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COMPARISONS OF PURCHASING POWER, REAL OUTPUT AND LABOUR PRODUCTIVITY IN MANUFACTURING IN JAPAN, SOUTH KOREA AND THE U.S.A., 1975-85

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This study presents binary comparisons of real output and labour productivity in manufacturing in Japan, South Korea and the U.S.A. in 1975, made according to an "industry of origin approach." The 1975 benchmark comparisons have been updated to 1985. Value added per hour worked in Japanese manufacturing increased from 54 percent of the U.S. level in 1975 to 76 percent in 1985. In certain important branches such as electrical machinery, metal products and machinery and transport equipment, productivity leadership shifted to Japan. In South Korea, labour productivity in manufacturing increased rapidly from 1975 to 1985, both in absolute terms and relative to the U.S.A. Nevertheless, in 1985 value added per hour worked was only 14 percent of the U.S. level.

1. INTRODUCTION

In this article the authors present results of a study comparing levels of real output and labour productivity in Japanese and South Korean manufacturing with those in the U.S.A. Binary comparisons of purchasing power parities, real output and labour productivity have been made according to the industry of origin approach (see Maddison and Van Ark, 1988 and 1989). 1975 has been taken as the benchmark year, for purposes of comparability with other studies. The 1975 benchmark comparison has been updated to 1985, using national indices of prices, output and labour input.

The article is accompanied by two DATA DISKETTES. The function of these diskettes is to set out our working procedures in such a way that they become transparent and replicable. One sample industry (grain mill products) has been selected as a model to illustrate all the steps from detailed matchings of products to the derivation of purchasing power parities (PPPs). It was not possible to include the basic data for all our 28 sample industries on the diskettes. For these the reader is referred to a 300 page annex to the full length research report on this project (Szirmai and Pilat, 1990).

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The present study is one of a series of studies being undertaken at the University of Groningen, within the framework of the International Comparisons of Output and Productivity project (ICOP). It can be seen as a sequel to the Maddison and Van Ark study of Mexico and Brazil published in this journal in 1989 (see Maddison and Van Ark, 1989).

Compared with previous publications this study contains some new elements: (1) the number of sample industries has been increased substantially from 17 to 28; (2) more attention has been paid to labour input, in particular to the calculation of hours actually worked; (3) the sensitivity of productivity comparisons to the use of census data vis à vis national accounts data has been examined more elaborately; (4) 1975 labour productivity comparisons have been updated to 1985 at branch level.

Our choice of countries was dictated by the following considerations: the U.S.A. figures as a base country in most binary comparisons within the ICOP project. As the twentieth century world productivity leader, the U.S.A. provides an interesting standard of comparison in assessing the economic performance of different countries. Japan has shown spectacular industrial growth in the post-war period. This study may serve to evaluate the claim sometimes made, that Japan is at present overtaking the U.S.A. as world productivity leader. South Korea is an example of a developing country which has succeeded in creating a competitive modern industrial sector in a short period of time. It is interesting to compare productivity levels there with those of advanced economies such as the U.S.A. Finally, all three countries have industrial statistics of sufficient detail and acceptable quality.

The most important sources in this study consist of the manufacturing censuses of the three countries. The censuses present information on quantities and corresponding gross output values for most products, making it possible to derive unit values.

The basic approach is to match products in a sample of 28 industries. These sample industries represent 29.1 percent of total value added in manufacturing in Japan, 58.1 percent in South Korea and 26.1 percent in the U.S.A.

Only those products are matched of which the description in the censuses of the two countries being compared is more or less consistent and comparable. In principle, products which account for more than 1 percent of gross value of output in a sample industry in either of the two countries, are matched (see Maddison and Van Ark, 1988; Szirmai and Pilat, 1990).

In the Japan/U.S.A. comparison 126 matches have been made, involving 220 products in Japan and 493 products in the U.S.A. The gross value of output of matched products in the Japan/U.S.A. comparison amounts to 22.4 percent of gross value of total manufacturing output in Japan and 21.9 percent in the U.S.A. In the South Korea/U.S.A. comparison 135 matches have been achieved, involving 230 products in South Korea and 536 products in the U.S.A. The value of matched products represents 46.0 percent of the gross value of manufacturing output in Korea and 22.4 percent in the U.S.A.

The unit value ratios of the matched products are used to derive purchasing power parities (PPPs) for the 28 sample industries. One should note, that for every binary comparison we have two PPPs, one at quantity weights of country

X and one at quantity weights of country *U*. Thus:

$$(1) \qquad PPP_j^{XU(X)} = \frac{\sum_{i=1}^{s} (Q_{ij}^X * P_{ij}^X)}{\sum_{i=1}^{s} (Q_{ij}^X * P_{ij}^U)} \quad \text{and} \quad PPP_j^{XU(U)} = \frac{\sum_{i=1}^{s} (Q_{ij}^U * P_{ij}^X)}{\sum_{i=1}^{s} (Q_{ij}^U * P_{ij}^U)}$$

where $PPP_j^{XU(X)}$ is the purchasing power parity of the currency of country *X* versus the currency of country *U* in industry *j*, at quantity weights of country *X*. $PPP_j^{XU(U)}$ is the purchasing power parity of the currency of country *X* versus the currency of country *U* in industry *j*, at quantity weights of country *U*. $i = 1, \ldots, s$ is sample of matched items; n = all items in a sample industry; $s \leq n$.

When a summary measure is required, the Fisher average of the two PPPs is used.

The 28 sample industries represent 15 branches of manufacturing. For each branch of manufacturing the branch PPP is calculated as a weighted average (by sample industry value added) of the sample industry PPPs in that branch. The branch PPPs calculated from the manufacturing censuses are applied to data on branch value added derived from the national accounts of the three countries, in order to make binary comparisons of real output and labour productivity on a national accounts basis.

2. Data Sources and Their Reconciliation

Branch PPPs from matched samples of products from industrial censuses can be applied to aggregate value added figures for industrial branches derived from the censuses themselves or from national accounts. In this section we will discuss and compare the different sources.

A recurring problem in the reconciliation of census data with national accounts data, is that the sources are based on different value added concepts. In the national accounts, service inputs from outside the manufacturing sector are excluded from manufacturing value added. The national accounts sources of this study utilize the present national accounts concept of value added, which deducts all service inputs, with the exception of financial service inputs. In the case of the census concept of value added, service inputs from outside the manufacturing sector are not deducted. This census concept therefore involves double counting not present in the national accounts (for an extended treatment see Maddison and Van Ark, 1988).

The Japanese *Census of Manufactures* is held every year in December. The 1975 issue used as source in this study, lists some 2,000 products. South Korean census data are taken from the *Mining and Manufacturing Survey 1975*. It is held annually in the intervening years between the quinquennial *Mining and Manufacturing Census*. The survey only covers establishments with five or more workers. Comparison with South Korean national accounts and census data of other countries requires an adjustment of output and labour input data in the *Survey*. For that purpose we have used proportions from the 1973 and 1978 issues of the *Census*. The *Census* presents information both for establishments with five or more workers and for all establishments. (See Szirmai and Pilat, 1990, DISKETTE TABLES 1.2 and 1.3).

The U.S. Census is held every five years. It categorizes more than 13,000 products according to the Standard Industrial Classification. Our primary source is the *1977 Census of Manufactures.*

The matchings of products are based on the 1977 *Census.* In order to put the resulting sample industry PPPs on a 1975 basis, we have to divide the PPPs by a 1975/1977 U.S. price ratio. This price ratio is calculated as follows. The *Annual Survey of Manufactures 1975-76* (ASM) shows data for output and input values and for employment by 4-digit SIC industry in 1975, but it contains no information on output quantities. For volume adjustments of 1977 census data to 1975, we use detailed indices of shipments in constant 1972 dollars from the *1982 U.S. Industrial Outlook* (U.S. Dept. of Commerce, 1982, pp. 431-438). This gives us 1975 output quantities at 1977 prices. Dividing 1975 output values from the *Annual Survey* by 1975 quantities at 1977 prices gives us the required 1975/1977 price ratios (DISKETTE TABLES 2.2-2.6, 5.2-5.6).

In the case of Japan and the U.S.A. we have used data on gross value of shipments rather than gross value of output. Data on gross output were not available in the U.S. census. In the Japanese census they were only available for larger establishments.

In all three censuses the value added concept is the U.S. census concept of value added: gross value of output minus cost of materials, fuel and energy and subcontracting. Costs of purchased services from outside the manufacturing sector are not deducted. At an aggregate level one can make a rough reconstruction of the national accounts concept of value added by applying proportions from input-output tables which provide enough detail to calculate both national accounts and census concepts of value added (see Table 1).

