Appendix C

LEVELS OF GDP

In order to compare levels of output or output per capita in different countries, or to add their output to form a larger regional or world aggregate, it is necessary to convert them into a common unit. There are three basic options for converting the nominal values:

a) use the exchange rate. This is the simplest option, but exchange rates are mainly a reflection of purchasing power over tradeable items. For these goods inter-country price differences are reduced because of possibilities for trade and specialisation. In poor countries where wages are low, non-tradeable services, like haircuts, government services, building construction, are generally cheaper than in high income countries, so there is a general tendency for exchange rates in poor countries to understate purchasing power (see Table C-1). The other problem with exchange rates is that they are often powerfully influenced by capital movements, or since the 1930s, by various kinds of exchange restriction. The last columns of Tables C-7 and C-11 give some idea of the divergence of purchasing power and exchange rates;

Table C-1
Confrontation of My Estimate of Real GDP per Capita in 1900 in "1990 international dollars" and the 1900 levels estimated using Exchange Rates

	1900 GDP in thousand national currency units	Exchange Rate US cents per unit of national currency	GDP in million 1900 dollars	Population 000s	GDP per capita 1900 dollars	GDP per capita index US=100	GDP per capita index using 1990 inter-national dollars
Australia	198,300	486.60	965	3,741	258	104.5	102.8
Canada	1,030,000	100.00	1,030	5,319	194	78.5	67.0
France	26,130,000	19.30	5,043	38,940	130	52.6	68.1
Germany	35,170,000	23.82	8,377	56,046	149	60.3	71.3
India	14,343,200	32.24	4,624	284,500	16	6.5	14.9
Japan	2,422,000	50.66	1,227	44,103	28	11.3	27.1
UK	1,922,000	486.60	9,352	41,155	227	91.9	106.5
USA	18,782,000	100.00	18,782	76,094	247	100.0	100.0

Source: First column: Appendix to A. Maddison, "A Long Run Perspective on Saving", *Scandinavian Journal of Economics*, June 1992; col. 2 from A. Maddison, *The World Economy in the Twentieth Century*, OECD Development Centre, Paris, 1989, p. 145, population from Appendix G, and from A. Maddison, *Dynamic Forces in Capitalist Development*, Oxford University Press, 1991, Appendix B. Last column from Appendices G and D. All the figures above refer to countries within their 1900 boundaries.

b) the second option is to use the purchasing power parity converters (PPPs) which have been developed by cooperative research of national statistical offices and international agencies in the past few decades. The expenditure approach, as instituted by OEEC in the 1950s for 8 countries and developed by Kravis, Heston and Summers in the ICP (International Comparisons Project) for 34 countries, was taken over by the United Nations/Eurostat/OECD joint programme in the 1980s, and ICP estimates are now available for 87 countries for at least one year. The ICP is basically a highly sophisticated comparative pricing exercise. It involves the collection of carefully specified price information by statistical offices for representative items of consumption, investment goods and government services. In the 1990 EUROSTAT exercise 2,553 prices were collected for specified sample items. These were allocated to 277 basic headings which were then aggregated to produce the PPP converters. The exercise helps to reinforce the comparability of national accounts, and provides detailed evidence on price structure as well as the aggregate converter which is our main concern here.

For countries not covered by the ICP, Summers and Heston have devised short cut estimates, and in their latest (1993) exercise provided PPP converters and real product estimates for 150 countries. Their estimates for countries which have never had an ICP exercise are necessarily rougher than for those where these exercises are available. For these they use much more limited 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.

As there are ICP estimates for 49 of our 56 sample countries and the Summers and Heston figures are available, for the others I have a strong preference for the ICP PPP converters over exchange rates. The only problem arose for a number of smaller countries outside my sample which had not been covered either by ICP or by Summers and Heston. For these countries I had to use crude proxies in Appendix E (these countries accounted for about 1 per cent of 1990 world GDP).

c) the third option is the approach developed by the ICOP (International Comparison of Output and Productivity) project of the University of Groningen. This involves comparison of real output (value added) by industry of origin using census of production material on output quantities as well as prices (for agriculture, industry and service activity). This approach is particularly useful for analysis of productivity performance by sector. Although there are a large number of such studies for agriculture and manufacturing, there are as yet few for the service sector, so that real GDP comparisons, on an ICOP basis, are feasible for only a limited number of countries.

The following notes distinguish between the situation for OECD countries where the latest 1990 PPP estimates are available for all the countries. For most non-OECD countries, it is necessary to adopt a more complicated procedure for updating the results of earlier PPP comparisons to 1990. I have presented my procedures in a transparent form and given a rather full range of alternative PPPs.

Source Notes on 1990 Benchmark Levels of GDP in OECD Countries

The annual GDP levels shown in Tables 3a to 3f of this appendix were derived by merging the GDP indices from appendix B with the 1990 benchmark values of GDP levels. The latter are corrected for differences in the purchasing power parities (PPPs) of currencies.

When international comparisons of performance levels are made it is now conventional to have only one summary set of results. In the ICP, the preferred option has until recently been the multilateral Geary Khamis indicator which I have used. 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 and productivity levels. In order to make the procedure as transparent as possible, so that it can easily be replicated (or modified) by those with different research objectives, I have presented all of the options for OECD countries in tables C-2 to C-8.

The results of binary studies can be used to compare the situation in a number of countries, each binary being linked via a "star" country. Hence a series of binary comparisons France/USA, Germany/USA and UK/USA are linked with the USA as the star country. However, the France-Germany, UK-Germany, and France-UK comparisons which can be derived from these are inferential and will not necessarily produce the same results as direct binary comparison of France and Germany, UK and Germany or France-UK. Such star system comparisons are not "transitive".

