The International Comparison of Real Product and Productivity

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Before one can make reasonably valid inter-country comparisons of macro-economic performance in quantitative terms, three conditions have to be fulfilled:-

a) it is necessary to have a conceptual consensus on the scope, meaning and coverage of national accounts;

b) it is necessary that national statistical authorities or academic researchers implement these general principles by making estimates of GDP and its components in real and money terms which follow the agreed guidelines;

c) appropriate purchasing power parity converters need to be devised to convert the estimates in different national currencies into a common numeraire.

Work on national accounts and international comparisons of real income levels started in the seventeenth century. In 1696, Gregory King used a mix of clues on the three main facets of national accounts - income, expenditure and production - to make rough comparisons of performance in France, the Netherlands and the UK. His approach was further developed by individual scholars over a period of 250 years, with substantial clarification of what the scope of the accounts should be, a large accumulation of estimates for individual countries, and, in the twentieth century, several important steps forward in the provision of international purchasing power converters, e.g. the Board of Trade enquiries into working class cost of living in Belgium, France, Germany, the UK and USA in the UK in 1908-13 (cited in Williamson 1992) and Colin Clark's bold (1940) attempt to compare real expenditure levels and productivity by major sector of the economy in 26 countries.

The big step forward in international comparison came from OEEC in the 1950s. It produced the first standardised system of national accounts which was accepted by its member countries and also by the United Nations, it promoted close consultation between statisticians in Western Europe and North America to ensure that the guidelines were implemented, and it made a massive breakthrough in developing purchasing power converters and international real product comparisons.

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All subsequent work in comparing levels of real product and purchasing power derive from (a) the Gilbert and Kravis (1954) expenditure comparisons and (b) the Paige and Bombach (1959) real product comparisons. There have been no comprehensive comparisons from the income side, but there are partial income comparisons most of which are concerned with wage income. Williamson (1992) is an intercountry and intertemporal comparison of the real wages of unskilled workers for 15 countries, 1830-1988.

The expenditure approach, as developed by Kravis, Heston and Summers in the ICP (International Comparisons Project) programme since the 1960s, is basically a highly sophisticated pricing exercise. It assembles a coherent, articulate and complete set of carefully specified prices at the final expenditure level from statistical offices in the participating countries (77 countries participated in at least one of the ICP rounds), together with supplementary studies of the cost of investment goods and government services. Kravis, Heston and Summers (1982 is their magnum opus) pioneered new techniques for providing multilateral measures at "international" prices. Their preferred multilateral measure was the Geary Khamis PPP. However, they continued to publish the three binary PPP variants which OEEC had used, i.e. the Paasche PPP (with own country quantity weights), the Laspeyres PPP (with quantity weights of the numeraire country - the USA) and the Fisher geometric mean of the Laspeyres and Paasche measures. The ICP converters were then applied to the values in the national accounts of 151 expenditure components. The interspatial differences in volume between countries are derived as the end product. For countries not covered by ICP, Summers and Heston (1991) devised short cut estimates for 130 countries which use price information from cost of living surveys (of diplomats, UN officials, and people working abroad for private business) as a proxy for the ICP specification prices.

The production approach as developed by the ICOP (International Comparison of Output and Productivity) project of the University of Groningen since 1983 is derived from Rostas (1948), Paige and Bombach (1959) and Maddison (1970). It is intended to be complementary to ICP, and we do not regard it as a substitute. It involves a comparison of real output (value added) in major sectors (agriculture, industry and services) and of branches within these three broad sectors, as well as measures for GDP as a whole. It takes an integrated view of output and input quantities, producer prices and the values derived from these prices and quantities. It includes labour productivity measures with labour input measured in working hours where possible. It has been used in conjunction with estimates of capital stock, to measure total factor productivity. As with the ICP, ICOP research has involved the merger of cross-country benchmarks with national time series estimates. It has been conducted on a transparent basis, making available diskettes, voluminous background memoranda, articulate source descriptions, full disclosure of sample sizes and aggregation techniques. A description of the ICOP methodology for manufacturing can be found in Maddison and van Ark (1988) and is further elaborated in van Ark (1993). The ICOP comparisons have essentially been bilateral, with the USA as the numeraire country and also as the star country. When comparing an array of

ICOP results we have generally considered either the Paasche or the Fisher PPP variants. However, Pilat and Prasada Rao (1991) applied multilateral techniques to our manufacturing comparisons.

The ICOP research technique is different from that of ICP. Rather than special surveys, it uses information from production censuses, input-output tables, national accounts and, more recently, information for individual firms. Its integrated statistics of quantity, unit value, and values permit crosschecks not available to ICP. It identifies variations in the coverage of national accounts which ICP has not explored.

The major reason why the methods and sources used by the ICOP team have been different from those of ICP is that its research strategy and objectives are different.

It has been conducted by a group of university researchers rather than by national governments or international organisations. Its research results are those of individuals rather than being institutional. It was created to provide a broad interactive framework for quantitative analysis of economic growth processes as well as levels of performance. We were just as interested in measuring productivity and the forces determining it as we were in price structures.

The interests of the ICOP group have been worldwide, but we never aspired to comprehensive coverage. We were satisfied to concentrate our efforts on relatively large countries which would provide a representative picture that covers about threequarters of world population and output and a very wide range of income levels. Some of the ICOP studies (particularly those of Maddison) have had a longer time perspective than ICP as we have merged our benchmark estimates with time series covering the whole of the twentieth century and a good deal of the nineteenth.

Our interest was not only macroeconomic, but involved close scrutiny of sectors where it was possible to get some appreciation of the processes of technical change. Hence our research has investigated productivity performance at a detailed industry level, and in some cases at a "representative" firm level. We also gave considerable attention to intercountry diffusion of technology and to differences between the lead country (USA in the twentieth century, UK for a good deal of the nineteenth) and the follower countries, and to processes of catch-up, convergence or divergence. This is a major reason why we have emphasized star system binary comparison rather than multilateral techniques which were appropriate to the mondialist and maximalist aspirations of ICP.

ICP has thrown great light on a vast array of problems, and ICOP opens up areas which are related but different. It permits:

a) analysis of real product and productivity by industry. Since the Physiocrats, Malthus and Ricardo, the breakdown between agriculture, industry and services has been considered of fundamental importance,

and the relative productivity standing of the three sectors is notoriously different;

b) structural analysis - stressed by Kuznets, Chenery and Denison - and fundamental to growth accounts. The "structure" of GDP on the production side involves a bigger service component than on the expenditure side, where some important services such as distribution are "disguised" (see Maddison 1983) because they do not figure explicitly as final expenditure items;

c) sharper analysis of the causes of economic growth and of patterns of divergence between nations in growth accounts, catch up and convergence analysis, exploration of lead country-follower country phenomena;

d) analysis of the locus of technical progress. For this purpose we have supplemented sector analysis by micro-oriented investigation of variance in performance between industries and between average and best practice firms.

e) analysis of the relation between productivity and competitivity.

The ICOP research programme can usefully be analysed under the following headings, work on a) agriculture; b) mining; c) manufacturing; d) services and (e) the whole economy.

Agriculture

Agriculture was the first sector on the ICOP research agenda because it has a simple commodity structure (about 200 products instead of up to 15,000 in manufacturing). The availability of standardised information on output, feed and seed inputs, farm prices and farm accounts from the Food and Agriculture Organisation (FAO) greatly facilitated the problem of assembling the basic data for multicountry analysis on a reasonably standardised basis. Problems of quality, product differentiation, and coverage are smaller than in other sectors and it is easier to deploy double deflation.

