Growth and Divergence in Manufacturing Performance in South and East Asia

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Research Memorandum GD-37

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June 1997

This paper is published jointly with
the Department of Technology and Development Studies,
Eindhoven University of Technology

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* This paper draws on earlier ICOP studies on Japan and Korea (Pilat 1993; Szirmai and Pilat, 1990), Indonesia (Szirmai, 1993), China (Szirmai and Ruoen, 1995) and India (van Ark, 1991). We have drawn extensively on the research output of these members of the ICOP research team, as acknowledged in the text and bibliography. We thank them for sharing their materials. Where possible, the data have been revised and updated. New benchmarks and time series will be presented for Taiwan and India. Thanks are due to the Directorate General of Budget Accounting and Statistics and the Ministry of Economic Affairs, Taipeh, Taiwan for providing Taiwanese data, and to Boon Lee for Indian statistics. Thanks also due to Bart van Ark, Bart Verspagen and participants at the 1996 IARIW conference in Lillehammer for useful comments. We gratefully acknowledge the support of the Netherlands Foundation for Scientific Research for the Ph.D. research of M. Timmer.

Abstract

The growth experience in manufacturing in South and East Asian economies is well documented. Less is known about absolute levels of economic performance. This paper presents a star comparison of six Asian economies (China, India, Indonesia, Japan, South Korea and Taiwan) and the USA, the world productivity leader in manufacturing. The comparison of manufacturing performance is based on an industry of origin approach. Korea and Taiwan experienced catch up compared to the USA, especially since 1985. In 1993, labour productivity in manufacturing in these countries had increased to 49% of the US level in the case of Korea, and to 28% in the case of Taiwan. On the other hand, relative productivity levels in Indonesia, India and China stagnated throughout the 1980s, and are only recently showing weak signs of convergence. Comparative levels of labour productivity were 12% in Indonesia (in 1993), 9% in India (in 1990) and 6% in China (in 1992). Adjusting for small scale establishments brings down the levels in the latter group even further.

A breakdown of manufacturing performance by fourteen branches of manufacturing, revealed the same patterns in each countries as at the aggregate level of manufacturing. This indicates that the factors making for catch-up or relative stagnation operate at the level of the total economy, rather than within specific branches. This finding is consistent with theories of conditional convergence.

Structural change within manufacturing contributed little or even negatively to the growth in labour productivity. There is no evidence of a systematic pattern of structural change from early industries characterised by low productivity levels, to late industries characterised by high productivity. Manufacturing structures of both catch-up and non-catch economies tend to converge to each other.

Comparisons of levels and trends of capital intensity and total factor productivity show a similar distinction between catch-up and non-catch-up economies. In Korea and Taiwan, labour productivity catch up is due to catch up in capital intensity, rather than catch up in total factor productivity. Capital intensity in Korea is 65% of the USA (in 1986) and almost 50% in Taiwan (in 1991), while relative total factor productivity levels are still below 30% of the US level in both economies. Capital intensities in China, India and Indonesia are still below 30% of the USA, with relative total factor productivities not exceeding the 25% level.

1 Introduction and Summary of Results

This paper presents a comparative overview of developments in labour productivity and total factor productivity in the manufacturing sector of six Asian economies: China, India, Indonesia, Japan, Korea and Taiwan[1]. Although all six economies show rapid growth of manufacturing output, a distinction can be made between economies experiencing catch-up and economies experiencing relative stagnation. Japan, Korea and to a lesser extent Taiwan are involved in a process of rapid catch-up with the USA. The second group of economies (China, India and Indonesia) has rapid industrial growth and growth of labour productivity, but with little or no catch-up. Though labour productivity is increasing in these countries, their position relative to the USA throughout the eighties shows little change. Within the Asian setting these differential patterns imply a process of economic divergence.

The paper focuses on both levels and trends in the period 1955-1993. The paper will provide star comparisons of labour productivity and total factor productivity, with the USA as the reference country. The level comparisons in the paper are based on standard industry of origin ICOP-methods for international comparisons, using PPPs at producer prices. Comparisons will be made not only for total manufacturing but also for detailed manufacturing branches. The paper is structured as follows:

In section 2, we discuss aggregate trends in labour productivity relative to the USA, both in the total economy and in manufacturing, against the background of the theoretical discussion of catch-up and structural change. In Japan, catch-up in manufacturing was rapid during the whole post-war period, though suddenly levelling off after 1982. In Korea the onset of catch-up in manufacturing can be dated around 1966, with an acceleration after 1988. Catch-up in Taiwan was more gradual, also setting in around 1966. Since the second half of the 1980's, India and Indonesia are starting to show indications of catch up, though to a very modest degree. China shows no signs of catch up so far.

In section 3, we discuss the importance of the manufacturing sector in total economy growth and conclude that manufacturing continues to be an important engine of growth. In section 4, we enquire whether growth of output in manufacturing is due mainly to growth of labour input or labour productivity growth. Although labour input growth is not unimportant, labour productivity growth is the prime mover of growth of output. This is especially true in the most recent period. This implies that the employment consequences of the expansion of manufacturing are modest. In the catch-up economies expansion of employment is only important in the earlier phases of catch-up.

In section 5 manufacturing labour productivity performance is put into comparative perspective, with the USA as the reference country. This section presents a brief discussion of the derivation of industry of origin purchasing power parities and of issues of data comparability. A distinction is found between 'rapid catch-up economies' (Japan, Korea and Taiwan) and the 'non-catch-up economies' characterised by absence of catch up (China) or by slow catch up in the latest period (India and Indonesia). The process of divergence between catch-up and non-catch-up economies is subjected to further examination.

Sections 6 and 7 present a desaggregated view of the manufacturing sector. First, we turn to the

[1] In this paper Korea, China and Taiwan denote resp. South-Korea, The People's Republic of China, and the Republic of China.

question of structural change within manufacturing in section 6. An analysis of branch shares in the Asian economies reveals a secular trend towards structural convergence in all countries. There is no evidence of an unilinear pattern of structural change within manufacturing, involving shifts from low productivity to high productivity branches of manufacturing. Therefore structural change is not important in explaining growth of aggregate labour productivity in manufacturing. Growth in aggregate labour productivity is associated with productivity increases within almost all branches of manufacturing.

Next, we identify the manufacturing branches which are the main generators of the rapid output growth in total manufacturing in different countries. Light industries such as food and textiles seem to have played only a minor role in manufacturing growth, in contrast to heavy industries such as chemicals and machinery. An analysis of branch contributions to overall manufacturing growth fails to pinpoint branches which are important in certain stages of industrial development. There are no typical differences between catch-up and non-catch-up economies.

Section 7 presents a discussion of comparative labour productivity by branch of manufacturing. This allows us to identify catch up and relative stagnation at branch level in the respective economies. Broadly speaking, comparative labour productivity trends within branches show the same patterns of catch up and stagnation as found for total manufacturing. There are no typical catch-up branches characterised by exceptional dynamism. Over time, there is a tendency for branch levels of relative labour productivity to converge within an economy. The analysis points to the importance of economy wide forces, rather than branch specific forces in productivity growth.

In section 8 the first steps are taken in the explanation of the international labour productivity differentials by introducing comparative capital intensity and relative total factor levels. Asian relative labour productivity, relative capital intensity and relative total factor productivity tend to move together. Differences in total factor productivity account for the greater part of the differences in labour productivity.

2 Catch up and Structural Change

The setting for the measurement and analysis of comparative labour productivity in manufacturing is provided by catch-up theory. The naive theory of catch up suggests that per capita incomes in low income countries will grow more rapidly than in high income countries, resulting in a narrowing of income differentials. Catch up is commonly measured either in terms of GDP per capita, GDP per person or GDP per hour worked.[2]

Four main sources of catch up are discussed in the literature: accumulation of physical capital, accumulation of human capital, structural change and international diffusion of technology. At early stages of industrialisation, very rapid growth of output and labour productivity can be realized through increases in physical capital intensity. The efficiency of the use of factor inputs (raw labour and capital) can be improved by increases in educational levels. The rapid increases in educational levels in low income countries in the post-war period (Szirmai, 1997, chapter 6) testifies to the

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2 Income per capita is determined by GDP per hour worked, average annual hours per worker and labour market participation.

importance assigned to this factor. Another obvious advantage of backwardness is the possibility of shifting productive resources from an agricultural sector with low productivity to industrial sectors with higher productivity (Abramovitz, 1986). This is an 'easy' form of catch up which is exhausted, once a country has developed a substantial industrial sector. Some further gains could potentially be made, by transferring productive resources from low productivity to high productivity branches within industry, but these are limited.[3]

However, the most important potential for catch up can be found in technology transfers. Low income countries can benefit from existing technologies, developed in advanced countries, without having to bear the costs and the risks associated with research and development. The transfer of technology can take the form of the import of capital goods, hitherto unknown. These capital goods transfer technology in embodied form. The transfer of technology can also take disembodied forms, such as the transfer of know how, organisation and management techniques.

The processes of increasing human and physical capital, and technology transfers are intertwined, indicating that the advantages of backwardness represent a two edged sword. Low levels of education and schooling are an obstacle to the transfer of technology and reduce the realization of catch-up potential. They result in inefficient use of capital and low rates of utilisation. Low levels of education make it more difficult to adapt foreign technologies and capital goods to new circumstances and to develop new domestic technologies. Low levels of capital intensity provide little opportunity for learning by doing and gaining experience and also make the further transfer of capital and technology more difficult (Abramovitz, 1986). Thus catchup potential may not be realized when countries are too backward (see Verspagen, 1991).

This two edged nature of backwardness comes to the fore in the debate between neo-classical and new growth theory. Neo-classical growth theory emphasizes the advantages of backwardness and predicts convergence and catch up in the world economy, as capital moves to areas with the highest return and technological knowledge diffuses from advanced to low income countries. Technological knowledge is freely available and can be assimilated by low income countries at little or no cost. New growth theory (Romer, 1986; Lucas, 1988; for an overview see Barro and Sala-i-Martin, 1995) emphasizes the advantages of leadership in technology, capital intensity and human capital. The more human and physical capital per worker a country has accumulated and the greater the stock of knowledge, the greater the returns to new investments in technology, human and physical capital (increasing returns to scale). This theory suggests increasing divergence in the world economy with the most rapid growth in the technological lead countries.

The increasing divergence of levels of per capita income in the world economy as a whole runs counter to the original neo-classical predictions (as stressed by Romer, 1989a). On first sight divergence seems consistent with new growth theories. However, economic performance in part of the world economy is also at variance with the predictions of new growth theory. The most rapid economic growth is presently found in a number of Asian economies some of which are still very poor such as China and Indonesia and others which are richer such as Taiwan and South Korea, but which are still far from being at the leading edge of technology.

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3 As this paper focuses on manufacturing, we will leave the service sector out of the discussion.

The most promising approach is that of conditional convergence, early formulations of which can be found in Gerschenkron (1952). It recently attracted new interest because of the empirical finding of world wide divergence combined with convergence within groups of countries. The theory of conditional convergence states that within sets of countries with similar fertility rates, investment rates, levels of human capital and other initial conditions, convergence tendencies predominate (Barro 1989; Mankiw, Romer and Weil, 1992; Wolff and Gittleman, 1993). Once certain threshold levels have been attained, the barriers to diffusion and assimilation of technology become weaker. Advantages of backwardness can be very substantial and catch up can be explosive.

Conditional convergence is also quite consistent with a recent reformulation of neo-classical growth theory by Solow (1991), which explains the lack of world wide convergence tendencies by institutional and socio-cultural barriers to diffusion of technology. He argues that it is difficult to choose between neo-classical and new growth theories on the basis of the empirical evidence. Solow's institutional interpretation is also in line with newer theories of technological diffusion (Evenson and Westphal, 1995), which emphasize the considerable efforts needed to adapt technology in new settings. There is no such thing as easy diffusion. All diffusion involves innovation, which requires a high level of technological capabilities.

Empirical support for conditional convergence was found by Mankiw, Romer and Weil (1992), although the estimated rate of the conditional convergence was rather slow. Recently however, using a panel data approach which allows for differences in the aggregate production function across different countries, Islam (1995) has argued that the rate of convergence is much faster. But simultaneously he found significant differences in the country specific production functions, which can be interpreted as level differences in total factor productivity. Hence, he argues that countries are converging to different GDP per capita levels and full catch up will never be realized. However, this last conclusion assumes that there can be no long-run convergence in production functions. We would assume that catch up ultimately also involves such convergence of the production functions themselves.

One of the hotly debated issues with regard to East Asian catch up is whether their rapid increase in GDP is due to improvements in total factor productivity (TFP) or not. In a review of the empirical evidence, the World Bank study *The East Asian Miracle* (1993, Chapter 1) concludes that TFP growth has been particularly high in the Asian newly industrialising economies. On the other hand however, Young (1994) confirmed the finding of Lau and Kim (1994) that TFP growth was negligible during the 1970's and 1980's. He measured TFP in a narrow sense, that is, excluding improvements in the quality of the inputs, and concluded that the East Asian new industrialising economies' success in catch up was solely due to structural change and resource intensive growth, with little improvement in total factor productivity. But whether catch up is achieved by increasing output per unit of capital and labour, or by increasing the capital intensity, is of secondary importance. In fact, the two often operate in combination, total factor productivity becoming the most important determinant of relative income levels only after capital intensity differentials have been substantially narrowed.

The focus in the present paper is on the measurement of catch up within the manufacturing sector. In section 3, we will argue that manufacturing has been and is still one of the important engines of economic growth. This is due in part to the structural change involved in the expansion of the share of manufacturing, and in part to productivity increases within manufacturing. The analysis of relative performance within manufacturing is important for an overall understanding of catch-up. Nation-wide conditions for overall catch up like educational attainments, technological capabilities and institutional characteristics hold equally within the manufacturing sector. Given the high tradability of manufacturing products and the associated competitive pressures, given the opportunities for capital intensification, and given the recent surges in foreign direct investment, one could argue that opportunities for technological transfer and diffusion, will be the largest in the manufacturing sector of the economy. Thus one might hypothesize that patterns of catch up and divergence in the total economy are reflected by similar or even more pronounced patterns at the level of the manufacturing sector.

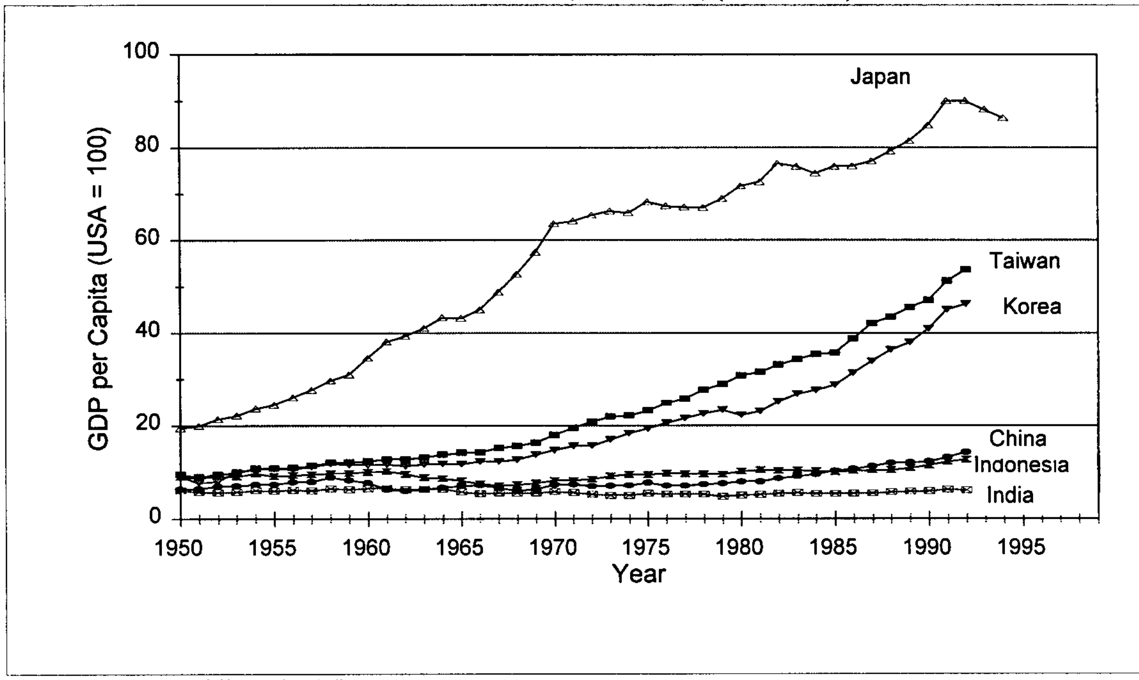
Patterns of relative economic performance in the total economy and in manufacturing are represented in figures 1 and 2. Figure 1 presents trends in GDP per capita in the total economy in 1990 international dollars from Maddison (1996). The figure shows rapid catch up in both Taiwan and Korea, starting around 1960 in Taiwan and around 1966 in Korea and gather pace from the 1970's onwards. Catch up takes place both relative to the USA and to Japan, the leading Asian economy, which itself was involved in catch up vis à vis the USA. By contrast, China, India and Indonesia show little or no long term tendency to catch up with the USA. The only trace of catch up is a slight improvement in relative GDP per capita in China during the 1980's and in Indonesia after 1985.

In the Asian context, the pattern is one of divergence, rather than convergence, with increasing differentials between Japan, Korea and Taiwan and the other three Asian economies. In 1950, China, India, Indonesia, Korea and Taiwan were at more or less similar levels of per capita income. After that Korea and Taiwan forged ahead, increasing the gap with China and Indonesia, and with India lagging behind.

Figure 2 presents data for GDP per person employed in the manufacturing sector, derived from different ICOP studies in which binary comparisons are made with the USA. The problems of comparing levels of productivity will be discussed at more length in section 5. Here we focus on the aggregate trends. The per capita figures in figure 1 and the figures per person employed in figure 2 are of course not quite comparable, but nevertheless the patterns for manufacturing are rather similar to those for the total economy. They point to catch up in Japan, Korea and Taiwan and little change in relative position in China, India and Indonesia. But there is no evidence that the patterns are more pronounced. The main difference is the sudden acceleration of manufacturing catch up in Taiwan and Korea after 1988, which is not reflected in the total GDP figures. In Japan manufacturing catch up accelerated till 1970 and then proceeded at a slower pace. After 1990 relative productivity vis à vis the USA deteriorated. In Korea the onset of catch up can be dated around 1966, with an explosive acceleration after 1988. In Taiwan catch up proceeded at a more gradual pace, also setting in around 1966.