The comparisons can be made transitive if they are done on a "multilateral" rather than a "binary" basis. The Geary-Khamis approach (named for R.S. Geary and S.H. Khamis) is an ingenious method for multilaterising the results which provides transitivity and other desirable properties. It was developed by Kravis, Heston and Summers (1982) as a method for aggregating ICP results available at the basic heading level, and they used it in conjunction with the CPD (commodity product dummy) method (invented by Robert Summers) for filling holes in the data at the basic heading level.

The Geary-Khamis approach gives a weight to countries corresponding to the size of their GDP, so that a large economy, like the USA, has a strong influence on the results. For this reason, alternative multilateral methods are sometimes used in which all countries have an equal weight, e.g. the Gerardi or EKS techniques for multilateralisation. For my purposes I see no point in equi-country weighting systems which treat Luxemburg and the USA as equal partners in the world economy, so I have a strong preference for the Geary-Khamis approach.

It should be noted that the transitivity one gains with the Geary Khamis multilateral comparison has a certain cost, because a comparison, e.g., between Japan and the USA is influenced by the price structure and relative size of the other countries. If one adds another country, e.g. China, which has hitherto been excluded from the comparison, then all the original

Geary Khamis comparisons will change, and may change significantly. With the "star" system, by contrast, one can add another binary comparison without changing the existing binaries.

The EKS PPP is the multilateral converter now preferred by EUROSTAT/OECD, but the one hitherto used by OECD and preferred by Kravis, Heston and Summers and myself, is the Geary-Khamis converter. The Geary Khamis PPP is usually nearest to the Paasche, the Fisher is somewhat higher, and the Laspeyres converter shows the highest PPPs. Generally speaking, the dispersion between alternative PPPs is wider, the lower the relative GDP per capita of the country concerned (see Tables C-7 and C-11). For consistency with the procedure used for non-OECD countries, I used the Geary Khamis rather than the EKS PPPs.

The ICP 6 Geary Khamis benchmark for l990 is the latest available and the most complete in country coverage. Table C-8 shows the variations in the level of GDP according to which ICP round is used as a benchmark. ICP 5 generally gave a less favourable picture of income levels in other countries (relative to the USA) than ICP 3, ICP 4 and ICP 6. It is inevitable that there should be variance between ICP rounds, as the patterns of output and prices change, the relative size of the countries varies, and the procedures for the calculation have undergone some change. Nevertheless, it is disconcerting that the growth implicit in successive ICP rounds should be so different from those in the national accounts estimates for individual countries.

These discrepancies between successive ICP rounds led Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1955-1988", *Quarterly Journal of Economics*, May 1991, to devise an elaborate compromise technique which purged the inconsistencies between the four successive ICP benchmark levels for l970, l975, l980 and l985 and those recorded in the national accounts. Their (1991) estimates are shown in the penultimate column of Table C-8, updated to l990. In most cases, their estimates fell outside the range of per capita product in all the other ICP rounds.

It is not easy to see why this should be the case, but one should keep in mind that their estimating procedures were different from mine in three very important respects:

a) they used the original basic data for countries which participated in ICP2, ICP3, ICP4 and ICP5 plus much rougher price information for 57 non-benchmark countries and reworked the Geary Khamis PPPs on a global basis for 138 countries. Their PPPs were therefore different from those of ICP which I used;

b) their updating was done on a disaggregated basis, with separate estimates for consumption, investment, government expenditure and net foreign balance, whereas my updating is cruder and done only at the GDP level;

c) their consistentising procedure to eliminate the variance between successive ICP rounds involved modification of the growth rates in national prices. I have not modified these because they are likely to contain less error than the successive ICP benchmarks. Furthermore, the Summers/Heston procedure is asymmetric, because it involves modification of growth rates only for those countries for which there is more than one ICP benchmark.

My own view, as expressed in Maddison (1991, p. 201) is that the variance between successive ICP rounds is more likely to be the source of the problem than errors in the national growth measures. If an averaging procedure is used, an average of the successive ICP rounds might well be preferable to the Summers-Heston 1991 procedure which also involved

adjustment of the growth rates. Summers and Heston concentrate on the situation since 1950 or 1960. Earlier than that it is impossible to use their procedure, as there are no equivalent benchmarks available.

Kravis and Lipsey also had doubts about the "consistentising" procedure because it diminishes transparency and introduces ambiguity in what is being measured: "Our view is that the best general-purpose estimates of growth rates are those derived directly from the national accounts - from domestic price deflators of the countries. They have relatively clear conceptual underpinning. (They are, to be sure, made less comparable from country to country by use of different base years.) Similarly, we think that the best estimates of real GDP per capita levels are those produced by the benchmark studies, unaltered by modifications based on a mixture of domestic and international prices." (see I.B. Kravis and R.E. Lipsey, "The International Comparison Program: Current Status and Problems", in P.E. Hooper and J.D. Richardson, *International Economic Transactions: Issues in Measurement and Empirical Research*, University of Chicago Press, Chicago, l99l.

Recently Summers and Heston (NBER diskette of June 1993) have issued new Penn World Tables: Mark 5.5, which do not involve adjustments of the national indicators of GDP growth (of the type mentioned in para c) above). They now apply "consistentisation" only to the successive ICP rounds. Their (1993) results are shown in the last column of Table C-8 and are more acceptable than their (1991) results as they now generally fall within the range of the ICP results.

Table C-2
Alternative PPPs for GDP from Round II of ICP and Exchange Rate for 1970
(units of national currency per US dollar)

	Laspeyres	Paasche	Fisher	Geary Khamis	Exchange Rate
Belgium	46.8	35.8	40.9	38.0	50.00
France	4.87	4.13	4.49	4.40	5.55
Germany	3.44	2.90	3.16	2.99	3.66
Italy	509	407	455	458	625
Netherlands	3.21	2.45	2.81	2.67	3.62
UK	0.333	0.278	0.304	0.301	0.417
USA	1.000	1.000	1.000	1.000	1.000
Japan	279	231	254	241	360

Source: I.B. Kravis, A. Heston and R. Summers, *International Comparisons of Real Product and Purchasing Power*, Johns Hopkins, Baltimore, 1978, p. 21 for Geary Khamis, pp. 174-96 for binaries. Exchange rates from OECD, *National Accounts 1960-1992*, vol. I, Paris 1994, p. 154.