Van Ooststroom and Maddison (1984) replicated the methodological approach of Maddison (1970). Maddison had covered 29 countries for 1965, using FAO statistics for 89 farm commodities, and employing a rough double deflation approach to measure gross value added at US prices. The 1984 study covered 144 farm products for 14 countries. It covered most of the countries targeted for subsequent ICOP manufacturing studies, and the benchmark year was 1975 to provide a comparison with round 3 of ICP. Maddison and Van Ooststroom (1993) is an updated version of the 1984 study, with a critical review of the literature on comparisons of agricultural performance.

It used the Laspeyres output variant as more prices were available for the USA than for other countries, so this option minimised the use of shadow

prices. Maddison and Van Ooststroom also felt that US prices were the most relevant for catch-up analyis.

Maddison and Prasada Rao (1993), used the same data base to calculate Paasche, Laspeyres and Fisher measures of agricultural output net of feed and seed, using the same technique as ICP for filling holes in the data array; they used the CPD (country product dummy) method invented by Robert Summers (1973), instead of shadow prices. Their results are shown in Table 2.

Table 1

Maddison-van Ooststroom Benchmark Results for Agriculture in 1975, Using Paasche PPPs and Shadow Pricing to Fill Data Gaps

	Gross Value Added Per Person Engaged (USA = 100)	Gross Value Added Per Head of Population (USA = 100)	Gross Value Added Per Hectare (USA = 100)	Paasche PPP for Gross Value Added Units of National Currency Per Dollar	Exchange Rate
Argentina	43.9	157.7	48.0	13.17	36.57
Brazil	10.0	80.2	81.7	7.47	8.127
China	2.3	47.9	218.2	n.a.	1.86
India	1.9	31.4	212.4	7.70	8.653
Indonesia	2.4	33.3	275.6	326.64	415.0
Korea	3.6	32.9	1015.5	682.99	484.0
Mexico	6.7	46.0	56.1	13.52	12.50
France	39.8	105.4	341.9	5.67	4.29
Germany	30.1	51.9	511.1	3.01	2.46
Japan	8.8	31.2	1,243.5	631.78	296.79
Netherlands	90.0	112.6	1,141.4	3.25	2.53
UK	54.7	42.5	256.1	0.50	0.45
USA	100.0	100.0	100.0	1.00	1.00

Source: A. Maddison and H. van Ooststroom (1993), using the shadow pricing technique (generally wheat relatives) for filling holes in the data. The figures underlying this table are all at US prices (with a Paasche PPP converter).

The main results of the agriculture study are shown in tables 1 and 2. It is clear that in our sample of countries, the USA was the productivity leader, and the Netherlands was the closest competitor. The UK was in third place with productivity about half of the US level. Some countries with high productivity levels in manufacturing had poor performance in agriculture e.g. Germany at well under a third of the US level and Japan where agricultural performance was abysmal (less than a tenth of the US level).

In a similar study, Prasada Rao (1993) found only two countries, Australia and New Zealand, to have a slightly higher labour productivity in agriculture in 1975 than the USA.

A major reason for US productivity leadership is its abundant supply of land. In terms of land productivity, US performance is only one fourteenth of that in the Netherlands. In fact, the only countries with lower levels of land productivity than the USA, in our sample, were Argentina, Brazil, and Mexico.

Table 2

Maddison-Prasada Rao Results for Agriculture in 1975, Using Three PPP Variants and the CPD Technique for Filling Data Gaps

	Gross Value Added Per Person Engaged (USA = 100)			PPP Variants (Units of National Currency Per US Dollar)		
	Laspeyres Volume Index Using US Price Weights	Paasche Volume Index Own Country Price Weights	Fisher Geometric Mean	Paasche PPP Own Country Quantity Weights	Laspeyres PPP US Quantity Weights	Fisher Geometric Mean
Argentina	44.0	43.9	44.0	13.03	13.05	13.04
Brazil	10.2	8.9	9.6	7.15	8.23	7.67
India	2.2	2.0	2.1	6.87	7.48	7.17
Indonesia	2.6	1.7	2.1	340.95	514.08	418.63
Korea	3.6	3.1	3.3	704.44	840.93	769.53
Mexico	6.9	5.3	6.1	13.61	17.78	15.56
France	43.6	38.6	41.0	5.67	6.41	6.03
Germany	30.6	22.5	26.2	2.74	3.73	3.20
Japan	9.2	8.8	9.0	629.06	661.31	645.00
Netherlands	84.3	42.9	60.1	2.83	5.56	3.97
UK	55.9	41.7	48.3	.502	.673	.581
USA	100.0	100.0	100.0	1.00	1.00	1.00

Source: A. Maddison and D.S. Prasada Rao (1993), using the CPD technique for filling holes in the data in order to get complete matching. Columns 1 and 4 of Table 2 differ from the corresponding columns of Table 1 for methodological reasons. The data base was virtually identical.

A comparison of the PPPs and the exchange rates shown in Table 1 shows that in all the European countries, Japan, Korea and Mexico the agricultural price level (i.e. the PPP divided by the exchange rate) was higher than in the USA, whereas in Argentina. Brazil, India and Indonesia, agricultural prices were lower. The extreme cases were Argentina (where

prices were one third of the US level) and Japan (prices twice the US level).

When international comparisons of performance levels are made, either by the ICP expenditure approach or the ICOP approach by industry of origin, it is now conventional to have only one summary set of results. In the ICP case, the preferred option has hitherto been the multilateral Geary Khamis indicator. In the ICOP studies, preference has been either for use of the Paasche or Fisher converter, depending on the taste of individual ICOP researchers.

In binary comparisons the three most straightforward options are: (i) Laspeyres volume comparisons based on the prices (unit values) of the numeraire country; (ii) Paasche volume comparisons based on the prices (unit values) of the other country or countries in the comparison; or (iii) the Fisher geometric average of these two measures which is in effect a compromise measure. Conversely, the PPPs corresponding to these three volume options are: (i) the Paasche PPP (with "own" country quantity weights); (ii) the Laspeyres PPP (with the quantity weights of the numeraire country); and the Fisher geometric average of the two measures. The difference between the Paasche and Laspeyres PPPs varies between countries and branches of the economy under investigation. The gap between the two measures is generally widest for comparisons between countries with very different income or productivity levels.

In the ICOP approach we have attempted to be as transparent as possible, so that our procedures can be easily replicated (or modified, by those with different research objectives). Hence we have generally presented all of the options, as in Table 2, even where, for convenience, we put most emphasis on one of the indicators.

Maddison-Prasada Rao (1993) also included an estimate of Geary Khamis PPPs. The intention was to crosscheck with FAO results, as the FAO has to some extent replicated the ICOP techniques. However, we have made very little use of the Geary Khamis PPP in ICOP studies.

Mining

Mining was the second sector which the ICOP group tackled. The rough international comparison of Wieringa and Maddison (1985) covered the same countries as the agriculture comparisons for 1975, and used only US prices as the basis for comparison. The prices were generally taken from the Statistical Abstract of the United States and from the US Minerals Yearbook and trade sources. Production of 45 minerals in the thirteen countries was generally taken from the UN Yearbook of Industrial Statistics.

Table 3 presents a modified version of the Wieringa-Maddison paper, with correction for an error in the price of manganese, and an adjustment to a value added basis. Like the agriculture study, our mining results were

generally from secondary sources. However, Houben (1990) was a more sophisticated analysis of the mining sector in Brazil, Mexico and the USA from census material, and was similar in approach to our studies for manufacturing.