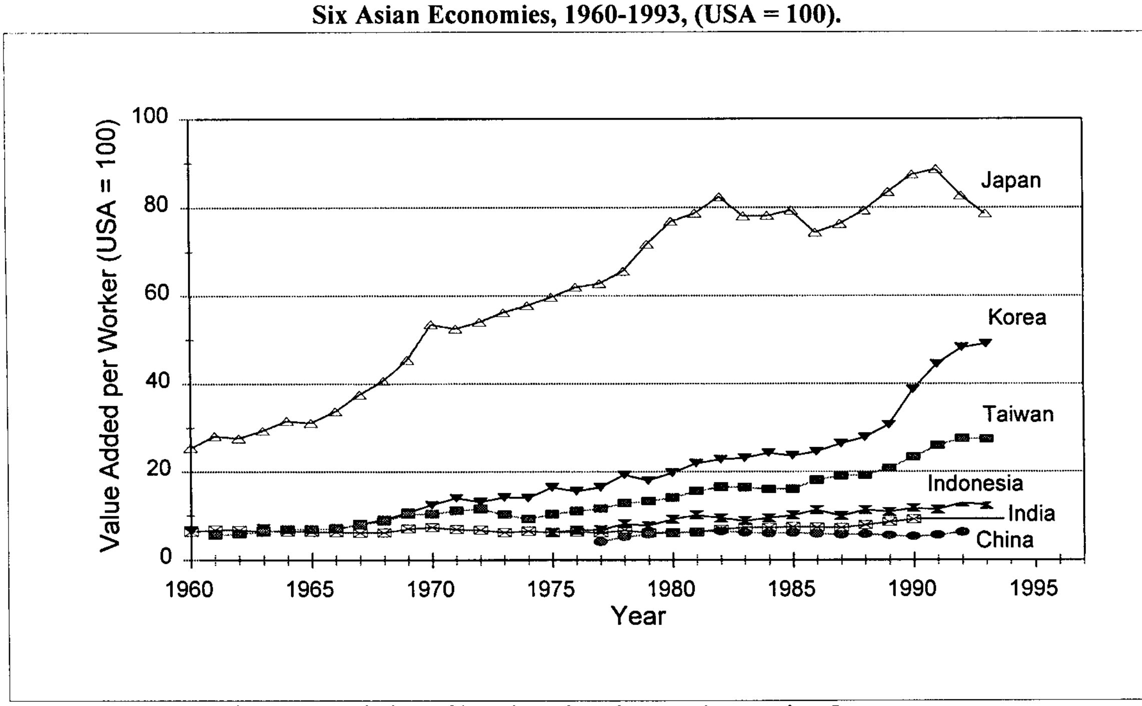
Compared to figure 1, the roles of Korea and Taiwan have been reversed, with higher relative manufacturing productivity in Korea. This underperformance of the Taiwanese manufacturing sector relative to the rest of the economy was also found by Young (1994). Manufacturing also shows a pattern of increasing divergence within Asia between the catch up countries and the countries experiencing relative stagnation. It should be stressed that these trends in relative performance take

Figure 1 Relative GDP per Capita in 1990 Geary Khamis Dollars for Six Asian Economies, 1950-1993, (USA = 100).



Source: Maddison (1996).

Figure 2 Relative Labour Productivity Levels in Manufacturing Six Asian Economies, 1960-1993, (USA = 100).



Sources: Based on extrapolation of benchmark estimates. See section 5.
Benchmark estimates: **China/USA 1985** from Szirmai and Ruoen (1997); **Indonesia/USA 1987** from Szirmai (1993); **India/USA 1983** and **Taiwan/USA 1976** from Timmer (1997a,b); **South Korea/USA 1987** and **Japan/USA 1987** from Pilat (1993).
Extrapolations from benchmark years: USA, Japan and Korea from Pilat (1993) with updating; Indonesia from Szirmai (1993) with updating and revision; Taiwan and India from Timmer (1997a,b); China from Szirmai and Ruoen (1997). See appendix B for original sources.

place in the context of rapid growth of manufacturing output in the low income Asian economies, as will be shown in the following section. With the exception of Korea after 1988, the hypothesis, formulated above, that manufacturing catch up is more pronounced than aggregate catch up is not supported by the evidence.

3. The Manufacturing Sector: Engine of Growth in Asia?

In the process of economic development the shift from agriculture to industry and especially to manufacturing is considered to be of crucial importance, as discussed in section 2. This section will investigate to what extent the dynamic manufacturing sector contributed to the growth of the total economy in the six Asian economies under study. For this we make use of the following equality. Let Y be total economy value added, generated in the manufacturing sector (m), and the non-manufacturing sector (nm): Y = m + nm. The growth of Y (g_Y) during a period can now be decomposed as:

$$g_Y = S_0^m \cdot g_m + S_0^{nm} \cdot g_{nm} \qquad (1)$$

were S_0^x denote the share in GDP of sector x at the beginning of the period, and g denotes growth rates. The equation shows that the growth of output can be decomposed into the growth of the manufacturing sector and growth of the non-manufacturing sector, each weighted by their share in the total economy value added at the beginning of the period. Thus manufacturing's importance depends on two things: the share of manufacturing in total GDP, and its growth rate. Both aspects will first be treated separately.

Growth of Manufacturing GDP

Table 1 shows the growth rates of the manufacturing sector of the countries under study, for 6 subperiods during 1953-1993 in constant prices. Table 1 shows that the manufacturing sector was growing rapidly in the Asian countries. In China, Indonesia, Korea and Taiwan, it expanded at double digit growth rates during almost all periods. Korea and Taiwan even approached average annual growth rates of 20% in the late 1960's. On the other hand, Indian growth rates never exceeded 7%. Japan switched abruptly from rapid to slow growth after the oil crisis of 1973. Chinese manufacturing had the highest growth rates in the most recent period 1987-1993, when growth in Indonesia, Korea and especially Taiwan, decelerated.

The Share of Manufacturing in Total GDP

Table 2 presents shares of manufacturing in total GDP for the period 1953-1993 at current prices.[4] In Japan the manufacturing share remained more or less stable around 30% in this period. In Korea and Taiwan, the share of the manufacturing sector surged to over 30% starting from around 10%, but

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[4] Constant price shares will give a completely different picture as prices in manufacturing decline rapidly relative to prices in the other sectors, except for India. This results in much too low shares of manufacturing in the early years. For example, the share of manufacturing in total GDP in Korea in 1953 in constant 1985 prices is 3%, while 8% at current prices.

declined after 1987. In India the manufacturing share has been stagnating ever since the mid sixties, never exceeding the 18% level, indicating that this sector is still relatively small. Indonesian industrialisation started late, with manufacturing accounting for only about 11% of GDP in 1973. But the share of manufacturing is increasing rapidly and surpassed the Indian level in 1990. The share of manufacturing is highest in China, accounting for 38% of total GDP in 1993.[5]

Table 1
Average Annual Real Growth Rates of Manufacturing GDP, 1953-1993 (percentage growth).

	China (a)	Indonesia (b)	India	Taiwan (c)	Korea	Japan	USA
1953-59			6.5		15.2	9.9	0.5
1959-66			6.9	11.6	11.1	14.3	6.3
1966-73		15.1	3.9	19.2	19.7	13.0	2.9
1973-80	8.6	14.4	4.8	11.5	18.1	4.9	3.2
1980-87	9.9	14.1	6.0	9.2	10.6	4.8	1.9
1987-93	12.7	10.0	5.0	4.7	9.2	4.9	2.4

Notes: (a) For China data only available from 1979 onwards; (b) For Indonesia data available from 1972 onwards; (c) For Taiwan data available from 1961 onwards;
Sources: **China**: 1978-1993 from World Tables 1995; **Indonesia:** 1973-1993 from World Bank, World Tables 1995, 1971-1972 from World Tables 1993; **India**: 1950-1979, Central Statistical Office (CSO) (1992) National Accounts Statistics, Disaggregated Results, 1950/51 - 1979/80,1980-1987, CSO (1992) NAS 1990, 1988-1992, CSO (1994) NAS 1992. 1993 from World Bank, World Tables 1995; **Taiwan**: from National Accounts 1994; **Japan**: 1953-1989 from Pilat (1993), 1990-1993 from EPA, Annual Report on National Accounts 1995, Tokyo, 1995; **Korea**: 1953-1988 from Pilat (1993), 1989-1993 from Bank of Korea, Monthly Statistics of Korea 1996.2-3.; **USA**: 1953-1990 from Pilat (1993), 1991-1993 from Survey of Current Business Oktober 1994 and April 1995.

Table 2
Share of Manufacturing in Total GDP, 1953-1993, current prices (in %).

	China	Indonesia	India	Taiwan	Korea	Japan	USA
1953			12	13	8	32	30
1959			14	19	13	32	28
1966			15	23	18	33	28
1973		11	16	37	25	35	24
1980	41	13	18	36	30	29	22
1987	37	17	18	39	31	29	20
1993	38	22	17	30	27	29	18

Source: Manufacturing and total GDP from sources quoted in Table 1.

5 Until recently Chinese national accounts where based on the material product system, in which large parts of service sector output were excluded in national income. Though Chinese national accounts are gradually moving towards a SNA basis, it is likely that the share of services is still underestimated, leading to inflated shares for manufacturing.

Contribution of the Manufacturing Sector to Total GDP Growth
Equation (1) allows us to assess the contribution of manufacturing to total growth of GDP[6]. The results are presented in Table 3. This table shows the percentage of total real GDP growth accounted for by manufacturing for 6 subperiods between 1953 and 1993

Table 3
Contribution of Manufacturing Sector to Real Growth in Total GDP, 1953-1993, (in percentages).

	China (a)	Indonesia (b)	India	Taiwan (c)	Korea	Japan	USA
1953-59			21		33	40	13
1959-66			30	28	30	53	40
1966-73		22	17	47	46	45	21
1973-80	45	25	25	44	48	35	17
1980-87	40	37	26	44	43	37	23
1987-93	54	29	16	17	30	38	16

Notes: (a) For China data available from 1978 onwards; (b) For Indonesia data available from 1971 onwards; (c) For Taiwan data available from 1961 onwards;
Sources: Calculated with equation (1) using begin of period current shares of manufacturing from Table 2, and real growth rates of manufacturing and total GDP from sources given in Table 1. See also footnote 6.

Table 3 shows that a substantial part of the growth of the catch-up countries Japan, Korea and Taiwan was accounted for by manufacturing. During their catch-up periods (starting around 1965), manufacturing's contribution was around 45%. From 1987 onwards, there is a sudden decline in the contribution of manufacturing, especially in Taiwan, where it drops to 17 %, due to sluggish manufacturing output growth. Japan witnessed a similar decline, but smaller, in the seventies, manufacturing maintaining its importance into the nineties. Its contribution in 1993 surpassed the levels in Korea and Taiwan. The importance of the manufacturing sector in Indonesia increased, peaking in the period 1980-87. During 1987-93 it accounted for 29% of total growth. In China the contribution to growth has been very high from 1978 to 1993[7], reaching Korean and Taiwanese levels. In India on the other hand the contribution of manufacturing never exceeded 30% and declined substantial to 16 % after 1987.

One may conclude that *manufacturing was one of the important sources of total economy growth in Asia in the post-war period*, particularly for Japan, Korea and Taiwan from the sixties onwards, and in China in the eighties. Its contribution was also substantial in Indonesia, though much less in India.

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[6] This can be done in two ways: using GDP series at current or at constant prices. As long as sectoral GDPs add up to total GDP, equation (1) will be valid. But, both ways have a disadvantage. Using current price series, one will not be able to assess manufacturing contribution to *real* growth. On the other hand, using constant price series, manufacturing shares in the early period are underestimated (see footnote 4), and so will be the contribution of manufacturing to total real growth. In Table 3 an alternative way has been chosen, using real growth rates and begin of period current shares. As sector contributions may not add up to one anymore, they have been normalized to one.

[7] Though the share of manufacturing in GDP and therefore its contribution is almost certainly overestimated in official statistics, see footnote 5.

The strong forward and backward linkages (both economic and technological) between manufacturing and other sectors make its contribution even more important, than measured in our narrow statistical sense. Especially the contribution of manufacturing to growth in periods of rapid catch up leads us to conclude that the manufacturing sector is still one of the main engines of dynamic growth.

4. Labour Productivity as a Source of Output Growth in Asian Manufacturing

In section 3, we demonstrated the continued importance of manufacturing as source of growth and catch up. In this section, we turn to aggregate labour productivity trends in total manufacturing within each of our Asian economies. In particular, we examine the extent to which growth of output is explained by growth of labour input or by labour productivity growth. In the next section, we will return to the comparative perspective linking the labour productivity time series to level comparisons for benchmark years.

Table 4
Indices of GDP per Person Employed in Manufacturing
(at constant national prices, 1980 = 100)

	India	China	Indonesia	Korea	Taiwan	Japan	USA
1963	76			26	33	28	73
1975	93	(a) 68	64	77	68	72	93
1980	100	100	100	100	100	100	100
1984	138	113	120	143	133	119	117
1987	160	123	146	180	182	134	135
1990	212	121	180	276	234	161	142
1993		(b) 149	210	387	304	160	156

Notes: (a) 1977; (b) 1992.
Sources: See Appendix B.

Table 4 presents the data on GDP per person employed in manufacturing for the countries under study in index number form.Table 4 shows that all countries have recorded impressive growth in labour productivity in the manufacturing sector. Between 1975 and 1990 all Asian countries, except China, more than doubled their output per person employed, emphasizing their dynamism in terms of labour productivity. Korea and Taiwan even showed a more than ninefold increase in labour productivity in three decades (1963-93) .

To assess the importance of these labour productivity growth trends for output growth, the following decomposition of the growth of output has been made. The growth of value added can be written as the sum of the growth of the labour force (L), the growth in labour productivity (Y/L, the value added per labourer) and a remaining (small) interaction effect equal to the product of the both growth rates. In a formula:

$$g_Y = g_L + g_{Y/L} + g_L \cdot g_{Y/L} \qquad \textbf{(2)}$$

where g denotes growth rates.

Table 5
Contribution of Growth of Employment (g_L) and of Labour Productivity ($g_{Y/L}$) to Average Annual Real Growth in Manufacturing GDP, 1959-1993 (in %).

	India (a)			China (b)			Indonesia (c)			Taiwan (d)		
	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)
1959-66	9.4	46	52							14.4	27	71
1966-73	4.8	38	60							21.4	58	39
1973-80	4.9	81	20				14.1	40	56	11.4	47	49
1980-87	5.2	-10	112	8.9	64	34	21.0	51	44	12.4	33	65
1987-93	11.0	20	78	6.2	30	70	17.6	65	31	8.1	-17	119
period	6.5	35	65	7.8	53	45	17.7	56	39	13.5	36	61

	Korea (e)			Japan			USA		
	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)	GDP Growth (%)	Contribution of g_L (%)	Contribution of $g_{Y/L}$ (%)
1959-65				14.3	30	67	6.3	29	69
1966-72	24.6	39	56	13.0	17	81	2.9	26	73
1973-79	19.5	61	34	4.9	-16	116	3.2	51	47
1980-86	12.1	32	65	4.8	19	80	1.9	-72	171
1987-93	14.7	6	94	4.9	20	79	2.4	-25	126
period	17.5	37	60	8.6	24	74	2.9	9	90

Source: Based on Equation (2), see main text. For data see Appendix B. Note that this data is based mainly on national census data. Hence GDP growth rates differ from the rates presented in Table 1 which were based solely on National Accounts.
Notes: (a) India from 1960-90; (b) China from 1980-92; (c) Indonesia from 1975 onwards; (d) Taiwan from 1960 onwards; (e) Korea from 1966 onwards.
N.B. Percentages do not add up to 100% because of small interaction effect (see main text for explanation)

Table 5 shows the proportion of growth of real value added in manufacturing explained by respectively growth of employment and growth of value added per person employed. (The two terms do not add up to 100 because of the small interaction effect as shown by equation 2). Several interesting conclusions can be derived from Table 5.

First of all, both growth in employment and in labour productivity have contributed to the growth in manufacturing value added, but contributions varied considerably between countries and periods. In China and Indonesia, employment growth was somewhat more important than productivity growth. Manufacturing output growth is fuelled by a massive intake of (surplus) labour from the agricultural sector, coupled with a modest increase in labour productivity. Korea and Taiwan experienced this in the 1960's and 1970's, but in the 1980's expansion of employment declined sharply in these countries. In the latest period, growth in these countries was solely based on labour productivity growth. Taiwan even underwent a labour shakeout, coupled with a decline in output growth and a restructuring of its manufacturing sector. An important determinant in this process is the rapid growth in wage rates, causing firms to pay more attention to their payrolls. The negative contribution of labour input growth is clearly visible in the USA as well, but here it is mainly caused by an outsourcing of service activities by manufacturing establishments concentrating on their core business. Japan is clearly ahead of the other Asian economies: labour input growth contributed no more than 20% after the mid 1960's. Surprisingly, the Indian development path parallels the Korean and Taiwanese paths: labour intake into the manufacturing sector already stagnated in the 1980's. Thus the contribution of manufacturing expansion to employment creation is but modest. This may be a result of the gradual liberalisation of the Indian economy, which includes privatisation of state enterprises (which had an important function in providing social security) and a relaxation of the stringent regulations with regard to lay-offs.

One may conclude that labour productivity levels are growing rapidly in the six Asian economies, indicating their dynamism. In all cases, the *rapid growth of labour productivity proved an important determinant of manufacturing value added growth.* But its importance varied, suggesting a two phase development path. In the first phase, manufacturing output growth is fuelled by both employment and labour productivity growth. The simple idea of rapid output growth in an otherwise static sector does clearly not accommodate this. China and Indonesia are currently in this phase. Korea and Taiwan entered a second phase in the eighties: labour productivity growth becomes the main contributor, and employment creation declines rapidly. India's entering into this phase seems to be premature, given its still low share of manufacturing in total GDP.

5. International Comparisons of Levels and Trends in Total Manufacturing Labour Productivity.

In section 4, we discussed the growth of labour productivity within countries. In this section labour productivity growth will be put into an international perspective. We present international comparisons of levels and trends in labour productivity for total manufacturing. These are based on star comparisons of real labour productivity with the USA as the reference country. In section 5.1 we will discuss our data and methods. Subsequently the results are given in section 5.2. Desaggregated results by branch of manufacturing will be discussed in section 7.

5.1 Methods and Data Comparability

The comparative levels and trends in labour productivity have been derived as follows.

a. First, national labour productivity figures for a given benchmark year are put on a comparable basis by adjusting all countries to conform to a common definition of value added and employment.
b. Second, the national figures on GDP per person (or per hour) in manufacturing in the benchmark year are converted to a common currency (the US dollar) by using binary Purchasing Power

Parities (PPPs) at producer prices, derived by an industry of origin approach.

c. Third, the benchmark comparison of real labour productivity is extrapolated forwards and backwards through time, on the basis of national time series of employment and value added in the countries being compared.

ad a. For the benchmark comparison we made use of the manufacturing censuses of the different countries. In general national accounts data are to be preferred over census data as they have a greater degree of international standardisation and a better coverage of the economy. But, unfortunately most countries have no employment data which match the national accounts output figures. As the principal aim in this paper is the comparison of labour productivity levels, we have chosen to derive national output and employment figures in the benchmark year from one and the same source, thus ensuring internal consistency in coverage.[8] Another advantage of census data is that in many developing countries, they provide more sectoral detail than the national accounts. Necessary adjustments to ensure comparability between countries are thus easier made. These adjustments are required because of: 1. differences in the definition of value added (especially whether purchased services from outside manufacturing are deducted as intermediate inputs); 2. differences in valuation: e.g. factor cost prices versus market prices, gross versus net value added; 3. differences in the classification of manufacturing activities; 4. differences in the definitions of employment (especially whether non-employees are included, and whether employment at head offices and auxiliary establishments is included) and 5. differences in coverage of the manufacturing establishments. This last important adjustment will be discussed at the end of this section.

ad b. The national figures on labour productivity in the benchmark year are converted to a common currency by using PPPs at producer prices. These PPPs are based on the industry of origin method for international comparisons as used and refined in the International Comparisons of Output and Productivity (ICOP) project. The comparisons are based on published and ongoing work in the ICOP project: China/USA based on a 1985 benchmark from Szirmai and Ruoen (1997)[9], India/USA based on a 1983 benchmark from Timmer (1997b), Indonesia/USA based on a 1987 benchmark from Szirmai (1993); Taiwan/USA based on a 1976 benchmark (Timmer, 1997a), South Korea/USA and Japan/USA based on a 1987 benchmark from Pilat (1993).[10]

For the purpose of comparing labour productivity levels by branch of industry, industry of origin PPPs are preferable to the expenditure based PPPs (as derived in the International Comparisons Project, ICP). Expenditure PPPs are based on prices of final goods and thus include not only indirect taxes and transport and trade margins, but also the prices of imported goods, while excluding the prices of exported goods. Even when the expenditure PPPs are corrected for such factors, the problem remains that PPPs refer only to final products. Branches producing intermediate products like textiles,

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8 For this purpose consistency *between* labour and output time series is valued higher than consistency *within* each series.

