Total Factor Productivity in Korea
and International Comparison

- Data Structure and Productivity Estimates of Korea Industrial Productivity Database

Hyunbae Chun[*], **Hak K. Pyo**[**] **and Keun Hee Rhee**[***]

May 2008

Abstract

The purpose of our study is to identify the sources of economic growth for the Republic of Korea, which experienced a financial crisis in 1997 after joining OECD. We report estimates of output, input, and productivity based on the newly constructed Korea Industrial Productivity (KIP) database following EU KLEMS project guidelines. We find that Korea's catch-up process with industrial nations in its late industrialization has been predominantly input-led and manufacturing-based. However, since its financial crisis in December 1997, the sources of growth seem to have switched to productivity-growth based. But lower productivity in service industries seems to work against finding renewed sustainable growth path.

[*] Department of Economics, Sogang University, Seoul 121-742, Korea. Tel: +82-2-705-8515. Fax: +82-2-704-8599. E-mail: hchun@sogang.ac.kr.
[**] School of Economics, Seoul National University, Seoul 151-746, Korea. Tel: +82-2-880-6395. Fax: +82-2-886-4231. E-mail: pyohk@plaza.snu.ac.kr. Corresponding author.
[***] Korea Productivity Center, Seoul 110-751, Korea. Tel: +82-2-724-1054. Fax: +82-2-704-1050. E-mail: ghlee@kpc.or.kr.

1. Introduction

In recent years, especially since the 1997 financial crisis in the East Asian countries including Korea, considerable changes such as investment stagnation (Pyo and Ha, 2005) and changes in production input patterns have taken place. One of the most important changes is the demand for high productivity, which would compensate the recent slowdowns of growth rates in capital and labor inputs. As Krugman (1994), Lau and Kim (1994), and Young (1994) showed, the East Asian economic miracle may be summarized as 'input-led' growth. Korea is no exception in this respect of growth pattern.

However, both the stagnation in investment and the decrease in average working hours require a productivity surge for long-term growth in Korea. In addition, a sharp decrease in the fertility rate in Korea necessitates productivity increase in order to improve the present income level and facilitate the support of the large elderly population by the small numbers of working age adults. For these reasons, 'productivity-driven' growth is indispensable for Korea. According to Lewis (2004), the fast economic growth in Korea is the result of both large labor input and capital accumulation. He argues that the average working hours is 40 percent higher than that of the U.S., and almost a third of GDP has been allocated to investment, while GDP per capita in Korea is about half of the U.S. GDP per capita. The focus is changing from how much inputs are put into production to how efficiently those are organized.

The purpose of this paper is to explain the data structure of the Korea Industrial Productivity (KIP) database following the guideline of EU KLEMS project and to present preliminary estimates of multifactor productivity (MFP).[1] We use 72-industry classification following the EU KLEMS guideline for the future comparability with the European Union member states, the United States, and Japan.[2] Therefore, an analysis based on detailed industry classification gives us better views on productivity and growth, which is difficult to grasp in broader industrial classifications. Industries in an economy have

---

[1] The preliminary KIP database includes gross output and KLEMS variables for 72 industries from 1970 to 2005 and is available at http://www.kpc.or.kr/publicwork_stat/kip_sub1_e.asp. For the final release of the EU KLEMS database, the raw dataset of the KIP database is currently being compiled by the EU KELMS team.

[2] The U.S. data in the EU KLEMS database is constructed using BEA, BLS, and Jorgenson, Ho, and Stiroh (2005) datasets. Japanese data in the EU KLEMS is based on Japan Industry Productivity (JIP) database. See Fukao *et al*. (2007) for the details on the JIP database. Latest version (March 2008) of the EU KLEMS database is now available at http://www.euklems.net.

shown different productivity trends and growth patterns according to their characteristics of production, competition policies, and other economic and non-economic circumstances.

We perform value-added growth accounting for the market economy including 6 sectors using the KIP database for the period of 1980-2005.[3] For international comparison, we also use EU KELMS' growth accounting results for the European Union, the United States, and Japan. We find that Korea's catch-up process with industrial nations in its late industrialization has been predominantly input-led and manufacturing based as documented in Timmer (1999) and Pyo (2001). Economic growth rates had decreased from the 1980s to the 1990s, and further fell down after the financial crisis in December 1997. However, since the 1997 financial crisis the sources of growth seem to have switched to MFP-growth based. The productivity resurgence in the post-crisis period is highly concentrated in information and communication technology (ICT) and manufacturing industries. But lower productivity in service industries seems to work against finding renewed sustainable growth path.

This paper is organized as follows. Section 2 examines data structure including the methodology about measuring gross output, intermediate inputs, labor hours and composition, and capital input. Section 3 presents the value-added growth accounting results and compares the results of the the Korean market economy and 6 sectors with those in the EU, Japan, and the U.S. Section 4 examines structural changes in Korean economy after the 1997 financial crisis, in particular focusing on changes in sectoral contributions of MFP growth. Section 5 concludes the paper.

2. Data Structure

In this section we construct gross output and inputs of labor, capital, energy, materials, and purchased services (KLEMS) variables following Timmer *et al*. (2007a) (hereafter EU KLEMS Manual) from 1970 to 2005 for 72 industries. Industry names in 72-industry classification and the coverage of the dataset are

---

[3] For cross-country comparison the EU KLEMS database reports growth accounting tables based on value-added, but not based on gross output. Thus we conduct value-added growth accounting although both KIP and EU KLEMS database follows the KLEMS methodology. As documented in the productivity literature the separability assumption on real value-added production function is not usually guaranteed. See Berndt and Christensen (1973) and Denny and Fuss (1977) for the U.S. and Pyo and Ha (2007) for Korea.

available in Table A1 of Appendix.[4]

2.1 Gross Output and Intermediate Inputs

National Accounts by the Bank of Korea (available at the Bank of Korea website)[5] report annual series (1970-2005) of nominal gross outputs at basic prices, both nominal and real value-added at basic prices, nominal compensation of employees, and operating surplus at current prices of 78 industries including 34 manufacturing industries. Since some industries in this 78-industry classification do not match with our 72-industry classification, we use the Bank of Korea internal data that includes both nominal and real gross output series for 397 industries.[6] National Accounts (1987, 1994, 1999, 2004) also report annual series (1985-2002) of both nominal and real Make Tables (V-Tables) and real Use Tables (U-Tables).

In addition to nominal gross output and both nominal and real value-added, real gross output at basic prices and real intermediate inputs at purchaser's prices can be obtained from Use Tables. However, since Make Tables and Use Tables for the years 1970-1984 and 2003-2005 are unavailable, we use the 1985 tables for the period of 1970-1984 and 2002 for the period of 2003-2005. As the published Use Tables of National Accounts in Korea present the Domestic and Import Use Tables combined, we have not been able to isolate them into two separate tables. In the case of Use Tables before 1995, all the intermediate commodity inputs by industry are measured at purchaser's prices. Since 1995, those inputs have been measured at incomplete basic prices in the sense that those inputs include trade and transportation margins but isolate net production tax to the last row of intermediate input matrix. Because we have no information for transformation of the Use Tables from purchaser's prices to basic prices before 1995 and the Use Tables after 1995 have been measured at incomplete basic prices, we have changed the Use Tables at basic price after 1995 into Use Tables at purchaser's price allocating net

---

[4] Industries 6, 33, 39, 56, and 72 are not (separately) available for the whole sample period of 1970-2005 and industries 5, 36, 54, and 55 are (separately) available only for the periods of 2004-2005, 1976-2005, 1976-2005, and 1986-2000, respectively.

[5] National Accounts are available at the Economic Data System of Bank of Korea (http://ecos.bok.or.kr).

[6] For the breakdown of these industries except for transportation industries (48-51) has been made using weights obtained from the IO tables of Korea. We also have used information in the Report on the Transport Survey published by Korea National Statistical Office (NSO).

production tax to each commodity proportional to each volume.

In order to decompose intermediate inputs into energy, materials, and services inputs, we have identified coal and lignite, crude petroleum and natural gas, uranium and thorium ores, metal ores, coke, refined petroleum products and nuclear fuel, gas, water, and electricity commodities as energy inputs, both primary commodities and remaining manufacturing commodities as material inputs, and remaining service inputs as service inputs.

2.2 Labor Input

In order to measure labor input for KLEMS model, we have to obtain both the quantity data of labor input such as employment and hours worked and quality factors such as sex, education, and age. To obtain employment numbers for the period of 1970-2005, we used Economically Active Population (EAP) Yearbook by National Statistical Office that reports the number of employment, unemployment, not-economically-active population and economically active population. Report on Monthly Labor Survey by Ministry of Labor publishes monthly earnings and working days of regular employees. Survey Report on Wage Structure by the same ministry reports wages. Nominal wages are also available from this survey.

