Technological Progress, Structural Change and Productivity Growth in Manufacturing Sector of South Korea

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Abstract: This paper focuses on the impact of technology and structural change on the aggregate productivity growth in the manufacturing sector of South Korea, using the eight firm size classes over the period 1970–2000. The conventional shift-share analysis is used to measure the impact of shift of both labour and capital inputs. The results show that structural change on an average was conducive to productivity growth during the 1970s and this pattern reversed afterwards. Small and medium industries were more dynamic in terms of reallocation of resources; however, the dominance of large-sized firms in the manufacturing sector outweighed the positive impact of that reallocation. Deliberate state policy favouring large-sized firms has impeded the restructuring process facilitated by technical progress, the penalty for which has been paid in terms of forgone growth.

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1   Introduction

The contribution of technological progress to modern economic growth and rising per capita income in the advanced countries is widely acclaimed and recognised. Long-run economic growth was sustained through continuous rise in productivity and entailed fundamental non-reversible structural changes. The production structure has grown mature and technologically sophisticated across and within sectors. The process of modern economic growth has recently been described as being driven on two paths

(Harberger, 1998): the 'mushroom-process' which is characterised by a spurt of economic activity in a particular sector or industry emerging from new innovations, which generates higher productivity growth and draws resources from relatively lesser productive activities; when the boom in productivity is widespread, it is termed as the 'yeast-process'. However, long-run economic growth is governed by a combination of the two processes. Despite the fact that the last three decades of the 20th century witnessed fast innovations and technological progress, yet the pace of economic growth in the advanced countries slowed down. Stimulus to global economic growth was provided by the East Asian countries, which emerged as the new growth pole of the world economy.

South Korea among the East Asian countries is an outstanding example. It has successfully transformed its economy from low-income to middle-income level and its production structure entails substantial technological sophistication. Industrialisation began in Korea in response to new opportunities created through the nature of technological change on the one hand and export demand generated by low cost production on the other. A flexible manufacturing system, which is also described as fragmentation of production (Jones, 2001), and revolution in information technology not only reduced the scale of production but also lowered the comparative disadvantage for the small and medium industries to operate at the global level.

Korea's industrial sector witnessed substantial non-reversible structural changes during the phase of technological catching-up and learning. The sector responded to the changes in the optimal industrial structure, which is required for maintaining international competitiveness. Thus, it is important to investigate how changes in the structure of the industrial sector generated additional growth advantage through shifting scarce resources from less productive manufacturing firm sizes to more productive firm sizes. This question is crucial to policy makers, because the slow movement towards optimal structure costs in terms of foregone growth will be higher and then the consequences for long-term growth will be alarming.

The purpose of this paper is to measure and analyse the impact of technological progress and changes in the industrial structure on the productivity growth of the manufacturing sector of the Republic of Korea. The paper is organised in five sections including the introduction. The second section reviews the theory of structural change, empirical evidence and underlying explanations. Methodology and database are described in the third section. Empirical evidence on productivity, employment and structural shift-share analysis is provided in section four. Conclusions and policy implications are provided in the fifth section.

2   Theoretical and empirical overview of literature

Long-term economic growth and dynamics in the structure of economic systems have remained the central concern of the economic profession and its roots can be traced to the classical economic literature. Prominent classical economists like Smith, Ricardo and Marx outlined the perennial and fundamental importance of structural dynamics in development theory. However, when it came to formal (logical) economic theorising, the constancy of the economic structure was assumed away (Smith, 1776; Ricardo, 1817; Marx, 1867). Therefore, dynamic structural analysis could not find any space in classical economic theory. With the rise of the marginal revolution, structural dynamics in

economic theory was relegated to the background. Modern theory of economic growth, which emerged after World War II, essentially recaptured the fundamental concerns of the classical theory and successfully developed analytical models of long-term economic growth (Domar, 1946; Harrod, 1949). However, Harrod-Domar and subsequent formal long-run economic growth theorists also failed to incorporate structural change hypothesis into their logical scheme. Even the endogenous growth theorists, who recently flooded economic journals and reinvigorated interest in long-term economic theorising, are no exception to this rule (Passinetti, 1993).