Table C-3
Alternative PPPs for GDP from Round III of ICP and Exchange Rate for 1975

	Laspeyres	Paasche	Fisher	Geary Khamis	Exchange Rate
Austria	18.77	15.89	17.27	17.5	17.4
Belgium	45.17	39.39	42.18	41.6	36.8
Denmark	8.007	6.872	7.418	7.29	5.75
France	5.207	4.292	4.727	4.69	4.29
Germany	3.143	2.638	2.880	2.81	2.46
Italy	620.1	515.1	565.2	582.0	652.9
Netherlands	3.236	2.758	2.987	2.84	2.53
UK	0.4267	0.3533	0.3883	0.406	0.452
USA	1.0000	1.0000	1.0000	1.0000	1.0000
Japan	315.0	245.2	277.9	271.0	296.8
Ireland	0.4246	0.3404	0.3802	0.388	0.452
Spain	50.05	38.12	43.68	42.3	57.4

Source: I.B. Kravis, A. Heston and R. Summers, *World Product and Income: International Comparisons of Real Gross Product*, Johns Hopkins, Baltimore, 1982, p. 21 for Geary Khamis, pp. 253-82 for augmented binaries. Exchange rates as for Table C-2.

Table C-4
Alternative PPPs for GDP from Round IV of ICP and Exchange Rate for 1980

	Laspeyres	Paasche	Fisher	Gerardi	Geary Khamis (OECD Version)	Exchange Rate
Austria	16.863	14.598	15.690	16.463	15.40	12.94
Belgium	40.337	35.268	37.718	39.375	36.60	29.24
Denmark	8.4552	7.1606	7.7810	8.0710	7.43	5.64
Finland	n.a.	n.a.	n.a.	n.a.	4.52	3.73
France	5.8318	5.0374	5.4201	5.6110	5.24	4.23
Germany	2.6151	2.3305	2.4687	2.5276	2.37	1.82
Italy	882.04	715.78	794.57	801.94	759.00	856.45
Netherlands	2.9055	2.4523	2.6693	2.7416	2.53	1.99
Norway	7.8282	5.8672	6.7771	6.7320	6.16	4.94
UK	0.59517	0.45089	0.51803	0.52130	0.487	0.430
Canada	1.1311	1.1047	1.1178	1.0952	1.08	1.17
USA	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Japan	282.08	218.97	248.53	251.16	240.00	226.74
Greece	47.195	33.247	39.611	38.452	35.40	42.62
Ireland	0.57343	0.43230	0.49789	0.50488	0.461	0.487
Portugal	47.280	26.629	35.483	32.115	31.70	50.06
Spain	77.165	58.766	67.340	67.083	63.70	71.70

Source: First four alternatives supplied by Hugo Krijnse Locker of EUROSTAT (1988-9 worksheets). Fifth column from Michael Ward, *Purchasing Power Parities and Real Expenditures in the OECD*, OECD, Paris, 1985, p. 13. Exchange rates as for Table C-2.

Table C-5
Alternative PPPs for GDP from Round V of ICP and Exchange Rate for 1985

	Laspeyres	Paasche	Fisher	Gerardi	Geary Khamis (OECD Version)	Exchange Rate
Austria	19.4849	15.6754	17.4767	18.180	16.60	20.69
Belgium	50.1568	41.7626	45.7677	48.587	44.60	59.38
Denmark	11.5111	9.1656	10.2716	10.7642	9.80	10.60
Finland	7.35488	5.67869	6.46267	6.5273	5.97	6.19
France	8.32432	6.75214	7.49713	7.8937	7.27	8.99
Germany	2.82225	2.37162	2.58714	2.6734	2.48	2.94
Italy	1523.45	1197.66	1350.77	1401.4	1302.00	1909.44
Netherlands	2.89318	2.43992	2.65691	2.7531	2.55	3.32
Norway	10.5057	8.2593	9.3150	9.3035	8.63	8.60
Sweden	9.70216	7.56799	8.56889	8.9021	8.15	8.60
UK	0.660073	0.532476	0.592851	0.61300	0.568	0.779
Australia	1.39921	1.15794	1.27287	1.3255	1.24	1.43
New Zealand	1.7218	1.2582	1.4719	1.4788	1.35	2.02
Canada	1.25866	1.20922	1.23369	1.2317	1.22	1.37
USA	1.00000	1.00000	1.00000	1.00000	1.000	1.000
Japan	298.979	201.452	245.418	239.23	222.00	238.54
Greece	101.135	66.147	81.791	84.576	77.3	138.1
Ireland	0.79803	0.70662	0.75094	0.78871	0.723	0.946
Portugal	97.339	58.377	75.381	73.066	66.20	170.40
Spain	116.635	86.411	100.392	102.575	95.30	170.04
Turkey	284.14	137.63	197.75	172.84	153.00	521.98

Source: First four alternatives supplied by Hugo Krijnse Locker of EUROSTAT (1988-89 Worksheets). The set of PPPs is also available in disaggregated form for 376 expenditure categories. Fifth column from OECD, *Purchasing Power Parities and Real Expenditures, 1985*, OECD, Paris, 1987, pp. 50-1. Exchange rates as for Table C-2.