Table 3

Wieringa-Maddison Benchmark Results for Mining in 1975

	Paasche PPP (Units of national currency per US $)	Gross Value Added Per Person Engaged (USA = 100)	Gross Value Added Per Head of Population (USA = 100)	Gross Value Added (USA = 100)
Argentina	22.20	33.3	21.5	2.62
Brazil	5.34	22.2	6.4	2.75
China	n.a.	5.7	6.6	28.96
India	3.32	6.5	2.6	7.06
Indonesia	957.53	117.6	11.3	6.88
Korea	395.51	12.6	6.3	1.01
Mexico	15.98	16.2	18.5	5.21
France	12.16	11.5	10.2	2.69
Germany	3.64	17.3	28.8	8.21
Japan	1,077.05	9.3	3.9	1.97
Netherlands	6.61	333.9	56.3	3.55
UK	0.640	15.0	27.7	7.22
USA	1.000	100.0	100.0	100.00

Source: Revised version of P. Wieringa and A. Maddison (1985). The measure of levels of gross value added was based on a Paasche PPP converter as in Table 1. Laspeyres and Fisher PPPs were not estimated.

Mining output per head of population depends very importantly on the luck of natural resource endowment, and on the geological research and prospection effort in the country. In both respects the US advantage is clear. It is better endowed with resources than almost all other countries, and the efforts of the US geological service have been exemplary since the 1860s. As a result, US mining output per head of population was well ahead of that in all the other countries in our sample, the nearest competitors being the Netherlands which had only 56 per cent of the US level per head of population. In terms of labour productivity, the Netherlands and Indonesia were the only countries in our sample to surpass the USA in 1975. Mining output in the Netherlands is dominated by the production of natural gas in Groningen which requires very little labour.

The relative standings of countries in mining productivity can change very rapidly, when new resources are developed. Thus the relative standing of Mexico and the UK has improved a good deal since 1975, because the two OPEC shocks led to very large increases in oil production.

Manufacturing

Before embarking on detailed binary comparisons for industry, we explored the possibilities of using the UNIDO industrial data files to see if they provided an opportunity for the same type of multi-country jump-start which was possible for agriculture and mining. However, the commodity specification in UNIDO's Industrial Statistics Yearbook is not very detailed and is incomplete for many countries, it contains no information on prices or unit values, and very little information on industrial input structures.

The basic sources for our manufacturing comparisons were therefore industrial production censuses and surveys where the ingredients for measuring real output, prices and labour productivity are available in returns from the same establishment. The degree of detail is very substantial. In most but not all cases we were able to confront the census results with national accounts and input-output tables, which helped us to get a better judgement on the comparability of our sources. The only important weakness of censuses is that information on service inputs is usually incomplete.

So far the ICOP group and our associates have carried out 21 binary comparisons for manufacturing. In 13 cases the USA was the star country. The benchmark year was generally 1975 or 1987, with earlier or later years in some cases. The comparisons with the USA included Argentina, Australia, Brazil, Ecuador, France, Germany, India, Indonesia, Japan, Korea, Mexico, the Netherlands and the UK. We also made binary comparisons for Czechoslovakia/Germany(FR), Germany(FR)/Germany(DR), Brazil/Mexico, Brazil/UK, France/UK, Netherlands/UK, Spain/UK, and Japan/Korea. Similar studies are under way for China/USA (Ren Ruoen and Szirmai) and Russia/USA. Other scholars have adopted our approach in binary comparisons for Germany(FR)/UK (O'Mahony, 1992), France/Germany(FR) (CEPII, Paris), Ireland/UK (Birnie) and Portugal/UK (Luis Peres).

Tables 4 and 4a show the productivity results for the countries where our research has been most intensive. The benchmark estimates were extrapolated to other years using time series at national prices. It demonstrates that the US leadership margin is smaller in manufacturing than in agriculture, and has been substantially eroded since 1950. In 1950 the four West European countries and Japan averaged 36 per cent of US manufacturing productivity, and by 1990 79 per cent.

Compared to the USA and to the other West European countries Germany (FR) lost ground between 1973 and 1990, and the position of the new Germany after reunification was adversely affected because of the much lower productivity levels in the Eastern provinces.

A striking feature of Table 4 is the results obtained for Czechoslovakia and East Germany. In both cases we found much lower levels of productivity than had been previously thought. There were very high ratios of inputs to gross output in these countries, and other evidence of

Table 4

Gross Value Added (Census Concept) Per Person Engaged in Manufacturing (Fisher Variant), 1950-90
(US = 100 in year specified)

	1950	1960	1973	1990
Argentina	n.a.	n.a.	25.9(1975)	26.5(1985)
Brazil	19.1	6.9	41.9	30.7(1987)
India	5.0	6.8	6.0	7.2(1987)
Indonesia	n.a.	n.a.	7.7(1975)	10.9(1987)
Korea	6.6(1953)	11.2	15.6	26.9(1989)
Mexico	19.6(1954)	19.6	33.6(1975)	32.8(1986)
France	39.9	54.1	76.2	85.8
Germany(FR)	45.6	66.6	76.0	71.6
Japan	14.3	25.5	56.3	87.5
Netherlands	37.3	55.2	79.6	86.8
UK	39.8	47.6	50.8	58.0
USA	100.0	100.0	100.0	100.0
Australia	n.a.	n.a.	45.1	47.3(1988)
Czechoslovakia	n.a.	n.a.	n.a.	16.0(1989)
Germany(DR)	n.a.	n.a.	n.a.	21.4(1987)

Source: Van Ark (1993), Szirmai (1993), van Ark and Beintema (1992), van Ark and Pilat (1993), Beintema and van Ark (1993), Kouwenhoven (1993), Van Ark and Kouwenhoven (1994), Pilat and Hofman (1990), Pilat, Prasada Rao and Shepherd (1993). All figures are Fisher geometric averages (of results using US and own country weights). The figures for Czechoslovakia and Germany(DR) are derived from binary comparisons with Germany(FR) and were linked to the USA via the Germany(FR)/USA relationship. The estimates for France, Germany (FR) and the Netherlands exclude establishments with less than 20 employees. Judging from the situation in the UK and USA the figures for these countries would probably have been lower if it had been possible to obtain data for all establishments. For the USA the figures would have been 2.2 per cent higher if establishments with less than 20 employees were excluded, in the UK 2.7 per cent and in Japan 7.8 per cent. For India and Indonesia establishments with less than 20 employees were also excluded, but in these countries, differences in productivity between large and small firms are big. Rough estimates suggest that Indian and Indonesian productivity would be 40% and 45% lower if small firms were included. The estimates for France, Germany, Japan and Mexico are on a "per employee" basis, rather than "person engaged". In those cases where the country ratios are for a year specified in brackets, the coefficient is based on the relationship to the USA in that year, i.e. the 25.6 ratio for Argentina (1985) refers to the relationship with the USA (1985) = 100.