9 Szirmai and Ruoen (1997) contains improved estimates of the results given in Szirmai and Ruoen (1995).

10 A new benchmark is in preparation for Taiwan/USA 1986. For India, Japan and Korea 1975 benchmarks are also available. In this paper we have only used one benchmark for each comparison. At a later stage in this project, the consistency between successive benchmarks and time series will be subject to further examination.

basic metals, pulp, wood products etc. will therefore not be covered by these final product PPPs.[11]

The basic data sources for the calculation of industry of origin PPPs are the manufacturing censuses of the different countries. On the basis of a careful matching procedure at product level Unit Value Ratios (UVRs) are derived, using value and quantity information from the producer side. These UVRs are subsequently aggregated into higher level PPPs by a stepwise procedure: first to industry level, then to branch level and finally to total manufacturing.[12] Output quantity weights are used at the first aggregation level, value added weights at the following steps. Using the quantity weights of each country in a binary comparisons, Laspeyres and Paasche PPPs at producer prices are derived. Subsequently Fisher PPPs are used to convert value added in national currencies into a common currency (single deflator procedure).[13] Details of the matching procedures (number of matches and coverage ratios) and the Fisher PPPs per branch are given in Appendix A.

ad c. The level comparison of labour productivity for the benchmark year is extrapolated backwards and forwards in time using national time series on real manufacturing output and employment[14]. These time trends are taken from the national accounts when available (Japan and USA), or from the manufacturing censuses or surveys, when consistent desaggregated national accounts series are not available (China, India, Indonesia and Korea), or from both (Taiwan). Census/survey data are subject to volatile changes in coverage; in general coverage is increasing over time[15]. However, as both labour and output figures are affected in the 'same' way by changes in coverage, labour productivity trends based on these figures will show much less sudden breaks, than the separate series for employment and output.

5.2 International Comparison of Labour Productivity in Total Manufacturing

The data on GDP per person employed in manufacturing relative to the USA from figure 2 are reproduced here as index numbers for selected years in panel A of table 6.

Japan was engaged in a process of rapid catch up in manufacturing till 1990, followed by a sudden decline in relative performance after that year, associated with an overall slowdown in economic growth, and an upward swing in the US economy. *Korea* and *Taiwan* started from very low levels of productivity in 1963 and achieved substantial advances both relative to the USA and to Japan (see figure 3). However, catch up in Taiwan was much slower than in Korea, with relative

11 See for elaborate discussion van Ark (1996, p.13-17).

12 ICOP sample industries consist of one or more four digit ISIC industries. ICOP branches consist of 2 or 3 digit ISIC divisions or branches. For a detailed discussion of the relationship between ISIC classification and ICOP see Szirmai and Pilat (1990a).

13 See for a more detailed description of the ICOP industry of origin approach Maddison and van Ark (1988), Pilat (1993) or van Ark (1993). Timmer (1996) provides a statistical reinterpretation of the ICOP approach as a stratified sampling approach.

14 For Indonesia time series have been rebased on a 1983 price basis in comparison to the 1975 based series used in Szirmai (1994).

15 This is exemplified by the Indonesian surveys of medium and large manufacturing establishments. The number of establishments covered in 1985 was 8006. In 1986 a new sampling frame was used, increasing the number to 12909 covered establishments.

productivity in 1993 at 28% of the US level against 49% for Korea.

Table 6 also illustrates the *divergence between India, China and Indonesia on the one hand and Korea and Taiwan on the other*. *India* for instance, stands at approximately the same level as Korea and Taiwan in 1963, but has made but modest gains since then, most of which occurred between 1987 and 1990, now standing at Korean levels of the end 1960's. A remarkable characteristic of *Chinese* economic performance is the combination of rapid growth of industrial output and rapid growth of labour productivity, with absence of improvement in relative productivity performance.[16] The same pattern of rapid growth with no or only slow catch up is found for *Indonesia*, during the 1980's, although in recent years an accelerating trend can be discerned.

Panel C of Table 6 shows the labour productivity levels put on a hourly basis. As hours worked in the Asian manufacturing sectors are much higher than in the USA (see panel B), relative labour productivity in Asia becomes much lower. On an hourly basis, the productivity gap relative to the USA is still enormous in Korea and Taiwan and substantial in Japan. The differentials between the Asian economies in 1987 become smaller, as Taiwanese and especially Korean economic development is still based in part on exceptionally long working weeks.

Table 6
Gross Value Added per Worker and per Hour Worked in Total Manufacturing for 6 Asian Economies, 1963-1993, (USA = 100)

	India (a)	China (a)	Indonesia (a)	Korea	Taiwan	Japan	USA
A. Gross Value Added per Worker (USA =100)							
1963	6.6			7.2	6.3	29.5	100.0
1970	7.4			12.4	10.4	53.5	100.0
1975	6.2		6.4	16.5	10.4	59.7	100.0
1980	6.2	6.3	9.2	19.8	14.1	77.0	100.0
1984	7.3	6.1	9.5	24.4	16.0	78.2	100.0
1987	7.3	5.7	10.0	26.5	19.1	76.4	100.0
1990	9.2	5.4	11.7	38.7	23.4	87.4	100.0
1993		(b) 6.3	12.4	49.1	27.5	78.7	100.0
B. Hours Worked per Worker							
1975	2,256			2,590	2,662	2,057	1,881
1987	2,397	2,225	2,178	2,757	2,509	2,168	1,920
C. Gross Value Added per Hour Worked (USA = 100)							
1975	5.2			12.0	7.3	54.6	100.0
1987	5.9	4.9	8.8	18.4	14.6	67.7	100.0

Notes: (a) Indian, Chinese and Indonesian figures have limited coverage excluding small establishments, see discussion below; (b) 1992 for China;
Source: See Figure 2, Chinese hours worked estimate from Jingwan e.a. (1993), p.168 ff.

[16] Note that comparisons between China and other countries are fraught with great difficulties, due to conceptual differences, uncertainties concerning coverage and lack of consistency and transparency in Chinese published statistics (see Szirmai and Ruoen, 1995, 1997).

As indicated in the notes to Table 6, the coverage of manufacturing activities in the censuses is not uniform. The Japanese and Taiwanese censuses cover total manufacturing. The Korean census covers only establishments with five employees or more, but a correction for this has already incorporated in Table 6. In the Chinese, Indian, and Indonesian surveys however, part of the manufacturing establishments are deliberately not covered. Hence for realistic comparisons, adjustments have to be made.

In *India*, the census only covers the 'registered' factories. Establishments with less than 20 employees using no power, or establishments with less than 10 employees using power, are not covered. In *Indonesia* only the medium and large scale sector is covered in the industrial surveys. Establishments with less than 20 employees are excluded. The coverage of the *Chinese* census is less clear cut, as it contains the results of four different types of questionnaires. The data given in the tables of this paper refer to independent accounting enterprises at township level and above. This means that independent accounting enterprises below township level, and non-independent accounting enterprises are excluded. For these sectors, no single cut off point in terms of establishment labor force size can be given, but the average employment size is six workers per establishment (see Szirmai and Ruoen 1997 for extensive discussion on this matter).

One could argue that for developing countries such as China, India and Indonesia, only the medium and large scale sector is relevant for the comparison with more advanced economies. The small scale and informal sector is not really part of a modern industrial sector and does not reflect structural change. Very small establishments perform traditional, non-automated forms of production which have no counterpart in advanced economies.

On the other hand, lower productivity in the small scale and informal sector will certainly affect the productivity comparisons for total manufacturing, especially when it is big in terms of employment. Using data in addition to census data an estimate can be given of the size of the non-covered, but formal, part of the manufacturing sector. In 1984, in *India,* the total number of persons engaged in the non-registered sector is 5 times as high as in the registered sector, producing only half its value added. This means that labour productivity of the non-registered sector is only 11% of that in registered firms.[17] In 1986, the *Indonesian* small scale sector employs twice as much persons as the medium and large scale sectors, while producing only a fifth. The labour productivity level of the Indonesian small scale sector is some 10% of the medium and large scale level, comparable to India.[18] In 1985, in the 'small' enterprises in *China* about half as many persons are engaged as in the independent accounting entreprises above township level (IAE), producing about a sixth of its output. Labour productivity of the 'small' enterprises is thus 33% of the IAE.[19]

Applying these ratios, a comparison of labour productivity levels for the total manufacturing sector in these three countries can be made.[20] In 1985, labour productivity levels of the total

17 From van Ark (1991, Table A.1.3).

18 See Szirmai (1993, Table A3).

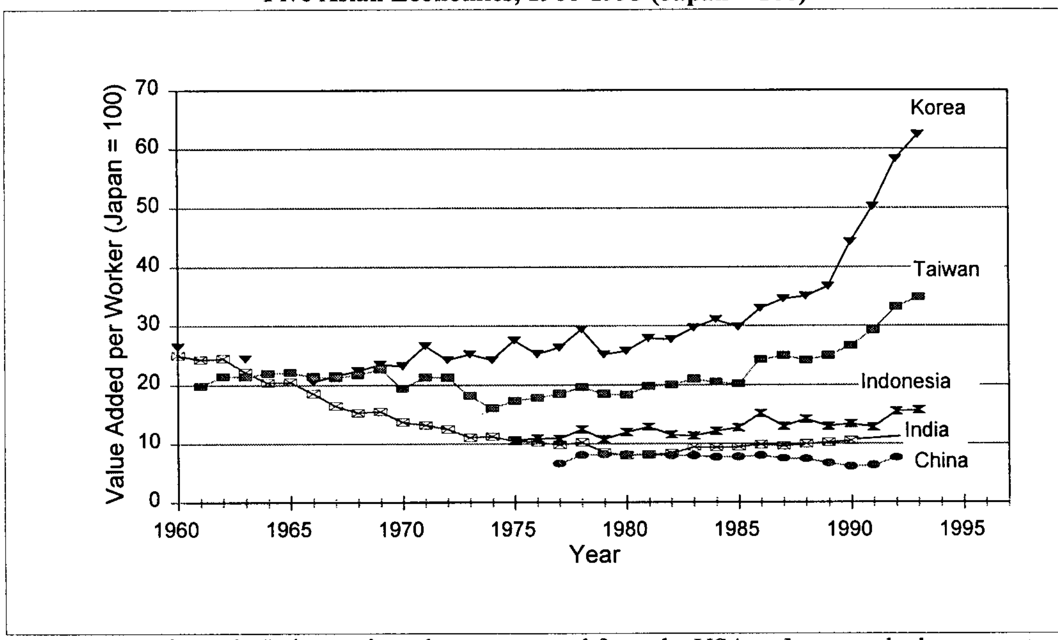
19 See Szirmai and Ruoen (1997, Table A.2)

20 We assume that the 1984 Indian and 1986 Indonesian labour productivity levels and size of the small scale sector, relative to the medium/large scale sector, are valid for 1985 as well.

manufacturing sector for China, India, and Indonesia become respectivily 5%, 2% and 4% of the USA level. This shows that when an adjustment for undercoverage in the census is made, Chinese labour productivity is higher than in Indonesia, and much higher than in India in contrast to the picture emerging from Table 6. Given the major uncertainties involved in the adjustments, and the lack of sectoral breakdown in the uncovered sector, we will continue to use the unadjusted benchmarks in the remainder of this paper.

Thus far the reference country was the USA. In Figure 3, productivity levels are expressed relative to Japan, the leading Asian economy. Figure 3 provides further illustration of the process of divergence between Asian economies. The pattern of relative stagnation in China, India and Indonesia, and catch up in Korea and Taiwan is even more pronounced, than in table 6.

Figure 3 Relative Labour Productivity Levels in Manufacturing Five Asian Economies, 1960-1993 (Japan = 100)



Source: See Figure 2. Estimates have been converted from the USA to Japan as the base country.

6. Structural Change in Asian Manufacturing

In this section we will concentrate on developments *within* the manufacturing sector. First we will compare patterns of structural change within manufacturing in our Asian economies in section 6.1. In section 6.2, we examine the contribution of structural change to aggregate productivity growth. Finally, we try to identify the manufacturing branches [21], which contributed most to growth of

[21] Conforming to standard practice in ICOP studies, we identify the following 14 branches: 1. Food products and beverages, 2. Tobacco products, 3. Textile mill products, 4.Wearing apparel, 5. Leather products and footwear, 6. Wood products, furniture & fixtures, 7. Paper products, printing & publishing, 8. Chemical materials and products, 9. Rubber and plastic products, 10. Non-metallic mineral products, 11. Basic & fabricated metal products, 12.Machinery & transport equipment, 13. Electrical machinery &

manufacturing output in section 6.3. This sets the stage for the international comparison of productivity trends at the branch level in section 7.

6.1 Branch Shares and Structural Change

Table 7 gives branch shares in total manufacturing value added for the years 1963, 1978 and 1993 (or latest year). These output shares tell us about the structure of production, and its change.

Table 7
Share of Manufacturing Branches in Total Manufacturing GDP (in current national prices) for 1963, 1978 and 1993 (in %).

	USA			Japan			Taiwan		
	1963	1978	1993	1963	1978	1993	1963	1978	1993
Food, bev. and tob.	12.9	9.8	11.0	14.8	11.2	12.1	42.2	13.7	9.1
Textile mill products	3.1	2.7	2.2	6.9	4.8	1.9	10.9	10.3	6.6
Wearing apparel	3.5	3.1	2.5	1.3	1.8	1.7	3.0	5.2	3.2
Leather products	1.1	0.6	0.4	0.5	0.4	0.4	0.2	1.4	1.0
Wood products	4.1	5.2	4.7	3.8	3.7	2.8	4.3	3.3	1.4
Papers, print & publ.	8.5	9.0	11.5	6.9	7.4	7.9	5.3	4.2	3.4
Chemicals products	10.1	10.9	14.8	13.9	11.2	12.6	14.5	11.2	15.2
Rubber and plastic	2.5	3.0	3.6	2.4	3.3	4.6	2.1	6.9	7.4
Non-metallic mineral	3.5	3.3	2.4	4.4	4.3	3.5	6.2	4.6	5.2
Basic & fabr. metal	14.4	15.3	10.2	13.4	16.5	13.5	4.1	9.2	14.6
Machinery & transport	24.2	23.9	21.1	19.0	22.8	21.7	3.9	8.9	12.7
Electrical machinery	8.1	8.5	9.9	9.3	9.2	14.3	2.2	12.2	16.3
Other manufacturing	4.1	4.6	5.6	3.3	3.4	3.1	1.1	8.8	3.6
Total manufacturing	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

	Korea			India			Indonesia		China	
	1963	1978	1993	1963	1978	1990	1978	1993	1980	1992
Food, bev. and tob.	31.6	18.0	10.0	12.6	10.7	11.5	32.5	24.0	10.4	12.7
Textile mill products	17.3	12.0	7.2	25.2	19.3	12.8	16.0	9.7	15.5	8.7
Wearing apparel	2.4	5.8	5.0	0.9	0.7	1.3	0.3	3.8	2.0	2.3
Leather products	0.3	2.2	1.1	0.3	0.6	1.0	0.9	4.4	1.0	1.0
Wood products	4.1	2.8	2.1	1.1	0.6	0.4	3.9	10.3	1.3	1.0
Papers, print & publ.	7.8	4.0	5.1	4.6	3.9	3.9	2.7	4.5	3.3	3.0
Chemicals products	12.0	13.5	11.3	10.6	18.0	19.3	(a) 13.1	(a) 9.5	16.4	16.2
Rubber and plastic	3.0	4.1	5.5	4.3	3.6	4.1	7.5	4.6	4.0	3.7
Non-metallic mineral	6.1	5.0	5.3	3.9	3.7	5.6	8.2	4.6	6.3	7.8
Basic & fabr. metal	5.8	10.3	12.7	16.0	15.3	16.1	3.9	10.8	13.1	14.6
Machinery & transport	5.5	10.7	14.9	15.7	15.6	14.9	6.8	9.3	17.3	17.9
Electrical machinery	2.4	8.9	16.8	3.9	6.7	8.2	3.8	3.3	6.0	7.9
Other manufacturing	1.7	2.8	2.8	0.9	1.3	1.0	0.4	1.1	3.4	3.1
Total manufacturing	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes: (a) Excluding oil refining and liquid natural gas.
Sources: See Appendix B.

equipment, 14. Other Manufacturing. In some cases tobacco is included in food and beverages, due to the lack of detailed data.

Table 7 highlights the dramatic changes in the structure of manufacturing in *Korea and Taiwan* in the course of catch up. Most importantly, the share of food, beverages and tobacco declined rapidly from 1963 to 1993, in Korea from 32% to 10%, and in Taiwan from 42% to a mere 9%. Also textiles are declining in importance, especially in Korea (from 17% in 1963 to 7% in 1993). The most rapid expansion is to be seen in machinery and transport equipment and electrical machinery and equipment, the latter branch increasing its share sevenfold in both countries, driven by explosive export growth. In 1993, these branches together accounted for 29% of manufacturing GDP in Taiwan, and no less than 32% in Korea. Basic and fabricated metals also improved their share, especially in Taiwan. The chemicals branch remained important throughout the whole period in both economies.

Trends in the structural change of the *Japanese manufacturing* sector seem to set in earlier than in Korea and Taiwan. The share of food manufacturing in 1963 is much lower than in Korea and Taiwan, the share of machinery and transport equipment and electrical machinery and equipment higher, the decline in the importance of textiles more marked (from 7% to a mere 2% during 1963-1993). The most important branch in Japan is the machinery and transport equipment branch, improving its share from 19% in 1963 to 22% in 1993. The development of electrical machinery and equipment was most marked, this branch increasing its share from 9% to 14% between 1963 and 1993.

From 1978 to 1993 patterns of structural change in *Indonesia* were quite different. The share of food manufacturing declined as in Korea and Taiwan, but there was no corresponding increase in the share of electrical machinery and equipment. Instead, rapid increases were registered in metal products and wood products, each accounting for some 11% of total output in 1993. Most dramatic increases are recorded in the labour intensive wearing apparel and leather products branches, together accounting for 14% in 1993, while contributing only 1% to manufacturing GDP in 1978. Indonesia followed a development path of both massive government investment in the metal branch and resource based industries such as wood, rubber and fertilisers. Thus Indonesian industrialisation was based on abundant natural endowments (Hill, 1992).

The development of the *Indian manufacturing* sector is also rather different from the East-Asian path. The structure of Indian manufacturing changed but slowly. As early as 1963, food manufacturing accounted for only 13% of manufacturing GDP. Notable are the high shares of basic and fabricated metals and machinery and transport equipment in 1963 (both 16%). This reflects the focus on heavy industry - machines to build machines - in post-war Indian development planning (Bardhan, 1984; Ahluwahlia, 1991). The most important branch in 1963 was textiles (25%). Its share declined to 13% in 1990, but it is still one of the important sectors. The most marked increases were those in chemicals up to 19%, and electrical machinery and equipment to 8%. Compared to the other countries, the structure of Indian manufacturing changed more gradually.

The structure of *Chinese manufacturing* in the 1980's was very similar to that of India characterized by a low share of food, and important heavy industries. Between 1980 and 1992 there was little change in industrial structure, except for a marked decline in the share of textiles.