Table C-6
Alternative PPPs for GDP from Round VI of ICP and Exchange Rate for 1990

	Laspeyres	Paasche	Fisher	Geary-Khamis (OECD Version)	EKS	Exchange Rate
Austria	15.118	13.492	14.282	13.899	14.091	11.370
Belgium	42.547	35.584	38.910	38.362	39.432	33.418
Denmark	10.574	8.017	9.207	8.700	9.398	6.189
Finland	7.0484	5.9736	6.4888	6.219	6.386	3.824
France	7.2861	5.9514	6.5850	6.450	6.614	5.445
Germany	2.1816	1.9263	2.0500	2.052	2.091	1.616
Italy	1601.5	1290.9	1437.8	1384.11	1421.6	1198.1
Netherlands	2.3269	1.9433	2.1264	2.084	2.1705	1.821
Norway	10.820	8.866	9.795	9.218	9.739	6.26
Sweden	10.288	8.310	9.246	8.979	9.341	5.919
Switzerland	2.3134	2.0731	2.1900	2.160	2.2045	1.389
UK	.66335	.55618	.60740	0.587	0.60227	0.563
Australia	1.4714	1.2968	1.3814	1.352	1.3864	1.281
New Zealand	1.7126	1.4709	1.5872	1.5574	1.6136	1.676
Canada	1.3246	1.2248	1.2737	1.274	1.3068	1.167
USA	1.0000	1.0000	1.0000	1.000	1.000	1.000
Japan	220.31	176.51	197.20	185.27	195.45	144.79
Greece	164.23	120.99	140.96	129.55	140.91	158.51
Ireland	.74827	.67363	.70997	0.688	0.69091	0.605
Portugal	126.94	85.24	104.02	91.737	103.75	142.56
Spain	125.00	100.70	112.19	105.71	109.55	101.93
Turkey	2032.4	1078.6	1480.6	1176.29	1492.05	2608.64

Source: First three alternatives supplied by EUROSTAT; fourth column derived from OECD *Purchasing Power Parities and Real Expenditures: GK Results*, vol. 2, Paris 1993, pp. 32-3, rebased with the US dollar as the reference currency (in line with the practice in earlier ICP rounds); last column from OECD, *Purchasing Power Parities and Real Expenditures: EKS Results, 1990*, vol. 1, Paris, 1992, pp. 30-1 (rebased as in column 4). Exchange rates from OECD, *National Accounts 1960-1992*, vol. 1, Paris, 1994, p. 155.

Table C-7
Ratio of Paasche, Laspeyres and Fisher PPPs and Exchange Rate to Geary Khamis PPP
OECD Countries, Round VI of ICP for 1990 for OECD Countries

	Geary Khamis	Paasche	Laspeyres	Fisher	Exchange Rate
Australia	1.00	.96	1.09	1.02	.92
Austria	1.00	.97	1.09	1.03	.81
Belgium	1.00	.93	1.11	1.01	.85
Canada	1.00	.96	1.04	1.00	.89
Denmark	1.00	.92	1.22	1.06	.66
Finland	1.00	.96	1.13	1.04	.60
France	1.00	.92	1.12	1.02	.82
Germany	1.00	.94	1.06	1.00	.77
Italy	1.00	.93	1.16	1.04	.84
Japan	1.00	.95	1.19	1.06	.74
Netherlands	1.00	.93	1.12	1.02	.84
New Zealand	1.00	.94	1.10	1.02	1.04
Norway	1.00	.96	1.17	1.06	.64
Sweden	1.00	.93	1.15	1.03	.63
Switzerland	1.00	.96	1.07	1.01	.63
UK	1.00	.95	1.13	1.03	.93
USA	1.00	1.00	1.00	1.00	1.00
Advanced Capitalist Average	1.00	.95	1.11	1.03	.80
Greece	1.00	.93	1.26	1.09	1.12
Ireland	1.00	.98	1.09	1.03	.88
Portugal	1.00	.93	1.38	1.13	1.37
Spain	1.00	.95	1.18	1.06	.93
Turkey	1.00	.92	1.73	1.26	1.75
South European Average	1.00	.94	1.33	1.11	1.21

Source: Derived from Table C-6.

Table C-8
Alternative Estimates of the Level of Real GDP per Capita in 1990 using Geary Khamis PPP Converters from Successive ICP Rounds and those of Summers and Heston
(USA=100.00)

	ICP3	ICP4	ICP5	ICP6	Summers and Heston (1991)	Summers and Heston (1993)
Australia	n.a.	n.a.	70.09	75.08	72.71	79.66
Austria	70.79	72.73	66.61	76.80	63.71	71.74
Belgium	77.10	80.65	67.97	76.86	65.50	77.60
Canada	n.a.	100.14	92.06	89.63	87.46	95.93
Denmark	80.26	84.56	71.96	82.10	66.42	77.32
Finland	n.a.	81.94	72.04	75.93	69.45	78.76
France	80.53	82.95	72.15	81.30	68.40	77.33
Germany	82.02	83.53	72.61	85.45	69.25	84.00
Italy (a)	62.91	75.18	66.46	72.95	64.01	67.74
Japan	82.89	85.16	79.48	84.83	71.21	82.48
Netherlands	72.31	77.76	70.85	75.79	66.16	72.06
New Zealand	n.a.	n.a.	56.33	64.00	52.97	65.76
Norway	n.a.	97.73	80.71	77.26	81.43	74.02
Sweden	n.a.	n.a.	71.06	80.92	70.57	80.29
Switzerland	n.a.	n.a.	n.a.	99.06	89.74	96.86
UK	64.41	75.60	70.22	74.55	65.46	71.27
USA	100.00	100.00	100.00	100.00	100.00	100.00
Greece	n.a.	48.50	43.61	45.96	39.84	45.82
Ireland	49.67	58.45	49.71	50.87	39.24	50.41
Portugal	n.a.	41.92	41.89	48.87	36.66	41.24
Spain	56.22	58.67	51.75	55.66	43.14	54.02
Turkey	n.a.	n.a.	23.25	19.50	20.29	20.40

Note: (a) Downward adjustment of 3 per cent for reasons explained in source notes for Italy in Appendix B.