Table 4a
Gross Value Added per Person Engaged, Annual Working Hours and Gross Value Added per Hour Worked, Around 1990

	Gross Value Added per Person Engaged (USA = 100)	Annual Working Hours per Person	Gross Value Added per Hour Worked (USA = 100)
Brazil (1987)	30.7	2,049	28.6
India (1987)	7.2	2,431	5.7
Indonesia (1990)	10.9	2,137	9.8
Korea (1989)	26.9	2,766	18.7
Mexico (1986)	32.8	2,053	30.2
France (1990)	85.8	1,616	101.7
Germany (FR) (1990)	71.6	1,539	85.9
Japan (1990)	87.5	2,154	77.9
Netherlands (1990)	86.8	1,506	110.5
UK (1990)	58.0	1,686	66.0
USA (1990)	100.0	1,918	100.0
Czechoslovakia (1989)	16.0	1,858	16.6
Germany (DR) (1987)	21.4	1,735	23.5

Sources: As for Table 4. The estimates for France, Germany, the Netherlands and the United Kingdom were derived by combining figures on weekly (or daily) hours including overtime with estimates of the average number of weeks (or days) actually at work, which were adjusted for days lost due to sickness, public holidays, vacation, etc. For the United States we made use of estimates of the Bureau of Labor Statistics on the ratio of hours worked to hours paid. For Japan and Korea figures were available on monthly hours actually worked excluding hours paid but not worked. The estimates of working hours for the other countries were cruder. In some cases (for example, Brazil and Mexico) we used figures on weekly hours assuming that the average working year had 46 weeks.

inefficiency in the form of unsaleable inventories.

For the rest of the world, the evidence is weaker, but Korea has obviously increased its standing very considerably vis-à-vis the USA since the 1950s. Latin America's catch-up process was generally reversed after the debt crisis of 1982.

Table 4a shows the intercountry variation in working hours. These vary from a low of 1506 per person per annum in the Netherlands to a high of 2766 in Korea. Working hours are significantly shorter in Western Europe than in Japan and the USA. As a result the productivity ratios in terms of value added per hour worked differ appreciably from those in Table 4. Figures on hours worked are not normally available in production censuses so in most cases we had to construct the hours estimates by merging data from various sources. The comparability of the hours estimates is still weak (see Van Ark, 1993).

Manufacturing output was converted to a common currency on the basis of average price ratios for sample products. The "prices" for manufacturing were obtained by dividing ex-factory sales values by the corresponding quantities. It is therefore more accurate to call them "unit value ratios" (UVRs), which identifies their nature more clearly than the traditional term "purchasing power parities". Unit values for individual products were weighted by the corresponding quantities to obtain the ratio for the "industry" to which the product belonged. Industry UVRs were then reweighted by the corresponding value added and aggregated to get estimates at the "branch" level (usually for 16 branches). The process was then repeated to get the result for total manufacturing. The major advantage of this stepwise procedure is that the original product UVRs are successively reweighted according to their relative importance in the aggregate.

Our approach is different from the direct comparisons of physical output of Rostas (1948). He weighted quantity relatives by value added or employment, assuming the quantity relatives for covered products to be representative for those not covered, whereas our approach (like that of Fabricant 1940) assumes that the price relationships (UVRs) we can measure are representative for what we could not measure. This coverage problem is much greater in manufacturing than for agriculture. The smallest sample size we accepted was 10 per cent of all manufacturing sales (in the India/United States comparison). In other cases we achieved a coverage of up to 40 per cent of total gross output. Sensitivity tests suggest that with our stepwise procedure the apparently low coverage is not a source of great error in the estimates (see Van Ark, 1993). In agriculture, the sample size ranged from threequarters to over 90 per cent of output, so the coverage problem was unimportant.

Unit value ratios cannot be obtained for all products for several reasons. Some products are unique e.g. sarees in India and spacecraft in the USA. For some products no information on sales value or quantity is reported, generally because to do so would breach confidentiality. The

characteristics of some products vary a good deal between countries, and the information the census provides may not be adequate to permit matching. For example, in the case of cars, we consulted industry experts and trade journals to obtain a better judgment on the matchings or to adjust for quality differences in the Brazil/USA and Mexico/USA comparison (Maddison and Van Ark, 1988), and in the France/UK comparison (Van Ark, August 1990). There were several other industries where census results were supplemented with trade sources, factory visits or consultation of engineering expertise.

More recently our unit value ratios Germany/USA and Japan/USA for beer, computers, food products, iron and steel, machine tools, motor vehicles and radio and television receivers were reexamined in McKinsey Global Institute (1993) (in the light of detailed information from major firms) to assess the extent to which differences in product mix and product quality affected these comparisons. For some industries (e.g. computers, machine tools and motor vehicles) McKinsey made substantial adjustments to the original ICOP UVRs, but there is no evidence of a systematic overall bias in our original UVRs. For example 1987 and 1990 Yen/US$ UVRs for passenger cars were adjusted upward to allow for the fact that Japanese cars were smaller than American cars, but this was partly offset to allow for the better quality of Japanese cars.

All our manufacturing comparisons have been of a binary nature, and are therefore based on weights of one of the two countries in each comparison. In most cases, the USA was the "star" country which figured in each of the binaries. The UVR ratios which result from this procedure are either Laspeyres (if one uses the quantity weights of the USA - the "numèraire" country) or Paasche (using the other country's quantity weights). In summarising our results we generally used the geometric mean of the two ratios (the Fisher index) but we have systematically presented the full range of binary comparisons on alternative weighting systems.

A disadvantage of "star" system comparisons which link up a series of binary comparisons is that they are not transitive, i.e. comparisons between Brazil and Mexico which one can infer from binary comparisons between Brazil/USA and Mexico/USA are not the same as one gets from a direct Brazil/Mexico comparison. We found after testing that this was not a big problem for these two countries which are similar in product mix and productivity level. However, we found that the direct France/USA comparison yielded a significantly different result from that which one can infer from a France/UK and a UK/USA comparison. For the problems of transitivity in this case, see Van Ark and Kouwenhoven (1994).

Pilat and Prasada Rao (1991) tried to deal with the transitivity problem by using the ICOP manufacturing results to experiment with alternative multilateral measures. The aim of multilateralisation is to provide inter-country relationships which are transitive and not influenced by the choice of the base country. A further motivation in studies published by the UN was to have a unit which, in some sense, had "world" characteristics. The Geary-Khamis approach satisfies these requirements, but creates new

problems, because a comparison between two countries is then influenced by the characteristics of other countries. Thus if one has Geary Khamis estimates for the twelve EC countries and then adds a data set for the USA and Japan, all the original Geary Khamis estimates will change, and change significantly, as Japan and the USA are very large countries.

The present official multilateral estimates for OECD countries are an amalgam of estimates for separate groups of countries on which fixity (in variant Geary Khamis relationships) has been imposed for the 12 EC countries. When the OECD estimates are in turn linked to regional estimates for other parts of the world, the situation becomes even more complex. The meaning of such an amalgam is much less clear than in the ICP 3 study of Kravis, Heston and Summers where the Geary Khamis estimates were for the universe they covered. A further problem is that EUROSTAT switched from the Geary Khamis to the EKS technique of multilateralisation in ICP6 for 1990.

As there are no index numbers which possess all desirable properties, our preference so far has been for binary comparisons and the "star" country system. The binaries are transparent and the easiest to calculate. They are the most "country characteristic", i.e., their weights best reflect the relative price and quantity structure of the countries compared.

Industry of origin comparisons face a major problem not encountered in those from the expenditure side, i.e. the need to get UVRs for both output and input to arrive at value added. The double deflation procedure was reasonably satisfactory in our study of agriculture but produced some implausible and erratic results when it was applied in manufacturing. The input structure is much more heterogeneous, and the production censuses often provide inadequate information on the composition of material and service inputs. Input-output tables are of some help, and on one occasion we made use of them to adjust the comparisons for the food processing industry in Japan for their use of relatively expensive agricultural inputs (Van Ark and Pilat, 1993). However, we found that on the whole, even with very good information, double deflation easily leads to volatile and improbable results, particularly when intermediate inputs make up a large part of gross output or when the input/output structure is very different between countries (Szirmai and Pilat, 1990; Van Ark, 1993).