In Japan and the U.S.A. the census value added concept is at factor cost, excluding indirect taxes. In the South Korean *Survey*, the gross value of output and gross value added are evaluated at f.o.b. plant prices including excise taxes such as sales tax, liquor tax and petroleum tax. In order to avoid bias in the PPPs, these indirect taxes have to be deducted. At branch level, we were able to calculate the ratio of gross value of output at factor cost, to gross value of output at market prices from the Korean input-output tables for 1975. This ratio was assumed to hold for gross value of output in the *Survey* as well and was used to adjust the survey data to a factor cost basis (DISKETTE TABLE 1.2-1.4).

In all three countries census employment is exclusive of head office employment.

The Japanese National Accounts are published annually by the Economic Planning Agency of the Government of Japan. Our main source for 1975 is an updated printout supplied by the Economic Planning Agency, dated March 1989. This printout contains information on GDP at market prices for 18 branches of manufacturing from 1975 to 1987. The 1975 data have been adjusted to factor cost using percentages from the 1975 input-output table (see DISKETTE TABLE 1.1). In Table 1 we have, however, used aggregate data for 1975 from the *Report on Revised National Accounts on the Basis of 1980*, as the 1989 update does not contain information on gross value of output, taxes and intermediate inputs.

The national accounts data for Korea are published annually by The Bank of Korea. Our sources for 1975 are *National Income in Korea 1987 (1960-86)*

and *National Income in Korea*, 1978. The 1987 edition shows GDP at factor cost for 9 sectors. We have redistributed the 9 sectors over our 15 sectors with data from the 1978 edition, after adjusting GDP figures at market prices in the latter source to factor cost with percentages derived from the 1975 input-output tables.

For the United States, the Bureau of Economic Analysis provided us with detailed figures on GDP from 1947-86, at branch level (BEA, 1987). This source includes information on indirect taxes and subsidies for our 15 branches, so we could derive GDP at factor cost.

Table 1 summarizes the relationships between census data, national accounts data and input-output data for the three countries involved. In all three countries census value added in the censuses (row 5, columns 1, 4 and 7) is much higher than national accounts value added from the national accounts (row 9, columns 3, 6 and 9)—11.6 percent higher in Japan, 18.2 percent higher in South Korea and 31.4 percent higher in the U.S.A. This is due to the fact that census value added involves more double counting than the present national accounts concept of value added. On the other hand, if we adjust the census figures to a present national accounts basis, using proportions from the input-output tables (see row 9, columns 1, 4 and 7), GDP in the Japanese and South Korean censuses is much lower than GDP from the national accounts (75 percent and 80.7 percent respectively). This is because the national accounts of these countries tend to include more activities than the census (e.g. informal sector, reclassified activities from other sectors than manufacturing). In the case of the U.S.A. adjusted GDP from the census is almost identical to national accounts GDP.

In all three countries, national accounts employment is substantially higher than census employment due to inclusion of head office personnel and more complete coverage of temporary workers, the self-employed and those engaged in informal activities.

In row 12 one can compare adjusted census value added per employee with national accounts value added per employee. In Japan, adjusted census value added per employee is 94.4 percent of national accounts value added per employee. On the other hand in South Korea and the U.S.A. adjusted census value added per employee is higher than national accounts value added per employee, by 12.2 percent in South Korea and 8.4 percent in the U.S.A.

The general conclusion of this section is that reconciliation of census and national accounts is not possible in the three countries under consideration. One can conceive of a reconstruction of the present national accounts concept of value added, by applying proportions from the input-output tables to the census data, but in Japan and South Korea the adjusted census estimates of GDP still differ greatly from the national accounts figures. Also, at branch level, the discrepancies between census and national accounts vary widely from branch to branch, due in part to differences in classification (DISKETTE TABLES 1.1, 1.4 and 1.5).

Thus, we are forced to choose between applying the PPPs derived from census data either to census branch value added data or to national accounts branch value added data. In principle, we prefer comparisons on a national accounts basis. National accounts are theoretically more sophisticated and internationally more standardized than censuses.

TABLE 1

THE RELATIONSHIP BETWEEN CENSUS OF MANUFACTURES, NATIONAL ACCOUNTS AND THE INPUT-OUTPUT TABLE, JAPAN, SOUTH KOREA AND THE UNITED STATES, 1975

		Japan		
		Census of Manufactures (bill. Yen) (1)	Input-Output Table (bill. Yen) (2)	National Accounts (bill. Yen.) (3)
Gross value of output	(1)	—	143,239.4	144,486.6
Taxes and subsidies	(2)	—	3,612.0	3,651.4
Gross value of output at factor cost	(3)	127,520.6	139,627.4	140,835.2
Non-service inputs	(4)	81,591.8	83,730.4	—
Census value added	(5)	45,928.8	55,897.0	—
Service inputs	(6)	15,083.2[a]	18,356.9	—
Total intermediate inputs	(7)	96,675.1	102,087.3	99,685.7
Gross domestic product at market prices	(8)	—	41,152.1	44,800.9
Gross domestic product at factor cost	(9)	30,845.5	37,540.2	41,149.5
Employment[c]	(10)	11,296,209	14,291,895	14,228,000
Census value added per employee	(11)	4,065,858	3,911,100	—
Nat. acc. value added per employee	(12)	2,730,609	2,626,675	2,892,149

[a]Calculated by applying ratios from the input-output table.

[b]Taxes and subsidies based on ratio factor cost/market prices from national accounts.

[c]Census employment excludes head office employment.

Sources: Col. 1 from MITI, *Census of Manufactures 1975, Report by Industries*; Col. 2 from MITI, *1970-1975-1980 Link Input-Output Tables, 1985*; Col. 3 from Economic Planning Agency, *Report on Revised National Accounts on the Basis of 1980*; Col. 4 from Economic Planning Board, *1975 Mining*

In order to test the sensitivity of our results to the choice of data sources, we have calculated international comparisons of value added per person engaged both on a census basis and on a national accounts basis. At an aggregate level, the various discrepancies between the sources tend to cancel out, particularly in the case of Japan. In South Korea, value added per person engaged as percentage of the U.S.A. (geometric average) is slightly higher on a census basis than on a national accounts basis (15.2 percent against 13.3 percent). In Japan the results are practically identical. At branch level, the discrepancies between the productivity results are greater than for manufacturing as a whole. However, the general pattern of international productivity differentials based on the national accounts is quite consistent with the pattern based on the censuses. We may conclude that the choice of data source will not affect our substantive results to any serious degree. In the rest of this article, we shall only present comparisons on a national accounts basis. The tables based on census data are available on the accompanying diskettes (see DISKETTE TABLES 3.2, 3.4, 6.4 and 6.6).

3. SAMPLE INDUSTRY PPPs, BRANCH PPPs AND BRANCH REAL OUTPUT COMPARISONS

Table 2 shows the sample industry PPPs which have been derived according to the procedure described in section 1 (equation 1). This table is the basis for the derivation of all PPPs at higher levels of aggregation.

South Korea			United States		
Census of Manufactures (mill. Won) (4)	Input-Output Table (mill. Won) (5)	National Accounts (mill. Won) (6)	Census of Manufactures (mill. US$) (7)	Input-Output Table (mill. US$) (8)	National Accounts (mill. US$) (9)
8,364,691	10,008,261	11,198,400	—	979,639	—
423,406[a]	506,601	561,900	—	19,228[b]	20,627
7,941,284	9,501,660	10,636,500	1,039,377	960,411[b]	—
5,442,868	6,385,098	—	596,892	548,728	—
2,498,417	3,116,562	—	442,485	411,683	—
792,406[a]	988,459	—	106,422[a]	97,835	—
6,235,273	7,373,557	8,522,200	703,315	646,563	—
2,129,417	2,634,704	2,676,200	—	333,077	357,312
1,706,011	2,128,103	2,114,300	336,063	313,849	336,685
1,585,391	—	2,205,000	17,174,000	—	18,658,000
1,575,899	—	—	25,765	—	—
1,076,082	—	958,866	19,568	—	18,045

and Manufacturing Survey (adjusted for small establishments); Col. 5 from UNIDO, *1975 Input-Output Tables for Korea*; Col. 6 from Bank of Korea, *National Income in Korea 1987*; Col. 7 from *Annual Survey of Manufactures 1975-1976*; Col. 8 from BEA, *Summary Input-Output Tables of the U.S. Economy*; *1973, 1974 and 1975.* Paula C. Young and Shirley F. Loftus, BEA Staff Paper 037. Col. 9 from BEA, *Gross National Product by Industry and Type of Income in Current Dollars, and by Industry in Constant Dollars, 1947-1986,* July 1987.

PPPs for 15 major branches of manufacturing are presented in Table 3. The PPP for each branch is the weighted average, weighted by sample industry value added, of the sample industry PPPs belonging to that branch. If a branch is only represented by a single sample industry, the PPP for the sample industry is taken as the PPP for the whole branch.

As explained in section 2, South Korean census value added data include indirect taxes and subsidies. Indirect taxes will introduce an upward bias in sample industry PPPs, subsidies a downward bias. Therefore, South Korean PPPs need to be adjusted. At branch level, we derived estimates of percentages of indirect taxes and subsidies to value added from the input-output tables and adjusted the branch PPPs accordingly (see DISKETTE TABLES 6.1-6.4 and 6.7).