The different development paths followed by the six Asian countries show that *there is no unilinear pattern of development*. Instead the pattern of change depends on country characteristics such as size, resource abundance, openness etc. (Syrquin and Chenery, 1988). Nevertheless, one can discern a tendency of convergence in the structure of manufacturing. In all economies the importance of the food and especially textiles branches is declining, and the shares of the capital goods sectors as machinery and transport equipment and electrical machinery are rising.

To illustrate this process of convergence in the structure of the manufacturing sectors under study we have calculated so called similarity indices. The basic idea of the similarity indices is to construct a share vector for each country in a binary comparison, consisting of the shares of all 13 manufacturing branches in total manufacturing value added. For each country the shares of all branches are represented by one single vector. The angle between the two vectors can be interpreted as a measure of the similarity between the two vectors. The similarity index, which is defined as the cosine of this angle, varies between 0 and 1 and is lower in case of greater dissimilarity. In a formula[22]

$$I^{ux} = \frac{\sum_{j=1}^{m} S_j^{u} S_j^{x}}{\sqrt{\sum_{j=1}^{m} (S_j^{u})^2 \sum_{j=1}^{m} (S_j^{x})^2}} \qquad \textbf{(3)}$$

I^{ux} is the similarity index between countries u and x. S_j^u and S_j^x are the branch shares in value added of respectively country u and x.

The results for these similarity indices are reproduced in Figure 4. This figure gives the similarity between the manufacturing structure of the Asian countries through time, with that of the US manufacturing sector in 1987. We took the US 1987 structure as a reference, both because the USA is the base country in all our binary comparisons, and because it is exemplifies the structure of a fully developed and mature manufacturing sector.

Figure 4 shows *strong tendencies towards convergence in manufacturing structures.* Korea and Taiwan, in particular, showed strong convergence during 1955-1993, though for Taiwan this process of convergence levelled off after the end of the seventies. Japan showed also strong convergence in the early period from 1955 to the beginning of the sixties. Since then, it had a structure which closely resembles the USA manufacturing structure. India also converged strongly in the sixties, starting from a relatively high level of similarity in 1960. China's industrial structure is also rather similar to that of the USA in the 1980's. The only exception in figure 4 is Indonesia, which shows a much lower degree of similarity to the US structure, as already noted above. But also Indonesia's structure is converging to the structure of the other Asian countries in the most recent years.

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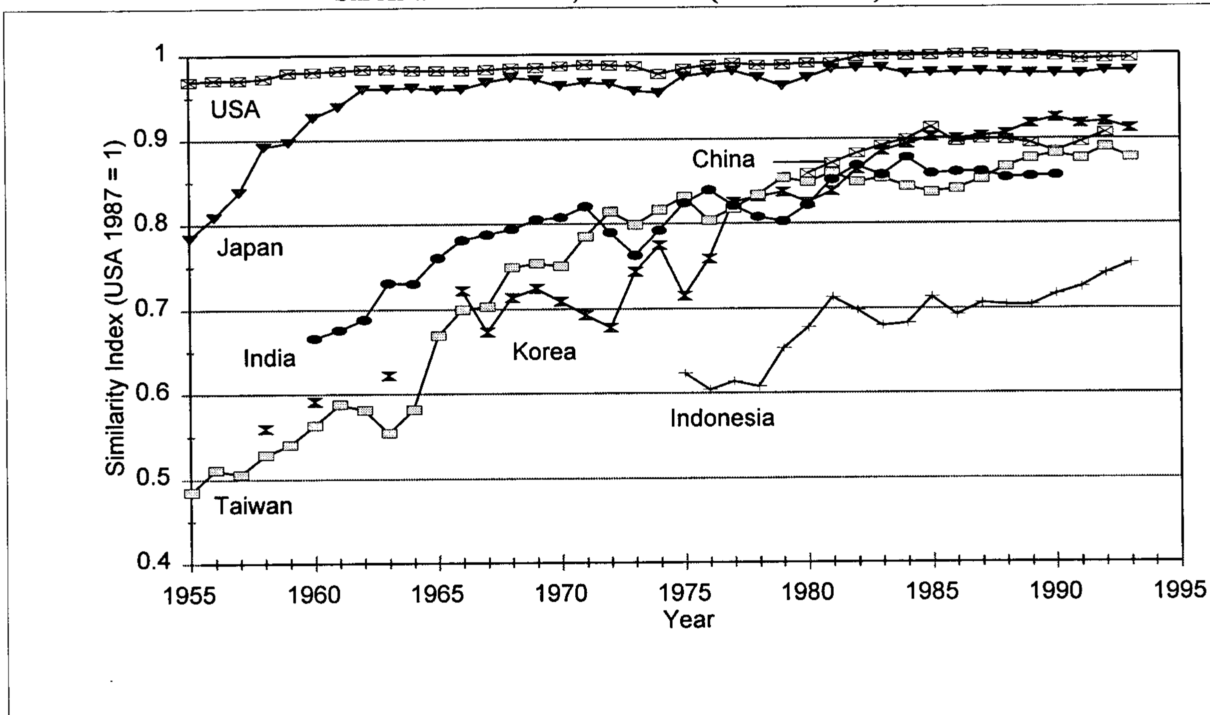
22 These measures are also used in ICP reports although in a different form, see, for example, Kravis, Heston and Summers (1982) p.348; Heston and Summers (1993). Besides this angle approach, we also used Euclidean distances to measure similarity. The results are nearly identical.

Figure 4
Similarity Indices for Total Manufacturing
Six Asian Economies, 1955-1993 (USA 1987 = 1)



Source: Based on current value added shares of thirteen manufacturing branches in total manufacturing. See formula in main text. For shares data see Appendix B.

6.2 The Impact of Structural Change on Labour Productivity Growth in Manufacturing

It is commonly hypothesized that structural change in manufacturing is beneficial for aggregate productivity growth, as labour is shifted out of low productivity industries like food and textiles into higher productivity manufacturing activities. To examine this, we follow Nordhaus (1972) in his decomposition of aggregate labour productivity growth.

Let LP denote the labour productivity level, subscripts i denote manufacturing branches (i=1,..,n with n the number of branches), and superscripts 0 and T denote the begin and end of the period [0,T]. S_i is the share of branch i in total employment. Labour productivity growth between 0 and T can be written as

$$LP^T - LP^0 =$$

$$\sum_{i=1}^{n}(LP_i^T - LP_i^0)\cdot S_i^0 + \sum_{i=1}^{n} LP_i^0\cdot(S_i^T - S_i^0) + \sum_{i=1}^{n}(LP_i^T - LP_i^0)\cdot(S_i^T - S_i^0) \tag{4}$$

Equation (4) shows that aggregate productivity growth can be decomposed into three parts: 1. intra-branch productivity growth, 2. a static structure effect, and 3. a dynamic structure effect. The last two terms taken together indicate the total effect of structural change on productivity growth.

A positive static effect indicates a shift of labour into branches with higher productivity at the beginning of the period. In addition, a positive dynamic effect indicates a shift into branches with higher productivity growth, i.e. to more dynamic branches.

Dividing each term of equation (4) by the total growth gives the percentage contribution of each part. Table 8 gives these contributions for the six Asian economies for 4 periods: 1963-75, 1975-87, 1987-93 and 1963-93 (insofar data are available).

Table 8
Decomposition of Manufacturing Productivity Growth in Six Asian Economies, 1963-1993, (in percentages).

Productivity growth explained by:	Japan 1963-75	Japan 1975-87	Japan 1987-93	Japan 1963-93	Taiwan 1963-75	Taiwan 1975-87	Taiwan 1987-93	Taiwan 1963-93	Korea 1963-75	Korea 1975-87	Korea 1987-93	Korea 1963-93
Intra branch productivity growth (%)	103	100	90	92	130	109	88	107	124	105	101	121
Structural change (%), of which:	-3	0	10	8	-30	-9	12	-7	-24	-5	-1	-21
Static effect (%)	-1	-3	8	-1	-21	-2	8	-4	-5	-7	1	-1
Dynamic effect (%)	-2	3	2	9	-9	-7	4	-3	-19	2	-2	-20

Productivity growth explained by:	Indonesia 1975-87	Indonesia 1987-93	Indonesia 1975-93	China 1980-87	China 1987-92	China 1980-92	India 1975-87	India 1987-90	India 1975-90
Intra branch productivity growth (%)	103	137	129	97	88	94	86	101	90
Structural change (%), of which:	-3	-37	-29	3	12	6	14	-1	10
Static effect (%)	0	-11	0	11	12	10	10	0	5
Dynamic effect (%)	-3	-26	-29	-8	0	-4	4	-1	5

Source: Using Equation (4). See main text. Data from sources given in Appendix B.

Table 8 shows first of all that *structural change is unimportant in explaining the growth of labour productivity in total manufacturing*. The structure effect never explained more than 14%. Thus, the rapid structural changes in Asian manufacturing did not involve a labour shift from low to high productivity branches. On the contrary, structural change often contributed *negatively* to manufacturing productivity growth (see also Dollar and Wolff, 1993). This indicates that the 'early' industries are among the highest productivity ranking industries. In *Taiwan* during the period 1963-1975 a labour shift took place from the high productivity and dynamic food, beverages and tobacco branch towards the low productivity electrical machinery branch, causing a -30% structure effect. However, this was compensated for by rapid labour productivity growth within almost all branches, resulting in rapidly rising overall labour productivity, as shown in Table 4. *Korea* had a similar experience with a structure effect of -24% in the early period, mainly caused by a shift out of the most dynamic branches as witnessed by a dynamic effect of -19%. In a similar fashion, *Indonesia* in recent years moved labour into static, low productivity branches like wood and wearing apparel, but nevertheless managed to increase its overall labour productivity performance because of productivity increases within its most important branches. Only in *China* 1987-92 and in *India* 1975-87 has a significant shift taken place towards higher productivity branches,especially chemicals. The structure effects were resp. +12% and +14%.

Thus one may conclude that although structural change in the total economy had beneficial consequences for overall labour productivity levels, this is not the case for the structural changes taking place within Asian manufacturing. There has not been any structural change bonus within manufacturing. Instead, the Asian economies have relied on the *rapid growth of labour productivity in all branches to raise overall levels of labour productivity in manufacturing.*

6.3 Branch Contributions to Aggregate Growth

Having analysed the changes in the structures of manufacturing, the question arises which branches were the driving forces in rapid growth of manufacturing output. To this end, we used equation (1) introduced in section 3. Instead of applying this equation to the contribution of manufacturing to GDP growth, we now apply it to calculate the contributions of each of the 14 manufacturing branches to the growth of GDP in the manufacturing sector as a whole. Equation (1) states that the contribution of each branch to the growth of the manufacturing sector in a period is dependent on the share of the branch in total output at the beginning of the period, and the growth rate of the branch during the period.

For each country, table 9 shows the percentage contribution of each branch to the growth of the manufacturing sector for the periods for which data is available. The bold printed figures in the table indicate the branches with the highest contribution to total manufacturing growth in each country, for each period.

A well-known classification of manufacturing branches is based on the stage of development in which branches make their main contribution to the growth of manufacturing output. The categories distinguished are early, middle and late (see Chenery and Taylor, 1968; Syrquin and Chenery, 1988). Branches important in early stages of industrialisation are food, beverages and tobacco, textiles and wearing apparel and other manufacturing. Branches important in middle stages of industrialisation are wood products, chemicals, rubber and plastics, and non-metallic minerals. Branches important in late stages of industrialisation are paper, basic and fabricated metals and machinery. If this classification is valid, one would expect this sequence in the importance of branches to unfold first in the early industrialiser in Asia, Japan, next in the catch-up countries Korea and Taiwan and finally in China, India and Indonesia. However, the data in table 9 do not bear out this hypothesis.

First, in the post-war period covered in the table two sectors provided an important contribution to growth in all economies and in all periods: namely chemicals together with rubber and plastics (a middle branch), and machinery and transport equipment (a late branch). *The chemicals branch was the most important branch for all economies*. This is both because it had a relatively large share in

Table 9 Contribution of Branches to Real Manufacturing Value Added Growth, Six Asian Economies, 1955-1993 (in percentages of total manufacturing growth

	Food Products & Beverages	Tobacco	Textile Mill Products	Wearing Apparel	Leather Products & Footwear	Wood Products, Furniture, Fixtures	Paper Products, Printing & Publishing	Chemicals, Petroleum & Coal Products	Rubber and Plastic Products	Non-Metallic Mineral Products	Basic & Fabricated Metal Products	Machinery and Transport Equipment	Electrical Machinery and Equipment	Other Manufacturing Industries	Total Manufacturing
India															
60-65	7.8	0.8	11.3	0.6	0.6	0.9	5.5	11.3	2.0	6.0	**24.9**	21.2	6.0	1.0	100.0
66-72	-7.7	-0.6	20.2	1.3	0.9	-0.4	6.3	**35.2**	5.3	0.3	6.8	13.9	15.8	2.7	100.0
73-79	7.0	1.0	17.2	-0.7	0.6	-0.2	1.9	18.0	1.2	4.8	17.5	**20.5**	10.2	1.0	100.0
80-86	15.5	1.9	2.1	1.1	1.2	0.3	3.4	**32.3**	4.6	6.8	4.9	11.9	12.4	1.8	100.0
87-90	8.8	1.3	13.9	2.4	1.1	0.5	3.7	**23.4**	6.4	6.6	12.3	11.3	7.7	0.6	100.0
60-90	8.8	1.2	10.9	1.2	1.0	0.3	3.9	**25.4**	4.5	5.7	11.5	14.1	10.2	1.3	100.0
China															
80-86	7.7	7.6	11.1	3.0	1.1	0.1	2.7	15.3	2.9	5.8	9.9	**19.5**	9.8	3.5	100.0
87-92	11.1	6.9	1.1	3.3	0.6	0.3	1.8	20.6	4.4	7.3	6.0	**24.8**	8.7	3.2	100.0
80-92	9.1	7.3	6.9	3.2	0.9	0.2	2.3	17.5	3.5	6.4	8.3	**21.7**	9.3	3.4	100.0
Indonesia								(b)							
75-79	0.5	**23.9**	10.1	0.6	0.2	11.4	1.2	13.8	5.8	8.8	6.5	8.3	8.3	0.5	100.0
80-86	10.5	12.1	11.4	2.7	0.3	17.1	4.6	8.3	3.5	4.0	**19.6**	5.2	0.4	0.4	100.0
87-93	**15.8**	6.7	12.2	6.2	7.5	9.4	5.2	7.6	4.4	4.1	7.1	8.4	3.8	1.7	100.0
75-93	**13.4**	9.3	11.9	5.0	5.3	11.3	4.8	8.2	4.3	4.4	9.9	7.7	3.3	1.3	100.0
Taiwan	(a)	(a)													
60-65	11.3		7.5	2.1	0.0	8.9	6.9	**26.1**	4.6	10.4	5.6	9.7	4.7	2.3	100.0
66-72	10.1		8.6	7.2	1.3	7.5	5.5	**16.8**	8.4	2.7	8.4	8.5	10.2	4.9	100.0
73-79	12.4		9.8	7.1	3.3	-0.9	5.0	5.0	7.2	5.8	11.3	**13.3**	11.6	9.2	100.0
80-86	9.5		7.2	3.9	1.5	2.8	3.1	**17.6**	9.3	2.6	12.9	9.6	14.5	5.5	100.0
87-93	3.5		5.9	-0.7	-0.5	-2.4	2.4	19.7	5.7	7.2	21.9	15.5	**23.5**	-1.8	100.0
60-93	8.0		7.3	3.2	1.1	1.2	3.5	**16.6**	7.6	4.8	15.0	12.0	16.4	3.5	100.0
Korea															
58-65	**25.2**	(a)	1.9	5.1	0.3	2.6	7.3	23.9	1.9	8.3	9.7	6.6	3.4	3.8	100.0
66-72	13.6	4.6	11.4	5.8	1.8	2.4	2.9	**25.1**	4.4	6.5	9.2	4.8	5.2	2.3	100.0
73-79	10.5	4.4	9.7	10.1	2.3	1.2	4.8	11.2	6.1	5.3	**11.5**	11.5	8.5	3.0	100.0
80-86	5.7	1.5	5.6	2.7	1.7	0.8	4.4	7.1	5.8	3.6	9.7	22.5	**23.8**	5.1	100.0
87-93	6.2	0.8	5.3	3.8	0.1	1.1	5.1	11.4	5.3	4.8	12.8	18.0	**23.2**	2.0	100.0
58-93	7.0	1.6	6.2	4.3	0.9	1.1	4.7	10.8	5.5	4.6	11.5	17.9	**20.7**	3.1	100.0
Japan	(a)	(a)													
55-58	15.0		8.4	1.8	0.8	7.9	10.7	12.2	5.6	6.4	8.3	**16.5**	2.0	4.3	100.0
59-65	12.9		5.4	2.4	0.7	6.2	9.9	12.2	4.6	5.4	15.2	**18.8**	2.3	3.9	100.0
66-72	13.5		2.5	1.6	0.3	4.0	5.7	10.2	3.9	6.7	**22.9**	19.8	6.7	2.3	100.0
73-79	8.8		2.1	1.4	0.4	-1.1	7.3	9.7	2.6	-3.7	8.2	**37.9**	21.2	5.2	100.0
80-86	1.5		-1.1	1.5	0.2	-0.0	6.1	13.4	5.4	3.1	4.0	23.8	**39.7**	2.5	100.0
87-93	2.9		-0.4	0.6	0.1	1.0	4.9	9.0	2.2	1.5	8.7	20.4	**47.6**	1.3	100.0
55-93	7.6		1.4	1.4	0.3	2.0	6.5	10.9	3.8	3.1	12.0	23.1	**25.1**	2.7	100.0

Notes: (a) Tobacco included in food products and beverages; (b) Excluding oil refining and liquid natural gas. N.B. Highest row figures have been printed bold.
Sources: Calculated with equation (1) using constant price GDP series (see appendix B for sources).

output, but also because it had high growth rates. Third in importance was the basic and fabricated metals branch, again a late branch. Thus, these three branches are not typical for a particular stage of industrial development.

Secondly, though the contributions of textiles, wearing apparel and food manufacturing have not been unimportant, *there is no evidence of the expected overwhelming importance of these light industries in typically early stages of industrialisation.* In Korea food manufacturing was important between 1958 and 1965, in India textiles were important in the seventies, and in Indonesia food and textiles were important from the eighties onwards. But, in all countries and periods, except for Indonesia, the combined contribution of the light industries (food manufacturing, tobacco, textiles and wearing apparel) nowhere exceeded 30% of the total growth of manufacturing. One may therefore not conclude that these 'light' branches have been the driving force in early industrialisation. Although they tend to be more important in earlier stages of development, they are by no means the *main* contributors to growth.

The only branches where typical differences between earlier and later industrialisers are found are food manufacturing (including food, beverages and tobacco) and electrical machinery and equipment. The importance of electrical machinery and equipment increased dramatically in Korea, Japan and Taiwan, remaining stagnant in China and India, and diminishing rapidly in Indonesia. In food manufacturing, we see declines in the importance of this branch in Japan, Korea and Taiwan, as would be expected. In China, India and Indonesia, this branch is more important. What is confusing, however, is that the importance of food manufacturing is also increasing over time in these countries, rather than decreasing. From the early-middle-late perspective this would imply that these countries have just started to industrialise. This may be true of Indonesia which started its industrialisation drive very late, but certainly not of India and China.

In sum, the hypothesis of a unique unilineal pattern of industrial development in which low income countries copy patterns earlier followed by succesful industrialisers, is not supported by the data in table 9. Light industries do not play a predominant role in early stages of industrial development. Rather, chemical industries and heavy industries such as metal products, machinery and transport equipment play an important role throughout the whole in the industrialisation of all the countries throughout the post-war period.