Instead of applying an incomplete and unsatisfactory double deflation procedure, we therefore followed the practice of earlier industry of origin studies. After deriving estimates for gross output, we moved to the value added measure by adjusting for the ratio of the value of inputs to gross output, i.e. we assumed the same UVR for output and input. This is an area where further experimentation and sensitivity analysis are necessary.

In many manufacturing censuses the concept of value added differs from modern national accounting practice. Traditionally these censuses correct for double counting by deducting raw materials, packaging and energy inputs from the gross value of output, but purchases of service inputs for repair and maintenance, advertising, accountancy etc. are not deducted. In table 4

we used this traditional "census concept" of value added, but in table 5 the productivity estimates for 1975 conform to the "present national accounts concept", where all service inputs are deducted, except bank charges which are deducted globally in present national accounting practice instead of being deducted separately for each sector of activity. Except for the service adjustment, the estimates in table 5 are based on the same census information as table 4.

Table 5 shows the manufacturing results for 1975 using three alternative UVR variants, the Paasche (at own country prices and US quantity weights, the Laspeyres (US prices and own country quantity weights) and the Fisher (geometric average of the Paasche and Laspeyres measures).

Table 5

Gross Value Added per Person Employed in Manufacturing in 1975 (present national accounts concept) Using Three UVR Variants

	Gross Value Added Per Person Engaged (USA = 100)			UVR Variants (Units of National Currency Per US Dollar)		
	Laspeyres Volume Index Using US Price Weights	Paasche Volume Index Own Country Price Weights	Fisher Geometric Mean	Paasche PPP Own Country Quantity Weights	Laspeyres PPP US Quantity Weights	Fisher Geometric Mean
Argentina	35.8	28.8	32.1	34.43	42.75	38.37
Brazil	54.3	42.7	48.1	6.91	8.77	7.79
India	9.5	5.0	6.9	6.70	12.77	9.25
Indonesia	12.3	8.6	10.3	374.99	535.29	448.02
Korea	12.4	9.3	10.7	436.50	584.80	505.20
Mexico	43.9	33.7	38.4	11.97	15.60	13.67
France	87.2	78.2	82.6	3.90	4.35	4.12
Germany	86.6	83.2	84.7	2.34	2.43	2.39
Japan	73.7	53.4	62.6	196.40	269.50	230.10
Netherlands	86.3	76.5	81.2	2.48	2.80	2.64
UK	52.6	46.0	49.2	.436	.499	.466
USA	100.0	100.0	100.0	1.00	1.00	1.00

Sources: As for table 4, except for Japan and Korea (Pilat, 1993) and the UK (van Ark, November 1990). Value added is adjusted here to the "present national accounts concept"; for Japan, Korea and the USA the adjustment was made by using the ratio of service inputs to census value added from the input-output tables for these countries (Szirmai and Pilat, 1990).

One can see that the Paasche UVR is more favourable for the follower countries than the Laspeyres UVR. This is due to the well-known

Gerschenkron effect, due to the inverse relation of relative prices and quantities (high prices reduce demand), which one also finds in our Table 2 for agriculture and in ICP studies.

Construction

This industry is engaged in building and repairing houses, offices, hotels, schools, hospitals, factories, roads and other kinds of government and private infrastructure etc. Its output is very heterogeneous. Designs, standards, types of building materials vary more between countries than for products where there is more international trade. The relative importance of site preparation or demolition varies a good deal from project to project. The average establishment is relatively small. In 1986, there were 492,000 in US construction compared with 355,000 in manufacturing, but employment was four times as high in manufacturing. For these reasons Paige and Bombach (1959) acknowledged that the construction sector was the most difficult they tackled.

Expenditure studies have devoted a good deal of effort to get detailed and well specified PPPs for different categories of construction. This careful approach was characteristic of the Gilbert-Kravis (1954) study and has continued with the ICP (see Kravis, Heston and Summers (1982) p.48).

Pilat (1993) applied the ICP PPPs as a proxy for ICOP PPPs in his Japan/USA, Korea/USA comparisons. But it would also be useful to apply double deflation for this sector using ICOP PPPs for inputs of building materials.

Services

The service sector is the activity which has been most "measurement resistant" both for the ICP and for our ICOP studies. The ICOP effort has so far been concerned with only five countries, information is generally poorer for this part of the economy, and our procedures still need improvement.

There are some services where the problems involved in comparing value added, relative prices and productivity are similar to those for manufacturing, and where census sources of information may be available for prices and quantities. This is true of electricity, gas and water supply, and sometimes for transport and communication.

Transport and Communications

Mulder (1994) covers Mexico/USA and includes a survey of previous comparisons for this sector. He distinguishes between the movement of freight and passengers and terminal costs. He makes adjustments for safety, comfort and reliability of travel. Mulder has also made transport comparisons for France, the UK and USA and Pilat (1993) contains comparisons of this kind for Korea, Japan and the USA.

Wholesale and Retail Trade

When one looks at the economy from the expenditure side as the ICP project does, the share of services is smaller than it appears from the production side. Distribution accounts for a good deal of this difference. It is a "disguised" activity in the ICP approach because its value added is incorporated in final expenditure. Thus ICP values consumption of bread, rice, butter, meat, eggs and milk at retail market prices whereas the ICOP approach allocates the value added mainly to three different industries: agriculture for the raw products, manufacturing for the food processing, and the distributive activity of traders who move goods from producers to consumers. The ICP in fact assumes that distributive margins are the same in all countries. Their basic procedure is the potato-is-a-potato rule "A potato with given physical characteristics was treated not only as the same product, but also as the same quantity, whether it was purchased in the country or in the city, in January, or in June, by the piece or by the bushel, and whether it was purchased at a retail market or consumed out of own production" (Kravis, Heston and Summers, 1982, p.31).

Because of these ICP assumptions and procedures there is a basic difference of approach to this sector in ICP and ICOP. Mulder and Maddison (1993) is a survey of previous attempts to measure distributive performance both intertemporally and internationally. Many other attempts to measure performance in this sector have simply used the ICP purchasing power parities for different categories of items traded and have reweighted them as a proxy for measuring gross output in this sector. This method, of course, implies acceptance of the potato-is-a-potato rule, so Mulder and Maddison (1993) compared this procedure with the results of a double deflated approach in a comparison between Mexico and the United States. They converted traders' sales values by detailed category (from the relevant censuses) with ICP PPPs for the corresponding items, and converted traders purchases with PPPs derived from the relevant ICOP studies for agriculture and manufacturing. They applied the same procedure for other inputs such as transport. The results of the two methods, i.e. single and double deflation, showed a substantial discrepancy. This was also true in a separate study (Mulder 1993c) for Brazil, but in this case the discrepancy was of an inverse character from that found for Mexico.

Unfortunately the basic census information on retailing generally contains nothing on quantities sold, but only on values of purchases and sales, number of employees and average sales by type of retail outlet. Furthermore countries vary in the degree to which they cover informal distributive activity, such as street vendors, or indeed the degree to which they cover family employees in the formal sector.