Source: The Geary Khamis PPP converters for 1975, 1980, 1985 and 1990 (see tables C-3 to C-6) were used to make a dollar conversion of the latest available estimate of GDP in national prices for these years. These estimates were updated in volume terms, and adjusted by the change in the GDP deflator for the numeraire country (the USA). They were divided by the population estimates for the relevant years and expressed as a per cent of US GDP per capita. The fifth column is derived from Summers and Heston (1991, pp. 351-4) estimates of GDP (population x per capita GDP) levels in 1988 at 1985 prices. The sixth column is from the Penn World Tables: 5.5 diskette, of 1993. The last two columns were updated to 1990 by the same procedure as above. The results in the second and third columns had "fixity" imposed on them for EC countries, whereas the results in the other columns were established without this constraint (hence, in these other columns, the interrelationship between levels in the 12 EC countries was not necessarily the same as was estimated by EUROSTAT). In 1994, the official estimates of 1990 GDP levels for Greece and Portugal were adjusted upwards:

Greece by 25.2 per cent from 10,546 billion drachma to 13,204 billion; Portugal by 14.2 per cent from 8,507,434 million escudos to 9,711,614 million in line with EUROSTAT recommendations.

The Estimation of 1990 Benchmark Levels of GDP for Non-OECD Countries

ICP estimates do not yet provide PPP converters for all our 34 non-OECD countries. ICP3 covered 13 of them, ICP4 20, ICP5 16, and ICP6 covered only the East European and African countries (the latter are not yet published). Altogether ICP estimates are available for 27 of our 34 countries for at least one year.

I used ICP converters for 17 of the non-OECD countries (ICP6 for 1990 for 6 East European countries, an update of ICP4 for 6 Latin American countries, and 4 Asian countries, and an update of ICP3 for Mexico).

For Bangladesh and Pakistan I used a 1950 benchmark estimate of their relative GDP levels which I linked to that of India. This was necessary for the purposes of historical consistency, and in any case the 1985 ICP estimates of Bangladeshi and Pakistani GDP seemed to me to be too high relative to the Indian level.

For the 15 other countries in my non-OECD sample (Bulgaria, Burma, China, Taiwan, Thailand and the ten African countries) I used the Summers and Heston (1993) 1990 estimates.

Table C-9 shows the full set of real per capita GDP levels which can be derived by applying ICP PPP converters in conjunction with the most recent estimates of nominal GDP and population. It also shows the variant I chose and the Summers and Heston (1993) estimates. The subsequent tables in this section show in detail how the updated estimates were established.

It should be noted that the alternative estimates from different ICP rounds for non-OECD countries show a greater variance than is the case for OECD countries (see Table C-10). This suggests that the OECD estimates are more firmly based than those for non-OECD countries. The biggest variance has been in Eastern Europe and in India where the earliest estimates generally gave higher estimates of GDP than the later results. For the OECD countries there has been a much narrower range of variance except for Italy and the UK.

Table C-11 shows the variation between the different possible PPP converters and the exchange rates for 1980, in relation to the Geary Khamis PPP which I used. This can be compared with Table C-7 for non-OECD countries. The range between the different converters is generally larger in the non-OECD countries because their price structures are more different from the USA (the numeraire country) than those in the higher income OECD countries.

Table C-9
Alternative Estimates of the Level of Real GDP per Capita in 1990 using Geary Khamis PPP Converters from Successive ICP Rounds and from Summers and Heston (1993)
(USA = 100.00)

	ICP3	ICP4	ICP5	ICP6	Summers and Heston (1993)	Maddison
Bulgaria	n.a.	n.a.	n.a.	n.a.	26.36	26.36
Czechoslovakia	n.a.	n.a.	n.a.	38.71	33.55	38.71
Hungary	42.86	36.11	29.92	29.03	29.08	29.03
Poland	31.41	27.81	19.89	23.38	20.71	23.38
Romania	22.62	n.a.	n.a.	15.82	18.41	15.82
USSR	n.a.	n.a.	n.a.	31.42	28.02	31.42
Yugoslavia	29.75	27.87	23.81	24.96	24.65	24.96
Argentina	n.a.	30.10	n.a.	n.a.	18.73	30.10
Brazil	22.88	22.01	n.a.	n.a.	14.36	22.01
Chile	n.a.	29.18	n.a.	n.a.	21.86	29.18
Colombia	21.99	22.49	n.a.	n.a.	17.09	22.49
Mexico	22.85	n.a.	n.a.	n.a.	28.90	22.85
Peru	n.a.	13.72	n.a.	n.a.	11.02	13.72
Venezuela	n.a.	37.22	n.a.	n.a.	29.79	37.22
Bangladesh	n.a.	n.a.	4.19	n.a.	6.39	3.19
Burma	n.a.	n.a.	n.a.	n.a.	3.14	3.14
China	n.a.	n.a.	n.a.	n.a.	12.35	12.35
India	7.70	6.02	4.98	n.a.	5.73	6.02
Indonesia	n.a.	11.55	n.a.	n.a.	10.22	11.55
Pakistan	8.30	8.93	8.19	n.a.	7.31	7.20
Philippines	10.09	10.52	10.10	n.a.	9.51	10.52
South Korea	44.83	41.05	36.77	n.a.	37.55	41.05
Taiwan	n.a.	n.a.	n.a.	n.a.	47.21	47.21
Thailand	22.64	n.a.	19.93	n.a.	19.08	19.08

Table C-9 contd.