Since EAP does not provide detailed industry-level data, we have used other sources for breaking down the labor data. For the breakdown of employment numbers into 72 industries we used the Survey Report on Wage Structure that contains detailed industry data at the 3-digit level except for 1971-1974 (4-digit level) and 2001-2005 (2-digit level). There were breaks between 1970-1992 and 1993-2005 periods due to industry reclassification. To correct breaks in the manufacturing sector, we used Mining and Manufacturing Census and Survey. To correct discontinuity in the service sector, we used Employment Table that was published as a supporting table to Input-Output Table.

Following the suggestion by the EU KELMS Manual and Jorgenson, Gallop, and Fraumeni (1987), we use two types of gender (male and female), three types of age (below 30, 30-49, and 50 or above), and three types of education (middle school or below, high school, college or above) and, therefore, there is in total 18 categories of labor. After calculating share in the 18-categories each year and each industry, we

took average share of 1970-1976 as benchmark share for 1970, the average share of 1977-1985 for 1977, and the average share of 1986-1992 for 1986. Then we interpolated the shares for years in the three periods, (1971-1976), (1978-1985), and (1987-1992). In contrast to the earlier period, the data for 1993-2005 shows stability, thus we stopped using interpolation for that period. We constructed this labor composition for 15 industries (including 6 manufacturing industries) with assumption of the composition at the lower level industry same as that at the higher level.

2.3 Capital Input

The success of late industrialization by newly industrializing economies could not have been made possible if both the rapid accumulation of capital and its changing distribution among sectors were not realized in their development process. However, it is difficult to identify these factors empirically because the time series data of capital stocks in fast-developing economies by both types of assets and by industries are not readily available. The lack of investment data for a sufficiently long period of time to apply the perpetual inventory estimation method was the main cause of the problem.

However, the National Statistical Office of the Republic of Korea has conducted economy-wide national wealth survey four times since 1968. Korea is one of a few countries which have conducted economy-wide national wealth surveys at a regular interval. Since the first National Wealth Survey (NWS) was conducted in 1968, the subsequent surveys were made in every ten years in 1977, 1987, and 1997, respectively. Since such regular surveys with economy-wide coverage are very rare in both developed and developing countries, an analysis on the dynamic profile of national wealth seems warranted to examine how national wealth in a fast growing economy is accumulated and distributed among different sectors.

The estimation of national wealth by types of assets and by industries was made by Pyo (2003) by modified perpetual inventory method and polynomial benchmark year estimation method using four

benchmark-year estimates. We have extended his estimates to the year 2005.[7] Since the database of Pyo (2003) covers 10 broad categories of industrial sector together with 28 sub-sectors of Manufacturing, it has been reclassified and reconciled with 72-industry classification using other sources such as Mining & Manufacturing Census and Surveys, Wholesale and Retail Surveys, and so on. We have classified assets into five categories[8]; residential building (1), non-residential building (2), infrastructure (3), transportation equipment (4), and machinery (5+6+7), while excluding large animals & plants, household durables, and inventory stocks. Estimated depreciation rates for each asset and by period are shown in Pyo (2003). Since Software (9) and Other intangibles (10) are not included in the NWS, we estimated the stock of software and intangibles using gross fixed capital formation in the National Accounts. Following the EU KELMS manual, we use 31.5% depreciation rates for both software and other intangibles.

3. International Comparison

3.1 MFP Growth in the Market Economy

As suggested in the EU KLEMS Manual, we focus on the market economy for international comparison of output and MFP growth. The market economy excludes the following non-market services industries: Imputation of owner occupied rents (56), Other real estate activities (57), Public admin and defense and compulsory social security (63), Education (64), and Health and social work (65).[9] The market economy consists of one ICT (information and communication technology)-producing sector , two goods-producing, and three services-producing sectors: Electrical machinery and post & communication services (26-33, 52), Manufacturing excluding electrical machinery (9-25, 34-39), Other goods producing industries (1-8, 40-43), Distribution Services (44-46, 48-51), Finance and business services excluding real estate (53-55, 58-62), and Personal and social services (47, 66-71).

We define multifactor productivity (MFP) growth as

---

[7] In contrast EU KLEMS is currently constructing the capital stock using the perpetual inventory method for the whole sample period of 1970-2005 and also uses depreciation rates provided by the EU KLEMS manual.
[8] Numbers in parentheses are EU KELMS' asset classification codes.
[9] Numbers in parentheses are EU KELMS' 72-industry classification codes. See Table A1 in Appendix.

$$\Delta \ln MFP_{it} = \Delta \ln V_{it} - \sum_{X=L,K} \bar{v}_{X,t} \Delta \ln X_{it}$$

where V, L, K are real value-added, labor, and capital inputs, respectively, $\bar{v}_{X,t} = 0.5(v_{X,t} + v_{X,t-1})$, and

$\sum_{X=L,K} v_{X,t} = 1$. Labor services are further decomposed into hours and compositional change. Regarding

the shares of inputs, we have used compensation of employees as shares of labor inputs and remaining

value-added as shares of capital inputs.

3.2 Cross-County Analysis

For cross-country comparison we examine the EU-15 (excluding 5 countries),[10] Japan, the U.S., and

Korea. The latest EU KLEMS dataset (available at http://www.euklems.net) covers up to 2005 (March

2008 version). Following the EU KLEMS growth accounting framework, we compare two periods of

1980-1995 and 1995-2005. Following Timmer, O'Mahony, and van Ark (2007c), we divided the sample

period into 1980-1995 and 1995-2005 because some countries such as the United States exhibits faster

productivity growth after 1995 but many European countries not.[11] Growth accounting format and results

for the EU, Japan, and the U.S. are the same as those reported in Timmer, O'Mahony, and van Ark

(2007c).

[Figure 1 about here]

There was a break in output growth in Korea's economy-wide economic performance only in the

year 1998 after the financial crisis in December 1997, which is shown in Figure 1. Even during the years

of first oil crisis of 1974-1975 and the second oil crisis of 1980-1981, the Korean economy's real output

---

[10] European Union-15 includes 15 old member countries (AUT, BEL, DNK, FIN, FRA, GER, GRC, IRL, ITA, LUX, NLD, ESP, PRT, SWE, UK). Five excluded countries are GRC, IRL, LUX, PRT, and SWE.
[11] Acceleration in productivity growth in the U.S. after 1995 is well documented in Jorgenson and Stiroh (2000). Using 2-digit level US industry data, Stiroh (2002) also links this productivity acceleration to the use of information technologies.

continued to grow without major setbacks (not shown in Figure 1). After the economic crisis in December 1997, Korean economy had to go through IMF-mandated adjustment and restructuring program as documented in Pyo (2004). Thus, we provide two periods of 1995-2005 with/without 1998-1999 period only for Korea.

[Table 1 and Figure 2 about here]

Table 1 and Figure 2 show that market economy real value-added, inputs, and MFP growth of the EU, Japan, the U.S., and Korea for two periods of 1980-1995 and 1995-2005. During the period of 1980-1995, the value-added or GDP growth rate of the Korean market economy is 9.5% that is about two to four times higher rate than those of the other three. During the same period in Korea, the contribution of capital input to GDP growth reaches about 58% while labor and MFP contributions are about 23% and 19%, respectively. The pattern of economic growth in the Korean market economy can be characterized as input-led growth. Especially capital input is a major contributor to faster GDP growth in Korea for the period of 1980-1995 (before the 1997 financial crisis). In contrast the other three countries exhibit lower GDP growth in 1980-1995 than does Korea, but their MFP contributions to GDP growth are higher and vary from 23% to 48%.

MFP growth rate decelerated in the EU and Japan from 1980-1995 to 1995-2005. But, during the same period MFP growth rates in the U.S. significantly accelerated from 0.7% to 1.7%. During the same period excluding 1998, MFP growth rate in Korea decelerated from 1.8% to 1.2% (excluding 1998-1999). However, the pattern of MFP deceleration in Korea is quite different from that of the EU whose value-added growth rate rather accelerated. GDP growth rate in Korea is also significantly lower over the 1995-2005 period compared to the pervious period. However, this slowdown in GDP growth is not due to lowered productivity growth. The contribution of MFP to value-added growth in the Korean market

economy slightly increased from 19% over 1980-1995 to 25% over 1995-2005.[12] Slowdown in Korean economic growth during the recent ten years is mainly due to the slowdown in input growth, especially in labor hours and capital input, but not in MFP growth. This change in contributions of inputs and MFP growths can be attributed to restructuring in the Korean economy after the 1997 financial crisis or other factors.

[Table 2 and Figure 3 about here]

Table 2 shows growth accounting results at the sectoral level. Figure 3 also shows sectoral contribution to market economy value-added and MFP growth. Sectoral composition of Korea contrasts with those of the other three. In particular, the share of two good-producing sectors (excluding the ICT sector) in Korea is the highest among the four and decreased from 55% in 1980-1995 to 48% in 1995-2005. The value-added share of the electrical machinery and post and communication services sector (ICT sector) in the market economy is also highest among the four. Especially, the contribution of two good-producing and ICT sectors to the output growth in the Korean market economy is about 61% in 1980-1995 and increased to 68% in 1995-2005, which are significantly higher than those (about 30-50%) in the other countries.