Finance, Banking and Insurance

Pilat (1993) measured financial services by the volume of monetary transactions. For this purpose he used the monetary indicator M2, which is the sum of cash in circulation, demand deposits and various kinds of time

and savings deposits, which he converted with the ICP GDP PPP. His separate comparison for insurance was based on the total number of life insurance policies. These estimates cover Japan, Korea, and the USA and we have not so far tackled this sector for other countries.

Housing Services and Commercial Real Estate

For housing there is often information in population censuses, which breaks down the stock into different categories by type of building or access to water, electricity etc. The material in the housing censuses for Brazil, Mexico and the USA is more or less adequate to make quantitative comparisons with adjustments for quality and these can be used with national accounts information on rents or imputed rents to get purchasing power parities.

In his Japan/USA comparisons, Pilat (1993) used an estimate of housing stock in the two countries from Maddison (1992) which was based on the perpetual inventory technique.

Information on the stock of commercial business premises is more difficult to assess.

Education

This is a sector where most of the value added consists of payment for labour services and where the discrepancy between the scope of the ICP expenditure measure and the industry of origin ICOP approach is not as great as in many others (though the difference between market price and factor cost valuations may be large because of subsidies). The ICP approach to this "comparison resistant" sector has been to measure output by employment inputs or adjusted employment inputs. Pilat (1993) innovated in measuring output in this sector by using IEA measures of educational achievement to correct for differences in cognitive outcomes. These IEA measures are based on tests of thousands of pupils at primary and secondary levels in a number of subjects, and are a very useful basis for qualitative adjustment. However, for Brazil and Mexico, such studies are not available and the quality adjustment is based on drop-out rates, i.e. not counting pupils who effectively learn nothing by dropping out before they are literate or numerate.

Health

This is also a comparison resistant sector where ICP uses inputs (employment with some adjustment) as its proxy measure of output. This assumes more or less equi-productivity in different countries. Pilat (1993) used ICP PPPs as a proxy for ICOP purposes. The recent World Bank, World Development Report 1993; Investing in Health, provides a vast range of new material and a new measure "DALY" (disability adjusted life year) which can be used in future studies as a quality adjustment for health analogous to that which Pilat (1993) used for education.

Defence and General Government

This is perhaps the most comparison-resistant sector, and ICP practice has generally been to use employment (weighted by education level) as an indicator for output. It is not easy to think of better measures though the US government has developed programmes for measuring public sector productivity (see Kendrick, 1989). In Maddison (1970) it was assumed that productivity in these services was related to that in commodity production. This is an arbitrary procedure but not without its intuitive appeal, because the quality of government that citizens demand or expect does seem to bear some relation to the general standard of living they enjoy. Pilat (1993) used the ICP PPPs as a proxy for a more direct ICOP measure.

Other Services

These are a mix of personal services - household and recreational, hotels and restaurants, tourism, etc. as well as business, legal and social services which are measurement resistant. Pilat (1993) used ICP PPPs as a proxy for ICOP PPPs in this instance.

The Economy as a Whole

The results of the ICOP and ICP approaches can only be fully compared at the most aggregative level - for the economy as a whole. The reason for this is that ICOP divides GDP at factor cost into value added by industry of origin, whereas ICP disaggregates GDP at market prices by type of expenditure. The individual real output components are therefore not comparable, because they look at economic activity from different vantage points. A full confrontation is possible only for the five countries (Brazil, Korea, Japan, Mexico and the USA) where ICOP has completed its estimates for the whole economy, but some important clues can be gained from a partial confrontation for ten countries.

We make these two types of confrontation between ICP and ICOP results for the year 1975 because Kravis Heston Summers (1982) covers that year and their work represents the ICP approach in its purest form together with fully transparent documentation and scholarly commentary. Subsequent EUROSTAT/OECD/UNSO estimates for ICP have a patchwork quality as regional estimates have been cobbled together from separate exercises, the UNSO results are published with very serious delay, transparency has suffered, and the scholarly commentary has disappeared.

We start with Table 6 which shows the aggregative ICP results for 10 countries for 1975 adjusted to a factor cost basis and gross of bank service charges, so that is a comparable aggregate with that which is used by the ICOP team. In fact the 1975 ICP results are available with four alternative PPP options: the three binary measures - Paasche, Laspeyres, Fisher and the Geary Khamis multilateral PPP. Our comparison is in terms of the Paasche

PPP, because this permits the broadest confrontation. However the differences between the two approaches would be similar if the other binary PPPs had been used.

The confrontation between ICOP and ICP results can be done in terms of (a) output and productivity; or (b) PPPs. In what follows we consider only approach (a), as it embraces the problem of comparability of census information and national accounts as well as that of converting currencies to a common numeraire.

(a) The Partial Confrontation for 10 Countries in Terms of Output and Productivity

Tables 7, 8, and 9 provide the first (partial) confrontation of the ICOP and ICP results for ten of our 13 core countries (Brazil, India, Korea, Mexico, France, Germany, Japan, Netherlands, UK and USA). There were no ICP estimates for 1975 for Argentina, China and Indonesia.

Table 7 presents ICOP estimates of value added for four commodity sectors, with the combined result being shown in the fifth column. The sixth column shows the ICP estimate of GDP, and the last column shows the difference between columns 5 and 6, i.e. the residual sectors of the economy. All the columns are shown before deduction of bank service charges which cannot be allocated by sector with the information presently shown in national accounts. Table 8 shows employment by sector.

Table 9 on labour productivity throws the most light on the compatibility of the ICOP and ICP approaches for these countries particularly the last column which shows what productivity levels in the non-commodity sector would be if the ICOP and ICP approaches were compatible.

For the advanced OECD economies, the differences between the level of productivity in the residual sector and that which we have measured in the commodity sector are not too great, and the productivity ranking of the countries is fairly similar in columns 5, 6 and 7. The most extreme case is the UK where the productivity level in the residual sector was 31 per cent higher than in the commodity sector.

However, in the lower income countries, the gap between commodity productivity and the apparent productivity in the residual sector is very big. In India the column 7 figure of Table 9 is sixteen times as high as that for the commodity sector, in Korea twelve times as high; in Mexico seven times as high; and in Brazil 2.7 times as high. The apparent productivity level in the residual sector in Mexico is above that in all the advanced countries.

This partial confrontation suggests that the ICP technique (a) exaggerates output and productivity levels in the lower income countries in the comparison resistant service sectors where ICP procedures lean towards the assumption of equal productivity between rich and poor countries, and (b) in "disguised" services, such as distribution where ICP's "potato is a potato"

rule infers that the distributive service content of various types of expenditure is the same in all countries.

(b) The Full Confrontation for 5 Countries in Terms of Output and Productivity

In the case of five countries, Brazil, Japan, Korea, Mexico and the USA, there are ICOP estimates for the whole economy. For these countries we can therefore make the full confrontation of the two approaches in Table 10.

In the case of Brazil, the ICOP estimate of total GDP is 79 per cent of the ICP estimate (see Table 10). The ICOP estimate of value added in the residual sector of the economy is 72 per cent of that we derived inferentially (compare Tables 7 and 10).

For Mexico, the ICOP estimate of total GDP in 1975 was 61 per cent of the ICP estimate. The ICOP estimate of value added in the residual sector of the economy is only 56 per cent of that we derived inferentially (compare tables 7 and 10).

In the case of Korea, the ICOP estimate for total GDP is 60 per cent of the ICP estimate and the ICOP estimate of gross value added in the residual sector is 55 per cent of that we derived inferentially (compare Tables 7 and 10).

In the case of Japan, the ICOP estimate of GDP is 94 per cent of the ICP estimate. The ICOP estimate for the residual sector is 91 per cent of the ICP estimate (compare Tables 7 and 10).