	ICP3	ICP4	ICP5	ICP6	Summers and Heston (1993)	Maddison
Cote d'Ivoire	n.a.	6.16	7.12	n.a.	5.60	5.60
Egypt	n.a.	n.a.	14.75	n.a.	9.28	9.28
Ethiopia	n.a.	1.50	1.66	n.a.	1.60	1.60
Ghana	n.a.	n.a.	n.a.	n.a.	4.42	4.42
Kenya	5.65	4.98	6.19	n.a.	4.93	4.93
Morocco	n.a.	10.83	15.26	n.a.	10.97	10.97
Nigeria	n.a.	8.47	7.01	n.a.	5.11	5.11
South Africa	n.a.	n.a.	n.a.	n.a.	17.01	17.01
Tanzania	n.a.	2.65	2.66	n.a.	2.74	2.74
Zaire	n.a.	n.a.	n.a.	n.a.	2.09	2.09

Source: ICP3 (1975) PPPs derived from I.B. Kravis, A. Heston and R. Summers, *World Product and Income*, Baltimore 1982; ICP4 (1980) from U.N., *World Comparisons of Purchasing Power and Real Product for 1980*, New York, 1986; ICP5 for 1985 from UN, *World Comparisons of Real Gross Domestic Product and Purchasing Power 1985*, New York, 1994. These PPPs were applied to the latest estimates of nominal GDP in World Bank, *World Tables*, to derive real output. Per capita levels were established by using the population figures in Appendix A. Updating procedures are shown in the following tables. Preliminary ICP6 estimates of East European GDP levels relative to Austria were kindly supplied by Gyorgy Szilagyi, and I applied the coefficients to the Geary Khamis estimate of Austrian GDP. Summers and Heston (1993) estimates of GDP were updated to 1990 in some cases, and for countries where I adopted their figures, I used my Appendix A population figures to establish the per capita estimates.

Table C-10
Range of Variation (highest/lowest) Between per Capita GDP Levels Shown by Different ICP Rounds

	Non-OECD Countries All		OECD Countries All	OECD Countries Rounds 3 and 6 only
Hungary	1.48	(4)	Australia	1.07 (2)	n.a.
Poland	1.68	(4)	Austria	1.15 (4)	1.08 (2)
Romania	1.43	(2)	Belgium	1.19 (4)	1.00 (2)
Yugoslavia	1.25	(4)	Canada	1.12 (3)	n.a.
			Denmark	1.18 (4)	1.02 (2)
East European Average	1.46		Finland	1.08 (3)	n.a.
			France	1.15 (4)	1.01 (2)
			Germany	1.18 (4)	1.04 (2)
Brazil	1.04	(2)	Italy	1.20 (4)	1.16 (2)
Colombia	1.02	(2)	Japan	1.07 (4)	1.02 (2)
			Netherlands	1.10 (4)	1.05 (2)
Latin American Average	1.03		New Zealand	1.14 (2)	n.a.
			Norway	1.26 (3)	n.a.
			Sweden	1.14 (2)	n.a.
India	1.57	(3)	UK	1.17 (4)	1.16 (2)
Pakistan	1.09	(3)			
Philippines	1.04	(3)	Advanced Capitalist Average	1.15	1.06
South Korea	1.22	(3)			
Thailand	1.14	(2)			
			Greece	1.11 (3)	n.a.
Asian Average	1.21		Ireland	1.18 (4)	1.02 (2)
			Portugal	1.17 (3)	n.a.
Cote d'Ivoire	1.16	(2)	Spain	1.13 (4)	1.04 (2)
Ethiopia	1.11	(2)	Turkey	1.19 (2)	n.a.
Kenya	1.24	(3)			
Morocco	1.41	(2)	Southern Europe Average	1.16	1.03
Nigeria	1.21	(2)			
Tanzania	1.00	(2)			
			20 OECD	1.15	
African Average	1.19				
			11 OECD		1.05
17 Non-OECD	1.24				

NB: Figures in brackets in first and second columns show the number of available published ICP rounds since ICP3. I have added the third column showing the variance between ICP3 and ICP6 for OECD countries. The Geary Khamis PPPs in these two rounds had a greater methodological similarity than those from ICP4 and 5 for OECD countries and the variance in results was smaller than in col. 2 (see source note to Table C-8).

Table C-11
Ratio of Paasche, Laspeyres, and Fisher PPPs and Exchange Rate to Geary Khamis PPP, Round IV of ICP for 1980 for Non-OECD Countries

	Geary Khamis	Paasche	Laspeyres	Fisher	Exchange Rate
Hungary	1.00	.98	.94	.96	2.42
Poland	1.00	1.02	1.03	1.03	1.92
Yugoslavia	1.00	.95	.90	.92	1.28
East European Average	1.00	.98	.96	.97	1.87
Argentina	1.00	.80	1.60	1.26	0.71
Brazil	1.00	.82	1.54	1.12	1.62
Chile	1.00	.88	1.67	1.21	1.46
Colombia	1.00	.89	1.44	1.13	2.15
Peru	1.00	.87	1.74	1.23	2.23
Venezuela	1.00	1.10	1.48	1.28	1.37
Latin American Average	1.00	.89	1.58	1.21	1.59
India	1.00	.71	1.68	1.09	2.33
Indonesia	1.00	.83	1.79	1.22	2.24
Pakistan	1.00	.91	1.70	1.24	3.16
Philippines	1.00	.87	1.55	1.16	2.36
South Korea	1.00	.88	1.68	1.22	1.58
Asian Average	1.00	.84	1.68	1.19	2.33
Cote d'Ivoire	1.00	1.00	1.86	1.36	1.07
Ethiopia	1.00	.54	2.15	1.08	2.07
Kenya	1.00	.73	1.60	1.08	1.51
Morocco	1.00	.89	1.91	1.30	1.37
Nigeria	1.00	.92	2.33	1.46	0.90
Tanzania	1.00	.90	1.51	1.17	1.42
African Average	1.00	.83	1.89	1.24	1.39

Source: Unpublished Paasche, Laspeyres and Fisher variants kindly supplied by Alan Heston.

However, the table also demonstrates very clearly how misleading exchange rate conversions can be. A high ratio in the last column indicates that the exchange rate understates a country's purchasing power, whereas a figure below 1 indicates that the exchange rate overvalues the purchasing power of the currency. It can be seen in Table C-6 that the advanced capitalist countries of OECD had exchange rates that led to substantial overvaluation of their currencies' purchasing power in 1990, whereas the opposite was true of most of the non-OECD countries in 1980. It can also be seen that the relationship between PPP and exchange rates was quite erratic between countries.