The relationship between economic growth and structural transformation, however, remained the concern of development economics, which essentially is regarded as an appreciative theory (Fagerberg and Bart, 2002). Schumpeter emphasised the relevance of technical innovations, which opens up entirely new possibilities for long-run changes in economic growth and economic structure (Schumpeter, 1934). Numerous other economists have underlined the importance of structural transformation for economic growth while theorising on the situation of the developing economies such as 'big push' (Rodan, 1943), 'unbalanced growth' (Streeten, 1959), 'dual economies' (Lewis, 1954; Nurkse, 1953) and 'stages of economic growth' (Rostow, 1960). It is worthwhile to mention here that the massive empirical tradition to examine the process of structural transformation that emerged was inspired by the work of Clark (1940). Subsequently, global institutions, such as the United Nations and the World Bank spearheaded this work. Prominent scholars in this tradition are Simon Kuznets and Hollis Chenery. Kuznets (1966), after carefully analysing cross-country data, concluded that the high rates of economic growth underlined substantial structural changes in economic structure apart from reporting other economic regularities.

Changes in the industrial structure and its relation to economic growth have been the major concern of empirical studies conducted by Hoffman (1958) and Chenery *et al*. (1986). It has been argued that the transformation of the industrial structure from consumer goods to capital goods entailed higher capital, which resulted in higher productivity growth at the aggregative level. Furthermore, evolution of a demand-led industrial structure involves technological sophistication and upgradation, which are supposed to generate a premium for aggregate productivity growth in the manufacturing sector (Chenery and Taylor, 1968; Syrquin, 1988). Salter's classic work deserves special mention here because it is a direct examination of the structural bonus hypothesis (Salter, 1960). Salter showed that productivity growth in the UK differed markedly across industries during the first half of the 20th century. Furthermore, the flexible industrial structure has shown to be an important source in the high rate of productivity growth. This allows the economy to redistribute resources to derive maximum advantage from the changing pattern of technological progress.

Fagerberg scrutinised the hypothesis verified by Salter while enlarging the scope of his study to 39 countries and 34 manufacturing branches during the period 1973–1993 (Fagerberg, 2000). He found that the last three decades of the 20th century, contrary to the findings of Salter, did not show structural change conducive for productivity growth. However, empirical evidence clearly showed higher productivity growth for countries whose industrial structure consisted of technologically progressive industries during the period of analysis. Similar evidence was found in a study conducted by Timmer and Szirmai for four Asian countries while covering 13 manufacturing branches during the period 1960–1993 (Timmer and Szirmai, 2000).

The nature of technological progress has undergone dramatic change. This has profound implications for the industrial structure and its impact on productivity. Automation, descaling the size of plants and market fragmentation have provided space for small- and medium-sized industries to flourish, along with linkage to the large-sized industries. Therefore, it is expected that the industrial structure might have undergone substantial changes. This has been put to scrutiny by Audretsch *et al*. (2002). The authors showed that countries, which were able to harness the forces of technology and globalisation by transforming their industrial structure, were rewarded by growth bonus.

3   Framework for analysis

The impact of the differences in the pattern of specialisation and structural change across industries on productivity growth has been analysed with the help of the Constant Shift-Share Method (CSSM). The method was devised by Fabricant to examine the labour requirements per unit of output (Fabricant, 1942). However, recent applications of this method essentially focus on labour productivity and total factor productivity (Fagerberg, 2000; Timmer and Szirmai, 2000). The utility of CSSM lies in its ability to decompose the aggregate productivity growth into three effects. First, the impact of structural change is shown in the shift of importance from low productivity growth industries to high productivity growth industries at the beginning of the period. This effect has been described by Timmer and Szirmai as the static-shift effect from structural change. The second impact of structural change is reflected in the interaction of changes in productivity growth within industries and changes in the allocation of labour across industries and is named the dynamic-shift effect by Timmer and Szirmai. Third is the contribution from productivity within industries and is described by Timmer and Szirmai as the intra-industry effect (Timmer and Szirmai, 2000). The CSSM to decompose the impact of structural change on productivity growth used in this paper is described as follows:

$$LP = V/E = \Sigma V_i / \Sigma E_i = \Sigma (V_i / E_i * E_i / \Sigma E_i) \tag{1}$$

where LP is labour productivity; V is value added; E is number of workers; V_i/E_i is labour productivity in i industry; $E_i/\Sigma E_i$ is the share of industry i in employment. Now after substituting V_i/E_i and $E_i/\Sigma E_i$ in Equation 1, we obtain

$$LP = \Sigma (LP_i * S_i) \tag{2}$$

Substituting $\Delta LP = LP_l - LP_f$, and $\Delta S = S_l - S_f$ in Equation 2 and rewriting it as follows:

$$\Delta LP = \Sigma_i (LP_f \Delta S_i + \Delta LP_i \Delta S_i + S_{if} \Delta LP_i) \tag{3}$$

where S is the share of employment; f is first period and l is the last period.

We can obtain the growth of labour productivity by dividing both the sides with LP_f. Labour productivity is a partial measure of technological progress and involves a single factor in the analysis. To overcome this limitation we have made use of the Total Factor Productivity (TFP). The impact of structural change in both the labour and capital shares on aggregate total factor productivity growth is estimated using a method to the one used by Timmer and Szirmai (2000). The measure of TFP growth based on the translog production function is given below:

$$\text{ATFPG}(t) = \Delta\log V(t) - [S_l(t)\,\Delta\log L(t) + S_k(t)\,\Delta\log K(t)] \tag{4}$$

The output share weighted total factor productivity growth is derived as follows:

$$\Sigma\lambda_i \text{TFPG}(t)_i = \Sigma\lambda_i\,\Delta\log V(t)_i - \Sigma\lambda_i\,S_{li}(t)\,\Delta\log L(t)_i - \Sigma\lambda_i S k_i(t)\,\Delta\log K(t)_i \tag{5}$$

where V is value added; L is labour; K is capital; λ is output share weight; S_l is share of labour in value added; S_k is share of capital income in value added.

TFPG estimated from Equation 4 is the aggregate ATFPG and it contains, in relation to sectoral TFPG, additional growth due to shift of factors to more productive uses. This additional growth is due to inter-industry technological change and is measured by sectoral $\Sigma\lambda_i$ TFPG (Massell, 1961). Total Reallocation Effect (TRE) is the resultant effect of the difference between the aggregate TFPG and the output weighted sectoral TFPG, which can be estimated as follows:

$$\text{TRE} = \text{ATFPG} - \Sigma\lambda_i \text{TFPG}_i = \Sigma\lambda_i\gamma_i S l_i + \Sigma\lambda_i\delta_i S k_i \tag{6}$$

Where $\lambda_i = V_i/V$ sector share in value added; $\gamma_i = \Delta E_i/E$ sector share in the labour; $\delta_I = \Delta K_i/K$ sector share in capital.

To empirically verify the impact of structural shift share on aggregate manufacturing productivity growth, we have used data drawn from secondary/published sources. *The Report of Mining and Manufacturing Survey* (1970–2000) published by the Economic Planning Board, the Republic of Korea, brings out data on eight firm size classes based on the number of workers employed in the firms. The survey covers all manufacturing establishments employing five or more workers. The variables used in the analysis are value added, emoluments, employment, capital stock and depreciation, which are reported in the survey on current values. Therefore, to make comparable data over time at 1990 prices we have used wholesale and consumer price indices with 1990 as the base year for value added and emoluments. The capital stock variable is constructed using the base year estimate from Pyo (1998) and the perpetual inventory method is used to generate time series along with using the appropriate wholesale price index for capital goods. The appropriate price indices used to make variables at constant prices are drawn from the *Korea Statistical Yearbook* (1984; 2001).