The exact level of the ICOP/ICP discrepancy for GDP varies a little according to whether one uses the Paasche or Fisher PPP converter, but the general picture is similar with either converter, i.e. the ICOP approach leads to substantially lower estimates for Korea and Mexico than those of ICP, but with a smaller gap for Brazil and Japan.

The results of the full confrontation from the production side confirm the results of the partial comparison, i.e. the ICP approach tends to overstate real product in the lower income countries. The main reason for this lies in the way the ICP calculates output in services. This conclusion is similar to that in Maddison (1983) where he made a preliminary confrontation of the expenditure and production approaches, comparing his (1970) estimates by industry of origin with those of ICP3.

(c) Partial and Full Confrontation of ICOP and ICP Results in Terms of PPPs

We can also compare the outcome of the ICOP and ICP approaches in terms of PPPs. We show the results in Tables 11 and 12 for the Paasche PPPs, but the character of the variation between the results of the two approaches would be similar for the binary Laspeyres and Fisher PPPs.

It can be seen from Table 11 that the ICOP consolidated PPPs for the four commodity sectors were a good deal higher than the ICP PPPs for GDP in the lower income countries, and the gap between the inferential PPPs in the last column and the ICOP commodity PPPs was even larger. For the higher income countries the differences between column 2 and columns 3 and 4 were much smaller.

Table 12 gives the full confrontation of ICOP and ICP PPPs for the five countries where this is presently feasible. For this table, we were able to use ICOP estimates of PPP for the rest of the economy in column 2. These can be compared with the inferential PPPs for the rest of the economy in Table 11, and it can be seen that the ICOP results were higher than the inferential PPPs. The last column of Table 12 shows the difference in the ICOP and ICP PPPs for the whole economy. The ICOP PPPs were higher than the ICP PPPs. The difference was biggest in Korea, Mexico, and Brazil, and smallest in Japan. It is also interesting to compare the last column of Table 12 with the last column of Table 10. These ratios of the results using the two methods would be identical if the two approaches had used completely compatible measures of GDP in national currencies. However, the PPP differences between the two methods in Table 12 are smaller than the real output discrepancies in Table 10. This arises because ICOP generally arrived at smaller estimates of nominal GDP by using census and survey information than is reflected in the national accounts, as used by ICP.

Conclusions

In the past 10 years the ICOP methodology has been developed on a systematic basis so that it can be replicated by other investigators covering other countries. We have published detailed descriptions of our methodologies for agriculture, manufacturing, transport, distribution and for some other service sectors. Our procedures are more-or-less fully transparent and we can make available complete statistical appendices. All data, including the calculations, are on computer, so that they can be easily used to fill in data for other countries.

So far we have covered one or more sectors of the economy for 20 countries. Given the requirement of reasonably reliable production censuses or surveys we do not believe the ICOP approach can cover as many countries as ICP has done over the years. We have not yet found a good shortcut procedure for countries without adequate statistics. Nevertheless, we know that the ICOP approach can probably be replicated for another 20 countries, which together with the countries already included in our project, would cover about threequarters of world GDP.

We have demonstrated that the ICOP results for those countries where we have covered the total economy can serve as a useful check on the ICP results. We are giving high priority to the measurement of output and productivity in the more comparison-resistant service industries, including education, health and government services. In the next year we hope to expand our economy-wide coverage from the five countries we have completed (Brazil, Japan, Korea, Mexico and the USA) to include India and France.

Table 6

1975 GDP at Factor Cost, Before Deduction of Bank Services Charges, Using the ICP Paasche PPP

	1975 GDP at Factor Cost Before Deduction of Bank Charge Million Units of National Currency	ICP Paasche PPP Converter Units of National Currency Per Dollar	National Ratio of Factor Cost to Market Price GDP Divided By US Ratio	ICP Paasche PPP Converter Adjusted to a Factor Cost Basis National Currency Unit/US$	1975 GDP at Factor Cost Before Deduction of Bank Service Charges $ Million at US Prices
Brazil	954,410	4.273	.97135	4.1506	229,945
India	736,383	1.896	.98995	1.8769	392,340
Korea	9,477,000	158.4	.98995	156.81	60,436
Mexico	1,112,612	6.05	1.02294	6.1888	179,778
France	1,356,197	4.292	.96788	4.154	326,480
Germany	964,248	2.638	.98008	2.5855	372,945
Japan	147,217,000	245.2	1.03234	253.13	581,587
Netherlands	212,663	2.758	.99359	2.7403	77,606
UK	99,749	.3533	.99178	.3504	284,672
USA	1,499,684	1.000	1.00000	1.0000	1,499,684

Source: Col.1 for Brazil, India, Korea and Mexico from national sources, other countries from OECD, National Accounts, 1960-91, Paris 1993; Col.2 from Kravis, Heston, Summers (1982), pp.255-82; Col.3 is the ratio of the factor cost GDP to market price GDP relative to that in the USA. Most countries had a higher proportion of indirect taxes than the USA, Mexico and Japan had a lower ratio; col.4 is column 2 adjusted by the coefficient in col.3. Col.5 is derived by dividing col.1 by col.4.

Table 7

Partial Confrontation of ICOP Estimates of Value Added by Sector at Factor Cost in 1975 with ICP GDP Estimate at Factor Cost
(All estimates are in million US$ based on the Paasche PPP converter)

	Agri-culture	Forestry & Fishing	Mining	Manu-facturing	Four Commodity Sectors	Four Before Deducting Bank Service Charges	GDP Residual
Argentina	8,933	114	987	10,024	20,058	-	-
Brazil	18,303	1,160	1,036	38,100	58,599	229,945	171,346
China	95,496	3,136	10,923	-	-	-	-
India	41,963	1,400	2,662	17,651	63,676	392,340	328,664
Indonesia	9,631	1,159	2,595	2,302	15,687	-	-
Korea	2,524	814	379	3,614	7,331	60,436	53,105
Mexico	6,024	225	1,964	14,043	22,256	179,778	157,522
France	12,982	631	1,015	82,568	97,196	326,480	229,284
Germany	6,976	488	3,095	134,576	145,135	372,945	227,810
Japan	7,569	3,553	744	184,885	196,751	581,587	384,836
Netherlands	3,347	99	1,340	18,090	22,876	77,606	54,730
UK	5,197	308	2,723	72,110	80,338	284,672	204,334
USA	46,981	4,405	37,718	336,063	425,167	1,499,684	1,074,517

Sources: Agriculture, Forestry and Fishing from Maddison and van Ooststroom (1993). Mining from Wieringa and Maddison (1985 revised). Manufacturing in national currencies (as derived from censuses of manufactures and adjusted to the present national accounts concept, i.e. without deduction of bank charges) from table 5, and converted into US dollars by use of the Paasche PPP converter for total manufacturing (derived from census sources). The estimates for India and Indonesia include small scale manufacturing, which was obtained from the national accounts for these countries and converted to US dollars using the Paasche PPP converter for medium and large scale manufacturing. Column 5 is the total of the four columns estimated by the ICOP method. The estimate for GDP is derived from the ICP sources shown in Table 6, applying the Paasche PPP converter. It is shown before deduction of bank service charges to correspond with our procedure in estimating the first four columns. Column 7 equals col.6 minus col.5.