Productivity growth rate in the electrical machinery and post and communication services sector is known to be very high. Panel B of Figure 3 shows that the contribution of this sector to the market economy MFP growth is relatively higher in Korea than in the others because both the sectoral share and MFP growth are relatively high in Korea. In addition, MFP growth in the manufacturing sector excluding ICT industries also exhibits relatively higher rate in Korea than in the other three. In Korea, the manufacturing sector contributes about half of the market economy GDP growth and moreover, does most of the market economy MFP growth. Sectoral MFP contributions are highly concentrated in Korea

---

[12] Although we exclude the 1998-1999 period, MFP contribution to market economy value-added growth changes little.

10

and Japan (especially 1995-2005 for Japan) while sectoral MFP contributions are more evenly distributed in the U.S.

4. Structural Changes in Korea after the 1997 Financial Crisis

After the financial crisis of December 1997, the Korean economy had to go through IMF-mandated adjustment and restructuring program as documented in Pyo (2004). During ten years after the crisis the Korean economy has experienced structural changes. In this section we examine this structural change through focusing on changes in sectoral contributions to aggregate productivity growth. Although the financial crisis occurred in 1997, its impact on economic growth was reflected in 1998 and 1999. Thus, we divide the sample period of 1980-2005 into three periods (1980-1990, 1990-1997, and 1999-2005) and exclude the period of the financial crisis (1998-1999). We also follow EU KLEMS' sectoral classification used in the pervious section.

[Table 3 about here]

Table 3 shows value-added growth accounting results for the Korean market economy for the three sub-periods. From 1980 to 2005, the contribution of labor input to output growth declined mainly due to fall in labor hours but not to compositional changes in labor input. The contribution of capital input also steadily declined since 1980, but more rapidly fell down after the 1997 crises. In particular the contribution of capital was on average very high as well as one of main sources for fast growth of the Korean economy until the crisis. However, the slowdown in investment after the crisis significantly lowered the market economy value-added growth. In contrast to slowdown in output and input growth since 1980, the contribution of MFP growth to output growth in the market economy is 2.1% in 1980-1990, 1.3% in 1990-1997, and 1.9% in 1999-2005 and shows a U-shaped pattern. MFP growth explains about 16.9% and 20.8% of output growth in the two subperiods before the crisis, but does up to 28.8% in

the post-crisis period. Overall, labor input growth accounts for 20% of value-added growth and its contribution also changes little, while capital input growth explains about 60% and 50% of value-added growth in pre- and post-crisis periods, respectively. In contrast, MFP growth explains about 20% of the market economy GDP growth before the crisis, but does almost 30% in the post-crisis period.

The revival in productivity growth in the post-crisis period can be attributed to IMF-mandated industrial restructuring (See Pyo and Ha, 2005).[13] Moreover, intensified competition due to globalization and diffusion of new information technologies can another sources of this resurgence. We will not investigate the underlying factor for the post crisis MFP growth resurgence, but will focus on changes in sectoral contribution to the post-crisis MFP growth resurgence.

[Table 4 and Figure 4 about here]

To assess sectoral shift in output and MFP growth after the 1997 crisis we begin with sectoral shifts away from service sectors (distribution, finance and business, personal and social services) toward good-producing and ICT sectors. Table 4 and Figure 4 show this change.[14] Value-added growth declined from 1980-1990 to 1990-1997 and further declined to the post-crisis period of 1999-2005. Lowered valued-added growth rate in ICT and good-producing sectors accounts for decline in the market economy value-added growth from 1980-1990 to 1990-1997. This suggests that after the 1997 crisis slowdown in the market economy value-added growth is not confined to a particular sector. All sectors except for the ICT sector exhibit slowdown in value-added growth rates after the crisis.

Table 4 shows the sectoral contribution to the market economy value-added or MFP growth. The contribution of the ICT sector to the market economy value-added growth has significantly grown since

---

[13] The role of productivity gain in Manufacturing in the catch-up process of Korea has been well-documented by Timmer (1999) and Pyo (2001).
[14] The share of manufacturing sector (measured by the value-added share in the Korean economy) increased from the 1970s and reached to the highest level in the 1980s. Then, the share of manufacturing sector slowly declined in the 1990s but rose again after the crisis. The service sector share steadily has increased since 1970. But, as shown in Table 4, the share of the other goods producing sector (especially, agriculture and mining industries) has rapidly declined since 1970.

1980, which explains about 13.2% of the market economy value-added growth in 1980-1990, 17.0% in 1990-1997, and 31.8% in 1999-2005. In contrast, the contribution of ICT, other goods producing, and distribution service sectors to the market economy value-added growth decreased since 1980. Finance and business services sector's contribution to the market economy value-added growth rose from the 1980s to the pre-crisis period, but fell again after the 1997 crisis. Overall the sectoral contribution to the market economy value-added growth after the crisis decreased for all sectors except for the ICT sector.

Contributions to resurgence in the market economy MFP growth resurgence after the crisis are highly concentrated in three sectors: ICT, manufacturing, and other good producing sectors. However, the channel of contribution to the market economy MFP growth is very different among the three sectors. Contribution of the manufacturing sector to the market economy MFP growth increased through its higher MFP growth rate while those of ICT and other goods producing do through changes in their sectoral shares. The two sectors of finance & business and personal & social services negatively contributed to the market economy MFP growth in the post-crisis period through lowered MFP growth well as expanded sectoral share.[15]

[Figure 5 about here]

Figure 5 shows 72-industry-level contributions to the market economy MFP growth before and after the 1997 crisis. Figure 5 is sorted by the difference between each industry's contribution to the market economy MFP growth in the pre- and post-crisis periods. In Panel A, contributions of ICT and manufacturing industries to the market economy MFP growth show that there has been industrial shift within the manufacturing sector away from light and low-tech industries to heavy and high-tech industries such as motor vehicles, basic metals, chemicals, and etc. This suggests that the post-crisis MFP growth resurgence might be resulted from more active innovations in these industries. In Panel B of non-

---

[15] These findings can suggest that sectoral growth in the service sector may not be related to its efficiency but rather to demand factors such higher demand for social services and outsourcing in business services in the manufacturing sector.

manufacturing industries (excluding ICT industries), only a few industries such as hotel and restaurants, construction, wholesale, and financial intermediation exhibit increased contributions to the market economy MFP growth from pre- to post-crisis periods. Except for these industries, Panel B confirms that the post-crisis slowdown in MFP growth prevails across industries within the non-manufacturing sector (including the service sector). Therefore, our findings through 72-idustry-level data are consistent with those in sectoral level analysis in the previous section. Structural changes after the crisis result in the productivity-driven growth across manufacturing and ICT industries. But this change is not observed in most service industries.

The relatively sluggish productivity gain in the service sector has been pointed out by IMF in their recent consultation with the Korean authorities as a bottleneck of sustainable growth for Korea. Inklaar, Timmer and van Ark (2006) also pointed out the slower productivity gain of service industries in Europe relative to those in the United States. According to Kim (2006), while the share of the service sector in Korean economy has increased sharply reaching 56% level of GDP and 65% of total employment in 2005, the service productivity is not only low in level terms compared to developed countries' levels but also lags behind in terms of growth rate. She also points out that Korea's inter-industry linkage effect between manufacturing and service is also only about half the size of to developed countries.

5. Conclusion

The purpose of this paper is to explain how the Korea Industrial Productivity (KIP) database has been constructed for estimating productivities by industry following the EU KLEMS industry classification and guideline and how we have estimated 72-industry MFP growth. We report value-added growth accounting for the market economy and 6 sectors and also perform international comparison of growth accounting results for Korea, the EU, the U.S., and Japan.

We find that lower MFP contribution to economic growth confirms input-led growth in the Korean economy. However, since its financial crisis in December 1997, GDP growth rates in the Korea economy

has declined, but the sources of growth seem to have switched to productivity-growth based. After the 1997 crisis there has been sectoral shift away from other goods producing (agriculture, mining, utility, and construction) toward manufacturing and service sectors. Moreover, difference in MFP growth between manufacturing and service sectors did not shrink but rather has expanded after the 1997 financial crisis. Therefore, post-crisis revival in productivity growth mainly attributed to strong productivity gains in ICT and manufacturing industries. Results also suggest that post-crisis productivity resurgence in ICT and manufacturing industries might be due to strong innovation activities and intensified competition associated with restructuring and globalization. Slowdown in service MFP can be associated with regulations and lack of competition.

Productivities in an economy are not identical across industries, and productivity differences are also observed when compared with other economies. For example, productivity growth in Korea after the 1990s are mainly attributed to strong productivity growth in ICT goods-producing industries such as semiconductors and telecommunication equipment and other manufacturing industries such as machinery, basic metal, and chemicals. International comparison of productivity among industries will demonstrate a relative productivity of each industry, illustrating whether the way goods and services are produced is relatively efficient or not and referring to the appropriate policies for improvement such as competition, restriction, R&D policies, and so on. Establishment of dataset with the same standards across countries for productivity measurement will facilitate these inter-industry and international comparisons, and contribute to better understanding of economic growth.