Turning to the most recent period, 1987-1993, manufacturing growth in *Japan, Korea and Taiwan* was fuelled by the electrical machinery and equipment branch. Its contribution was more than 23% in Korea and Taiwan, and in Japan even 48%. In Taiwan the metal manufacturing branch is of increasing importance, contributing 22% to growth. In Korea this branch contributes 13%. Japan distinguishes itself from all the other Asian economies by its high dependence on electrical machinery and marked declines in the importance of textiles (which even contributed negatively to growth in recent years) and metal manufacturing.

Recent manufacturing growth in *India* was fuelled by chemicals, alone accounting for 23% of growth. Textiles accounted for another 14%. In *China*, the most important branches, by far, were the machinery and transport equipment branch (25%), followed by chemicals. Recent *Indonesian* manufacturing growth had its base in food manufacturing (16%), followed by textiles (12%) and wood (9%). Indonesia seems exceptional in Asian context in the increasing importance of these light

Sources: Calculated with equation (1) using constant price GDP series (see appendix B for sources).

industries and the quite low contribution of electrical machinery and equipment. These developments reflect the effects of the gradual deregulation of the 1980's and the associated shift towards more labour intensive, resource based sectors in line with Indonesia's comparative advantage (Szirmai, 1993; Hill, 1992).

7. Comparative Labour Productivity in Asian Manufacturing, by Branch of Manufacturing

Section 6.2 showed that the growth of manufacturing labour productivity in the Asian economies was entirely due to the rise in labour productivity levels within manufacturing branches. In this section these rises in labour productivity at branch level will be put into comparative perspective, in the same way as was done for total manufacturing in section 5. In section 7.1 we present the comparative branch labour productivity levels for four selected years. In 7.2 we address the question whether international differentials in aggregate manufacturing labour productivity are primarily explained by within branch differentials in labour productivity, or by differences in manufacturing structure between the countries being compared.

7.1 Comparative Labour Productivity at Branch Level

For each manufacturing branch, GDP per worker in national currencies is converted into US $, using branch specific PPPs, derived according to the ICOP industry of origin method described in Section 5. The branch PPPs are given in Appendix A. For each branch, table 10 gives GDP per worker in each Asian economy as a percentage of the USA level for 4 selected years. Full time series of relative labour productivity are presented in Appendix C.

First of all, table 10 shows that the relative trends and levels between branches in a country differ considerably, illustrating the usefulness of the disaggregated study of manufacturing performance.

In *India* productivity levels are still low in all branches. No branch has a labour productivity level of more than 24% of the USA, with worst performance in the food, beverages and tobacco branches (5% of the US level in 1990). Modest catch up at the aggregate level in 1987-90 has been due to an across the board catch up in all branches (except other manufacturing).

In *China,* no branch has a relative labour productivity exceeding 13% of the US level, in 1992 (except tobacco). Although some catch up has taken place in food and wearing apparel, the period of 1980-92 overall has been characterised by relative stagnation throughout the manufacturing sector (again with the exception for tobacco[23]).

In *Indonesia* there is more variation in relative performance. Some branches show considerably catch up, notably tobacco (albeit from a very low level), wood products, paper products and metals. In 1993 no branch exceeds the 30% level, while five branches exceed the 20% level relative to the USA. Food and other manufacturing on the other hand are still below the 10% level. Again, aggregate catch up is accompagnied by (modest) catch up taking place in almost all branches. It is not confined

[23] This is due to a dramatic decline in labour producitvity in the tobacco branch in the USA, rather than to above average performance of the Chinese tobacco branch.

Table 10 Gross Value Added per Person Employed as % of the USA, by Branch of Manufacturing, (USA = 100)

	Food Products & Beverages	Tobacco	Textile Mill Products	Wearing Apparel	Leather Products & Footwear	Wood Products, Furniture, Fixtures	Paper Products, Printing & Publishing	Chemicals, Petroleum & Coal Products	Rubber and Plastic Products	Non-Metallic Mineral Products	Basic & Fabricated Metal Products	Machinery and Transport Equipment	Electrical Machinery and Equipment	Other Manufac-turing Industries	Total Manufac-turing	Coefficient of Variation
India																
1963	5.2	3.5	14.7	19.3	12.1	n.a.	3.4	7.5	**23.1**	6.3	9.7	9.1	7.5	n.a.	6.6	0.58
1975	3.0	2.2	13.3	12.5	10.8	3.6	4.7	5.9	**17.0**	5.6	8.1	11.2	7.8	10.1	6.2	0.51
1987	4.8	3.0	12.1	14.0	15.7	4.3	4.6	5.8	15.5	7.3	7.5	10.5	8.9	**20.4**	7.3	0.53
1990	5.5	4.4	16.1	19.2	15.7	7.1	6.4	7.8	**24.1**	10.0	10.4	12.5	9.1	17.1	9.2	0.48
China																
1980	6.0	8.2	12.4	7.1	**15.9**	4.8	3.9	7.9	7.6	7.4	11.7	3.3	9.6	4.8	6.3	0.43
1987	5.8	15.5	8.9	8.3	**16.4**	3.3	3.9	5.5	5.4	6.8	12.1	3.2	11.7	3.9	5.7	0.54
1992	8.1	**26.7**	7.1	9.0	12.4	4.3	4.2	6.4	5.8	8.8	12.1	3.7	10.6	3.8	6.3	0.65
Indonesia																
1975	5.9	0.7	7.6	6.8	**34.3**	5.1	5.4	10.5	11.2	5.0	5.5	13.1	23.5	3.6	6.2	0.87
1987	4.2	3.9	12.7	17.1	**30.5**	13.9	9.0	13.4	8.6	11.0	25.2	14.0	21.0	4.0	10.0	0.57
1993	9.3	11.3	17.9	23.8	**28.6**	15.6	16.1	22.7	14.6	13.8	20.9	22.2	21.3	5.5	12.4	0.35
Taiwan	(a)	(a)														
1963	6.0		10.4	5.5	1.5	9.5	4.5	5.2	2.5	**26.7**	2.3	1.9	5.3	0.9	6.3	1.03
1975	7.3		20.7	12.9	32.5	14.2	8.1	8.7	10.5	**33.4**	7.4	11.8	15.8	5.4	10.4	0.61
1987	15.0		50.2	29.4	49.1	20.6	13.6	15.3	19.2	**65.8**	17.7	17.0	27.7	9.3	19.1	0.62
1993	17.4		83.2	35.6	45.4	27.3	15.7	23.8	32.5	**123.3**	26.0	19.4	37.6	8.9	27.5	0.80
Korea																
1963	5.7	1.5	9.9	**15.3**	8.3	4.2	7.0	5.4	4.4	8.8	7.7	3.1	10.1	3.0	7.2	0.52
1975	11.1	3.2	26.2	19.4	**51.4**	8.2	9.3	21.8	11.9	28.0	27.3	13.0	15.1	4.9	16.5	0.68
1987	12.9	16.7	34.2	20.2	47.6	12.8	32.1	20.8	19.3	**49.3**	45.0	43.8	40.7	15.3	26.5	0.46
1993	24.1	50.7	59.5	32.4	60.1	24.4	59.8	61.9	46.3	**84.6**	79.3	62.1	63.3	24.5	49.1	0.36
Japan	(a)	(a)														
1963	27.4		50.3	51.0	53.3	18.4	31.1	20.5	**84.3**	25.1	21.9	33.2	10.6	20.8	29.5	0.56
1975	46.9		108.7	52.9	55.3	22.0	52.2	62.5	**117.4**	52.2	67.9	84.5	34.7	30.2	59.7	0.45
1987	39.1		68.2	54.7	69.5	28.4	69.5	75.9	**127.5**	78.8	91.6	118.4	94.2	52.0	76.4	0.37
1993	38.2		58.5	47.0	50.2	36.2	77.2	85.9	**117.4**	76.7	90.2	100.1	106.9	43.9	78.7	0.37

Remark: Highest row figures have been printed bold; n.a. = not available.
Notes: (a) Food products and beverages including Tobacco.
Source: See Appendix C.

to a few highly performing branches.

Taiwan showed a rapid catch up in all branches of manufacturing. From 1963 to 1975, relative productivity levels more than doubled in all branches except food manufacturing, wood products, chemicals and non-metallic minerals. Some branches with lowest relative levels such as machinery and leather products showed the highest rates of catch-up. During 1975-93, textiles and non-metallic minerals showed the most impressive catch-up. Textiles went from 21% of the US level in 1975 to 83% in 1993. Surprisingly, in 1993 labour productivity in non-metallic minerals exceeded the US level by 23 percent.

Korea showed a similar pattern of catch up in all branches. In 1993, relative productivity in the worst performing branches such as food manufacturing, wood products, other manufacturing and wearing apparel exceed the 24% level, indicating that Korea had no laggard branches like Taiwan. Rapid catch up had taken place in tobacco, machinery, non-metallic minerals and metal products. The last two branches attained levels of 80% of the USA in 1993. Especially during the most recent period, 1987-93, the labour productivity levels in Korea caught up very rapidly. In 6 years relative productivity levels went up by 50 to 150% in all branches.

Japan also showed rapid catch up in all branches, though this was reversed in no less than 9 branches in the most recent period. The most pronounced decline can be found in the textiles sector, coming from 109% of the US level in 1975 to 59% in 1993. Over the whole period, electrical machinery, chemicals and metal products were the branches with the highest catch up performance. In 1993, Japan surpassed or equalled US levels in three branches: rubber and plastics, machinery and transport equipment and electrical machinery and equipment. The performance of branches such as food manufacturing and wood products, on the other hand, is still substandard.

Taking all Asian countries together, one notices that there are certain branches which do badly in all countries, notably food products and beverages, wood products and other manufacturing. In the most recent year, the labour productivity level in food in India, China and Indonesia was below 10% of the US level, below 25% in Taiwan and Korea and below 40% in Japan. Although some catch up has taken place in this branch, it is still the worst performer in the Asian economies. With regard to catch up one may conclude that the branches in which catch up is most marked, differ from country to country. *There are no typical catch-up branches.*

Moreover, branch trends in relative performance within a country tend to be rather similar, and there is a *tendency to convergence in relative branch labour productivity levels within the countries.* This is illustrated by the last column of Table 10 which shows the coefficient of variation across the branches for each country and each year. This coefficient shows a tendency to decline over time in all countries except for China, showing that branches with the lowest relative labour productivity levels have been growing more rapidly than the branches which already had high levels.This points to a modified version of the catch-up hypothesis at branch level: within an economy branches with the lowest relative labour productivity level manifest the strongest catch-up tendencies. At branch level there are advantages of backwardness which are consistent with the catch-up hypothesis.

It should also be noted that all countries show a similar spread in relative branch performance, except Taiwan. This indicates that in Taiwan the differences between well and badly performing branches is substantially higher than in the other economies.

The main conclusion is that *stagnation or catch up in total manufacturing reflects stagnation or catch up across all branches of manufacturing.* This points to the importance of economy wide forces determining relative labour productivity trends at branch level, reinforcing the notion of conditional convergence.

7.2 The Role of Branch Productivity Differentials in Explaining Aggregate Productivity Differentials in Manufacturing

In section 6.1 we concluded that catch up in Japan, Korea and Taiwan is combined with increasing convergence in the structure of manufacturing with that of the US. But, on the other hand, the economies of China and India also manifest a high degree of similarity with the USA, though the convergence trends are less pronounced. This suggest that structural differences between the Asian countries and the USA at given points in time might have been an important determinant of productivity differences, at least in early years. To investigate this we use the same method as in section 6, but now in a interspatial context rather than a intertemporal context.

Let superscripts A and B denote country A and B. Country A is the reference country, the USA. The difference in labour productivity levels in two countries A and B ($LP^B - LP^A$, both given in the same currency) can be written as:[24]

$$LP^{B} - LP^{A} = \sum_{i=1}^{n} (LP_i^{B} - LP_i^{A})\, S_i^{A} + \sum_{i=1}^{n} LP_i^{B}\, (S_i^{B} - S_i^{A}) \qquad \textbf{(5)}$$

with S_i branch labour shares. Equation (5) shows that difference in labour productivity levels in two countries can be decomposed into two parts: the part due to intra-branch productivity differences, and the part due to differences in structure. Dividing each part by the total difference gives the percentage contribution of each part to the total difference. The results for the years 1963, 1975 and 1987 for all comparisons are given in Table 11.

The overwhelming conclusion emerging from Table 11 is that intra-branch productivity differentials explain more than 90% of aggregate manufacturing productivity differentials. The gaps between countries are explained by productivity gaps within all the branches rather than by structural differences. This is true for 1987, but also for earlier years. So even in early years of industrialization when structural differences with the USA are big, it is not true that labour is concentrated in below average productivity activities. Instead the *international productivity differentials in manufacturing are due to great labour productivity differentials in all branches of manufacturing.* This also implies that catch up potential of structural change within manufacturing is limited. Even if the structural differences vis à vis the USA would become smaller, the productivity gap relatively the USA would only show modest decline. Catch up can only be realised if labour productivity levels in all branches of manufacturing increase sufficiently.

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[24] The last two terms in (4) have been taken together. There is no point in distinguishing a dynamic effect in a cross country comparison at one point in time.

Table 11
Decomposition of Manfucturing Labour Productivity Differences with USA in Six Asian Economies, 1963, 1975 and 1987, (in percentages).

Productivity difference explained by:	Japan 1963	Japan 1975	Japan 1987	Taiwan 1963	Taiwan 1975	Taiwan 1987	China 1987
Intra branch productivity differences (%)	99	98	91	101	100	102	100
Structural difference (%)	1	2	9	-1	0	-2	0

Productivity difference explained by:	Korea 1963	Korea 1975	Korea 1987	Indonesia 1975	Indonesia 1987	India 1975	India 1987
Intra branch productivity differences (%)	100	98	94	96	94	99	99
Structural difference (%)	0	2	6	4	6	1	1

Source: Using Equation (5). See main text. Productivity levels from Appendix C.

8. International Comparisons of Total Factor Productivity Levels

The previous sections showed that labour productivity differences are still substantial between the USA and Japan on the one hand, and the other Asian economies on the other, even when structural differences were taken into account. An obvious explanation of this gap can be found in differences in capital intensity in these economies. Figure 5 shows these differences in capital intensities. Using a variety of sources, we have put together comparable capital stock estimates for total manufacturing for (varying) benchmark years. We have extrapolated these stock estimates in time using national time series on capital stock growth. The data sources are given in Appendix B[25].

Figure 5 indicates that the capital intensities in the Asian economies (except Japan) are still well below the USA level. Korea achieved substantial catch-up after 1975, standing close to 70% in 1985. Rather surprisingly, Taiwan only start to catch-up in capital intensity from the beginning of the eighties onwards, reaching the 50% in 1990. China, India as well as Indonesia show stagnating relative capital intensity levels throughout the whole period.[26]

25 The estimates in this section are provisional and should be treated as a first rough indication, especially in the case of China and Indonesia. Otherwise than in the case of labour and value added, the capital stock data and value added data come from different sources, with different scope and coverage. The comparability of the different national capital stock data is open to question, as the estimates have not been standardised across the economies. For China, only capital stock data for industrial state enterprises is available. See Appendix B for more detail of our estimation procedure. Further research is being undertaken in this area. Capital stock data in national currencies have been converted by ICP PPPs for equipment and structures.

26 The relatively high levels in India and Indonesia compared to the other Asian countries are in part caused by the fact that only medium and large scale establishments have been taken into account in these countries. See section 5.2.

To assess the impact of the differences in capital intensity on labour productivity differences, level comparisons of total factor productivity (TFP) are required. As in our labour producitvity comparisons, we first make a benchmark comparison of TFP which is subsequently up- and backdated with national time series on TFP growth. For the national TFP growth series we follow Solow (1957) and construct Törnqvist TFP indices:[27]

$$\Delta \ln TFP_t = \Delta \ln \frac{Y_t}{L_t} - (1 - \overline{\alpha}_t)\Delta \ln \frac{K_t}{L_t} \qquad (6)$$

where $\overline{\alpha}_t = 1/2(\alpha_t + \alpha_{t-1})$ and α_t is the labour share of value added in year t. Note that we implicitly assume constant returns to scale, profit maximization and perfect competition.

For constructing benchmark estimates of TFP, no unique best method is available as discussed by Bernard and Jones (1996). Countries differ not only in their input quantities and their efficiency (TFP), but also in their labour shares α. Technology of production varies with the α parameter as well as with TFP. Hence the classic index number problem shows up: in order to compare TFP levels, one has to fix α's, or to fix inputs. Here we choose to fix α and use a Cobb-Douglas production function, which gives the following formula for relative TFP levels in the benchmark year:

$$\ln \frac{A^X}{A^U} = \ln \frac{Y^X/L^X}{Y^U/L^U} - (1-\alpha)\ln \frac{K^X/L^X}{K^U/L^U} \qquad (7)$$

with α representing the unweighted average of the shares of labour compensation in manufacturing GDP at factor cost in the benchmark year in the two countries X and U being compared[28] (see Appendix B for data sources).[29]

No attempt has been made so far to take into account increases in the quality of the inputs of labour and capital: changes in total factor productivity include the effects of quality changes. Relative levels of total factor productivity for total manufacturing are reproduced in Figure 6.

Figure 6 indicates that in terms of relative total factor productivity the Asian economies are still at very low levels: below 30% for all countries, including Korea and Taiwan. Hence the opportunities for growth through improvement in total factor productivity in the Asian economies is still enormous. In terms of total factor productivity the similarities between the five Asian economies are more marked than in terms of labour productivity or capital intensity. Although differences in capital

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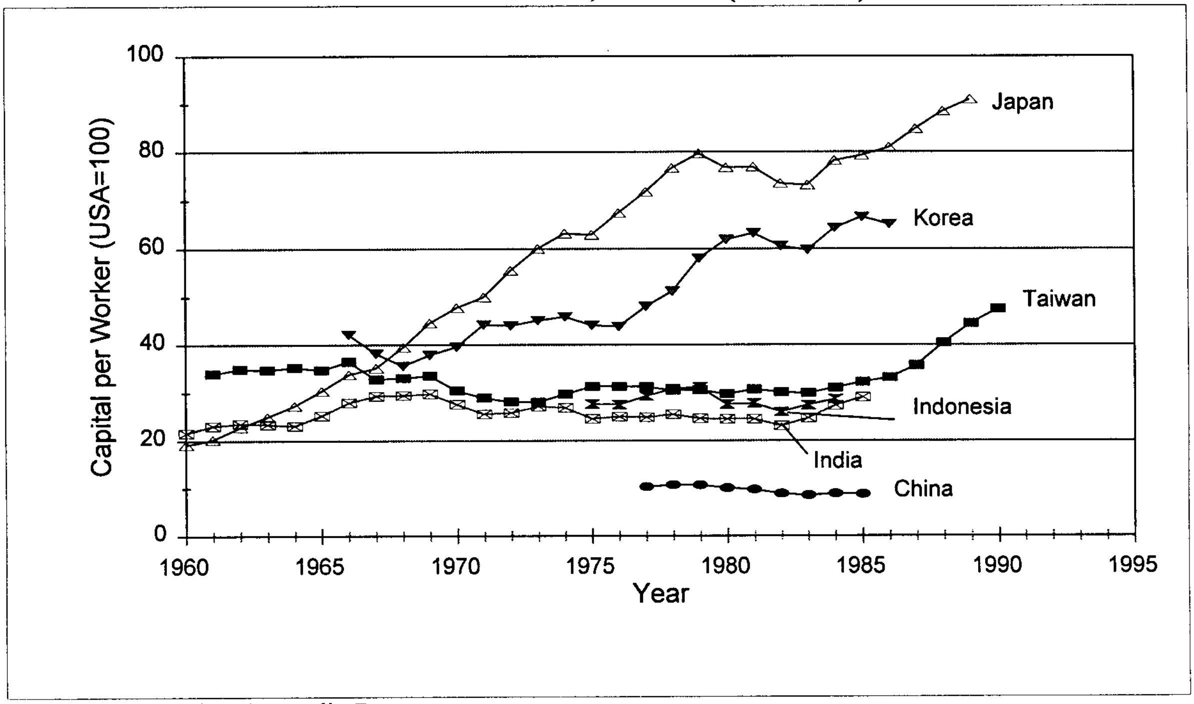
27 The Törnqvist index is a discrete approximation of the continuous Divisia index and is exact for the homogeneous translog production function.