Table 8
Employment by Sector in 1975
(000s)

	Agri-culture	Forestry & Fisheries	Mining	Manu facturing	Four Commodity Sectors	Total Economy	Residual
Argentina	1,389	17	59	1,525	2,990	9,587	6,597
Brazil	12,468	805	93	3,824	17,190	35,740	18,550
China	281,378	12,032	3,852	40,920	338,182	377,685	39,503
India	147,936	13,503	816	19,594	181,849	240,345	58,496
Indonesia	27,400	1,978	44	2,126	31,548	47,030	15,482
Korea	4,831	942	60	1,585	7,418	11,830	4,412
Mexico	6,134	229	241	1,744	8,348	16,178	7,830
France	2,074	82	176	5,155	7,487	21,452	13,965
Germany	1,585	216	356	8,460	10,617	26,110	15,493
Japan	5,870	740	160	13,733	20,503	52,230	31,727
Netherlands	254	9	8	1,142	1,413	4,743	3,330
UK	649	38	361	7,467	8,518	25,055	16,540
USA	3,208	299	752	18,302	22,561	88,026	65,465

Sources: The four ICOP sectors from the same sources as Table 7. Total employment for OECD countries from OECD Labour Force Statistics 1970-90, Paris 1992. Total employment for Argentina, Brazil and Mexico derived from Maddison, The World Economy in the Twentieth Century, 1989, Korea from Pilat (1993), China, India, Indonesia from national sources. Our estimates are for mid-year 1975.

Table 9

Productivity (Gross Value Added Per Person Engaged)

(GDP in US$ (using Paasche PPP converter) per person engaged)

	Agri-culture	Forestry & Fishing	Mining	Manu-facturing	Four Commodity Sectors	GDP	Residual
Argentina	6,431	6,706	16,720	6,573	6,708	-	-
Brazil	1,468	1,441	11,138	9,962	3,409	6,433	9,237
China	339	261	352	..	-	-	-
India	284	104	3,263	301	350	1,632	5,619
Indonesia	351	586	58,977	1,083	497	-	-
Korea	522	864	6,321	2,279	988	5,109	12,036
Mexico	982	983	8,149	8,053	2,666	11,112	20,118
France	6,259	7,695	5,765	16,017	12,982	15,219	16,418
Germany	4,401	2,259	8,693	15,907	13,670	14,284	14,704
Japan	1,289	4,801	4,651	13,463	9,596	11,135	12,130
Netherlands	13,177	11,000	167,451	15,847	16,195	16,362	16,433
UK	8,008	8,105	7,544	9,657	9,435	11,362	12,354
USA	14,645	14,732	50,157	18,362	18,845	17,037	16,414

Source: Derived from Tables 7 and 8.

Table 10

Full Confrontation of ICOP and ICP Estimates of 1975 GDP at Factor Cost (without Deduction of Bank Service Charges)

(All estimates are in million $ at US prices based on the Paasche PPP converters)

	ICOP Estimate of Gross Value Added in Four Commodity Sectors	ICOP Estimate of Output in Rest of Economy	ICOP Estimate of GDP	ICP Estimate of GDP	Coefficient of col. 3/4
Brazil	58,599	122,936	181,535	229,945	.789
Mexico	22,256	88,227	110,483	179,778	.614
Korea	7,331	29,072	36,403	60,436	.602
Japan	196,751	349,327	546,078	581,587	.939
USA	425,167	1,074,517	1,499,684	1,499,684	1.000

Source: Col.1 from Table 7; col.2 Brazil and Mexico from preliminary estimates by Maddison and Mulder, Korea and Japan from Pilat (1993). Col.3 is col.1 plus col.2, col.4 is from Table 6. Col.5 is the ratio of col.3 to col.4.

Table 11

10 Country Partial Confrontation of ICOP's Paasche PPPs with the Exchange Rate and ICP's Paasche PPPs in 1975
(units of national currency per US dollar)

	Exchange Rate	ICOP Paasche PPP for 4 Commodity Sectors	ICP Paasche PPP for GDP	Implicit Paasche PPP for Residual Part of Economy
Argentina	36.57	24.18	n.a.	n.a.
Brazil	8.13	6.96	4.27	3.35
India	8.65	6.67	1.90	0.97
Indonesia	415.00	447.94	n.a.	n.a.
Korea	484.00	515.49	158.40	109.11
Mexico	12.50	12.78	6.05	5.10
France	4.29	4.23	4.29	4.32
Germany	2.46	2.38	2.64	2.80
Japan	296.79	220.03	245.20	258.07
Netherlands	2.53	2.78	2.76	2.75
UK	0.45	0.45	0.35	0.32
USA	1.00	1.00	1.00	1.00

Source: Col.1 from Kravis, Heston, Summers (1982) and IMF, International Financial Statistics; col.2 is a weighted average of the PPPs for agriculture (fourth col. of Table 2), mining (first column of Table 3), manufacturing (fourth col. of Table 5) and forestry and fishing (assumed to be the same as for agriculture, except in Japan and Korea, where we used Pilat's (1993) estimate); col.3 Paasche PPPs from Kravis, Heston and Summers (1982). The last column is inferred from columns 2 and 3 (using as weights the estimates of sectoral output and GDP in national prices).

Table 12

5 Country Full Confrontation of ICOP's Paasche PPPs with ICP's Paasche PPPs in 1975

	ICOP Paasche PPP for Four Commodity Sectors	ICOP Paasche PPP for Rest of Economy	ICOP Paasche PPP for GDP	ICP Paasche PPP for GDP	Coefficient col. 4/3
Brazil	6.96	4.33	5.18	4.27	.824
Mexico	12.78	6.21	7.53	6.05	.803
Korea	515.49	153.72	226.60	158.40	.699
Japan	220.03	278.07	257.16	245.20	.954
USA	1.000	1.000	1.000	1.000	1.000

Source: Col.1 as for Table 11; col.2 estimates of Mulder and Maddison for Brazil and Mexico, Pilat (1993) for Korea and Japan; col.3 is the weighted average of cols.1 and 2; col.4 from Kravis, Heston Summers (1982); col.5 is the ratio of col.4 to col.3.

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ERRATA TO

The International Comparison of Real Product and Productivity

by Angus Maddison and Bart van Ark
Groningen Growth and Develoment Centre
Research Memorandum 567 (GD-6)

Since this paper was prepared van Ark and Kouwenhoven have revised their France/ USA comparison for manufacturing (see van Ark and Kouwenhoven, 1994). As a result the following amendments are necessary:

p. 9, 4th para, 5th line: "36 per cent" should be "35 per cent".

p. 9, 4th para, 6th line: "79 per cent" should be "76 per cent".

p. 10, table 4: Delete the line for France and substitute by:

France:	37.9	49.7	69.1	77.1

p. 11, table 4a: Delete the line for France and substitute by:

France:	77.1	1,616	91.3

p. 15, table 5: Delete the line for France and substitute by:

France:	79.8	72.2	75.9	4.18	4.61	4.39

p. 20, 3rd para from below, last sentence: "The most extreme case ... the commodity sector" should read: "The most extreme case is France, where the productivity level in the residual sector was 41 per cent higher than in the commodity sector".

p. 24, table 7: Delete the line for France and substitute by:

France:	12,982	631	1,015	74,469	89,097	326,480	237,838

p. 25, table 8: Delete the line for France and substitute by:

France:	2,074	82	176	5,085	7,417	21,452	14,035

p. 26, table 9: Delete the line for France and substitute by:

France:	6,259	7,695	5,765	14,645	12,013	15,219	16,914

p. 28, table 11: Delete the line for France and substitute by:

France:	4.29	4.26	4.29	4.30