References

Berndt, Ernst R., and Laurits R. Christensen, "The Translog Function and the Substitution of Equipment, Structures, and Labor in U.S. Manufacturing, 1929-1968," *Journal of Econometrics*, 1(1), 1973, 81-114.

Denny, Michael, and Melvyn A. Fuss, "The Use of Approximation Analysis to Test for Separability and the Existence of Consistent Aggregates," *American Economic Review*, 67(3), 1977, 404-418.

Fukao, Kyoji, Sumio Hamagata, Tomohiko Inui, Keiko Ito, Hyeog Ug Kwon, Tatsuji Makino, Tsutomu Miyagawa, Yasuo Nakanishi, and Joji Tokui, "Estimation Procedures and TFP Analysis of the JIP Database 2006," RIETI Discussion Paper Series 07-E-003, June 2007.

Inklaar, Robert, Marcel P. Timmer, and Bart van Ark, "Mind the Gap!: International Comparisons of Productivity in Services and Goods Production," GGDC Research Memorandum GD-89, Groningen Growth and Development Centre, University of Groningen, 2006.

Jorgenson, Dale W., Frank M. Gallop, and Barbara M. Fraumeni, *Productivity and US Economic Growth*, Cambridge, MA: Harvard University Press, 1987.

Jorgenson, Dale W., Mun S. Ho, and Kevin J. Stiroh, *Productivity Volume 3: Information Technology and American Growth Resurgence*, Cambridge, MA: MIT Press, 2005.

Jorgenson, Dale W., and Kevin J. Stiroh, "Rising the Speed Limit: U.S. Economic Growth in the Information Age," *Brookings Papers on Economic Activity*, 1, 2000, 125-233.

Kim Hyunjeong, "The Shift to the Service Economy: Causes and Effects," Bank of Korea Institute, Working Paper 254, May 2006.

Krugman, Paul, "The Myth of Asia's Miracle," *Foreign affairs*, 73(6), November/December 1994.

Lau, Lawrence J., and Jong-Il Kim, "The Sources of Growth of East Asian Newly Industrialized Countries," *Journal of the Japanese and International Economies*, 8(3), 1994, 235-271.

Lewis, W. William, *The Power of Productivity: Wealth, Poverty, and the Threat to Global Stability*, Chicago: University of Chicago Press, 2004.

Pyo, Hak K, "Economic Growth in Korea (1911-1999): A Long-term Trend and Perspective", *Seoul Journal of Economics*, 14(1), 2001.

Pyo, Hak K., "Estimates of Capital Stocks by Industries and Types of Assets in Korea (1953-2000)," *Journal of Korean Economic Analysis*, 18(3), Panel for Korean Economic Analysis and Korea Institute of Finance, 2003.

Pyo, Hak K., "Interdependency in East Asia and the Post-Crisis Macroeconomic Adjustment in Korea," *Seoul Journal of Economics*, 17(1), Spring 2004.

Pyo, Hak K., and Bongchan Ha, "Productivity Convergence and Investment Stagnation in East Asia," presented at CIRJE seminar, University of Tokyo, Japan, July 21, 2005.

Pyo, Hak K., and Bongchan Ha, "A Test of Separability and Random Effects in Production Function with Decomposed IT Capital," *Hitotsubashi Journal of Economics*, 48(1), 2007, 67-82.

Stiroh, Kevin J., "Information Technology and the U.S. Productivity Revival: What Do the Industry Data Say?" *American Economic Review*, 92(5), 2002, 1559-1576.

Timmer, Marcel, "The Dynamics of Asian Manufacturing: A Comparative Perspective, 1963-1993,"` Eindhoven Centre for Innovation Studies, Dissertation Series, 1999.

Timmer, Marcel, Ton van Moergastel, Edwin Stuivenwold, Gerard Ypma, Mary O'Mahony, and Mari Kangasniemi, "EU KLEMS Growth and Productivity Accounts (Version 1.0, Part I Methodology),"

EU KLEMS Consortium, March 2007a.

Timmer, Marcel P., Mary O'Mahony, and Bart van Ark, "EU KLEMS Growth and Productivity Accounts: Overview," EU KLEMS Consortium, March 2007b.

Timmer, Marcel P., Mary O'Mahony, and Bart van Ark, "EU KLEMS Growth and Productivity Accounts: Overview November 2007 Release," EU KLEMS Consortium, November 2007c.

Young, Alwyn, "Lessons from the East Asian NICs: A Contrarian View," *European Economic Review Papers and Proceedings*, 38(3-4), 1994, 964-973.

Figure 1. Trend of Market Economy Real Value-Added and MFP in Korea, 1980-2005
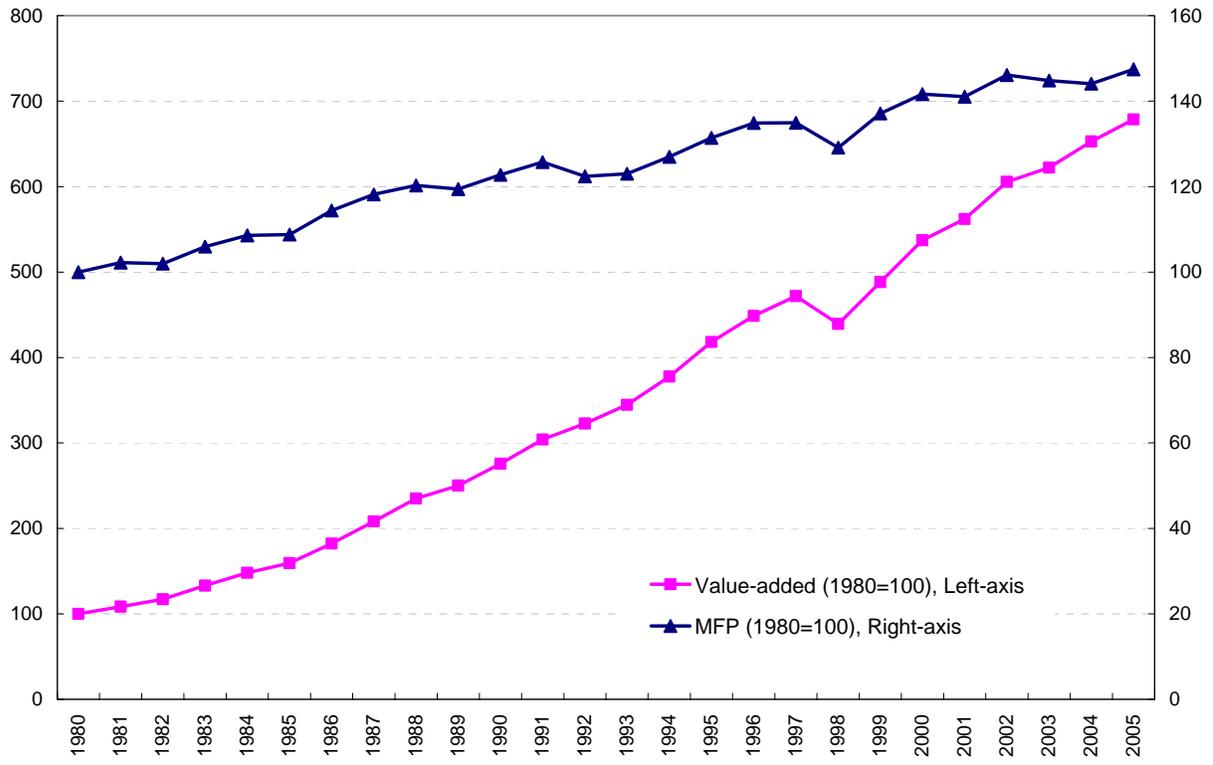
**Figure 2. Contributions to Market Economy Value-Added Growth:
1980-1995 and 1995-2005**
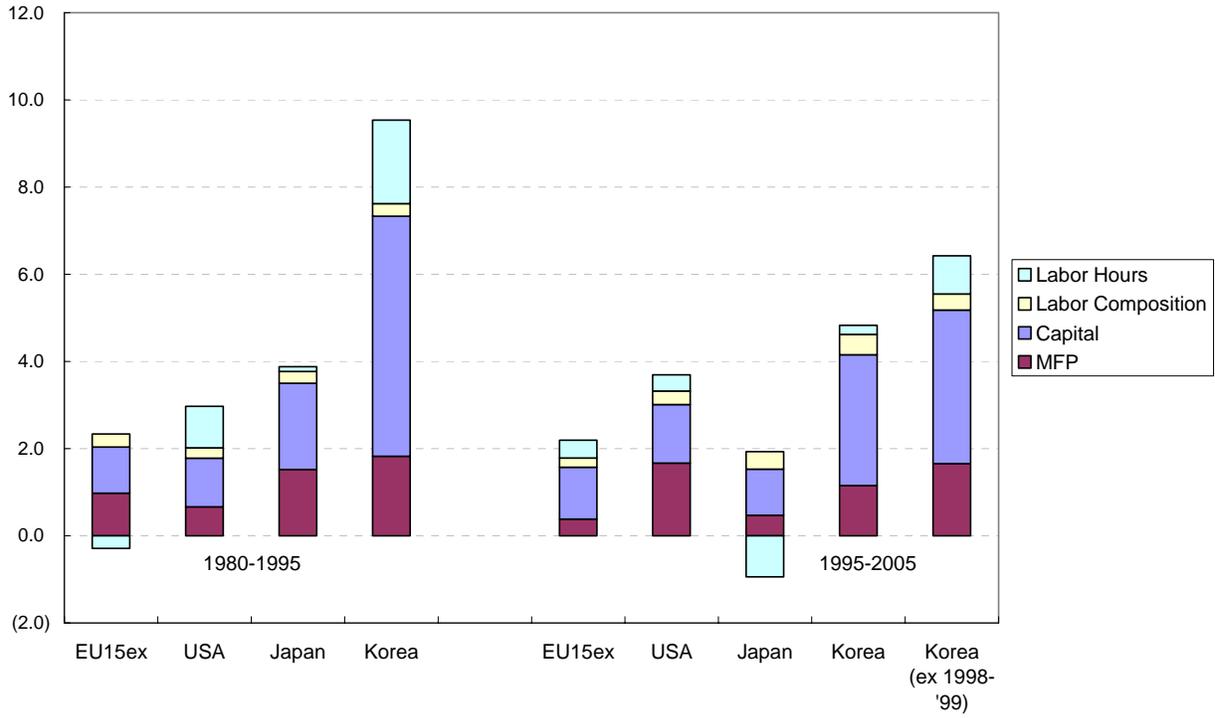
Figure 3. Sectoral Contributions to Market Economy Value-Added and MFP Growth, 1980-1995 and 1995-2005