The geometric average of the national accounts PPPs in Table 3 is 18.8 percent lower than the exchange rate in the case of South Korea and 17.6 percent in the case of Japan.

We apply the branch PPPs to national accounts branch value added data in order to convert them into a common currency for purposes of real output comparisons

$$(2) \quad GVA_k^{X(U)} = GVA_k^{X(X)} / PPP_k^{XU(X)} \quad \text{and} \quad GVA_k^{U(X)} = GVA_k^{U(U)} * PPP_k^{XU(U)}$$

where $GVA_k^{X(U)}$ is gross value added in branch k of country X at prices of country U; $GVA_k^{X(X)}$ is gross value added in branch k of country X at national currencies.

TABLE 2

SAMPLE INDUSTRY PURCHASING POWER PARITIES, JAPAN/U.S.A. (YEN TO THE U.S.$) AND SOUTH KOREA/U.S.A. (WON TO THE U.S.$), 1975

	Sample Industries	PPP: Yen/US$			PPP: Won/US$		
		U.S. Quantity Weights (1)	Japan Quantity Weights (2)	Geometric Average (3)	U.S. Quantity Weights (4)	South Korea Quantity Weights (5)	Geometric Average (6)
1	Dairy products	534.71	586.65	560.08	676.13	781.11	726.73
2	Fats and oils	451.00	433.29	442.05	1,059.80	792.65	916.54
3	Grain mill products	411.73	405.19	408.45	673.98	537.56	601.91
4	Sugar & sugar factories	378.15	378.13	378.14	772.00	562.85	659.18
5	Confectionery products	(a)	(a)	(a)	389.22	472.19	428.70
6	Malt and malt beverages	523.55	523.53	523.54	1,030.76	1,077.30	1,053.77
7	Tobacco and tobacco products	(a)	(a)	(a)	556.66	791.98	663.98
8	Textile yarn and cloth	328.40	212.49	264.16	363.78	381.94	372.75
9	Men's clothing	318.42	272.36	294.49	480.60	459.57	469.97
10	Footwear and leather products	336.31	321.28	328.71	291.08	193.13	237.10
11	Sawmills, planing and other woodmills	669.70	658.39	664.02	349.32	100.06	186.96
12	Pulp and paper	345.00	329.99	337.41	565.36	413.06	483.25
13	Agricultural fertilizers	250.91	258.12	254.49	445.71	487.16	465.97
14	Manmade fibres	335.58	327.99	331.77	541.90	510.42	525.92
15	Paints	334.22	329.68	331.94	574.45	495.44	533.48
16	Soap and detergents	315.40	316.93	316.16	309.74	254.32	280.67
17	Petroleum refineries	514.06	406.02	456.86	1,311.10	706.47	962.42
18	Tires and inner tubes	133.88	144.37	139.02	768.87	734.78	751.63
19	Rubber and plastic footwear	185.58	117.62	147.75	206.69	176.93	191.23
20	Bricks	328.62	264.50	294.82	286.98	105.37	173.90
21	Cement	209.63	204.61	207.11	477.11	437.92	457.10
22	Iron and steel	207.60	203.82	205.70	409.29	374.41	391.46
23	Metals cans and shipping containers	188.29	188.28	188.29	513.71	380.31	442.01
24	Screw machine products	139.66	148.66	144.09	243.80	251.44	247.59
25	General machinery and equipment	376.45	253.62	308.99	2,141.51	1,753.07	1,937.58
26	Radio and TV receivers	171.09	140.08	154.81	148.84	123.18	135.40
27	Lamps and bulbs	178.45	166.77	172.51	413.39	161.93	258.73
28	Motor vehicles and equipment	142.09	140.64	141.36	504.98	476.96	490.77
	Weighted average PPP for sample (value added-US Census concept-weights)	300.00	205.84	248.50	607.21	347.87	459.60
	Exchange rate	296.80	296.80	296.80	484.00	484.00	484.00

Source: See DISKETTE TABLES 2.2-2.6, 5.2-5.6; exchange rates from IMF, International Financial Statistics, 1980.

TABLE 3

PURCHASING POWER PARITIES BY MAJOR MANUFACTURING BRANCH JAPAN/U.S.A. (YEN TO THE U.S.$) AND SOUTH KOREA/U.S.A. (WON TO THE U.S.$), 1975

(after adjustment for indirect taxes and subsidies in South Korea)

		PPP: Yen/U.S.$			PPP: Won/U.S.$		
		U.S. Quantity Weights	Japan Quantity Weights	Geometric Average	U.S. Quantity Weights	South Korea Quantity Weights	Geometric Average
1	Food manufacturing	480.29	466.70	473.45	725.45	617.70	669.41
2	Beverages	523.55	523.53	523.54	590.22	616.87	603.40
3	Tobacco products	487.59	475.21	481.36	235.26	334.71	280.61
4	Textiles mill products	328.40	212.49	264.16	331.52	348.07	339.69
5	Wearing apparel	318.42	272.36	294.49	464.43	444.10	454.15
6	Leather products and footwear	336.31	321.28	328.71	282.93	187.72	230.46
7	Wood products, furniture and fixtures	669.70	658.39	664.02	323.70	92.72	173.24
8	Paper products, printing and publishing	345.00	329.99	337.41	532.96	389.38	455.55
9	Chemicals, petroleum and coal products	404.88	344.63	373.54	743.43	511.16	616.45
10	Rubber and plastic products	138.25	131.46	134.81	692.91	236.68	404.97
11	Non-metallic mineral products	251.20	228.03	239.33	385.69	250.51	310.84
12	Basic and fabricated metal products	197.64	196.79	197.21	387.02	351.06	368.60
13	Machinery and transport equipment	172.03	145.02	157.95	648.90	461.87	547.46
14	Electrical machinery and equipment	173.64	140.99	156.47	198.68	102.44	142.67
15	Other manufacturing industries	293.69	208.60	247.52	554.42	330.55	428.09
	Total manufacturing	289.24	206.95	244.66	525.36	293.98	392.99
	Exchange rate	296.80	296.80	296.80	484.00	484.00	484.00

Source: Sample industry PPPs from Table 2. The PPPs for Manufacturing Branches are the weighted averages (sample industry value added weights) of the sample industry PPPs belonging to a manufacturing branch (see DISKETTE TABLES 2.7, 3.1, 5.7 and 6.1). The South Korea/U.S.A. PPPs have been adjusted for indirect taxes and subsidies. The PPP for total manufacturing is the weighted average of all branch PPPs, weighted with national accounts branch value added weights (see Tables 4 and 5). Exchange rates from IMF, International Financial Statistics, various issues.

TABLE 4

GROSS VALUE ADDED AT FACTOR COST (NATIONAL ACCOUNTS CONCEPT) BY MAJOR MANUFACTURING BRANCH, JAPAN/U.S.A., 1975

		at Japanese "Prices"			At U.S. "Prices"		
		Japan 1975	U.S.A. 1975	Japan/ U.S.A (%)	Japan 1975	U.S.A. 1975	Japan/ U.S.A. (%)
		(1975 Yen million)			(1975 U.S.$ million)		
1	Food manufacturing	3,451,832	12,789,648	26.99	7,396.3	26,629	27.78
2	Beverages	681,891	2,827,712	24.11	1,302.5	5,401	24.12
3	Tobacco products[a]	210,913	1,352,562	15.59	443.8	2,774	16.00
4	Textile mill products	2,067,868	3,234,733	63.93	9,731.8	9,850	98.80
5	Wearing apparel	1,044,327	3,620,732	28.84	3,834.4	11,371	33.72
6	Leather products and footwear	111,634	834,376	13.38	347.5	2,481	14.01
7	Wood products, furniture and fixtures	1,578,322	10,238,366	15.42	2,397.2	15,288	15.68
8	Paper products, printing and publishing	3,007,398	11,024,238	27.28	9,113.6	31,954	28.52
9	Chemicals, petroleum and coal products	3,618,010	14,233,028	25.42	10,498.1	35,154	29.86
10	Rubber and plastic products	546,827	1,332,057	41.05	4,159.5	9,635	43.17
11	Non-metallic mineral products	1,856,610	2,858,394	64.95	8,142.1	11,379	71.55
12	Basic and fabricated metal products	7,123,612	10,901,347	65.35	36,198.7	55,158	65.63
13	Machinery and transport equipment	10,404,967	13,636,753	76.30	71,748.0	79,268	90.51
14	Electrical machinery and equipment	3,226,775	4,873,504	66.21	22,886.8	28,066	81.55
15	Other manufacturing industries	2,189,629	4,909,070	44.60	10,496.7	16,715	62.80
	Total manufacturing	41,120,615	98,666,521	41.68	198,697.0	341,123	58.25

Source: Gross value added in national currencies from Economic Planning Agency Japan, 1989 and BEA, 1987 (see DISKETTE TABLES 1.1 and 1.5): converted by PPPs from Table 3.