4 Empirical results and discussion

South Korea not only achieved spectacular economic growth but also successfully transformed its economy from an agrarian to an industrialised one. The process of structural transformation entailed numerous changes within and across sectors. The industrial sector, considered the most dynamic sector, involves substantial technological progress, spearheads the process of transformation and provides new technologies to other sectors. It also draws surpluses from other sectors for more efficient use. Similarly, changes within the industrial sector are more pronounced and rapid due to the technological changes. Thus, high-tech industrial activities attract resources for more efficient use. The process of industrialisation is essentially based on the catch-up model. The success of such a model depends mainly on the quantum of import of technology as well as the capability to absorb and disseminate imported technology.

The industrial model of Korea is not simply based on the catch-up process; it also entails substantial technological learning due to the sector's tie-up with the external world through the export of intermediate products (Amsden, 1989). The capacity to learn the processes involved in new technologies provided space for reverse engineering. Learning and reverse engineering of technology have the capacity to raise productivity and efficiency across industrial activities. However, the lead in raising the level of productivity in the process of learning and reverse engineering mainly lies with the sectors that are pioneers. Therefore, it is expected that South Korean industrialisation, which involved substantial structural changes within the sector, must reflect its impact on the additional aggregate output and productivity growth. To understand the impact of technology and structural change on aggregate productivity growth requires analysing the pattern of productivity and employment growth across industrial sectors so that we can clearly discern the underlying pattern of change. Overall and the sub-period productivity growth rates across size of workers of the industrial sector of South Korea are presented in Table 1.

Table 1   Labour productivity growth by size of workers (1970–2000)

Size of Workers	1970–2000	1970–1996	1970–1980	1980–1990	1990–2000	1990–1996
5–9	9.73	9.76	8.65	12.31	7.49	11.92
10–19	9.70	9.57	8.32	11.50	8.61	12.37
20–49	9.85	9.74	7.56	11.76	8.60	12.87
50–99	9.32	8.93	4.89	11.39	9.16	12.77
100–199	10.46	10.14	5.20	12.58	9.75	12.80
200–299	11.24	10.83	8.36	11.94	11.78	13.66
300–499	10.20	9.62	4.77	11.05	11.86	16.60
500 and above	11.05	10.42	3.93	11.42	12.93	16.69
Mean	10.19	9.88	6.46	11.74	10.02	13.71
SD	0.68	0.58	1.94	0.51	1.93	1.88

Table 1 indicates that labour productivity in the Korean industrial sector witnessed accelerated rate of growth during the period 1970–2000. Labour productivity grew at an average annual rate of 10.2%. There are noticeable differentials in labour productivity across firm sizes defined in terms of the number of workers. It is important to note here that the firms belonging to the first four size classes recorded labour productivity growth rates higher than 9% per annum. Firms in the rest of the four size classes recorded marginally higher labour productivity growth compared with overall labour productivity growth of the industrial sector. The pattern of labour productivity growth, thus, tends to be positively related to the size of the firms.

However, the sub-period labour productivity growth pattern may not subscribe to the overall pattern observed during the whole period of analysis. When we compare labour productivity growth rates across firm sizes of the two smallest sized classes with the two largest sized classes it clearly shows a reversal of the overall trend. The small sized factories recorded higher labour productivity growth rates during the period 1970–1980. The variability of labour productivity growth was substantial across size classes as can be observed from the value of standard deviation (Table 1).

Industrial labour productivity growth rate recorded quantum jump during the period 1980–1990 compared to the period 1970–1980. The labour productivity growth rate almost doubled. It is surprising that the differentials in labour productivity growth declined substantially during the 1980s. The firms that lie in the largest sized class recorded labour productivity growth rates three times higher during the period 1980–1990 compared with 1970–1980. It seems that the technology learning effect during this period reduced the differentials in labour productivity growth across the board. Labour productivity growth further accelerated in the early 1990s and the gain in productivity was more for the large-sized firms compared to the small-sized firms. This reversal of trend in labour productivity growth compared to the seventies clearly shows an edge the large-sized firms had in terms of comparative cost advantage and economies of scale. However, labour productivity growth decelerated after 1996 due to the economic crisis triggered by the collapse of the foreign exchange rate and the small-sized firms were the worst sufferers in terms of labour productivity growth. During the period 1990–2000, which also includes the crisis period, the variability in labour productivity growth was the highest across the board.