Panel A. Sectoral Contributions to Market Economy Value-Added Growth
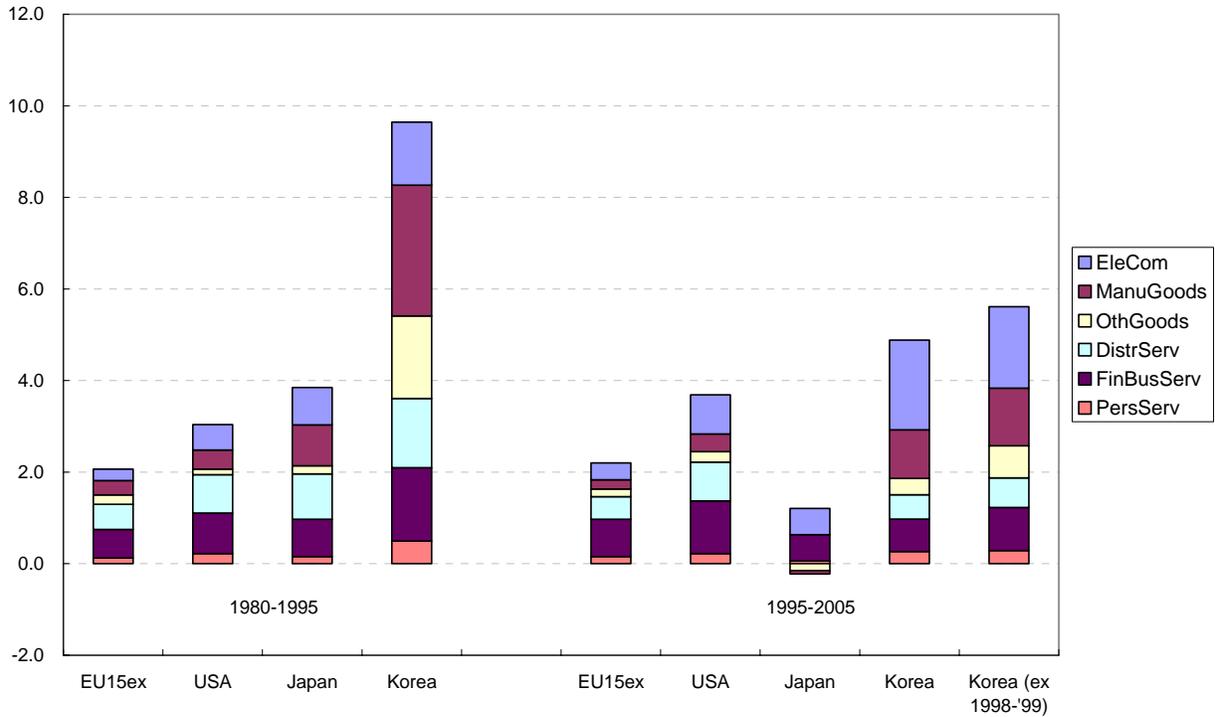
Panel B. Sectoral Contributions to Market Economy MFP Growth
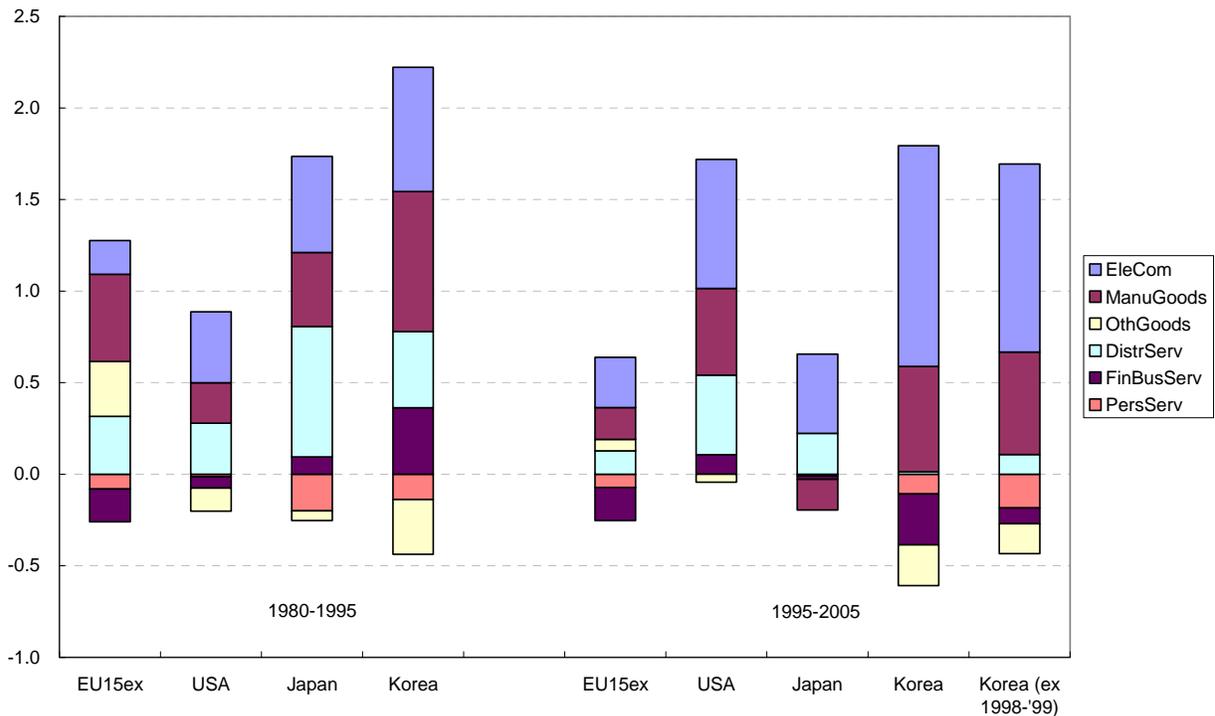
Figure 4. Structural Change in Korean: Sectoral Contributions to Market Economy Value-Added and MFP Growth