[a]No match was possible in this branch. The average PPP for food products and beverages was used to convert gross value added in this branch.

TABLE 5

GROSS VALUE ADDED AT FACTOR COST (NATIONAL ACCOUNTS CONCEPT), BY MAJOR MANUFACTURING BRANCH, SOUTH KOREA/U.S.A., 1975

		At South Korean "Prices"			At U.S. "Prices"		
		S. Korea 1975 (1975 Won million) (1)	U.S.A. 1975 (1975 Won million) (2)	S. Korea/ U.S.A. (%) (3)	S. Korea 1975 (1975 U.S.$ million) (4)	U.S.A. 1975 (1975 U.S.$ million) (5)	S. Korea/ U.S.A. (%) (6)
1	Food manufacturing	197,029	19,317,917	1.02	319.0	26,629	1.20
2	Beverages	60,418	3,187,828	1.90	97.9	5,401	1.81
3	Tobacco products	55,053	652,611	8.44	164.5	2,774	5.93
4	Textile mill products	286,808	3,265,489	8.78	824.0	9,850	8.37
5	Wearing apparel	173,661	5,280,989	3.29	391.0	11,371	3.44
6	Leather products and footwear	46,031	701,953	6.56	245.2	2,481	9.88
7	Wood products, furniture and fixtures	53,900	4,948,735	1.09	581.3	15,288	3.80
8	Paper products, printing and publishing	116,100	17,030,148	0.68	298.2	31,954	0.93
9	Chemicals, petroleum and coal products	351,526	26,134,610	1.35	687.7	35,154	1.96
10	Rubber and plastic products	52,974	6,676,182	0.79	223.8	9,635	2.32
11	Non-metallic mineral products	124,800	4,388,776	2.84	498.2	11,379	4.38
12	Basic and fabricated metal products	125,701	21,347,163	0.59	358.1	55,158	0.65
13	Machinery and transport equipment	209,208	51,437,303	0.41	453.0	79,268	0.57
14	Electrical machinery and equipment	187,096	5,576,258	3.36	1,826.4	28,066	6.51
15	Other manufacturing industries	73,994	9,267,093	0.80	223.9	16,715	1.34
	Total manufacturing	2,114,300	179,213,054	1.18	7,192.1	341,123	2.11

Source: Gross value added in national currencies from *National Income in Korea, 1978*, and *1987*, and BEA, Washington, D.C., 1987 (see DISKETTE TABLES 1.4 and 1.5); converted by PPPs from Table 3.

The real output relationships are given in Tables 4 and 5.

Throughout this article, we have applied PPPs derived from price ratios of output quantities (see equation (1)) to branch value added data (see equation (2)). In the ideal case, one would not only gather information on output quantities and prices, but also on input quantities and prices in order to calculate separate PPPs for inputs. Applying both input and output PPPs would give us "double deflated" value added in sample industries. Unfortunately, in manufacturing double deflation is usually not possible due to insufficient data. Our experiments with double deflation at branch level, using input-output tables have not yet generated sufficiently reliable results (Szirmai and Pilat, 1990).

4. Labour Input in 1975

Comparisons of real labour productivity in manufacturing between countries not only depend on accurate estimates of real gross value added, but also on accurate estimates of labour input. The figures on labour input should be comparable between the countries under study and consistent with the estimates of gross domestic product.

We have made estimates both of numbers of persons engaged and the total number of hours worked per year. This total refers to hours actually worked, excluding time not worked because of sick leave, strikes, vacations, national holidays and weekends (see Maddison, 1980).

Japan

The Japanese national accounts only distinguish 13 divisions of manufacturing. For these 13 divisions, data are available on the total number of persons engaged. We use the proportions of workers engaged in branches of manufacturing in the 1975 input-output tables (MITI, *1970-1975-1980 Link Input-Output Tables*) to distribute persons engaged in the divisions over our 15 branches. The results are presented in column 1 of Table 6.

On a national accounts basis we have calculated hours worked as follows. The input-output tables contain information on the numbers of persons in various categories of employment per branch (regular, temporary, self-employed etc.). The proportions between these categories are used to distribute the total numbers of persons engaged in each branch over the different categories of employment. For regular employees (some 76 percent of all persons engaged in Japan), average monthly hours worked in each branch are derived from *Monthly Labour Statistics Annual Report* (1979 edition).

For other categories of employment the *Annual Report on the Labour Force Survey, 1975* provides information on hours paid for by branch for each category of employment. We assume that the ratio of hours worked by regular employees to hours paid for regular employees also applies for the other categories of employment. Thus, we are able to arrive at an estimate of average hours worked for all separate categories of employment in each branch of manufacturing. Applying these average hours worked to the numbers of persons engaged in the different categories in each branch, gives us our estimates of total hours worked by manufacturing branch (see DISKETTE TABLES 8.1-8.5).

TABLE 6

LABOUR INPUT IN MANUFACTURING, JAPAN, SOUTH KOREA AND THE UNITED STATES, 1975

		Japan			South Korea			United States		
		All Persons Engaged (1)	Annual Hours Worked per Person Engaged (2)	Total Hours Worked All Persons Engaged (million) (3)	All Persons Engaged (4)	Annual Hours Worked per Person Engaged (5)	Total Hours Worked All Persons Engaged (million) (6)	All Persons Engaged (7)	Annual Hours Worked per Person Engaged (8)	Total Hours Worked by All Persons Engaged (million) (9)
1	Food manufacturing	1,197,569	2,050	2,455.0	211,434	2,419	511.5	1,465,046	1,696	2,484.0
2	Beverages	116,431	2,072	241.2	53,779	2,503	134.6	225,954	1,696	383.1
3	Tobacco products	36,000	2,127	76.6	31,335	2,400	75.2	73,000	1,730	126.3
4	Textile mill products	1,395,000	2,007	2,799.7	503,164	2,560	1,287.9	873,000	1,654	1,444.2
5	Wearing apparel	628,964	1,970	1,238.8	237,675	2,629	624.9	1,266,000	1,527	1,933.0
6	Leather products and footwear	124,845	2,006	250.5	48,084	2,472	118.9	252,000	1,594	401.7
7	Wood products, furniture and fixtures	776,230	2,078	1,613.2	87,530	2,696	236.0	1,121,000	1,665	1,866.2
8	Paper products, printing and publishing	865,808	2,088	1,807.9	101,834	2,469	251.4	1,784,000	1,582	2,821.8
9	Chemicals, petroleum and coal products	633,000	2,020	1,278.8	131,538	2,472	325.2	1,215,000	1,736	2,109.2
10	Rubber and plastic products	215,692	2,055	443.3	125,607	2,708	340.2	603,000	1,720	1,037.3
11	Non-metallic mineral products	750,000	2,040	1,530.2	95,069	2,496	237.3	642,000	1,738	1,116.0
12	Basic and fabricated metal products	1,871,000	2,002	3,745.1	141,308	2,550	360.3	2,621,000	1,710	4,482.6
13	Machinery and transport equipment	2,946,000	2,014	5,933.0	141,357	2,504	353.9	3,806,000	1,728	6,576.4
14	Electric machinery and equipment	1,473,000	1,945	2,864.7	180,036	2,404	432.9	1,706,000	1,719	2,932.3
15	Other manufacturing industries	1,198,460	2,033	2,436.7	115,250	2,506	288.8	1,005,000	1,666	1,674.6
	Total manufacturing	14,228,000	2,018	28,714.6	2,205,000	2,530	5,579.1	18,658.000	1,681	31,368.0

Sources: Col. 1 from Economic Planning Agency, *Report on Revised National Accounts on the Basis of 1980*, distributed with data from MITI, 1970-1975-1980 Link Input-Output Tables; Col. 2: hours worked for regular employees from Ministry of Labour, *Monthly Labour Statistics 1979, Annual Survey*, hours worked for other persons engaged from *Annual Report on the Labour Force Survey*; Col. 4 from Bank of Korea, *Economic Statistics Yearbook*, distributed with data from Economic Planning Board, *1975 Mining and Manufacturing Survey* (adjusted for small establishments); Col. 5 hours worked for regular employees from *1981 Yearbook of Labour Statistics*, hours worked for other persons engaged from *Annual Report on the Economic Active Population Survey 1981*; Col. 7 from BEA, *The National Income and Product Accounts of the United States, 1929-1982*; Col. 8 from data supplied by the Bureau of Labour Statistics to the Japan Productivity Centre, adjusted for paid absence.

South Korea

The only direct information about labour input in the national accounts consists of the total number of persons engaged in manufacturing. We distribute this total over 15 manufacturing branches, using proportions of persons engaged by manufacturing branch from the *1975 Mining and Manufacturing Survey* (adjusted for employment in small establishments).