28 Ideally labour compensation measures include not only wages and salaries paid, but also other emoluments (like benefits in kind) and costs incurred by the employer like old age benefits and other social security charges. Also an imputation for earnings of self-employed should be made.

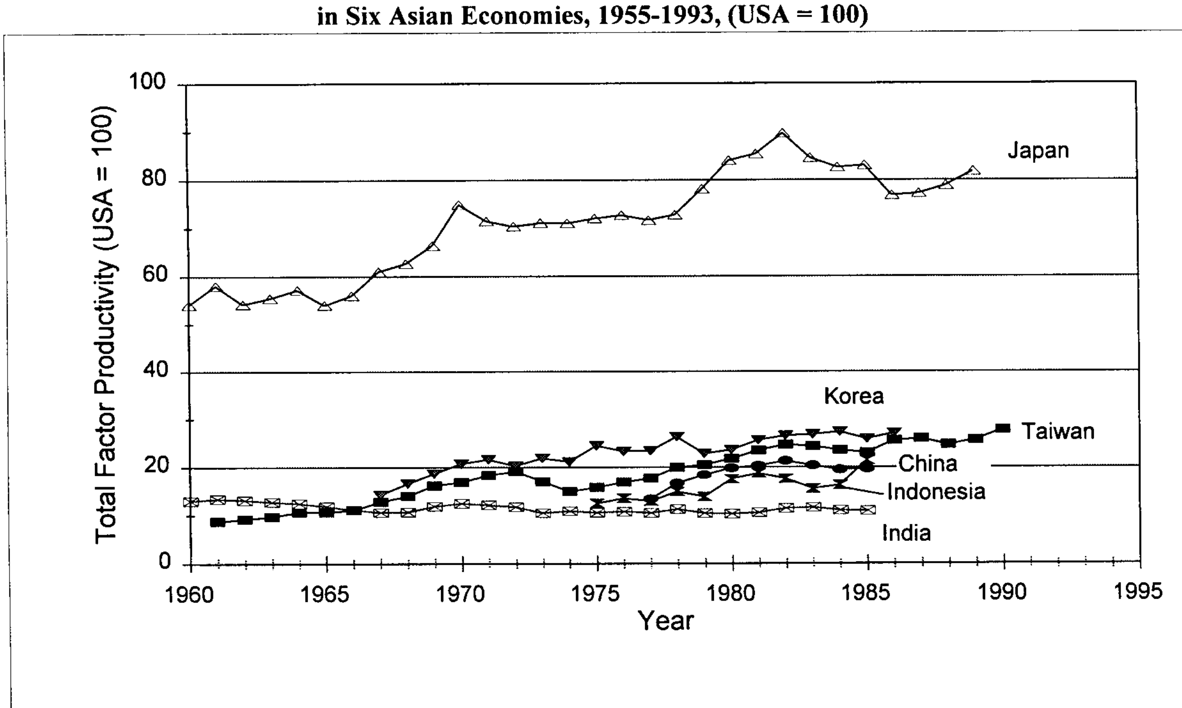
29 Other weighting schemes as proposed in Bernard and Jones (1996) have been tried, but the overall results are robust.

Figure 5 Relative Capital per Worker in Manufacturing in Six Asian Economies, 1955-1993 (USA = 100)



Source: See Appendix B.

Figure 6 Relative Total Factor Productivity Levels in Manufacturing in Six Asian Economies, 1955-1993, (USA = 100)



Sources: See Appendix B. Total factor productivity level benchmarks based on a Cobb-Douglas using average factor shares in manufacturing for each pair of countries. Benchmarks extrapolated with national time series (see main text).

intensity are not unimportant, on basis of equation 7 one can derive that by far the greatest part of the difference in labour productivity with the USA in all economies is accounted for by the relatively inefficient use of factor inputs. In 1985, the part of labour productivity differences explained by TFP differences ranged from 59% in China to 88% in Korea.

Comparison of the trends in relative capital intensity and relative total factor productivity in Figure 5 and 6 with the trends in relative labour productivity shown in Figure 2, reveals a close relationship between the three. For *India* 1960-1985 all three trends are stagnating. In *Indonesia* 1975-1985 relative capital intensity did not rise, but total factor productivity did, causing a modest increase in relative labour productivity. *Taiwan* also shows a relatively long period (1961-1985) of stagnating relative capital intensity, fluctuating around 30% of the US level. But in this period total factor productivity grew rapidly from a low 10% to 25%, doubling relative labour productivity to 16%. After 1985 capital intensity grew rapidly, and together with the sustained increase in total factor productivity causing an acceleration in labour productivity in the second half of the eighties. *Korea*, on the other hand, already started to increase its capital intensity around 1975. Together with a catch up in total factor productivity levels, labour productivity caught up rapidly. The growth rates of TFP for Korea and Taiwan are significantly higher than those given in Young (1994). This is because Young made adjustments for the rapid increase in quality of the inputs used. In this paper quality improvements are included in the TFP growth rates to indicate growth in the efficiency in crude labour and capital inputs. The *Japanese* level of capital intensity, total factor productivity and labour productivity moved up together rapidly until the beginning of the eighties. From then on, all three trends more or less stagnated at the 80% level.

The provisional figures shown above represent a first step in our attempts to make systematic comparisons of capital intensity and total factor productivity for six Asian economies. They indicate that *relative labour productivity, total factor productivity and capital intensity tend to move together*. The patterns of convergence and divergence found for labour productivity, are visible for total factor productivity and capital intensity as well. They point to abundant opportunities for further catch-up growth in the Asian economies (except Japan), as levels of capital intensity and total factor productivity are still well below the US levels.

9. Conclusions

This paper studies developments of manufacturing productivity levels and contributions of structural change in six rapidly growing Asian economies, from an international perspective. Star comparisons with the USA are made, both at the aggregate and detailed branch level, using currency conversion factors derived with the industry-of-origin approach.

Our principal findings are as follows.

1. Manufacturing labour productivity levels in Japan, Korea and Taiwan drew closer to US levels between 1960-1993. Especially after 1985, catch up in Korea and Taiwan was marked.
In 1993 labour productivity levels in Japan stood at 79% of the USA, in Korea at 49% and in Taiwan at 28%. In contrast, China experienced relative stagnation, and India and Indonesia only recently showed the first indications of catch up. This second group of economies had rapid industrial growth

and growth of labour productivity, but their position relative to the USA throughout the eighties showed little change. Comparative levels of labour productivity were 12% in Indonesia (in 1993), 9% in India (in 1990) and 6% in China (in 1992). Adjusting for small scale establishments brings down the levels in the latter group even further, but putting China at a higher level than both India and Indonesia.

2. The aggregate trends in comparative productivity performance over time in Asian economies do not mask divergent developments at branch levels. In catch-up countries, catch up is not limited to a few branches, while other branches are stagnating or falling behind. The same holds for relative stagnation. This suggests that the determinants of catch up or stagnation operate at the level of total manufacturing, rather than within specific branches. This finding is consistent with theories of conditional convergence. The policy implications of this finding are that at least at branch level, industrial policy should not target specific branches for special attention.

3. Manufacturing structures in the Asian economies have strongly converged during the period 1955-1993. This applies both to rapid catch-up and non-catch-up economies. In all economies the importance of the food and textiles branches is declining, and the shares of the capital goods sectors as machinery and transport equipment and electrical machinery are rising.

4. Structural change within manufacturing contributed little or even negatively to the growth in labour productivity. There is no evidence of a systematic pattern of structural change from early industries characterised by low productivity levels, to late industries characterised by high productivity. For all economies alike, manufacturing growth was primairely fuelled by growth in heavy industries like chemicals and machinery. Light industries like food and textiles played only a minor role, even in early stages of development.

5. The rapid growth of manufacturing GDP is based mainly on growth of labour productivity, and less so on employment growth. Especially at a later stage of development, employment creation is but modest.

6. In level comparisons with the USA, structural differences in branch shares of employment explained virtually nothing of the productivity gaps found between the Asian countries and the USA. This is true not only in recent, but as well as in earlier times. There is no potential catch-up bonus involved in structural change within the manufacturing sector. Catch up can only take place if productivity levels within all branches are improving.

7. The distinction between catch up and relative stagnating economies also obtains for comparisons of capital intensity and total factor productivity (TFP). But for Korea and Taiwan, the gap in terms of TFP is much larger than in terms of capital intensity. The catch up in labour productivity is primairily due to the fact that capital intensity levels have drawn closer to those in the USA. This is consistent with Young's (1994) conclusion that growth of inputs was more important than TFP growth in the East Asian economies. However, the conclusion of Young that the (easy) opportunities for catch up in East Asian economies have been exhausted is too pessimistic. First, even in terms of capital intensity there are still large gaps compared to the USA. Second, theories of conditional convergence argue that catch up due to rapid diffusion of technology only takes place once initial conditions such as sufficient human capital levels and technological capabilities have been fulfilled. In this respect, the rapid increase in educational levels and abundant experience accumulated in decades of booming manufacturing activities, have paved the way towards realization of the considerable potential of TFP catch up in Korea and Taiwan in the years ahead.

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Appendix A Detailed Results of Matching Procedure for International Level Comparisons.

Appendix Table A1 shows the results of the matching procedure to arrive at binary producer price PPPs which are used to convert value added in a common currency (see section 5). It gives for each comparison at branch level the Fisher PPP, the relative price level (PPP divided by the exchange rate), the number of product matches made and the covered output in both countries. The data is taken for China/USA 1985 from Szirmai and Ruoen (1997); India/USA 1983 from Timmer (1997b); Indonesia/USA 1987 from Szirmai (1993); South Korea/USA 1987 from Pilat (1993); Taiwan/USA 1976 from Timmer (1997a) and Japan/USA 1987 from Pilat (1993).

Appendix B Data Sources for National Time Series for Manufacturing

This appendix gives the data sources for the national timeseries of value added, employment and capital.

<u>USA, 1950-93</u>

Data for the USA is based upon worksheets underlying Pilat (1993) and van Ark and Pilat (1993). The data has been updated and slightly revised for the years after 1987 (see below). The original primairy sources are given below.

- <u>GDP at constant 1982 market prices:</u>

Coverage: all manufacturing establishments.
1947-76 , BEA, (Bureau of Economic Analysis) National Income and Product Accounts of the United States, 1929-82, Washington D.C,1986 (print out)
Linked in 1977 to new series.
1977-87 from BEA, Survey of Current Business, January 1991, April 1991;
1988-89 from BEA, Survey of Current Business, November 1993.
1990 from BEA, Survey of Current Business, Oktober 1994.
1991-1993 from BEA, Survey of Current Business, April 1995.
Figures for 1987-1993 are 1987 price based and have a new classification. For each branch we calculate an index on these figures. We apply this index to the 1987 (1982 price based and pre 1987 classification), and control for total manufacturing, calculated in the same way. Thus in order to keep the series both consistent and additive.

- <u>Number of persons employed:</u>

Coverage: all manufacturing establishments.
Number of full time employees + part time employees + self employed workers.
1950-58: BEA, (Bureau of Economic Analysis) National Income and Product Accounts of the United States, 1929-82, Washington D.C., 1986;
1959-88: BEA, (Bureau of Economic Analysis) National Income and Product Accounts of the United States, vol. 2 1959-88, Washington D.C., 1992;
1988-89: BEA, Survey of Current Business, various issues.
1990-93: BEA, Survey of Current Business, July 1994.

- <u>Hours worked:</u>

1975,1987: Pilat (1993, Antab III.15)

- <u>Capital stock:</u>

1955-90: PIM based, see van Ark and Pilat (1993, p.41-43).

- <u>Labour share:</u>

1955-88: Pilat (1991) Table A4.2.

Table A1 Fisher PPPs, Relative Prices, Coverage Ratios and Number of Product Matches by Manufacturing Branch for Six Asian Binary Comparisons.

	China/USA, 1985					India/USA, 1983.					Indonesia/USA, 1987				
	Fisher PPP	Relative Price Level China	Matched Output as % of Total		Number of Product Matches	Fisher PPP	Relative Price Level India	Matched Output as % of Total		Number of Product Matches	Fisher PPP	Relative Price Level Indo	Matched Output as % of Total		Number of Product Matches
	Yuan/ US$	USA = 100	China	USA		Rs/ US$	USA = 100	India	USA		Rps/ US$	USA = 100	Indo	USA	
Food Manufacturing	1.64	57	57.1	30.7	22	7.80	77	56	19	30	1,159	70	51.9	28.9	41
Beverages	0.91	31	13.0	27.5	1	8.33	82	10	30	2	1,735	106	32.7	27.5	1
Tobacco Products	0.38	13	10.6	15.2	3	1.65	16	47	81	3	817	50	94.8	91.5	4
Textile Mill Products	1.47	51	69.8	53.1	7	5.55	55	45	13	9	841	51	60.3	49.2	13
Wearing Apparel (a)	1.38	48	0.0	0.0	0	6.17	61	14	22	5	509	31	85.9	36.1	20
Leather Products & Footwear	0.84	29	42.9	43.7	1	9.17	91	43	13	3	514	31	65.0	57.1	5
Wood Prod., Furniture & Fixtures	1.73	60	40.0	19.7	2	13.28	131	22	8	8	1,261	77	86.9	19.2	10
Paper Prod., Printing & Publishing	1.76	61	64.0	11.9	4	4.45	44	25	51	4	1,150	70	37.3	12.5	13
Chemical Products	1.37	47	30.6	25.5	10	7.60	75	36	16	14	1,781	108	70.3	31.0	36
Rubber & Plastic Products	1.72	59	30.7	3.2	4	12.90	128	22	9	26	812	49	10.3	2.6	7
Non-metallic Mineral Products	0.77	27	56.9	7.8	3	8.28	82	29	8	9	993	60	50.6	6.5	4
Basic & Fabricated Metal Products	0.99	34	48.5	14.7	2	10.16	101	40	15	22	1,333	81	61.2	17.9	34
Machinery & Transport Equipment	2.34	81	10.8	20.8	4	4.90	49	22	17	8	1,086	66	29.8	16.0	15
Electrical Machinery & Equipment	0.86	30	20.1	5.1	4	9.28	92	8	4	6	640	39	25.2	4.6	11
Other Manufacturing Industries	1.45	50	0.0	0.0	0	3.27	32	3	1	7	1,291	79	0.0	0.0	0
Total Manufacturing	1.45	50	37.1	18.9	67	8.08	80	33	14	156	1,200	73	60.7	19.6	214
Exchange Rate	2.9	100				8.28	100				1,644	100			

Note: (a) Wearing Apparel PPP for China/USA is weighted average of Textile and Leather;
Sources: China/USA 1985 from Szirmai and Ruoen (1997); India/USA 1983 from Timmer (1997b); Indonesia/USA 1987 from Szirmai (1993).

Table A1 (Continued) Fisher PPPs, Relative Prices, Coverage Ratios and Number of Product Matches by Manufacturing Branch for Six Asian Binary Comparisons.

	Japan/USA, 1987					Korea/USA, 1987					Taiwan/USA, 1976				
	Fisher PPP	Relative Price Level China	Matched Output as % of Total		Number of Product Matches	Fisher PPP	Relative Price Level India	Matched Output as % of Total		Number of Product Matches	Fisher PPP	Relative Price Level Indo	Matched Output as % of Total		Number of Product Matches
	Yen/ US$	USA = 100	Japan	USA		Won/ US$	USA = 100	Korea	USA		NT$/ US$	USA = 100	Taiwan	USA	
Food Manufacturing	266.2	184	13.7	11.2	16	977	119	46.7	33.0	29	43.9	115	41.9	15.4	20
Beverages	208.1	144	32.7	30.2	3	553	67	21.1	30.3	4	34.5	91	23.6	26.7	1
Tobacco Products	113.3	78	86.0	80.7	1	753	92	98.8	77.4	2	23.8	63	56.4	89.8	3
Textile Mill Products	181.7	126	25.9	38.9	14	747	91	39.9	26.3	8	23.4	62	45.0	29.4	5
Wearing Apparel	179.2	124	21.2	30.4	9	942	115	29.4	13.5	6	24.1	63	43.6	17.4	7
Leather Products & Footwear	208.9	144	34.1	29.3	4	554	67	55.9	53.4	7	13.4	35	39.3	59.8	5
Wood Prod., Furniture & Fixtures	471.5	326	19.5	7.9	2	1,270	154	39.3	13.9	4	28.1	74	52.4	19.8	4
Paper Prod., Printing & Publishing	188.1	130	13.0	15.0	10	645	78	25.0	11.8	6	36.0	95	43.7	14.6	8
Chemical Products	232.5	159	26.8	36.8	37	1,149	140	41.4	35.4	46	56.3	148	44.5	40.4	18
Rubber & Plastic Products	121.3	84	7.4	11.4	6	791	96	41.3	10.5	4	21.8	57	30.5	20.1	6
Non-metallic Mineral Products	189.3	131	33.0	27.8	9	458	56	47.4	23.3	6	10.3	27	44.0	11.5	1
Basic & Fabricated Metal Products	178.4	123	24.9	22.9	34	694	84	59.1	24.1	39	28.5	75	28.2	17.6	13
Machinery & Transport Equipment	125.0	83	20.3	17.7	26	491	60	22.4	17.7	14	24.3	64	13.0	12.3	6
Electrical Machinery & Equipment	142.7	99	11.5	11.0	18	524	64	19.5	5.1	15	25.7	68	24.4	19.1	8
Other Manufacturing Industries	173.6	123	0.0	0.0	0	785	95	0.0	0.0	0	29.5	78	0.0	0.0	0
Total Manufacturing	173.6	123	19.1	19.9	189	700	85	36.7	21.0	190	29.5	78	35.8	19.7	105
Exchange Rate	144.6	100				823	100				38.0	100			

Sources: Japan/USA 1987 from Pilat (1993); Korea/USA 1987 from Pilat (1993); Taiwan/USA 1976 from Timmer (1997a).

Japan, 1955-93
Data for Japan is based upon worksheets underlying Pilat (1993) and van Ark & Pilat (1993). The data has been updated. The original sources are given below.
- GDP at constant 1985 market prices:
Coverage: all manufacturing establishments.
1955-1987: Economic Planning Agency (EPA), Report on National Accounts from 1955 to 1989, Tokyo 1991.
1988-1993: EPA, Annual Report on National Accounts 1995, Tokyo 1995.
Industry breakdown of some branches with MITI (Ministry of International Trade and Industry) Census of Manufactures, Report by Industries, Tokyo various issues.
- Number of persons employed:
Coverage: all manufacturing establishments.
1955-1989: EPA, Report on National Accounts from 1955 to 1989, Tokyo 1991.
1990-93: EPA, Annual Report on National Accounts 1995, Tokyo 1995.
Industry breakdown of some branches with MITI Census of Manufactures, Report by Industries, Tokyo various issues.
- Hours worked:
1975,1987: Pilat (1993, Antab III.9)
- Capital stock:
1955-90: PIM based, see van Ark and Pilat (1993, p.41-43). Conversion to US$ on the basis of Fisher PPPs for 1985 for capital formation in machinery and equipment and structures given there.
- Labour share:
1987: van Ark and Pilat (1993) Table 7.