Panel A. Sectoral Contributions to Market Economy Value-Added Growth
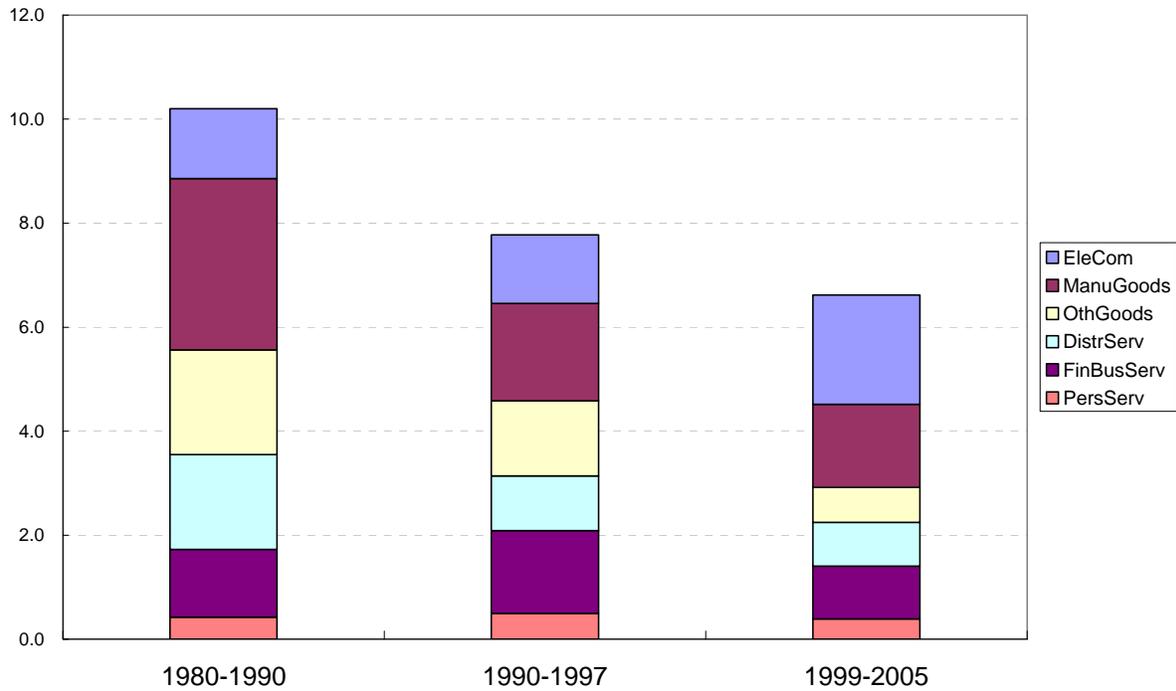
Panel B. Sectoral Contributions to Market Economy MFP Growth
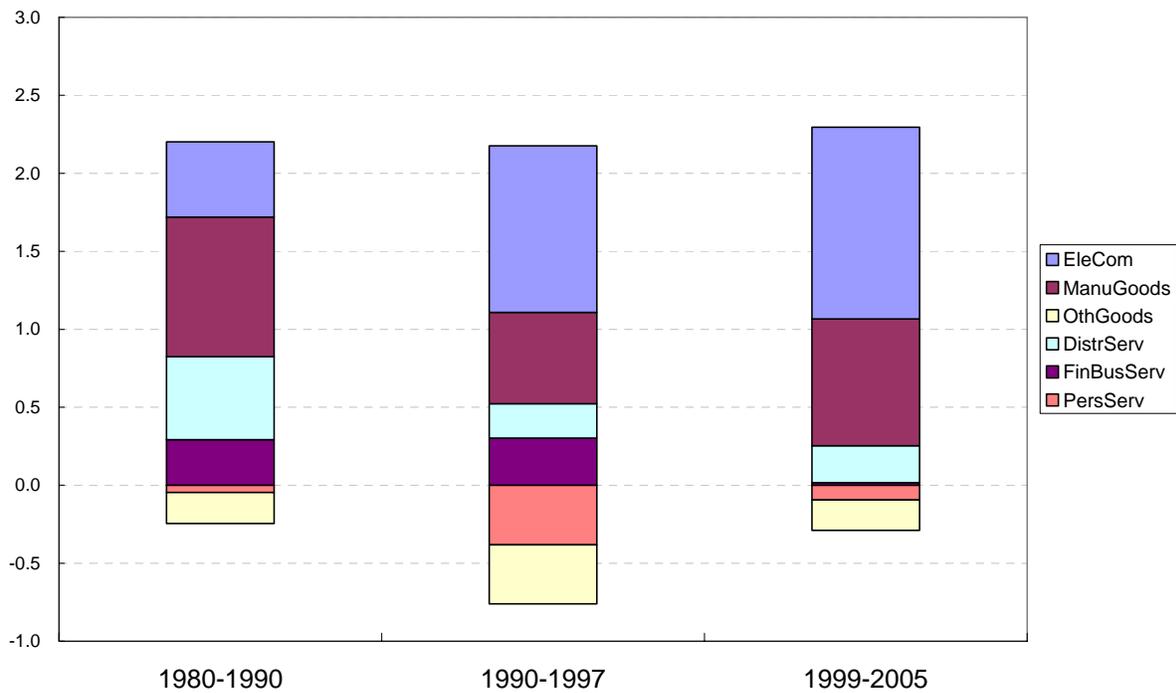
Figure 5. Contribution to MFP Growth in the Market Economy: ICT and MFG versus Non-MFG, Before and After the 1997 Financial Crisis

Panel A. ICT and MFG Industries
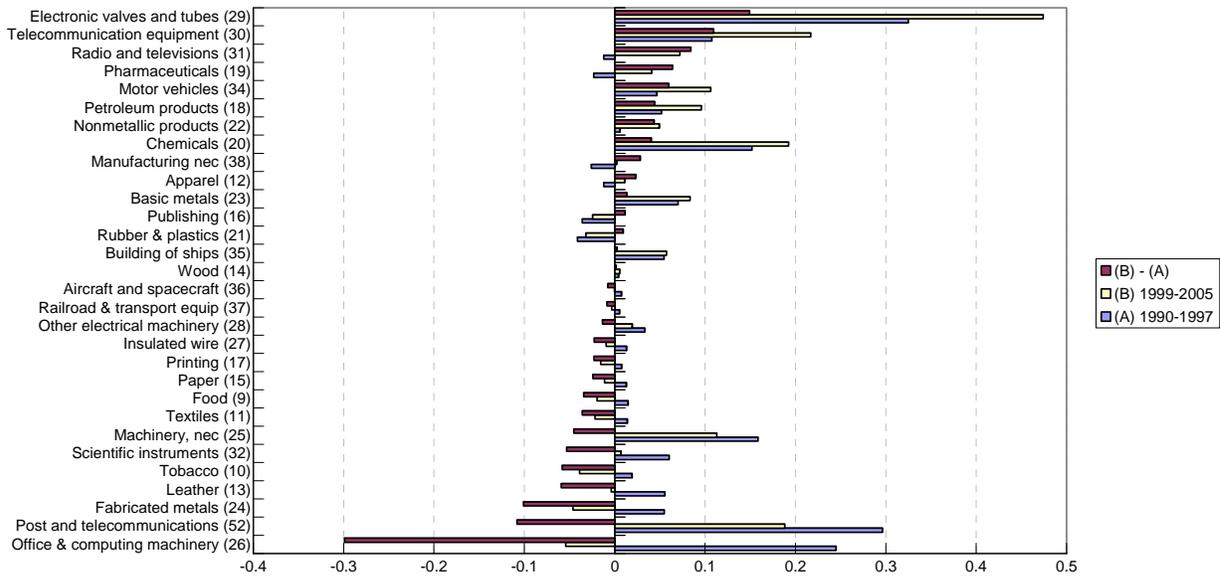
Panel B. Non-MFG Industries (Excluding ICT Industries)
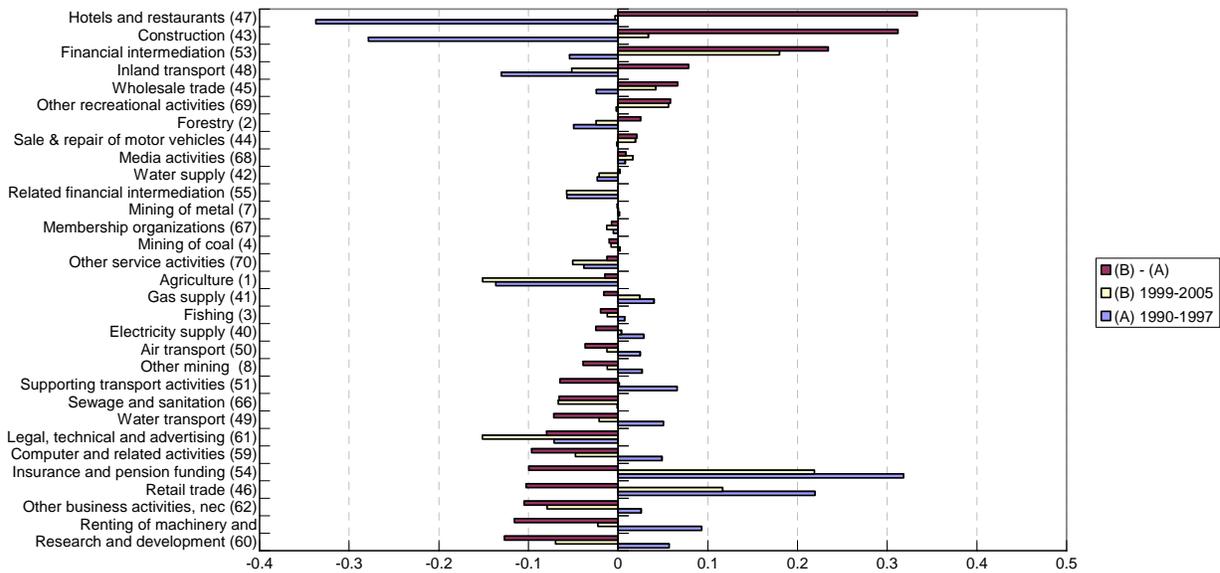
Notes: Data is sorted by the difference between sectoral contributions of 1991-1997 and 2000-2005 periods. Industries in Panel A includes Electrical machinery and post & communication services (26-33, 52) and Manufacturing excluding electrical machinery (9-25, 34-39), while industries in Panel B includes the other four sectors of Other goods producing industries (1-8, 40-43), Distribution Services (44-46, 48-51), Finance and business services (53-55, 58-62), and Personal and social services (47, 66-71)