The pattern of employment growth during the period 1970–2000 and sub-periods (1970–1980; 1980–1990; 1990–1996; and 1990–2000) is presented in Table 2. The overall rate of industrial employment growth was 4.12% per annum. However, firms employing 5–9 workers recorded 5.68% rate of growth, which is higher than the overall average. The highest growth rates of employment were recorded in the size groups of 10–19 and 20–49. Four firm size groups (100–199; 200–299; 300–499; and 500 and above) recorded employment growth rates below the overall average. Obviously, the variability of growth rates of employment across firm sizes was quite high. However, employment growth during sub-period 1970–1980 was recorded to be 9.62% per annum, which is higher than labour productivity growth. It is pertinent to point out here that the correlation between the employment and labour productivity growth rates showed a significant negative correlation (–0.63). The employment growth rate ranges between –1.39 to +13.79% per annum, which clearly shows wide differentials across firm sizes. When we look at the growth rates of employment during the sub-period 1980–1990, the trend is reversed compared to the period 1970–1980. Lower sized firms recorded higher employment growth rates and higher sized firms recorded lower employment growth rates. The overall employment growth rate during the period 1980–1990 was 5.87% per annum, which is quite low in comparison to 1970–1980.

From the above analysis it can be concluded that the employment generation potential during the 1980s decelerated. Furthermore, the employment growth rate of the industrial sector dwindled to less than 1% in the early 1990s. Except the small-sized firms, that is 5–9; 10–19; and 20–49, all the other firm sizes recorded negative employment growth rates. The employment situation worsens when we include the post-economic crisis period in the analysis. Not only is the variability in rates of growth of employment higher, but also its correlation with labour productivity is negative. Therefore, the opposite trends of employment growth and labour productivity growth have substantial implications for the structural bonus hypothesis.

In order to understand the relative importance of each firm size in terms of its contribution to industrial employment, we have estimated shares of employment at four points of time, which are presented in Table 3. The perusal of Table 3 shows that employment was concentrated in the firm size group employing 500 and more workers in

1970. However, the concentration further increased in 1980 and decreased substantially afterwards. During the period of substantial gains in labour productivity in the large-sized firms, the capacity to generate employment seems to have declined. The relative contribution of the small-sized firms in generating employment has substantially increased.

Table 2   Employment growth by size of workers (1970–2000) percent per annum

Size of Workers	1970–2000	1970–1996	1970–1980	1980–1990	1990–2000	1990–1996
5–9	5.68	5.45	–1.39	6.59	8.34	12.55
10–19	7.05	8.00	4.83	9.55	1.42	5.12
20–49	7.06	8.52	9.76	11.84	–0.93	0.54
50–99	5.40	6.92	13.09	7.52	–1.59	–0.60
100–199	3.40	4.70	13.79	4.51	–1.99	–1.49
200–299	2.30	3.77	13.64	1.58	–3.60	–1.26
300–499	0.89	2.01	9.85	2.92	–4.40	–4.17
500 & above	1.19	2.64	13.42	2.44	–5.38	–4.12
Mean	4.12	5.25	9.62	5.87	–1.62	0.82
SD	2.51	2.42	5.40	3.65	4.34	5.57

Table 3   Distribution of workforce in manufacturing by size of workers

Size of Workers	1970	1980	1990	1996	2000
5–9	10.07	03.71	04.93	09.90	11.14
10–19	07.16	05.18	09.04	12.18	13.16
20–49	12.10	09.64	17.44	18.50	20.03
50–99	08.84	10.06	12.64	12.32	13.37
100–199	10.09	12.32	11.35	10.40	11.05
200–299	06.84	08.54	06.32	05.93	05.24
300–499	09.45	08.58	06.79	05.70	05.31
500 & above	35.46	41.97	31.47	25.07	20.69
Total	100	100	100	100	100