Korea, 1958/60/63, 1966-93
Data for Korea is based upon worksheets underlying Pilat (1993, 1995). The data has been updated. The original sources are given below.
- GDP at 1985 constant market prices:
Coverage: Excluding establishments with < 5 employees
Current Value Added:
1958/60/63, 1966-1989: EPB (Economic Planning Board), Report on Mining and Manufacturing Survey, various issues; EPB, Report on Mining and Manufacturing Census, various issues; Industry breakdown with Bank of Korea, National Accounts 1990, Seoul 1990.
1990-1993: Korea Statistical Yearbook 1995 and 1994, National Statistical Office, ROC, 1995 and 1994. Table V.1. Industry breakdown for 1990 and 1991 on basis of 1989 shares.
Deflators:
1958/60/63, 1966-1969: Bank of Korea, National Income in Korea 1975, Seoul 1975.
1970-89: National Accounts, 1970-1989: Bank of Korea, National Accounts 1990, Seoul 1990; Bank of Korea, Printout on Manufacturing Value Added in Current and Constant Prices, Seoul, July, 1990;
1990-1993: Producer Price Index from Monthly Statistics of Korea 1996, Feb-March, National Statistical Office, ROC, Table 3-1. Controlled for total manufacturing deflated with total manufacturing deflator from National Accounts.
- Number of persons employed:
Coverage: Excluding establishments < 5 employees. Full time + part time employees.
1958/60/63, 1966-1989: EPB (Economic Planning Board), Report on Mining and Manufacturing Survey and Census, various issues;
1990-1993: Korea Statistical Yearbook 1995 and 1994, National Statistical Office, ROC, 1995 and 1994. Table V.1
- Hours worked:
1975,1987: Pilat (1993, Antab III.24)

- Capital stock:
1955-90: H.K. Pyo (1992). Conversion to US$ on the basis of augmented binary Fisher PPPs for 1975 for domestic capital formation from Kravis, Summers and Heston (1982, Aptab 7-16).
- Labour share:
1970-88: Pilat (1991) Table A4.1.

Taiwan, 1961-92

- GDP at constant 1991 market prices:
Coverage: all manufacturing establishments.
1961-1992: GDP at current prices from DGBAS (Directorate-General of Budget, Accounting and Statistics), Executive Yuan, Republic of China, National Income in Taiwan Area of the Republic of China 1994, Jan. 1995;
Deflated with deflators from DGBAS, Printout on Wholesale price indices of Manufacturing Branches, Taipei, March 1995. Industry breakdown for some branches with DGBAS, National Income in Taiwan Area of the Republic of China, 1992 and MOEA (Ministry of Economic Affairs), Department of Statistics, Printout on Index of Industrial Production of Manufacturing Branches, Taipei, March 1995. Branch GDPs at constant prices have been summed to obtain total manufacturing GDP at constant prices.
- Number of persons employed:
Coverage: all manufacturing establishments.
1974-1994: number of employees from DGBAS, Monthly Bulletin of Earnings and Productivity Statistics, Taiwan Area of R.O.C., February 1995; Industry breakdown for some branches with DGBAS, Yearbook of Earnings and Productivity Statistics Taiwan Area of R.O.C., 1993 and DGBAS, The Report on 1976 Industrial and Commercial Census Taiwan-Fukien Area, R.O.C. Adjusted with ratio non-employees/employees found in DGBAS, The Report on Industrial and Commercial Census Taiwan-Fukien Area, R.O.C, 1976, 1986 and 1991 issues.
1961-1973: DGBAS, "Printout on Employment in Manufacturing Branches from the Labor Force Survey, 1961-1992", December 1995. Linked in 1974.
- Hours worked:
1975,1987: DGBAS, "Monthly Bulletin of Earnings and Productivity", Feb. 1995, Table 12.
- Capital stock:
1955-90: DGBAS (1994) The Trends in Multifactor Productivity, Taiwan Area, Table 1. Converted to US$ on basis of Fisher converter for Domestic Capital Formation in 1985 from Yotopoulus (1993, Table 4).
- Labour share:
1978-92: DGBAS (1994) The Trends in Multifactor Productivity in Taiwan Area, Table 16.

Indonesia, 1975-91.

Data for Indonesia is based upon worksheets underlying Szirmai (1993, 1994). The data has been updated and revised. The revision involved 1. a rebasing from 1975 to 1983 prices (this affected especially the basic and fabricated metal branch) and 2. a summation of branch GDPs at constant prices to obtain total manufacturing GDP at constant prices, instead of seperate deflation of total manufacturing. This resulted in lower figures for early years (up to 14%) and higher figures for later years (up to 8%). The original sources are given below.
- GDP at constant 1975 market prices:
Coverage: excluding establishments with < 20 employees and excluding oil refining and liquid naturel gas.
1975-1990: GDP at current prices from Biro Pusat Statistik, Statistik Industri, 1975-1990 (revised figures on tape LPEM),

1991: from Statistik Indonesia 1993, 9 major branches. Industry breakdown with 1990 shares. Deflated by deflators 1975-1991, derived from Szirmai (1993, Table A4). Original source: Indikator Ekonomi various issues.

- Number of persons employed:

Coverage: excluding establishments with < 20 employees and excluding oil refining and liquid naturel gas.

1975-1990, Biro Pusat Statistik, Statistik Industri, 1975-1990, (revised figures on tape LPEM).

1991: from Statistik Indonesia 1993, 9 major branches. Industry breakdown with 1990 shares.

- Hours worked:

1987: Szirmai (1993, Table A2).

- Capital stock:

1975-85: From Keuning (1988, 1991): capital stock for total manufacturing excl. Wood products. As this capital stock is based on national accounts (NA) figures it includes all manufacturing establisments. To make this capital stock comparable to our census value added for large and medium establisments we first adjusted the NA value added to exclude the small establishments based on ratio small/ large and medium for 1987 found in Szirmai (1993, Table A3). Next, assuming all capital to reside in the medium and large establishments, we applied the ratio of the capital stock and adjusted NA value added to our census value added.

Converted to US$ on basis of 1980 investment price level and exchange rate given in Penn-World Tables 5.5 (data on file).

- Labour share:

1978, 1985: from BPS, Economic Census 1978, 1986, Large and Medium Manufacturing Industries.

India, 1960-90

- GDP at constant 1980/81 market prices:

Coverage: only factory sector: excluding establishments without power and < 20 employees and with power < 10 employees.

Current prices:

1975, 1980-1990: Central Statistical Organization (CSO), Annual Survey of Industries (ASI), Summary for the Factory Sector, annual issues.

1960-1979: CSO, 1984, Principal Characteristics of Selected Industries in Organised Manufacturing Sector, 1960-1980, Bulletin No. ISD/9 which is data summary of ASI, annual issues. Trends of some branches have been based on trends of the main industries within these branches.

Deflated with implicit deflators derived from National Accounts Statistics (NAS) for registered Manufacturing:

1960-1979, CSO, NAS, Disaggregated Statements, 1950/51-1979/80, Statement 28

1980-1985, CSO, NAS 1990, Statement 60.

1986-1990, CSO, NAS 1994, Statement 60

-Number of persons employed:

Coverage: only factory sector: excluding establishments without power and < 20 employees and with power < 10 employees.

1975, 1980-1990: CSO,ASI, Summary for the Factory Sector, annual issues.

1960-1979: CSO, 1984, Principal Characteristics of Selected Industries in Organised Manufacturing Sector, 1960-1980, Bulletin No. ISD/9 which is data summary of ASI, annual issues. Trends of some branches have been based on trends of the main industries within these branches.

- Hours worked:

1975: index from van Ark (1991, Table A.3.1) applied to 1987.

1987: CSO, ASI, Summary for the Factory Sector, 1987.

- Capital stock:

1960-89: From Bhatia and van Ark (1991, Table A.1). Conversion to US$ on the basis of augmented binary Fisher PPPs for 1975 for domestic capital formation from Kravis, Summers and Heston (1982, Aptab 7-9).

- Labour share:

1959-65 (average) and 1966-80 (average) from Ahluwahlia (1985) Tables A.5.2/3.

1980-85 from Statistical Abstract 1992, Table 38.

China, 1977-92

- Net value added at constant 1980 market prices:

Coverage: Independent accounting enterprises in manufacturing.

1977-92: Szirmai & Ren (1995, Table 8 and 13). Original: Current prices from State Statistical Bureau (SSB), Industrial Economic Statistics Yearbook 1993, p.142-154. Deflated with delators from SSB, China Statistical Yearbook, 1993, p.238.

- Number of persons employed:

Coverage: Independent accounting enterprises in manufacturing.

1977-92: Szirmai & Ren (1995, Table A4 and 13). Original from SSB, Industrial Economic Statistics Yearbook 1993.

- Capital stock:

1977-85: From Chen et. all (1988). This capital stock is for independent accounting units in state sector in total industry. To make this capital stock comparable to our census value added for independent accounting units in manufacturing, we applied the 1980 capital / net value added at market prices ratio for state sector of industry (2.98) to our census manufacturing net value added at market prices. Net value added at market prices in state sector industry taken from Industrial Statistics Yearbook, 1993. Conversion to 1980US$ on the basis of binary Fisher PPPs for 1986 for domestic capital formation from Ren (1996), backdated on basis of 1980-1986 change in PPP for investment as given in Penn-World Tables 5.5 (data on file).

- Labour share:

1987: State Statistical Bureau (1987), Input-Output Table of China, 1987.

Appendix C Labour Productivity in Manufacturing Branches, countries as % of USA

Table CT Total Manufacturing

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						20.3
1956						22.3
1957						22.6
1958				5.9		22.3
1959						22.9
1960	6.4			6.8		25.5
1961	6.9				5.6	28.2
1962	6.8				5.9	27.7
1963	6.6			7.2	6.3	29.5
1964	6.5				7.0	31.6
1965	6.4				6.9	31.1
1966	6.3			7.0	7.3	33.8
1967	6.2			8.1	8.0	37.6
1968	6.2			9.1	8.8	40.7
1969	7.1			10.7	10.3	45.5
1970	7.4			12.4	10.4	53.5
1971	6.9			14.0	11.2	52.5
1972	6.8			13.1	11.5	54.1
1973	6.3			14.2	10.2	56.3
1974	6.5			14.0	9.3	57.8
1975	6.2		6.4	16.5	10.4	59.7
1976	6.4		6.8	15.7	11.1	62.0
1977	6.2	4.2	6.9	16.6	11.6	62.9
1978	6.7	5.3	8.2	19.4	12.9	65.6
1979	6.2	5.9	7.8	18.1	13.3	71.8
1980	6.2	6.3	9.2	19.8	14.1	77.0
1981	6.4	6.4	10.2	22.0	15.6	78.7
1982	6.9	6.6	9.5	22.9	16.6	82.5
1983	7.4	6.2	8.9	23.2	16.4	78.2
1984	7.3	6.1	9.5	24.4	16.0	78.2
1985	7.5	6.2	10.1	23.7	16.1	79.4
1986	7.4	5.9	11.3	24.6	18.1	74.4
1987	7.3	5.7	10.0	26.5	19.1	76.4
1988	7.9	5.9	11.3	27.9	19.2	79.4
1989	8.6	5.6	10.9	30.7	20.9	83.5
1990	9.2	5.4	11.7	38.7	23.4	87.4
1991		5.6	11.4	44.6	26.0	88.6
1992		6.3	12.9	48.3	27.6	82.8
1993			12.4	49.1	27.5	78.7
1994						

Source: See Figure 2.

Table C1 Food and beverages

Year	India	China	Indon-esia	South Korea	Taiwan (a)	Japan (a)
1955						29.8
1956						29.1
1957						27.5
1958				4.3		25.0
1959						26.4
1960	6.8			5.4		25.5
1961	7.5				5.2	27.2
1962	6.7				5.6	26.6
1963	5.2			5.7	6.0	27.4
1964	5.2				6.3	27.8
1965	5.6				5.7	27.7
1966	5.7			5.2	5.1	29.1
1967	4.2			6.3	6.4	31.7
1968	4.1			5.9	7.0	33.7
1969	6.5			6.8	8.1	35.7
1970	5.3			7.6	7.8	39.2
1971	3.7			10.0	7.9	38.2
1972	3.3			7.9	6.9	36.6
1973	3.0			8.1	6.0	43.1
1974	3.0			7.9	7.3	47.8
1975	3.0		6.0	11.1	7.3	46.9
1976	2.9		4.5	10.7	9.4	43.3
1977	3.3		5.7	12.0	9.6	49.1
1978	3.6		5.9	12.6	9.2	39.9
1979	2.8		5.6	10.5	9.4	45.7
1980	2.1	6.0	4.5	10.6	9.2	44.6
1981	2.6	6.0	5.5	11.1	10.6	44.1
1982	3.4	5.6	5.2	11.3	11.1	44.1
1983	4.7	5.4	4.9	11.2	12.3	45.2
1984	4.6	5.4	4.6	12.2	12.3	42.3
1985	4.6	5.3	4.6	11.7	12.5	39.4
1986	4.8	5.6	4.3	12.3	13.1	40.6
1987	4.8	5.8	4.2	12.9	15.0	39.1
1988	5.8	6.2	5.5	13.3	15.0	38.1
1989	6.6	6.4	5.3	16.4	15.8	40.6
1990	5.5	6.4	7.6	17.9	16.2	40.7
1991		7.8	7.9	21.3	16.8	40.0
1992		8.1	9.2	23.6	17.7	38.3
1993			9.3	24.1	17.4	38.2
1994						

Note: (a) Taiwan and Japan incl. Tobacco
Source: See Figure 2.

Table C2 Tobacco Products

Year	India	China	Indon-esia	South Korea	Taiwan (a)	Japan (a)
1955						
1956						
1957						
1958						
1959						
1960	3.3					
1961	3.4					
1962	3.1					
1963	3.5			1.5		
1964	3.7					
1965	4.8					
1966	5.2			2.6		
1967	4.2			3.5		
1968	4.3			3.3		
1969	5.0			3.6		
1970	4.8			4.2		
1971	4.2			3.0		
1972	2.9			2.6		
1973	2.0			2.5		
1974	1.4			2.4		
1975	2.2		0.7	3.2		
1976	2.2		1.1	3.1		
1977	1.3		0.9	4.9		
1978	1.6		0.9	5.7		
1979	1.3		1.0	5.3		
1980	1.2	8.2	1.7	5.8		
1981	1.1	8.3	1.7	5.9		
1982	1.2	9.3	1.7	7.3		
1983	2.4	10.1	1.8	8.1		
1984	2.5	10.3	2.2	9.8		
1985	2.7	12.4	2.5	12.6		
1986	2.3	11.4	2.7	10.9		
1987	3.0	15.5	3.9	16.7		
1988	4.1	17.4	4.9	21.1		
1989	3.8	19.3	5.5	30.7		
1990	4.4	22.5	7.4	36.6		
1991		24.5	7.9	47.6		
1992		26.7	10.1	49.1		
1993			11.3	50.7		
1994						

Note: (a) Taiwan and Japan incl. in Food & Beverages
Source: See Figure 2.

Table C3 Textile Mill Products

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						50.3
1956						55.8
1957						59.1
1958				17.2		55.5
1959						53.7
1960	17.7			15.9		57.1
1961	18.5				11.3	59.0
1962	18.4				11.2	59.6
1963	14.7			9.9	10.4	50.3
1964	14.3				12.5	52.6
1965	13.5				12.1	53.5
1966	13.0			7.3	12.8	57.6
1967	14.0			9.3	12.8	58.1
1968	14.0			11.0	11.6	60.6
1969	15.0			13.3	15.2	63.0
1970	12.8			13.0	15.5	72.6
1971	11.6			15.6	16.4	69.8
1972	13.7			16.9	17.4	72.3
1973	14.5			19.8	18.9	77.8
1974	15.2			23.9	16.0	108.8
1975	13.3		7.6	26.2	20.7	108.7
1976	11.7		8.1	27.8	20.6	86.5
1977	10.0		5.7	21.3	18.8	69.7
1978	12.1		9.3	24.4	23.5	68.1
1979	11.7		7.5	21.7	22.2	71.9
1980	12.2	12.4	8.5	23.7	28.2	87.7
1981	12.0	12.0	8.5	28.1	33.6	84.6
1982	10.9	11.1	9.1	28.4	35.7	81.6
1983	11.8	9.7	8.3	27.5	33.2	73.8
1984	11.3	9.5	12.0	31.8	37.1	75.2
1985	12.6	9.8	12.0	34.0	39.9	72.1
1986	12.9	9.2	15.3	32.8	44.4	62.9
1987	12.1	8.9	12.7	34.2	50.2	68.2
1988	13.3	9.0	15.8	40.3	51.0	67.9
1989	14.9	8.0	17.7	41.1	54.3	53.7
1990	16.1	7.3	17.0	46.6	63.0	55.9
1991		6.6	16.4	51.4	70.0	52.7
1992		7.1	18.6	57.6	80.5	53.3
1993			17.9	59.5	83.2	58.5
1994						

Source: See Figure 2.

Appendix C (continued) Labour Productivity in Manufacturing Branches, countries as % of USA

Appendix C (continued) Labour Productivity in Manufacturing Branches, countries as % of USA

Table C4 Wearing Apparel

Year	India	China	Indonesia	South Korea	Taiwan	Japan
1955						32.1
1956						32.8
1957						34.0
1958				11.2		33.1
1959						35.1
1960	17.2			15.2		37.1
1961	19.0				3.9	40.1
1962	19.5				3.9	43.1
1963	19.3			15.3	5.5	51.0
1964	19.7				9.6	51.9
1965	18.5				5.8	49.5
1966	17.9			7.4	5.8	52.2
1967	19.0			10.5	6.4	53.4
1968	18.6			10.0	7.0	56.3
1969	20.2			8.6	11.7	62.9
1970	19.5			10.3	17.5	65.4
1971	17.6			11.6	20.6	66.9
1972	18.7			11.5	17.2	62.8
1973	19.5			14.4	16.4	54.9
1974	17.4			17.6	16.4	52.6
1975	12.5		6.8	19.4	12.9	52.9
1976	12.7		11.2	14.4	17.1	58.1
1977	13.3		9.7	16.0	19.0	54.7
1978	13.8		12.3	19.8	20.7	53.3
1979	12.4		12.2	19.9	22.2	54.5
1980	12.5	7.1	8.5	23.1	26.5	54.2
1981	15.4	7.5	10.9	23.5	28.7	57.5
1982	17.3	7.8	17.7	20.6	33.3	58.4
1983	15.8	7.6	17.3	18.7	30.8	56.6
1984	18.7	8.0	21.6	20.0	31.9	58.7
1985	11.8	8.4	16.8	19.3	27.2	59.0
1986	12.9	8.4	28.3	19.2	30.3	56.0
1987	14.0	8.3	17.1	20.2	29.4	54.7
1988	18.1	8.2	21.1	21.0	26.6	54.2
1989	18.3	8.1	21.3	20.8	29.4	51.7
1990	19.2	7.8	20.7	24.2	33.6	53.2
1991		7.9	18.7	27.2	31.2	51.6
1992		9.0	25.2	28.1	32.2	49.8
1993			23.8	32.4	35.6	47.0
1994						

Source: See Figure 2.