Table 1. Market Economy Value-Added Growth and Contributions:
    1980-1995 and 1995-2005

	VA	L	*LH*	*LC*	K	MFP
	(1)=(2)+(5)+(6)	(2)=(3)+(4)	(3)	(4)	(5)	(6)
European Union (EU-15EX)						
1980-1995	2.1	0.0	-0.3	0.3	1.1	1.0
1995-2005	2.2	0.6	0.4	0.2	1.2	0.4
1995-2000	3.0	0.9	0.8	0.2	1.5	0.5
2000-2005	1.4	0.3	0.0	0.3	0.9	0.2
United States						
1980-1995	3.0	1.2	1.0	0.2	1.1	0.7
1995-2005	3.7	0.7	0.4	0.3	1.3	1.7
1995-2000	5.1	1.8	1.6	0.2	1.9	1.4
2000-2005	2.3	-0.5	-0.8	0.4	0.8	2.0
Japan						
1980-1995	3.9	0.4	0.1	0.3	2.0	1.5
1995-2005	1.0	-0.6	-0.9	0.4	1.1	0.5
1995-2000	1.0	-0.4	-0.9	0.4	1.1	0.4
2000-2005	1.0	-0.7	-1.0	0.4	1.1	0.6
Korea						
1980-1995	9.5	2.2	1.9	0.3	5.5	1.8
1995-2005	4.8	0.7	0.2	0.5	3.0	1.2
1995-2005 (excl. 1998-'99)	6.4	1.2	0.9	0.4	3.5	1.7
1995-2000	5.0	0.2	-0.2	0.4	3.3	1.5
1995-2000 (excl. 1998-'99)	7.9	1.1	0.8	0.3	4.4	2.3
2000-2005	4.7	1.1	0.6	0.5	2.7	0.8

Notes: European Union: 15 old member states (AUT, BEL, DNK, FIN, FRA, GER, GRC, IRL, ITA, LUX, NLD, ESP, PRT, SWE, UK). Five excluded countries are GRC, IRL, LUX, PRT, and SWE.

VA = Value-added growth rate (%)
L = Contribution of labor input
LH = Contribution of labor hours
LC = Contribution of labor composition
K = Contribution of capital input
MFP = Contribution of multifactor productivity growth = (1)-(2)-(5)

Among 72 industries (See Table A1 in Appendix for the industry classification of EU KLEMS), the market economy excludes the following five industries: Imputation of owner occupied rents (56), Other real estate activities (57), Public admin and defense and compulsory social security (63), Education (64), and Health and social work (65).

Table 2. Value-Added Growth and Contributions:
Six Sectors in the Market Economy, 1980-1995 and 1995-2005

Panel A. EU-15 (excl. Greece, Ireland, Luxemburg, Portugal, and Sweden)

	VA	L	*LH*	*LC*	K	MFP	VA weight
	(1)=(2)+(5)+(6)	(2)=(3)+(4)	(3)	(4)	(5)	(6)	
1980-1995							
Market Economy	2.1	0.0	-0.3	0.3	1.1	1.0	100
Electrical mach & comm services	3.6	-0.6	-0.9	0.3	1.6	2.6	7.1
Manufacturing excl. electrical	1.1	-1.2	-1.5	0.3	0.7	1.7	28.0
Other goods producing industries	1.1	-1.1	-1.4	0.2	0.7	1.6	18.7
Distribution services	2.6	0.3	0.1	0.2	0.8	1.5	21.1
Finance and business services	3.5	2.4	1.9	0.4	2.1	-1.0	17.8
Personal and social services	1.7	1.8	1.5	0.3	0.9	-1.1	7.4
1995-2005							
Market Economy	2.2	0.6	0.4	0.2	1.2	0.4	100
Electrical mach & comm services	5.5	-0.4	-0.6	0.2	1.7	4.1	6.7
Manufacturing excl. electrical	0.8	-0.4	-0.7	0.3	0.6	0.7	24.8
Other goods producing industries	1.1	0.0	-0.1	0.2	0.7	0.4	15.5
Distribution services	2.3	0.6	0.5	0.1	1.1	0.6	21.3
Finance and business services	3.6	2.2	1.9	0.3	2.2	-0.8	22.7
Personal and social services	1.7	1.5	1.4	0.1	1.0	-0.8	9.0

Panel B. United States

	VA	L	*LH*	*LC*	K	MFP	VA weight
	(1)=(2)+(5)+(7)	(2)=(3)+(4)	(3)	(4)	(5)	(6)	
1980-1995							
Market Economy	3.0	1.2	1.0	0.2	1.1	0.7	100
Electrical mach & comm services	6.6	0.1	-0.3	0.4	1.9	4.6	8.4
Manufacturing excl. electrical	1.7	0.1	-0.2	0.3	0.6	0.9	24.6
Other goods producing industries	0.7	0.7	0.4	0.3	0.7	-0.7	18.0
Distribution services	3.9	1.3	1.2	0.2	1.2	1.3	21.4
Finance and business services	4.4	2.9	2.7	0.2	1.8	-0.3	20.2
Personal and social services	2.9	2.5	2.5	0.1	0.5	-0.2	7.5
1995-2005							
Market Economy	3.7	0.7	0.4	0.3	1.3	1.7	100
Electrical mach & comm services	10.5	-0.4	-0.8	0.5	2.2	8.7	8.1
Manufacturing excl. electrical	1.8	-1.0	-1.4	0.3	0.6	2.2	21.5
Other goods producing industries	1.6	1.1	1.0	0.1	0.8	-0.3	14.4
Distribution services	4.1	0.6	0.3	0.3	1.5	2.1	20.7
Finance and business services	4.3	1.9	1.5	0.4	1.9	0.4	26.7
Personal and social services	2.6	1.7	1.4	0.3	0.9	0.0	8.5

[Table 2 Continued]

Panel C. Japan

	VA	L	*LH*	*LC*	K	MFP	VA weight
	(1)=(2)+(5)+(6)	(2)=(3)+(4)	(3)	(4)	(5)	(6)	
1980-1995							
Market Economy	3.9	0.4	0.1	0.3	2.0	1.5	100
Electrical mach & comm services	11.0	0.5	0.3	0.1	3.4	7.1	7.4
Manufacturing excl. electrical	3.1	-0.2	-0.4	0.2	2.0	1.4	28.8
Other goods producing industries	1.0	0.0	-0.3	0.3	1.3	-0.3	18.0
Distribution services	4.3	0.1	-0.1	0.2	1.0	3.1	23.0
Finance and business services	6.1	1.9	1.5	0.4	3.6	0.7	13.4
Personal and social services	1.6	1.4	0.8	0.5	2.3	-2.1	9.5
1995-2005							
Market Economy	1.0	-0.5	-0.9	0.4	1.1	0.5	100
Electrical mach & comm services	7.2	-0.8	-1.1	0.4	2.5	5.4	8.0
Manufacturing excl. electrical	-0.3	-0.9	-1.2	0.3	1.2	-0.7	24.0
Other goods producing industries	-1.0	-1.3	-1.7	0.4	0.3	0.0	15.2
Distribution services	0.0	-1.1	-1.5	0.4	0.3	0.9	24.8
Finance and business services	3.2	1.1	0.6	0.5	2.2	-0.1	17.8
Personal and social services	0.6	0.1	-0.4	0.4	0.6	-0.1	10.1

[Table 2 Continued]

Panel D. Korea

	VA	L	*LH*	*LC*	K	MFP	VA weight
	(1)=(2)+(5)+(6)	(2)=(3)+(4)	(3)	(4)	(5)	(6)	
1980-1995							
Market Economy	9.5	2.2	1.9	0.3	5.5	1.8	100
Electrical mach & comm services	16.9	2.2	1.7	0.5	6.4	8.3	8.2
Manufacturing excl. electrical	10.2	2.3	1.7	0.6	5.2	2.7	27.8
Other goods producing industries	6.6	1.1	1.1	0.1	6.6	-1.1	27.4
Distribution services	8.0	1.6	1.4	0.1	4.3	2.2	18.7
Finance and business services	13.7	6.2	6.0	0.2	4.5	3.1	11.7
Personal and social services	7.9	2.9	2.3	0.5	7.3	-2.2	6.2
1995-2005							
Market Economy	4.8	0.7	0.2	0.5	3.0	1.2	100
Electrical mach & comm services	15.9	1.2	0.7	0.4	5.0	9.7	12.4
Manufacturing excl. electrical	4.1	-0.4	-0.9	0.5	2.3	2.2	26.2
Other goods producing industries	1.6	-0.2	-0.6	0.4	2.9	-1.0	21.6
Distribution services	3.4	0.6	0.1	0.5	2.7	0.1	15.7
Finance and business services	4.2	2.6	2.0	0.6	3.3	-1.7	16.8
Personal and social services	3.7	2.8	2.4	0.4	2.1	-1.5	7.2
1995-2005 (excluding 1998-1999)							
Market Economy	5.6	1.1	0.7	0.4	3.3	1.2	100
Electrical mach & comm services	14.2	0.7	0.3	0.4	5.3	8.2	12.5
Manufacturing excl. electrical	4.8	0.0	-0.5	0.4	2.7	2.1	26.2
Other goods producing industries	3.3	1.0	0.6	0.4	3.1	-0.8	21.3
Distribution services	4.1	0.4	-0.2	0.6	3.0	0.7	15.7
Finance and business services	5.5	2.7	2.4	0.3	3.4	-0.5	17.0
Personal and social services	4.0	3.8	3.5	0.3	2.5	-2.5	7.3

Notes: European Union: 15 old member states (AUT, BEL, DNK, FIN, FRA, GER, GRC, IRL, ITA, LUX, NLD, ESP, PRT, SWE, UK). Five excluded countries are GRC, IRL, LUX, PRT, and SWE.