The following notes by region and country give more detail of the procedures I used and some of the problems in such comparisons.

Eastern Europe

Some of the East European countries have been included in all of the ICP rounds, but ICP6 was the most comprehensive in coverage and involved six of our seven sample countries. The 1990 comparisons were carried out by the United Nations Economic Commission for Europe in cooperation with the national statistical office and were compared on a binary basis with Austria. I multiplied the binary real GDP ratios by the Austrian GDP in 1990 Geary Khamis dollars, using a provisional version of ECE, *International Comparison of Gross Domestic Product in Europe*, Geneva, 1994. For Bulgaria, I used Summers and Heston (1993), as Bulgaria did not participate in the ECE study. The details for earlier years are shown in Tables C-12a, C-12b, and C-12c.

Table C-12a
East European ICP3 (1975) Results Updated to 1990

	1975 GDP in million national currency units	1975 ICP PPP units of national currency per dollar	1975 GDP in million 1975 Geary Khamis $	1990 GDP in million 1975 Geary Khamis $	1990 GDP in million 1990 Geary Khamis $
Hungary	482,700	12.3	39,244	43,003	98,906
Poland	1,752,268	14.3	122,536	121,065	278,449
Romania	437,000	8.8	49,659	49,887	114,739
Yugoslavia	581,937	11.2	51,959	67,341	154,884

Source: Col. 1 from World Bank, *World Tables*; col. 2 from ICP3; col. 3 is col. 1 ÷ col. 2; col. 4 is col. 3 adjusted for change in GDP volume 1975-90 (from Table 2c); col. 5 is col. 4 adjusted by change in US GDP deflator 1975-90.

Table C-12b
East European ICP4 (1980) Results Updated to 1990

	1980 GDP in million national currency units	1980 ICP PPP units of national currency per dollar	1980 GDP in million 1980 Geary Khamis $	1990 GDP in million 1980 Geary Khamis $	1990 GDP in million 1990 Geary Khamis $
Hungary	721,000	13.55	53,210	52,770	83,312
Poland	2,482,452	16.14	153,807	146,808	231,780
Yugoslavia	1,800,000	19.42	92,688	91,907	145,102

Source: Method as in Table C-12a with adjustment from 1980 to 1990.

Table C-12c
East European ICP5 (1985) Results Updated to 1990

	1985 GDP in million national currency units	1985 ICP PPP units of national currency per dollar	1985 GDP in million 1985 Geary Khamis $	1990 GDP in million 1985 Geary Khamis $	1990 GDP in million 1990 Geary Khamis $
Hungary	1,033,700	17.27	59,855	57,430	68,901
Poland	10,400,000	69.62	149,382	138,186	165,787
Yugoslavia	12,722,797	114.4	111,213	103,317	123,953

Source: Method as in Table C-12a with adjustment from 1985 to 1990.

Estimates of 1990 GDP Level in Latin America

The ICP covered only three of our Latin American countries (Brazil, Colombia and Mexico) in 1975 and six (Argentina, Chile, Colombia, Peru and Venezuela) in 1980. They were not included in ICP5 for 1985. I therefore used the 1980 Geary Khamis PPPs as a benchmark for these six countries, and the 1975 Geary Khamis PPP for Mexico. I updated these figures to 1990 using the volume movement in GDP from the benchmark year to 1990, and then adjusting the result in line with the movement in the US GDP deflator from the benchmark year to 1990.

A major problem with the national accounts of Latin American economies is the assessment of activity in the informal sector. Recent official revisions for Argentina have been very substantial. Instead of a GDP totalling 2,830 million australes in 1980, it is now estimated to have been 3,840 million (nearly 36 per cent higher). Maddison and Van Ark (1989) pointed out that the Mexican national accounts carry a very large imputation for informal activity, whereas in Brazil, the official imputation for such activity is relatively modest. Because of this, I have adjusted the official estimate of the GDP levels in national currency in conjunction with the ICP PPPs for Brazil and Mexico. For Brazil I made an upward adjustment of GDP by 3.27 per cent to allow for underestimation of GDP in agriculture and manufacturing (see Maddison and

Van Ark, "International Comparison of Purchasing Power, Real Output and Labour Productivity: A Case Study of Brazilian, Mexican and US Manufacturing in 1975", *Review of Income and Wealth*, 1989 and Maddison and H. van Ooststroom, "The International Comparison of Value Added, Productivity and Purchasing Power Parities in Agriculture", *Research Memo GD-1*, Groningen, 1993). For Mexico I made a downward adjustment of GDP by 17.96 per cent for apparent exaggeration of output levels in agriculture and manufacturing.

H. de Soto, *El Otro Sendero*, Instituto Libertad y Democracia, Lima, 1987, p. 13 suggested that the official Peruvian national accounts missed a good deal of informal activity. It seems likely that the Colombian national accounts may also understate informal activity. However I did not have an adequate basis for making adjustments to the estimates for Peru and Colombia.

Table C-13
Latin American Results of ICP 4 for 1980 for 6 Countries, and ICP 3 for 1975 for Mexico, updated to 1990

	GDP in million national currency units	ICP PPP units of national currency per dollar	Benchmark GDP in million benchmark Geary Khamis $	1990 GDP in million benchmark Geary Khamis $	1990 GDP in million 1990 Geary Khamis $
Argentina	3,840	.02604	147,465	134,607	212,518
Brazil	12,805	.03252	393,773	458,266	723,510
Chile	1,075,269	26.67	40,318	53,229	84,038
Colombia	1,579,130	21.99	71,811	100,736	159,042
Mexico	967,252[a]	7.4[a]	130,709[a]	187,208[b]	430,578
Peru	5,970,000	129.6	46,065	41,157	64,979
Venezuela	297,800	3.14	94,841	101,753	160,648

a) 1975 (other countries' figures are for 1980); b) at 1975 prices (other countries are in 1980 prices).