The estimates of the decomposition of aggregate manufacturing labour productivity growth are reported in Table 4. We have arrived at these estimates using eight firm size data of labour productivity growth and relative shares of employment. For each of the five periods, that is, two overall (1970–2000 and 1970–1996) and three sub-periods, the percentages of aggregate manufacturing labour productivity growth are explained by the transfer of resources from low to high productivity firm sizes (static shift effect), the interaction effect (dynamic-shift effect) and productivity growth within size class of firms. The results of the decomposition of aggregate manufacturing labour productivity growth between the periods 1970 to 1980 predominantly adhere to the standard pattern of structural change. The static-shift effect explained as much as 12.24% of the aggregate manufacturing labour productivity growth. This simply means that the transfer of resources from low productivity to high productivity was satisfactory. However, the

dynamic-shift effect was also positive but only explained 3.36% of the productivity growth. It is important to note here that the intra-size effect was a dominant one. Labour reallocation has remained an important source of explaining the labour productivity growth in aggregate manufacturing during the period 1970–80. In rest of the two sub-periods and overall analysis, the overwhelming part of the aggregate labour productivity growth is accounted for by the intra-size effect. Thus, on the whole, the empirical estimates of the decomposition of aggregate manufacturing productivity growth go against the conventional shift share analysis (structural bonus hypothesis).

Table 4   Estimates of the decomposition of aggregate labour productivity growth based on size of workers

Period	Static Shift Effect	Dynamic Shift Effect	Intra-size Effect	Total
1970–1980	12.24	03.36	84.39	100
1980–1990	–05.14	–12.95	118.09	100
1990–2000	–08.09	–23.73	131.82	100
1970–2000	–01.09	–24.52	125.61	100
1970–1996	–01.39	–15.82	117.21	100

This clearly indicates that structural change often involved a shift of resources to firms that had both lower productivity growth rates and levels. The results of the impact of structural change on aggregate manufacturing productivity presented above are based on a partial measure and involve only labour input; thus the analysis is incomplete. To consider other inputs, we decompose the TFP and the results are reported in Table 5.

Table 5   Decomposition of total factor productivity growth in aggregate manufacturing based on eight firm sizes

Year	TFPG	Intra-branch Effect	TRE	Labour Shift Effect	Capital Shift Effect
1970–1980	2.80	2.59	0.21	0.13	0.08
1980–1990	3.87	3.89	–0.02	–0.16	0.14
1990–1996	3.62	3.54	0.08	–0.20	0.28
1990–2000	0.09	0.06	0.03	0.18	–0.15
1970–2000	2.62	2.57	0.05	–0.07	0.12

Total factor productivity growth reflects the efficiency at which factors of production are utilised in the industrial sector of the economy. TFPG is the most commonly used method to determine whether technology or accumulation of factor inputs dominates economic growth. TFPG rates estimated from Equation 4 are reported in first column Table 5 for the period 1970–2000 and the four sub-periods. This is decomposed into the output share weighted TFPG rates estimated from Equation 5 for the eight firm size classes, which is described as intra-firm size class effect, and are reported in second column. The difference between the TFPG rates derived from the aggregate manufacturing sector and the output weighted TFPG rates estimated from the eight firm size classes is called total reallocation effect (TRE) and is shown in the third column. Further, the TRE derived

from Equation 6 is also decomposed between labour and capital factor inputs and reported in columns four and five.

The perusal of the estimates presented in the Table 5 shows that except for the sub-period 1970–1980 the total reallocation effect was less than 0.1%. Empirical evidence thus clearly goes against the structural bonus hypothesis. However, capital input contributes positively to the total reallocation effect. Contrary to this, during the period of economic crisis in the Korean economy, the total reallocation effect was mainly contributed by the labour factor and obviously capital input contributed negatively. Our empirical evidence on the structural shift analysis of the Korean manufacturing sector has shown a somewhat similar picture which has been reported in earlier studies conducted by Fagerberg (2000), which covered 39 countries including Korea, and Timmer and Szirmai (2000) who covered four Asian countries. But the empirical evidence recently arrived at for the Korean economy (including the present one) and the studies conducted by Salter of an earlier period for the UK economy are at variance (Salter, 1960). This begs for explanation.