The *Annual Report on the Economic Active Population Survey, 1981*, presents figures on the distribution of employment in terms of actual hours worked per week for the whole of mining and manufacturing. This source shows the number of persons working less than 17 hours per week, 18-26 hours, 27-35 hours, 36-44 hours, 45-53 hours and 54 hours and above. For each branch of manufacturing we distribute the employment figures over these six categories, according to the proportions in the *Annual Report.*

Hours actually worked per branch are calculated as follows. For regular employees, the 1981 *Yearbook on Labour Statistics* contains information on hours actually worked per branch in 1975. We assume that the 54 hours and above category in the *Annual Report* (70 percent of all employment) represents regular employment. For this category, we apply the estimates of average hours per branch from the *Yearbook.* For the remaining categories, we simply assume that the midpoint of each category in the *Annual Report* represents the average hours actually worked (e.g. the midpoint of the 45-53 category is 49 hours). Multiplying hours worked and numbers of persons engaged per branch in different categories of employment, gives us an estimate of total hours worked per branch of manufacturing (see DISKETTE TABLES 9.1-9.3). However, the quality of our hours worked estimates for South Korea still leaves much to be desired.

United States

The *National Income and Product Accounts, 1929-1982*, presents figures on numbers of employees, numbers of employees on a full time equivalent basis and total number of persons engaged on a full-time equivalent basis, by manufacturing branch. The difference between the total number of persons engaged on a full-time equivalent basis and the number of employees on a full-time equivalent basis consists of self-employed persons. This small category has not been adjusted to a full-time equivalent basis. No information is available on unpaid family workers, but the number of persons in this category is negligible.

Average hours per day worked by persons working full-time have been derived from information supplied by the Bureau of Labour Statistics to the Japan Productivity Center. The number of days worked per year by a person working full-time has been calculated as 365 days minus weekends, vacations and days lost due to work stoppages and sickness (from *Statistical Abstract of the United States, 1977* and Maddison, 1980). Combining this information with the total number of persons engaged in manufacturing gives us the total number of hours worked per year (see DISKETTE TABLES 10.1-10.3).

5. Value Added per Hour Worked in 1975 (National Accounts)

Dividing labour input data into the real output comparisons results in real labour productivity comparisons. We have made three kinds of real labour

productivity comparisons: (1) value added per person engaged on the basis of census data; (2) value added per person engaged on a national accounts basis and (3) value added per hour worked on a national accounts basis. Since Japanese and South Korean workers tend to work longer hours than U.S. workers, value added comparisons per hour worked will show lower labour productivity in Japan and South Korea relative to the U.S.A., than comparisons per person engaged. In this article we only show the results for value added per hour worked. The other comparisons are available on the accompanying diskettes (DISKETTE TABLES 3.4, 3.7, 6.6 and 6.10).

Table 7 presents a comparison of value added per hour worked in Japan and the U.S.A. Japanese value added per hour worked in manufacturing in 1975 was 45.5 percent of the U.S. level with Japanese price weights, 63.6 percent with U.S. price weights. These differences in productivity ratios with different price weights reflect differences in economic structure in the two countries.

The best relative performance in Japan is found in rubber and plastic products, basic and fabricated metal products, machinery and transport equipment and electrical machinery. Lowest relative productivity is found in wood products, leather products, tobacco and food manufacturing. On the basis of the data in Table 11, one may conclude that in 1975 Japan was already approaching productivity levels of the U.S.A. in some fields (see also results for 1972 in Yukizawa, 1978). However, average productivity (geometric average) was still low relative to the U.S. level, due to the existence of branches of manufacturing in Japan with rather low productivity.

Table 8 shows that productivity per hour worked in South Korean manufacturing was still very low in 1975. Value added per hour worked (geometric average) was only 8.9 percent of the U.S. level. Highest relative performance was found in branches such as electrical machinery, leather products, wood products and non-metallic minerals. The four branches with worst relative performance were rubber and plastic products, food manufacturing, beverages and other manufacturing industries.

6. Trends in Real Output and Labour Input 1975-85

Full benchmark comparisons require a great deal of time and cannot be made for each year. As up-to-date figures are necessary for analysis and policy, updating has come to be of considerable importance in this field of research.

Two approaches to updating are possible. First, national price indices can be used to update purchasing power parities. These updated purchasing power parities are then applied to gross value added in national currencies. Combined with data on labour input, they give updated productivity comparisons.

Second, quantity indices at constant national prices can be used to update gross value added in the countries involved. Subsequently these updated gross value added figures are divided by updated labour input figures to arrive at updated productivity comparisons.

In principle the two methods give identical results, if the price deflators used to update PPPs are based on the same data as the real quantity indices used to update value added comparisons. In this section we have chosen to show indices

TABLE 7

GROSS VALUE ADDED AT FACTOR COST (NATIONAL ACCOUNTS CONCEPT) PER HOUR WORKED BY MAJOR MANUFACTURING BRANCH, JAPAN/U.S.A., 1975

		At Japanese "Prices"			At U.S. "Prices"			
		Japan 1975 (1975 Yen) (1)	U.S.A. 1975 (2)	Japan/ U.S.A. (%) (3)	Japan 1975 (1975 U.S.$) (4)	U.S.A. 1975 (5)	Japan/ U.S.A. (%) (6)	Geometric Average of Col. 3 & 6 (7)
1	Food manufacturing	1,406	5,149	27.31	3.01	10.72	28.10	27.70
2	Beverages	2,827	7,381	38.30	5.40	14.10	38.30	38.30
3	Tobacco products	2,755	10,708	25.73	5.80	21.96	26.40	26.06
4	Textiles mill products	739	2,240	32.98	3.48	6.82	50.97	41.00
5	Wearing apparel	843	1,873	45.01	3.10	5.88	52.62	48.66
6	Leather products and footwear	446	2,077	21.46	1.39	6.18	22.46	21.96
7	Wood products, furniture and fixtures	978	5,486	17.83	1.49	8.19	18.14	17.99
8	Paper products, printing and publishing	1,663	3,907	42.58	5.04	11.32	44.52	43.54
9	Chemicals, petroleum and coal products	2,829	6,748	41.93	8.21	16.67	49.26	45.44
10	Rubber and plastic products	1,234	1,284	96.06	9.38	9.29	101.02	98.51
11	Non-metallic mineral products	1,213	2,561	47.37	5.32	10.20	52.18	49.72
12	Basic and fabricated metal products	1,902	2,432	78.21	9.67	12.30	78.55	78.38
13	Machinery and transport equipment	1,754	2,074	84.58	12.09	12.05	100.33	92.12
14	Electrical machinery and equipment	1,126	1,662	67.77	7.99	9.57	83.47	75.21
15	Other manufacturing industries	899	2,931	30.65	4.31	9.98	43.16	36.37
	Total manufacturing	1,432	3,145	45.53	6.92	10.87	63.63	53.82

Source: Gross value added from Table 4, hours worked from Table 6.

TABLE 8

GROSS VALUE ADDED AT FACTOR COST (NATIONAL ACCOUNTS CONCEPT) PER HOUR WORKED BY MAJOR MANUFACTURING BRANCH, SOUTH KOREA/U.S.A., 1975

		At South Korean "Prices"			At U.S. "Prices"			
		S. Korea 1975 (1975 Won) (1)	U.S.A. 1975 (1975 Won) (2)	S. Korea/ U.S.A. (%) (3)	S. Korea 1975 (1975 U.S.$) (4)	U.S.A. 1975 (1975 U.S.$) (5)	S. Korea/ U.S.A. (%) (6)	Geometric Average of Col. 3 & 6 (7)
1	Food manufacturing	385	7,777	4.95	0.62	10.72	5.82	5.37
2	Beverages	449	8,321	5.39	0.73	14.10	5.16	5.28
3	Tobacco products	732	5,167	14.17	2.19	21.96	9.96	11.88
4	Textile mill products	223	2,261	9.85	0.64	6.82	9.38	9.61
5	Wearing apparel	278	2,732	10.17	0.63	5.88	10.64	10.40
6	Leather products and footwear	387	1,747	22.16	2.06	6.18	33.40	27.21
7	Wood products, furniture and fixtures	228	2,652	8.61	2.46	8.19	30.08	16.10
8	Paper products, printing and publishing	462	6,035	7.65	1.19	11.32	10.47	8.95
9	Chemicals, petroleum and coal products	1,081	12,391	8.72	2.11	16.67	12.69	10.52
10	Rubber and plastic products	156	6,436	2.42	0.66	9.29	7.08	4.14
11	Non-metallic mineral products	526	3,933	13.37	2.10	10.20	20.59	16.59
12	Basic and fabricated metal products	349	4,762	7.33	0.99	12.30	8.08	7.69
13	Machinery and transport equipment	591	7,821	7.56	1.28	12.05	10.62	8.96
14	Electrical machinery and equipment	432	1,902	22.73	4.22	9.57	44.08	31.65
15	Other manufacturing industries	256	5,534	4.63	0.78	9.98	7.76	6.00
	Total manufacturing	379	5,713	6.63	1.29	10.87	11.85	8.87

Source: Gross value added from Table 5, hours worked from Table 6.

of real output movements and changes in labour input, because they serve to highlight trends in labour productivity in our three countries. (Deflators used to update PPPs and the updated 1985 PPPs themselves are available on the DISKETTE TABLES 4.1, 4.2, 4.8, 7.1, 7.8).