Table C5 Leather Products and Footwear

Year	India	China	Indonesia	South Korea	Taiwan	Japan
1955						35.8
1956						36.6
1957						41.0
1958				33.3		42.5
1959						38.1
1960	11.7			18.6		48.2
1961	12.0				2.2	47.5
1962	12.5				1.7	46.4
1963	12.1			8.3	1.5	53.3
1964	12.6				1.5	54.8
1965	13.2				1.8	53.2
1966	12.6			10.7	1.5	51.9
1967	14.3			20.0	3.9	59.7
1968	15.3			22.3	4.6	62.5
1969	16.6			27.3	6.9	68.2
1970	19.1			19.9	9.6	73.0
1971	16.3			27.1	20.0	69.4
1972	14.6			30.1	20.0	72.7
1973	14.6			34.4	21.5	59.5
1974	15.3			41.5	29.5	56.1
1975	10.8		34.3	51.4	32.5	55.3
1976	10.1		27.5	37.1	28.4	61.0
1977	12.2		23.4	41.5	29.2	62.2
1978	12.5		24.3	43.7	33.6	60.7
1979	12.4		31.6	42.4	43.7	70.2
1980	11.2	15.9	26.1	42.6	42.3	65.2
1981	12.2	15.6	18.6	44.1	38.8	66.4
1982	13.7	15.1	26.2	35.5	43.8	67.7
1983	17.2	14.8	36.8	37.3	44.2	70.4
1984	17.3	14.0	38.8	45.3	48.4	69.1
1985	13.4	15.3	32.0	47.6	52.8	72.7
1986	14.1	17.8	66.9	54.0	60.3	76.7
1987	15.7	16.4	30.5	47.6	49.1	69.5
1988	12.8	15.3	32.9	50.4	46.2	66.9
1989	13.8	14.4	30.4	49.3	45.7	65.7
1990	15.7	14.9	31.7	55.2	47.4	68.3
1991		14.4	19.8	56.2	53.1	62.8
1992		12.4	23.5	61.3	45.4	54.9
1993			28.6	60.1	45.4	50.2
1994						

Source: See Figure 2.

Table C6 Wood Products, Furniture & Fixtures

Year	India	China	Indonesia	South Korea	Taiwan	Japan
1955						11.6
1956						13.1
1957						13.8
1958				4.7		14.6
1959						14.0
1960				6.7		16.2
1961					9.6	17.7
1962					9.5	18.1
1963				4.2	9.5	18.4
1964					10.3	17.7
1965					10.3	16.4
1966				3.6	10.0	18.9
1967				3.9	9.8	19.9
1968				6.1	11.8	21.3
1969				4.4	17.4	24.0
1970				5.4	18.1	26.0
1971				8.3	18.2	24.9
1972				7.2	22.6	26.0
1973				7.7	19.9	27.0
1974				5.6	13.1	22.9
1975	3.6		5.1	8.2	14.2	22.0
1976			5.3	8.1	11.9	23.7
1977			6.6	9.3	11.3	24.7
1978			7.2	13.5	14.9	25.8
1979			6.7	10.8	15.2	26.5
1980	3.3	4.8	10.7	8.8	12.6	25.4
1981	3.8	5.6	12.5	10.9	16.0	29.2
1982	3.7	5.2	9.7	14.7	14.3	29.2
1983	4.4	4.8	8.5	13.0	13.9	27.5
1984	4.1	4.6	5.9	13.2	14.2	27.1
1985	3.8	4.6	11.9	13.6	16.5	29.0
1986	4.2	4.5	17.5	13.4	20.8	29.0
1987	4.3	3.3	13.9	12.8	20.6	28.4
1988	4.7	3.5	15.1	14.2	19.9	31.6
1989	4.5	3.3	13.6	16.7	21.1	32.5
1990	7.1	3.2	13.8	22.7	22.9	36.0
1991		3.6	14.9	29.9	26.7	35.1
1992		4.3	16.7	29.4	28.3	35.3
1993			15.6	24.4	27.3	36.2
1994						

Source: See Figure 2.

Table C7 Paper Products, Printing & Publishing

Year	India	China	Indonesia	South Korea	Taiwan	Japan
1955						18.2
1956						20.5
1957						21.1
1958				4.7		22.5
1959						21.6
1960	3.2			5.8		25.4
1961	3.2				4.2	27.9
1962	3.3				4.6	28.1
1963	3.4			7.0	4.5	31.1
1964	3.4				5.1	31.2
1965	3.6				5.3	31.7
1966	3.5			5.8	5.8	35.3
1967	3.6			5.8	5.8	38.3
1968	3.9			6.3	6.7	41.4
1969	4.1			7.0	7.0	44.0
1970	5.0			8.2	7.0	49.8
1971	4.1			9.0	8.5	49.0
1972	4.2			8.0	9.8	50.6
1973	3.9			9.1	9.0	45.7
1974	5.1			9.1	6.8	46.4
1975	4.7		5.4	9.3	8.1	52.2
1976	3.9		3.7	10.6	8.6	54.5
1977	3.7		4.5	12.1	9.1	51.8
1978	3.8		4.2	15.5	11.3	52.9
1979	3.6		5.0	16.7	12.7	58.3
1980	3.7	3.9	5.2	18.2	13.1	63.0
1981	3.9	3.9	4.0	19.1	13.2	65.9
1982	3.2	3.9	4.5	21.0	12.0	68.1
1983	3.5	3.9	4.0	25.6	11.7	66.5
1984	4.3	4.0	5.6	27.4	12.2	69.0
1985	3.8	4.1	7.3	27.0	12.5	69.1
1986	4.6	4.0	7.7	28.7	14.2	68.2
1987	4.6	3.9	9.0	32.1	13.6	69.5
1988	5.1	4.1	14.4	33.6	14.2	73.1
1989	5.9	3.7	11.7	37.3	15.0	79.3
1990	6.4	3.7	15.8	48.5	15.4	82.3
1991		3.8	18.4	51.6	15.6	81.1
1992		4.2	17.9	56.3	15.9	78.5
1993			16.1	59.8	15.7	77.2
1994						

Source: See Figure 2.

Appendix C (continued) Labour Productivity in Manufacturing Branches, countries as % of USA

Table C8 Chemicals Products

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						7.6
1956						8.4
1957						9.4
1958				3.3		11.6
1959						12.7
1960	7.5			3.2		14.8
1961	7.6				4.0	16.9
1962	7.6				4.7	18.0
1963	7.5			5.4	5.2	20.5
1964	6.8				5.9	23.5
1965	6.3				6.1	24.8
1966	6.3			6.7	7.0	31.2
1967	6.6			10.6	7.9	38.9
1968	6.9			12.1	10.4	41.7
1969	7.5			15.7	13.1	48.7
1970	6.9			17.1	13.1	50.7
1971	7.3			19.3	13.6	50.4
1972	7.0			20.5	14.6	54.3
1973	6.2			21.3	11.2	51.6
1974	6.4			17.1	8.0	50.0
1975	5.9		10.1	21.8	8.7	62.5
1976	6.2		16.8	19.2	8.1	63.6
1977	6.0		15.4	20.3	8.9	69.4
1978	6.6		19.6	23.2	9.2	86.0
1979	5.4		14.2	19.8	9.3	70.7
1980	5.5	7.9	17.8	24.6	9.2	78.6
1981	5.8	7.9	22.8	29.1	11.1	93.0
1982	6.0	7.5	17.2	25.0	11.2	95.1
1983	5.8	6.7	14.7	24.1	11.1	82.5
1984	5.5	6.3	15.5	24.8	10.9	79.3
1985	6.2	6.2	17.7	24.9	11.2	86.0
1986	5.9	5.9	14.7	19.8	14.2	59.4
1987	5.8	5.5	13.4	20.8	15.3	75.9
1988	6.0	5.5	17.2	21.8	15.1	68.8
1989	6.8	5.0	14.4	25.4	15.2	79.7
1990	7.8	5.3	18.0	34.6	15.2	84.0
1991		5.7	24.4	52.6	22.0	82.1
1992		6.4	23.0	58.8	22.6	89.4
1993			22.7	61.9	23.8	85.9
1994						

Source: See Figure 2.

Table C9 Rubber and Plastic Products

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						82.8
1956						85.6
1957						89.3
1958				4.4		83.3
1959						70.0
1960	25.3			8.3		83.0
1961	26.1				1.7	85.1
1962	26.5				2.3	77.2
1963	23.1			4.4	2.5	84.3
1964	17.8				3.2	89.2
1965	19.0				4.2	85.7
1966	17.6			3.8	5.6	95.7
1967	18.4			5.0	6.7	103.6
1968	18.4			6.5	7.7	105.1
1969	18.7			6.9	8.6	111.0
1970	29.3			9.0	11.0	130.7
1971	26.7			13.4	13.3	127.0
1972	24.2			14.3	12.8	130.4
1973	19.4			12.3	11.2	118.2
1974	20.3			11.9	9.6	127.6
1975	17.0		11.2	11.9	10.5	117.4
1976	18.4		16.2	12.8	12.8	135.8
1977	16.0		15.9	12.6	10.4	128.3
1978	19.3		22.0	18.2	12.4	131.9
1979	19.3		16.9	22.5	13.6	140.7
1980	15.2	7.6	13.6	17.3	13.4	138.6
1981	12.8	7.0	11.7	15.5	13.1	127.7
1982	17.0	7.1	12.1	14.7	13.7	135.1
1983	12.1	6.5	12.3	15.4	13.5	128.0
1984	14.7	6.4	13.3	18.6	13.5	132.3
1985	18.9	6.0	17.8	17.0	14.4	128.9
1986	15.1	5.7	10.7	19.2	18.2	128.3
1987	15.5	5.4	8.6	19.3	19.2	127.5
1988	17.6	5.8	11.7	24.1	19.4	132.6
1989	19.6	5.5	11.8	22.0	21.8	129.0
1990	24.1	5.4	12.2	28.4	26.2	135.0
1991		5.3	12.3	41.1	27.9	128.1
1992		5.8	15.7	46.3	30.0	121.3
1993			14.6	46.3	32.5	117.4
1994						

Source: See Figure 2.

Table C10 Non-metallic Mineral Products

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						11.6
1956						14.9
1957						15.1
1958				5.0		15.3
1959						16.9
1960	6.6			9.2		19.8
1961	6.9				23.6	22.9
1962	6.8				26.5	22.3
1963	6.3			8.8	26.7	25.1
1964	5.8				28.6	29.0
1965	6.6				29.1	29.7
1966	7.2			9.8	32.3	31.8
1967	7.2			9.6	32.9	34.8
1968	6.4			11.7	34.4	38.6
1969	7.2			16.2	39.6	43.6
1970	7.6			17.4	40.7	53.2
1971	6.8			21.2	43.4	55.7
1972	5.8			21.0	37.5	55.7
1973	5.0			26.8	29.6	59.0
1974	4.8			26.5	30.0	59.2
1975	5.6		5.0	28.0	33.4	52.2
1976	5.5		8.0	29.0	38.3	48.7
1977	6.6		11.1	32.6	41.3	52.9
1978	5.9		12.8	34.8	47.3	57.1
1979	5.1		12.5	32.9	46.2	60.6
1980	5.2	7.4	11.4	35.3	49.1	57.9
1981	5.3	7.6	14.1	35.9	54.8	67.9
1982	6.0	7.7	9.1	32.4	50.4	67.6
1983	5.8	7.3	10.2	36.9	52.9	74.8
1984	6.6	7.3	10.0	38.6	51.0	67.6
1985	6.6	6.9	9.9	38.0	51.9	72.8
1986	6.2	6.7	10.6	43.0	54.5	70.3
1987	7.3	6.8	11.0	49.3	65.8	78.8
1988	7.8	7.1	10.7	52.9	75.3	82.5
1989	8.5	6.3	7.4	57.3	83.8	83.4
1990	10.0	6.2	10.2	68.2	95.8	84.1
1991		7.3	12.2	80.5	107.3	82.9
1992		8.8	11.7	76.2	108.8	76.7
1993			13.8	84.6	123.3	76.7
1994						

Source: See Figure 2.

Table C11 Basic & Fabricated Metal Products

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						15.3
1956						15.2
1957						16.5
1958				7.9		12.9
1959						15.2
1960	8.9			6.8		19.9
1961	9.3				2.6	24.1
1962	9.2				2.3	20.2
1963	9.7			7.7	2.3	21.9
1964	9.7				2.3	28.0
1965	9.1				2.6	27.2
1966	8.4			8.0	2.8	28.7
1967	7.9			8.3	2.9	32.5
1968	8.1			11.6	3.4	36.5
1969	8.4			15.7	4.5	45.4
1970	8.9			16.6	5.2	57.6
1971	8.6			15.7	6.7	59.3
1972	8.2			16.6	8.2	64.7
1973	6.8			21.9	7.9	69.9
1974	8.1			21.7	5.6	62.3
1975	8.1		5.2	27.3	7.4	67.9
1976	8.6		5.5	27.8	9.0	72.4
1977	8.0		4.3	26.4	8.5	71.3
1978	8.2		4.7	29.0	10.5	81.1
1979	7.6		6.3	26.9	10.7	96.5
1980	8.0	11.7	6.8	31.0	11.4	94.6
1981	8.4	11.6	7.9	36.8	11.9	83.4
1982	8.4	13.2	9.8	42.6	14.2	95.0
1983	8.9	13.3	13.9	43.6	15.2	86.9
1984	7.6	12.7	23.2	45.0	15.8	94.3
1985	8.3	12.5	19.6	45.2	15.2	96.2
1986	7.7	12.7	32.6	45.6	17.2	92.6
1987	7.5	12.1	25.2	45.0	17.7	91.6
1988	9.7	12.6	25.9	44.5	19.3	100.3
1989	9.4	12.7	28.6	57.6	21.1	105.9
1990	10.4	10.8	24.1	70.6	23.7	107.2
1991		10.4	15.8	79.9	24.9	103.0
1992		12.1	18.9	83.7	26.4	93.9
1993			20.9	79.3	26.0	90.2
1994						

Source: See Figure 2.

Appendix C (continued) Labour Productivity in Manufacturing Branches, countries as % of USA

Appendix C (continued) Labour Productivity in Manufacturing Branches, countries as % of USA

Table C12 Machinery & Transport Equipment

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						12.2
1956						19.4
1957						20.3
1958				3.4		18.5
1959						21.0
1960	8.9			3.4		27.6
1961	9.5				1.7	30.8
1962	9.7				1.8	32.1
1963	9.1			3.1	1.9	33.2
1964	9.6				2.4	37.7
1965	9.2				4.2	37.1
1966	9.0			4.5	5.0	38.8
1967	9.3			4.7	6.6	45.9
1968	8.9			6.7	7.7	51.9
1969	9.5			9.1	8.4	59.8
1970	10.3			8.1	7.6	80.2
1971	10.4			7.9	9.4	73.5
1972	10.3			9.1	10.9	70.5
1973	10.3			12.9	8.6	74.6
1974	11.5			13.7	8.8	83.0
1975	11.2		12.5	13.0	11.8	84.5
1976	12.6		10.5	15.1	11.7	93.0
1977	11.8		11.0	21.9	14.0	94.5
1978	13.0		13.6	25.3	14.1	100.1
1979	11.5		14.4	24.7	14.6	117.5
1980	12.5	3.3	21.5	25.6	15.9	138.4
1981	13.3	3.6	30.6	33.5	19.3	149.9
1982	14.5	3.9	21.9	39.2	20.4	153.9
1983	13.1	3.5	14.9	37.4	18.9	132.0
1984	12.9	3.4	14.8	35.7	17.0	125.6
1985	11.4	3.6	16.0	32.6	15.2	124.9
1986	11.2	3.2	14.0	37.5	16.2	117.2
1987	10.5	3.2	14.0	43.8	17.0	118.4
1988	10.0	3.3	15.4	43.2	16.9	123.4
1989	11.5	3.0	16.4	44.9	18.3	128.2
1990	12.5	2.8	17.7	57.5	20.4	134.9
1991		3.1	15.7	65.5	22.4	136.6
1992		3.7	21.0	67.8	23.6	117.6
1993			22.2	62.1	19.4	100.1
1994						

Source: See Figure 2.

Table C13 Electrical Machinery & Equipment

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						4.2
1956						3.6
1957						4.2
1958				15.2		5.1
1959						6.2
1960	8.3			9.0		7.5
1961	8.8				4.5	10.3
1962	7.4				5.3	11.3
1963	7.5			10.1	5.3	10.6
1964	7.1				8.5	11.4
1965	6.8				8.6	9.9
1966	6.6			8.9	11.2	10.7
1967	6.9			5.3	11.9	13.8
1968	6.9			7.8	16.3	16.6
1969	7.1			8.1	15.6	19.2
1970	8.0			10.6	14.7	22.9
1971	8.1			10.5	15.8	23.7
1972	8.4			11.6	16.0	29.1
1973	8.2			13.3	16.0	34.2
1974	7.9			14.9	13.4	37.5
1975	7.8		23.5	15.1	15.8	34.7
1976	8.0		27.7	16.1	15.1	43.0
1977	7.5		27.5	15.9	14.4	42.9
1978	7.2		23.6	18.1	17.0	48.0
1979	6.7		18.1	15.8	16.7	56.2
1980	7.1	9.6	26.9	16.5	17.6	62.5
1981	7.3	10.3	22.9	20.7	19.9	65.0
1982	8.6	11.4	30.0	24.9	21.0	73.8
1983	8.7	12.0	20.5	29.3	21.7	80.2
1984	9.9	12.7	21.0	35.0	22.5	88.2
1985	8.0	14.5	30.4	32.8	23.5	93.3
1986	8.6	12.8	26.9	39.4	27.1	96.6
1987	8.9	11.7	21.0	40.7	27.7	94.2
1988	9.0	12.9	23.6	42.3	29.2	107.7
1989	9.4	12.2	20.7	42.0	31.4	109.9
1990	9.1	10.5	22.7	52.7	35.3	116.0
1991		10.2	21.3	57.2	36.6	124.4
1992		10.6	32.5	60.5	38.3	112.9
1993			21.3	63.3	37.6	106.9
1994						

Source: See Figure 2.

Table C14 Other Manufacturing Industries

Year	India	China	Indon-esia	South Korea	Taiwan	Japan
1955						11.1
1956						12.6
1957						13.3
1958				2.2		13.5
1959						13.3
1960				2.5		15.5
1961					0.8	16.8
1962					0.8	17.3
1963				3.0	0.9	20.8
1964					1.0	21.9
1965					1.1	22.3
1966				2.9	1.5	23.4
1967				2.0	1.5	25.4
1968				2.7	1.8	27.2
1969				2.9	2.8	28.5
1970				4.8	3.5	31.9
1971				3.8	4.6	30.0
1972				3.9	4.6	29.6
1973				4.4	4.8	31.2
1974				5.1	6.9	33.3
1975	10.1		3.6	4.9	5.4	30.2
1976			3.1	5.4	7.0	33.6
1977			3.6	5.6	10.0	35.3
1978			4.2	7.7	10.6	39.6
1979			3.6	8.1	9.9	42.9
1980	16.8	4.8	6.0	8.7	10.2	50.2
1981	14.1	4.3	3.7	9.2	8.8	48.9
1982	17.7	4.5	3.6	9.9	9.2	53.3
1983	20.8	4.6	3.0	10.8	10.1	58.6
1984	20.9	4.0	3.6	9.9	8.4	53.0
1985	30.1	4.7	4.6	10.4	8.7	60.4
1986	20.5	4.5	4.3	12.3	9.0	54.4
1987	20.4	3.9	4.0	15.3	9.3	52.0
1988	15.8	3.5	4.1	15.7	8.4	48.0
1989	19.7	3.6	5.0	17.0	8.8	52.3
1990	17.1	3.3	4.1	20.8	9.1	52.3
1991		3.4	3.8	23.0	8.6	51.6
1992		3.8	6.9	25.3	8.9	47.9
1993			5.5	24.5	8.9	43.9
1994						

Source: See Figure 2.

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