The first line of thinking to explain this anomaly is put forward by Fagerberg. He has showed that economies whose industrial sector has the presence of high-tech industries such as information technology contributed positively in reallocating their resources. However, the total effect of the high-tech sector was so small that the negative impact outweighed the positive (Fagerberg, 2000). A second plausible explanation is that the economic growth process is mainly governed by the mushroom-process in the present phase of development. Innovations in a particular sector play an important role and are reflected in higher productivity as well as in the reallocation of resources in such advanced countries as the USA. Third, technological progress in the last three decades of the 20th century was essentially labour displacing, at least directly and this is more true with the revolution of information and automation technologies (Postal-Vinay, 2002). The South Korean industrial development model is based on technology catch-up model and the yeast-process, which clearly shows higher levels of productivity achieved simultaneously across industrial activities. The nature of technological progress had substantial employment generation effect in the 1970s and employment-displacing effects in the 1980s and the 1990s. However, the flexible manufacturing technology system provided leverage to small and medium firms, which contributed both in terms of higher productivity and employment. This important empirical evidence of higher productivity (Lee and Sungsoo, 2000) and its contribution in resource reallocation has profound implications for policy makers.

5   Concluding remarks and policy implications

A striking feature of Korea's industrial economy has been rising productivity growth driven by the forces of technical progress and increasing export demand in the world economy. The industrial structure has undergone non-reversible structural changes, which have shown to occur as underlined by the appreciative economic theory. This paper examines the role of structural change in explaining aggregate productivity growth in the manufacturing sector of Korea. The conventional shift-share analysis, both for labour productivity and total factor productivity, is used to empirically verify the structural bonus hypothesis. The results are based on eight firm size classes in terms of workers employed and cover the period 1970–2000. Structural bonus hypothesis was

confirmed and verified for the sub-period 1970–80. However, reallocation of inputs within the manufacturing sector did not provide extra benefit to aggregate productivity growth during the period 1980–2000. Productivity growth differentials declined across firm size classes, which has blurred the impact of structural change on the aggregate productivity growth during the 1980s and the 1990s. Employment growth differentials widened during the same period. Small- and medium-sized firms generated higher employment and productivity and thus spearheaded structural change in the Korean manufacturing sector.

This result shows that though the small and medium firms were dynamic in reallocating resources, the predominant presence of large-sized firms in the manufacturing sector outweighed the positive impact of this reallocation. On the whole, empirical evidence suggests that deliberate state policy in favour of large firms may have impeded the restructuring process facilitated by technical progress, which may be viewed as a penalty in terms of forgone growth.

Implications for public policy that emerge from this paper suggest that an additional set of instruments, apart from macroeconomic policies, may be valuable in generating economic growth and overall welfare. Thus, public policies which facilitate technological progress, a factor that determines industrial structure and allows the industrial structure to adjust towards the optimal level will be rewarded by growth dividends. Furthermore, discriminatory public policies – financial and innovative resources – against smaller-sized industries need to be arrested. Instead, active public policy support to harness additional productivity growth to enhance potential for greater economic growth is required. The recent wave of globalisation has resulted in decentralisation of industrialisation in the developing economies. However, the pace of shift in the industrial structure substantially varies across countries and may have been rewarded by higher productivity and economic growth. In the absence of comparative studies in the dynamism of industrial structure, it becomes difficult to discuss generalised policy prescriptions in a meaningful way. Therefore, these questions deserve priority in the future research agenda in this area.

Acknowledgements

References

Amsden, A.H. (1989) *Asia's Next Giant: South Korea and Late Industrialization*, Oxford University Press, New York.

Audretsch, D.B., Carre, M.A., van Stel, A.J. and Thurik, A.R. (2002) 'Impeded industrial restructuring: the growth penalty', *Kyklos*, Vol. 55. pp.81–98.

Chenery, H.B. and Taylor, L. (1968) 'Development patterns among countries and over time', *Review of Economic and Statistics*, Vol. 50, pp.391–416.