VA = Value-added growth rate (%)
L = Contribution of labor input
LH = Contribution of labor hours
LC = Contribution of labor composition
K = Contribution of capital input
MFP = Contribution of multifactor productivity growth = (1)-(2)-(5)

EU KLEMS Sector Classification (See Table A1 in Appendix)
Among 72 industries, the market economy excludes the following five industries: Imputation of owner occupied rents (56), Other real estate activities (57), Public admin and defense and compulsory social security (63), Education (64), and Health and social work (65).

Electrical machinery and post & communication services (26-33, 52)
Manufacturing excluding electrical machinery (9-25, 34-39)
Other goods producing industries (1-8, 40-43)
Distribution Services (44-46, 48-51)
Finance and business services (53-55, 58-62)
Personal and social services (47, 66-71)

Table 3. Structural Changes in Korea: Before and After the 1997 Financial Crisis

	VA	L	*LH*	*LC*	K	MFP	VA weight
	(1)=(2)+(5)+(6)	(2)=(3)+(4)	(3)	(4)	(5)	(6)	
1980-1990							
Market Economy	10.1	2.1	1.8	0.3	6.0	2.1	100.0
Electrical mach & comm services	17.2	3.0	2.5	0.5	7.9	6.2	7.8
Manufacturing excl. electrical	11.6	2.8	2.2	0.6	5.6	3.1	28.4
Other goods producing industries	7.1	0.8	0.6	0.1	7.1	-0.7	28.4
Distribution services	8.8	1.5	1.3	0.2	4.7	2.6	20.7
Finance and business services	14.0	6.0	5.8	0.2	4.9	3.1	9.3
Personal and social services	7.7	1.6	0.9	0.7	7.0	-0.8	5.5
1990-1997 (Before Crisis)							
Market Economy	7.7	1.8	1.6	0.3	4.5	1.3	100.0
Electrical mach & comm services	15.0	-0.4	-0.8	0.4	3.2	12.1	8.8
Manufacturing excl. electrical	6.9	0.4	-0.1	0.5	4.4	2.2	27.1
Other goods producing industries	5.5	1.5	1.4	0.1	5.4	-1.4	26.3
Distribution services	6.3	1.5	1.2	0.3	3.5	1.3	16.7
Finance and business services	11.2	5.5	5.5	0.1	3.5	2.1	14.2
Personal and social services	7.2	5.1	4.9	0.2	7.6	-5.5	6.9
1999-2005 (After Crisis)							
Market Economy	6.6	1.3	0.9	0.4	3.3	1.9	100
Electrical mach & comm services	17.1	2.0	1.6	0.3	5.0	10.0	12.3
Manufacturing excl. electrical	6.1	0.3	-0.2	0.4	2.8	3.1	26.2
Other goods producing industries	3.1	0.8	0.5	0.2	3.3	-0.9	21.7
Distribution services	5.3	0.7	0.3	0.5	3.1	1.5	15.8
Finance and business services	6.1	2.9	2.4	0.5	3.2	0.1	16.7
Personal and social services	5.4	3.7	3.5	0.2	2.9	-1.3	7.2

Table 4. Sectoral Contributions to Market Economy Value-Added and MFP Growth

	1980-1990		1990-1997		1999-2005	
Value-Added Growth						
Market Economy	10.1	(100)	7.7	(100)	6.6	(100)
Electrical mach & comm services	1.3	(13.2)	1.3	(17.0)	2.1	(31.8)
Manufacturing excl. electrical	3.3	(32.3)	1.9	(24.0)	1.6	(24.1)
Other goods producing industries	2.0	(19.8)	1.4	(18.6)	0.7	(10.2)
Distribution services	1.8	(17.9)	1.1	(13.5)	0.8	(12.7)
Finance and business services	1.3	(12.8)	1.6	(20.5)	1.0	(15.4)
Personal and social services	0.4	(4.2)	0.5	(6.4)	0.4	(5.9)
MFP Growth						
Market Economy	2.1	(100)	1.3	(100)	1.9	(100)
Electrical mach & comm services	0.5	(24.7)	1.1	(75.5)	1.2	(61.3)
Manufacturing excl. electrical	0.9	(45.7)	0.6	(41.3)	0.8	(40.5)
Other goods producing industries	-0.2	(-10.2)	-0.4	(-26.8)	-0.2	(-9.7)
Distribution services	0.5	(27.2)	0.2	(15.6)	0.2	(11.8)
Finance and business services	0.3	(14.9)	0.3	(21.4)	0.0	(0.8)
Personal and social services	0.0	(-2.3)	-0.4	(-27.0)	-0.1	(-4.7)

Note: Table 4 shows underlying data for Figure 4. Numbers in parentheses are sectoral contributions whose sum is normalized to 100%.

Appendix

Table A1. 72-Industry Classification and Coverage

Code	Industry Name	Note
	Agriculture and Mining (1-8)	
1	Agriculture	
2	Forestry	
3	Fishing	
4	Mining of coal and lignite; extraction of peat	
5	Extraction of crude petroleum and natural gas and services	2004-2005
6	Mining of uranium and thorium ores	N.A.
7	Mining of metal ores	
8	Other mining and quarrying	
	Manufacturing (9-39)	
9	Food products and beverages	
10	Tobacco products	
11	Textiles	
12	Wearing apparel, dressing and dying of fur	
13	Leather, leather products and footwear	
14	Wood and products of wood and cork	
15	Pulp, paper and paper products	
16	Publishing	
17	Printing and reproduction	
18	Coke, refined petroleum products and nuclear fuel	
19	Pharmaceuticals	
20	Chemicals excluding pharmaceuticals	
21	Rubber and plastics products	
22	Other non-metallic mineral products	
23	Basic metals	
24	Fabricated metal products	
25	Machinery, nec	
26	Office, accounting and computing machinery	
27	Insulated wire	
28	Other electrical machinery and apparatus nec	
29	Electronic valves and tubes	
30	Telecommunication equipment	
31	Radio and television receivers	
32	Scientific instruments	
33	Other instruments	
34	Motor vehicles, trailers and semi-trailers	
35	Building and repairing of ships and boats	
36	Aircraft and spacecraft	1976-2005
37	Railroad equipment and transport equipment nec	
38	Manufacturing nec	
39	Recycling	N.A.

[Table A.1 continued]

Code	Industry Name	Note
	Utilities and Construction (40-43)	
40	Electricity supply	
41	Gas supply	
42	Water supply	
43	Construction	
	Services (44-72)	
44	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	
45	Wholesale trade and commission trade, except of motor vehicles and motorcycles	
46	Retail trade, except of motor vehicles and motorcycles; repair of household goods	
47	Hotels and restaurants	
48	Inland transport	
49	Water transport	
50	Air transport	
51	Supporting and auxiliary transport activities; activities of travel agencies	
52	Post and telecommunications	
53	Financial intermediation, except insurance and pension funding	
54	Insurance and pension funding, except compulsory social security	1976-2005
55	Activities related to financial intermediation	1986-2005
56	Imputation of owner occupied rents	N.A. (Incl. in 57)
57	Real estate activities	
58	Renting of machinery and equipment	
59	Computer and related activities	
60	Research and development	
61	Legal, technical and advertising	
62	Other business activities, nec	
63	Public admin and defense; compulsory social security	
64	Education	
65	Health and social work	
66	Sewage and refuse disposal, sanitation and similar activities	
67	Activities of membership organizations nec	
68	Media activities	
69	Other recreational activities	
70	Other service activities	
71	Private households with employed persons	
72	Extra-territorial organizations and bodies	N.A.

Note: EU KLEMS Sector Classification
Electrical machinery and post & communication services (26-33, 52)
Manufacturing excluding electrical machinery (9-25, 34-39)
Other goods producing industries (1-8, 40-43)
Distribution Services (44-46, 48-51)
Finance and business services (53-55, 58-62)
Personal and social services (47, 66-71)
Non-market services (56-57, 63-65)