Although the procedures for updating are quite straightforward, the results may be significantly biased, especially when results are updated over long periods of time. One of the reasons is that the weights used in constructing national indices of prices and quantities differ from the weights used in the benchmark comparisons. In due time, the updated comparison for 1985 will have to be complemented by a new benchmark study for that year.

Tables 9, 10 and 11 contain our indices of gross value added, persons engaged and hours worked from 1975 to 1985. For Japan we used information supplied by the Economic Planning Agency on nominal and real GDP at market prices for 18 branches of manufacturing, 1975-87 to obtain indices of gross value added from 1975 to 1985 (Economic Planning Agency, March 1989). The primary source for updating labour input is the *Annual Report on National Accounts, 1987.* In the Japanese national accounts only thirteen divisions of manufacturing are distinguished. Therefore, numbers of persons engaged in 1985 are reallocated over our 15 branches using branch proportions from the *Statistical Yearbook for Japan* (1986, p. 74). This source also contains information concerning the distribution of persons over different categories of employment. Hours worked per branch by regular employees derive from the *Monthly Labour Statistics—Annual Report* (1987). For other categories of employment, hours worked are derived from the *Annual Report on the Labour Force Survey* (1985). The procedures for calculating hours worked have been explained in section 4.

Indices of gross domestic product in South Korea are derived from the *Annual Report on Current Industrial Production Survey* (1985). The branch indices in this source are based on a national accounts concept of value added. Numbers of persons engaged in manufacturing in 1985 are from the *Economically Active Population Survey*, 1985. This total is distributed over our 15 branches using proportions from the *Mining and Manufacturing Survey* 1985. Hours worked by regular employees in 1985 are from *Yearbook of Labour Statistics* (ILO, 1987). For other categories of employment we assume that the proportions in the different categories of employment and the proportions of hours worked in the different categories are the same as in 1975.

Our source for trends in real value added in the U.S.A. consists of information supplied by BEA, "Gross National Product By Industry and Type of Income in Current Dollars, and by Industry in Constant Dollars, 1947-1986." For persons engaged, our source is the *Survey of Current Business* (various issues). This source also provides employment figures in full-time equivalents. Hours worked by regular employees are from data directly supplied by the Bureau of Labour Statistics to the Japan Productivity Center in Tokyo. The calculation procedure for labour input by branch is the same as in section 4.

From 1975 to 1985 gross value added in Japanese manufacturing more than doubled. During the same period, the number of persons engaged in manufacturing increased only marginally, by 5 percent. There was a 3 percent increase in annual hours worked per person. The net result was a very rapid increase in

TABLE 9

GROSS VALUE ADDED (NATIONAL ACCOUNTS CONCEPT) AND LABOUR INPUT IN MANUFACTURING, JAPAN, 1985

		Gross Value Added at Factor Cost (mill.Yen, 1975 prices) (1)	Index (1975 = 100) (2)	All Persons Engaged (3)	Index (1975 = 100) (4)	Annual Hours Worked by Persons Engaged (5)	Index (1975 = 100) (6)
1	Food manufacturing	3,569,975	103.4	1,226,176	102.4	2,050	100.0
2	Beverages	720,810	105.7	104,824	90.0	2,057	99.3
3	Tobacco products	184,572	87.5	33,902	94.2	2,076	97.6
4	Textile mill products	2,317,495	112.1	1,100,000	78.9	2,014	100.4
5	Wearing apparel	950,321	91.0	820,356	130.4	1,989	101.0
6	Leather products and footwear	96,057	86.0	126,479	101.3	1,968	98.1
7	Wood products, furniture and fixtures	1,753,341	111.1	559,493	72.1	2,149	103.4
8	Paper products, printing and publishing	5,040,382	167.6	976,141	112.7	2,161	103.5
9	Chemicals, petroleum and coal products	6,527,376	180.4	575,000	90.8	1,973	97.7
10	Rubber and plastic products	1,223,918	223.8	560,371	259.8	2,082	101.3
11	Non-metallic mineral products	2,234,309	120.3	741,000	98.8	2,090	102.4
12	Basic and fabricated metal products	12,490,428	175.3	1,748,000	93.4	2,095	104.7
13	Machinery and transport equipment	24,610,499	236.5	3,094,000	105.0	2,148	106.7
14	Electrical machinery and equipment	33,670,034	1,043.5	2,194,000	148.9	2,052	105.5
15	Other manufacturing industries	6,843,009	312.5	1,050,258	87.6	2,035	100.1
	Total manufacturing	84,455,438	205.4	14,910,000	104.8	2,080	103.0

Sources: Col. 1 from Economic Planning Agency, 1989; col. 3 from *Annual Report on National Accounts*, 1987; col. 5 from *Monthly Labour Statistics, 1987* and *Annual Report on the Labour Force Survey, 1985* (see DISKETTE TABLES 4.1, 4.3).

TABLE 10

GROSS VALUE (NATIONAL ACCOUNTS CONCEPT) AND LABOUR INPUT IN MANUFACTURING, SOUTH KOREA, 1985

		Gross Value Added at Factor Cost (mill. Won, 1975 prices) (1)	Index (1975 = 100) (2)	Persons Engaged (3)	Index (1975 = 100) (4)	Annual Hours Worked per Person Engaged (5)	Index (1975 = 100) (6)
1	Food manufacturing	775,862	393.8	212,395	100.5	2,612	108
2	Beverages	154,941	256.4	39,815	74.0	2,608	104
3	Tobacco products	94,352	171.4	15,324	48.9	2,608	109
4	Textile mill products	710,709	247.8	540,224	107.4	2,699	105
5	Wearing apparel	515,609	296.9	353,036	148.5	2,699	103
6	Leather products and footwear	119,064	258.7	91,231	189.7	2,711	110
7	Wood products, furniture and fixtures	97,735	181.3	96,960	110.8	2,651	98
8	Paper products, printing and publishing	307,310	264.7	155,823	153.0	2,587	105
9	Chemicals, petroleum and coal products	1,004,084	285.6	163,557	124.3	2,521	102
10	Rubber and plastic products	207,553	391.8	302,337	240.7	2,842	105
11	Non-metallic mineral products	347,310	278.3	149,378	157.1	2,683	107
12	Basic and fabricated metal products	720,870	573.5	332,413	235.2	2,645	104
13	Machinery and transport equipment	1,129,915	540.1	435,531	308.1	2,586	103
14	Electric machinery and equipment	1,468,560	784.9	419,204	232.8	2,511	104
15	Other manufacturing industries	173,046	233.9	192,774	167.3	2,584	103
	Total	7,630,659	360.9	3,500,000	158.7	2,644	105

Source: Col. 1 from *Annual Report on Current Industrial Production Survey*, 1985; col. 3 from *Economically Active Population Survey*; col. 5 from *Yearbook of Labour Statistics*, ILO, 1987 (see DISKETTE TABLES 7.1 and 7.3).

TABLE 11

GROSS VALUE ADDED (NATIONAL ACCOUNTS CONCEPT) AND LABOUR INPUT IN MANUFACTURING, U.S.A., 1985

		Gross Value Added at Factor Cost (mill. 1975 U.S.$) (1)	Index (1975 = 100) (2)	Persons Engaged (3)	Index (1975 = 100) (4)	Annual Hours Worked per Person Engaged (5)	Index (1975 = 100) (6)
1	Food manufacturing	35,415	133.0	1,408,794	96.2	1,676	98.8
2	Beverages	6,506	120.5	217,206	96.1	1,676	98.8
3	Tobacco products	1,921	69.3	61,000	83.6	1,774	102.5
4	Textile mill products	15,056	152.8	712,000	81.6	1,714	103.6
5	Wearing apparel	13,548	119.1	1,148,000	90.7	1,532	100.3
6	Leather products and footwear	1,898	76.5	174,000	69.0	1,594	100.0
7	Wood products, furniture and fixtures	20,392	133.4	1,280,000	114.2	1,708	102.6
8	Paper products, printing and publishing	44,443	139.1	2,210,000	123.9	1,605	101.5
9	Chemicals, petroleum and coal products	45,866	130.5	1,226,000	100.9	1,746	100.6
10	Rubber and plastic products	16,581	172.1	793,000	131.5	1,744	101.4
11	Non-metallic mineral products	13,786	121.2	608,000	94.7	1,808	104.0
12	Basic and fabricated metal products	58,494	106.0	2,307,000	88.0	1,748	102.2
13	Machinery and transport equipment	138,107	174.2	4,224,000	111.0	1,751	101.3
14	Electrical machinery and equipment	59,499	212.0	2,207,000	129.4	1,725	100.4
15	Other manufacturing industries	23,728	142.0	1,145,000	113.9	1,689	101.4
	Total manufacturing	490,207	143.7	19,721,000	105.7	1,704	101.4

Source: Col. 1 from BEA, 1987; col. 3 from *Survey of Current Business*, various issues; col. 5 from BLS, n.d. (see DISKETTE TABLES 4.2 and 4.4).