Chenery, H.B., Robinson, S. and Syrquin, M. (Eds.) (1986) *Industrialization and Growth: A Comparative Study*, Oxford University Press, New York.

Clark, C. (1940) *The Conditions of Economic Progress*, Macmillan, London.

Domar, E. (1946) 'Capital expansion, rate of growth and employment', *Econometrica*, Vol. 14, pp.137–147.

Fabricant, S. (1942) *Employment in Manufacturing 1899–1939*, NBER, New York.

Fagerberg, J. (2000) 'Technological progress, structural change and productivity growth: a comparative study', *Structural Change and Economic Dynamics*, Vol. 11, pp.393–411.

Fagerberg, J. and Bart, V. (2002) 'Technology-gaps, innovation-diffusion and transformation: an evolutionary interpretation', *Research Policy*, Vol. 31, pp.1291–1304.

Harberger, A.C. (1998) 'A vision of the growth process', *American Economic Review*, Vol. 88, pp.1–32.

Harrod, R. (1949) *Towards a Dynamic Economics*, Macmillan, London.

Hoffman, W.G. (1958) *Growth of Industrial Economies*, Manchester University Press, Manchester.

Jones, R.W. (2001) 'Globalization and the fragmentation of production', *Seoul Journal of Economics*, Vol. 14, pp.1–13.

Korea National Statistical Office (1984 & 2001) *Korea Statistical Yearbook*, Republic of Korea.

Kuznets, S. (1966) *Modern Economic Growth: Rate, Structure and Spread*, Yale University Press, New Haven.

Lee, K. and Sungsoo, K. (2000) 'Characteristics and economic efficiency of the venture companies in Korea', *Seoul Journal of Economics*, Vol. 13, pp.335–60.

Lewis, W.A. (1954) 'Economic development with unlimited supplies of labour', *Manchester School Economics and Sociology Studies*, Vol. 22, pp.139–191.

Marx, K. (1867) *Das Capital*, Progressive Publishers, Moscow, Vol.I.

Massell, B.F. (1961) 'A disaggregated view of technical change', *Journal of Political Economy*, Vol. 69, pp.547–557.

Nurkse, (1953) *Problems of Capital Formation in Underdeveloped Countries*, Oxford University Press, Basil Blackwell, Oxford.

Passinetti, L.L. (1993) *Structural Economic Dynamics: A Theory of the Economic Consequences of Human Learning*, Cambridge University Press, Cambridge.

Postal-Vinay, F. (2002) 'The dynamics of technological unemployment', *International Economic Review*, Vol. 43, pp.737–760.

Pyo, H.K. (1998) 'Estimates of fixed reproducible tangible assets in the Republic of Korea, 1953–1996', *KDI Working Paper No. 9810*, KDI, Seoul.

Ricardo, D. (1817) *Principles of Political Economy and Taxation*, with an introduction by Donald Winch, Dent, London.

Rodan, Rosentein, P.N. (1943) 'Problems of industrialization in Eastern and South Eastern Europe', *Economic Journal*, Vol. 53. pp.204–207.

Rostow, W.W. (1960) *The Stages of Economic Growth – A Non-communist Manifesto*, Cambridge University Press, Cambridge.

Salter, W.E.G. (1960) *Productivity and Technical Change*, Cambridge University Press, Cambridge.

Schumpeter, J.A. (1934) *The Theory of Economic Development*, Harvard University Press, Cambridge, Massachusetts.

Smith, A. (1776) *The Wealth of Nations*, with introduction by Andrew Skinner, Pelican Books, Harmondsworth.

Streeten, P. (1959) 'Unbalanced growth', *Oxford Economic Papers*, New Series, Vol. 11, pp.167–190.

Syrquin, M. (1988) 'Patterns of structural change', in Chenery, H.B. and Srinivasan, T.N. (Eds.): *Hand Book of Development Economics*, Elsevier Science Publishers, Amesterdam.

Timmer, M.P. and Szirmai, A. (2000) 'Productivity growth in Asian manufacturing: the structural bonus hypothesis examined', *Structural Change and Economic Dynamics*, Vol. 11, pp. 371–392.