TABLE 12

GROSS VALUE ADDED (NATIONAL ACCOUNTS CONCEPT) PER PERSON ENGAGED AND PER HOUR WORKED JAPAN, SOUTH KOREA AND THE U.S.A., 1985 (1975 = 100)

		Japan		South Korea		United States	
		Gross Value Added per Person Engaged (1975 = 100) (1)	Gross Value Added per Hour Worked (1975 = 100) (2)	Gross Value Added per Person Engaged (1975 = 100) (3)	Gross Value Added per Hour Worked (1975 = 100) (4)	Gross Value Added per Person Engaged (1975 = 100) (5)	Gross Value Added per Hour Worked (1975 = 100) (6)
1	Food manufacturing	101.0	101.0	392.0	363.2	138.3	139.9
2	Beverages	117.4	118.2	346.4	332.5	125.3	126.8
3	Tobacco products	92.9	95.2	350.4	322.5	82.9	80.8
4	Textile mill products	142.1	141.6	230.8	218.9	187.4	180.9
5	Wearing apparel	69.8	69.1	199.9	194.8	131.4	131.0
6	Leather products and footwear	84.9	86.6	136.3	124.3	110.8	110.8
7	Wood products, furniture and fixtures	154.1	149.0	163.7	166.5	116.8	113.8
8	Paper products, printing and publishing	148.7	143.7	173.0	165.1	112.3	110.6
9	Chemicals, petroleum and coal products	198.6	203.3	229.7	225.2	129.3	128.5
10	Rubber and plastic products	86.2	85.1	162.8	155.1	130.9	129.1
11	Non-metallic mineral products	121.8	118.9	177.1	164.8	127.9	123.0
12	Basic and fabricated metal products	187.7	179.3	243.8	235.0	120.5	117.9
13	Machinery and transport equipment	225.2	211.2	175.3	169.7	157.0	154.9
14	Electrical machinery and equipment	700.6	663.8	337.1	322.8	163.9	163.3
15	Other manufacturing industries	356.6	356.3	139.8	135.6	124.6	122.9
	Total manufacturing	196.0	190.2	227.4	217.6	136.0	134.1

Source: Tables 9, 10 and 11; levels for 1975 from Tables 6, 7 and 8, DISKETTE TABLES 4.5 and 7.5.

labour productivity. Value added per hour worked increased by 6.6 percent per annum; value added per person engaged by 7 percent per annum. South Korean manufacturing output in 1985 was more than 3.6 times as high as output in 1975. However, labour input also increased by approximately 60 percent so that productivity growth was less rapid than the increase in output. The net result was a spectacular increase in value added per hour worked of 8 percent per annum. Compared to Japan and South Korea, labour productivity growth in U.S. manufacturing from 1975 to 1985 was sluggish. Value added per person engaged increased by 3.1 percent per annum, value added per hour worked by 3 percent.

7. Review of the Results

In Table 13 a comparison is made between the industry of origin PPPs for 1975 derived from our own empirical research, exchange rates and ICP PPPs. In comparing our PPPs with expenditure PPPs and exchange rates, the primary purpose is to examine how different yardsticks affect international comparisons of output and productivity.

TABLE 13

Confrontation of Industry of Origin PPPs for Manufacturing with the Exchange Rate and ICP PPPs for 1975

	Japan/U.S.A. (Yen/U.S.$)	South Korea/U.S.A. (Won/U.S.$)
Our (Fisher) PPPs for manufacturing (weighted by major branch)	244.66	392.99
Proxy PPPs for manufacturing derived from ICP augmented binaries	322.29	336.68
Exchange rate	296.80	484.00
Industry of origin exchange rate deviation index	1.21	1.23
ICP exchange rate deviation index	0.92	1.44

Source: Industry of Origin PPPs from Table 3; ICP PPPs from Kravis, Heston and Summers, 1982, pp. 266 and 268 as follows: the ICP augmented binary PPPs for expenditure on the consumer items food, beverages, tobacco, clothing, footwear, furniture, appliances, transport equipment and producer durables were used to calculate the weighted average. These are the ICP PPPs which are conceptually closest to our type of comparison. The exchange rate deviation index is the exchange rate divided by PPP.

The Fisher averages of our PPPs are below the exchange rate in both binary comparisons. This implies that comparisons of real output based on our PPPs will result in higher estimates of real output in South Korea and Japan compared to the U.S.A., than comparisons based on exchange rates.

We have used ICP PPPs to derive a crude proxy PPP estimate for manufacturing as a whole. In the Japan/U.S.A. comparison the industry of origin PPP is 24.1 percent lower than the proxy ICP PPP for manufacturing. Our industry of origin estimate of real output in Japanese manufacturing will be substantially higher than the estimate with ICP proxy PPPs. On the other hand, in the South Korea/U.S.A. comparison, the industry of origin PPP is 16.7 percent higher than the proxy ICP PPP. ICP estimates of real manufacturing output in South Korea will therefore be higher than estimates based on the industry of origin PPPs.

The aggregate results for Japan and the U.S.A. are presented in Table 14. In 1975 average value added per hour worked in Japanese manufacturing was 53.8 percent of the U.S. level (geometric average). Value added per person engaged was 64.6 percent of the U.S. level, because of longer working hours in Japan.

TABLE 14

SUMMARY RESULTS FOR MANUFACTURING OUTPUT AND PRODUCTIVITY, JAPAN AND THE U.S.A., 1975 AND 1985

	1975			1985		
	Japanese "Prices"	U.S. "Prices"	Geometric Average	Japanese "Prices"	U.S. "Prices"	Geometric Average
Value added in Japan as a percentage of the U.S.A.	41.68	58.25	49.27	72.69	83.25	77.79
Persons engaged in manufacturing as a percentage of the U.S.A.	76.26	76.26	76.26	75.60	75.60	75.60
Hours worked as a percentage of the U.S.A.	91.54	91.54	91.54	92.26	92.26	92.26
Value added per person engaged as a percentage of the U.S.A.	54.65	76.38	64.61	78.78	110.11	93.14
Value added per hour worked percentage of the U.S.A.	45.53	63.63	53.82	64.56	90.24	76.33

Source: Tables 4, 6, 7, 9, 11 and 12; DISKETTE TABLE 4.5.

By 1985 average value added per person engaged in manufacturing (geometric average) was 93.1 percent of the U.S. level. With U.S. price weights it was 110.1 percent of the U.S. level. In terms of average output per hour worked, Japanese labour productivity was more modest, namely 76.3 percent of the U.S. level (geometric average), due to longer working hours in Japanese manufacturing. With U.S. price weights it was 90.2 percent.

The results for 1975 and 1985 at branch level are summarized in Table 15. As in 1975, Japanese productivity performance in 1985 varied widely by branch. Relative labour productivity was highest in branches such as electrical machinery and equipment, machinery and transport equipment, basic and fabricated metal products and other manufacturing products (including the rapidly growing precision instruments industry). In 1985 these branches all had higher labour productivity (per hour worked, geometric average) than their U.S. counterparts. Productivity in electrical machinery was more than 3 times as high as in the U.S.A.,[1] in machinery and transport equipment productivity was 26 percent higher, in metal products 19 percent higher, in other manufacturing 5 percent higher (geometric averages). Lowest relative productivity can be seen in Japanese branches such as leather products and footwear, food products, wood products, and wearing

[1]The 1985 productivity differential in the electrical machinery branch may be overstated because of the different procedures used in Japan and the United States in deflating gross value added in this sector.

TABLE 15

GROSS VALUE (NATIONAL ACCOUNTS CONCEPT) PER HOUR WORKED, BY MAJOR MANUFACTURING BRANCH, JAPAN/U.S.A., 1975-85 (in %)

	Major Manufacturing Branches	1975			1985		
		Japanese "Prices" (1)	U.S. "Prices" (2)	Geometric Average (3)	Japanese "Prices" (4)	U.S. "Prices" (5)	Geometric Average (6)
1	Food manufacturing	27.31	28.10	27.70	19.71	20.29	20.00
2	Beverages	38.30	38.30	38.30	35.71	35.71	35.71
3	Tobacco products	25.73	26.40	26.06	30.30	31.09	30.69
4	Textile mill products	32.98	50.97	41.00	25.81	39.89	32.09
5	Wearing apparel	45.01	52.62	48.66	23.73	27.75	25.66
6	Leather products and footwear	21.46	22.46	21.96	16.77	17.55	17.16
7	Wood products, furniture and fixtures	17.83	18.14	17.99	23.35	23.75	23.55
8	Paper products, printing and publishing	42.58	44.52	43.54	55.30	57.81	56.54
9	Chemicals, petroleum and coal products	41.93	49.26	45.44	66.32	77.91	71.88
10	Rubber and plastic products	96.06	101.02	98.51	63.28	66.55	64.89
11	Non-metallic mineral products	47.37	52.18	49.72	45.79	50.45	48.06
12	Basic and fabricated metal products	78.21	78.55	78.38	118.94	119.45	119.20
13	Machinery and transport equipment	84.58	100.33	92.12	115.29	136.76	125.57
14	Electrical machinery and equipment	67.77	83.47	75.21	275.55	339.37	305.80
15	Other manufacturing industries	30.65	43.16	36.37	88.83	125.07	105.41
	Total manufacturing	45.53	63.63	53.82	64.56	90.24	76.33

Source: Derived from Tables 7 and 12.

apparel. In these branches, productivity per hour worked was less than a quarter of the U.S. level (geometric averages).

We may conclude that by 1985 productivity leadership had indisputably shifted to Japan in some branches of manufacturing. On the other hand, other branches of manufacturing with low labour labour productivity markedly depressed the average productivity level of Japanese manufacturing. As can be seen from Table 14, in 1985 the United States was still the world productivity leader for manufacturing as a whole, both in terms of value added per person engaged and value added per hour worked.

Interesting to note is the wide divergence of Japanese productivity trends from 1975 to 1985. Three of the four branches with highest relative performance in 1975 show sharp increases in productivity (electrical machinery, metal products and machinery and transport equipment). The exception is rubber and plastic products, where the productivity ratio dropped from 98.5 percent of the U.S. level in 1975 to 64.9 percent in 1985 (geometric averages). Rapid productivity increases are also found in chemical products, though this is less visible because chemical products have been lumped along with petroleum and coal products where productivity stagnated during the same period.

On the other hand other branches are characterized by stagnant or even declining relative productivity performance. Declining performance is found in food manufacturing, beverages, textile mill products, wearing apparel and leather products, all branches with below average performance in 1975.

Three branches with below average performance in 1975 show marked improvement; paper products, printing and publishing, aforementioned chemicals, petroleum and coal products and the miscellaneous category "other." In the latter category, the spectacular increase is to a considerable extent due to productivity increases in the "precision instruments" industry.

Our conclusions with regards to trends are rather similar to those of Sadler (Sadler, 1986; see also Sadler and Grossman, 1982). According to Sadler, Japan had forged ahead of the U.S.A. by 1984 in electrical machinery, primary metals and chemicals and was slightly ahead of the U.S.A. in transportation equipment. Sadler also noted the increasing divergence of productivity trends in different branches of Japanese manufacturing. Converting Yen into dollars at an exchange rate of 272.5 Yen per dollar, Sadler estimated Japanese value added per hour worked in 1984 at 92.1 percent of the U.S. level. This level is higher than the 76.3 percent (geometric average) found with our industry of origin approach.

Summarizing with regard to Japan, four conclusions can be drawn. First, the level of labour productivity per person engaged in Japanese manufacturing by 1985 had drawn close to the U.S. level. Second, labour productivity per hour worked was still substantially below the level of the world productivity leader, the U.S.A. Third, the improving average labour productivity performance was accompanied by increasing divergence of productivity trends at branch level, with some branches stagnating and others showing spectacular increases. Fourth, by 1985, Japan had become the indisputable productivity leader in three important branches of manufacturing: electrical machinery and equipment, basic and fabricated metal products and machinery and transport equipment.

Table 16 summarizes the results of the South Korea/U.S.A. comparison for the whole of manufacturing. In 1975 manufacturing GDP in South Korea was only 1.6 percent of that in the U.S.A. (geometric average). On the other hand, the number of persons engaged in Korean manufacturing was no less than 11.8 percent of the number of persons engaged in manufacturing in the U.S.A. Labour productivity in South Korean manufacturing was extremely low compared to the United States. With Korean prices, value added per hour worked was 6.6 percent of the U.S. level, with U.S. prices 11.9 percent. With regard to value added per person engaged South Korean performance was somewhat better: 10 percent of the U.S. level at South Korean prices and 17.8 percent at U.S. prices. This difference is due to the extremely long hours worked by South Korean workers.

From 1975 to 1985 value added in South Korea as a percentage of value added in the U.S.A. more than doubled (geometric average), reflecting the increasing importance of South Korea in world manufacturing. South Korean productivity performance improved markedly compared to the United States. The geometric average of the productivity ratios (value added per hour worked) increased from 8.9 percent in 1975 to 14.4 percent in 1985. With U.S. prices South Korean labour productivity was 19.2 percent of U.S. productivity in 1985, against 11.9 percent in 1975. Nevertheless, for a country well known as a successful industrial exporter, South Korea had surprisingly low labour productivity in manufacturing in 1985. Even with U.S. prices, South Korean labour productivity in 1985 was less than one fifth of the U.S. level.

At branch level, highest relative productivity was found in electrical machinery and equipment (62.6 percent of the U.S. level, geometric average). With U.S. prices, productivity in this branch was 87.6 percent of the U.S. level. Electrical machinery already had highest relative performance in 1975 and showed rapid productivity growth in the intervening period. Above average performance was found in branches such as tobacco products, leather products, wood products and non-metallic mineral products. Relative productivity in 1985 was particularly low in branches such as rubber and plastic products, machinery and transport equipment and textile mill products.

Productivity trends were less divergent than in the case of Japan. All branches showed some increase in productivity performance vis à vis the U.S.A. Above average increases were to be noted in electrical machinery, tobacco, food and beverages.

The conclusion with regard to South Korea is that even after a decade of rapid productivity growth, labour productivity in manufacturing was surprisingly low in 1985. That South Korea is nevertheless able to compete in international markets is due to extremely low levels of labour remuneration. For instance, the average level of labour remuneration in South Korean manufacturing in 1975 was only 8.5 percent of the U.S. level (see *Annual Survey of Manufactures, 1975-1976* and *Report on Mining and Manufacturing Survey, 1975*). The combination of a large manufacturing labour force, low labour productivity and low levels of labour remuneration reflects the labour intensive character of Korean industrialization.

TABLE 16

SUMMARY RESULTS FOR MANUFACTURING OUTPUT AND PRODUCTIVITY, SOUTH KOREA AND THE U.S.A., 1975 AND 1985

	1975			1985		
	South Korean "Prices"	U.S. "Prices"	Geometric Average	South Korean "Prices"	U.S. "Prices"	Geometric Average
Value added in South Korea as a percentage of the U.S.A.	1.17	2.11	1.57	2.96	5.30	3.96
Persons engaged in manufacturing as a percentage of the U.S.A.	11.82	11.82	11.82	17.75	17.75	17.75
Hours worked as a percentage of the U.S.A.	17.79	17.79	17.79	27.54	27.54	27.54
Value added per person engaged as a percentage of the U.S.A.	9.98	17.84	13.35	16.69	29.84	22.32
Value added per hour worked percentage of the U.S.A.	6.63	11.85	8.87	10.76	19.23	14.38

Source: Tables 5, 6, 8, 10, 11 and 12; DISKETTE TABLE 7.5.

TABLE 17

GROSS VALUE ADDED (NATIONAL ACCOUNTS CONCEPT) PER HOUR WORKED, BY MAJOR MANUFACTURING BRANCH, SOUTH KOREA/U.S.A., 1975-85 (IN PERCENT)

	Major Manufacturing Branches	1975 South Korean "Prices" (1)	1975 U.S. "Prices" (2)	1975 Geometric Average (3)	1985 South Korean "Prices" (4)	1985 U.S. "Prices" (5)	1985 Geometric Average (6)
1	Food manufacturing	4.95	5.82	5.37	12.85	15.09	13.93
2	Beverages	5.39	5.16	5.28	14.14	13.53	13.83
3	Tobacco products	14.17	9.96	11.88	56.51	39.72	47.38
4	Textile mill products	9.85	9.38	9.61	11.92	11.35	11.63
5	Wearing apparel	10.17	10.64	10.40	15.12	15.82	15.47
6	Leather products and footwear	22.16	33.40	27.21	24.87	37.48	30.53
7	Wood products, furniture and fixtures	8.61	30.08	16.10	12.60	43.98	23.54
8	Paper products, printing and publishing	7.65	10.47	8.95	11.42	15.63	13.36
9	Chemicals, petroleum and coal products	8.72	12.69	10.52	15.29	22.23	18.44
10	Rubber and plastic products	2.42	7.08	4.14	2.91	8.51	4.97
11	Non-metallic mineral products	13.37	20.59	16.59	17.91	27.58	22.23
12	Basic and fabricated metal products	7.33	8.08	7.69	14.60	16.10	15.33
13	Machinery and transport equipment	7.56	10.62	8.96	8.28	11.63	9.82
14	Electrical machinery and equipment	22.73	44.08	31.65	44.94	87.16	62.59
15	Other manufacturing industries	4.63	7.76	6.00	5.11	8.57	6.61
	Total manufacturing	6.63	11.85	8.87	10.76	19.23	14.38

Source: Derived from Tables 8 and 12.

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