Source: col. 1 from World Bank, *World Tables*, with adjustments indicated above for Brazil and Mexico. Otherwise as described in text.

Estimates of 1990 GDP Level in Asia

The 1970 ICP exercise covered three of our Asian countries (India, Korea and the Philippines), five for 1975 (India, Korea, Pakistan, Philippines and Thailand), five for 1980 (India, Indonesia, Korea, Pakistan and Philippines) and six for 1985 (Bangladesh, India, Korea, Pakistan, Philippines and Thailand). The 1985 figures have not yet been officially released. China and Taiwan do not figure in any of the ICP comparisons. The results of the different rounds are somewhat erratic, and we must necessarily use a mixture of sources. The first table below takes the results of ICP 3 for 1975 and updates them to 1990 using the volume indices in our table, and the US GDP deflator for 1975-90. The second and third tables do the same for the 1980 (ICP 4) and 1985 results (ICP 5).

Table C-14a
Asian Results of ICP 3 for 1975 updated to 1990

	1975 GDP in million national currency units[a]	ICP PPP[b] units of national currency per dollar	1975 GDP in 1975 Geary-Khamis $ (million)	1990 GDP[c] in 1975 Geary-Khamis $ (million)	1990 GDP[d] in 1990 Geary-Khamis $ (million)
India	787,600	2.59	304,093	620,907	1,428,085
Korea	10,224,000	190.0	53,811	182,388	419,492
Pakistan	112,270	3.18	35,305	88,657	203,911
Philippines	107,950	2.89	37,353	58,997	135,693
Thailand	303,300	7.6	39,908	120,107	276,246

Table C-14b
Asian Results of ICP 4 for 1980 updated to 1990

	1980 GDP in million national currency units[a]	ICP PPP[b] units of national currency per dollar	1980 GDP in 1980 Geary-Khamis $ (million)	1990 GDP[c] in 1980 Geary-Khamis $ (million)	1990 GDP[d] in 1990 Geary-Khamis $ (million)
India	1,360,100	3.37	403,591	706,866	1,115,999
Indonesia	48,914,000	280.0	174,693	286,805	452,807
Korea	380,410,000	384.0	99,065	243,333	384,174
Pakistan	234,530	3.13	74,930	138,957	219,385
Philippines	243,750	3.18	76,651	89,551	141,383

a) Estimates from World Bank, *World Tables 1993*, which involve revisions from the original figures used by ICP.
b) Geary-Khamis converter.
c) Col. 3 adjusted for volume increase shown in our Table 2.
d) Col. 4 multiplied by US GDP deflator 1980-90.

I have not used the 1985 ICP results because they were not available until the present study was in its final stages, and involved some methodological differences from earlier studies. For Asia ICP contained an implausibly low figure for India relative to Bangladesh and Pakistan, so I preferred to use the 1980 ICP 4 figures. For India, Bangladesh and Pakistan I needed to have benchmarks which are compatible with the fact that the three countries were united until 1947. I assumed that Pakistan and Bangladesh combined had the same average per capita income as India in 1950, and used the careful official estimates of relative income levels in Pakistan and Bangladesh when they were two "wings" of the former Pakistan (see A. Maddison, *Class Structure and Economic Growth: India and Pakistan since the Moghuls*, Allen and Unwin, London, 1971, p. 171).

Table C-14c
Asian Results of ICP 5 for 1985 updated to 1990

	1985 GDP in million national currency units	ICP PPP units of national currency per dollar	1985 GDP in 1985 Geary-Khamis $ (million)	1990 GDP in 1985 Geary-Khamis $ (million)	1990 GDP in 1990 Geary-Khamis $ (million)
Bangladesh	406,930	6.075	66,884	81,455	97,724
India	2,662,500	4.667	570,495	769,290	922,944
Korea	80,847,000	459.5	175,946	286,760	344,036
Pakistan	472,160	3.761	125,541	167,766	201,275
Philippines	571,880	6.297	90,818	113,221	135,836
Thailand	1,014,400	8.094	125,327	202,652	243,128

Source: Col. 1 from World Bank, *World Tables 1994*, Washington DC, 1993; col. 2 PPPs from UN, *World Comparisons of Real Gross Domestic Product and Purchasing Power 1985*, New York, 1994.

For Taiwan and Thailand I took the 1990 GDP estimate given in the June 1993 Supplement (PWT 5.5) to R. Summers and H. Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988", *Quarterly Journal of Economics*, May 1991.

The Merits of Four Alternative Measures of the Chinese GDP Level

For China there are four significant benchmarks to choose from. The first three are binary comparisons from the expenditure side between China and the USA.

The first of these is that of Irving Kravis, "An Approximation of the Relative Real Per Capita GDP of the People's Republic of China", *Journal of Comparative Economics*, 5, 1981, pp. 60-78. This comparison relates to 1975, and was based on price and expenditure information supplied by official sources in both countries according to the standard specifications of the UN ICP. It was a "reduced information" exercise as the amount of detail on prices and expenditure in China was significantly less than normal by ICP standards. It involved the highest levels of expertise available in this field, but the publication included no detailed information by category of expenditure.

Kravis did the comparison of real GDP per capita in Chinese and US prices, and the geometric mean of the two estimates showed Chinese per capita GDP to be 10.4 per cent of that in the USA in 1975. The fourfold spread between the two basic estimates was unusually large, with per capita GDP (Chinese weights) 5 per cent of the USA, and 21 per cent with Chinese weights. This was due to the nature of the Chinese price system where important basic commodities were supplied very much below cost and some consumer durables had very heavy implicit taxes.

ICP comparisons are normally carried out at multilateral (Geary Khamis) prices rather than the Fisher binary which Kravis estimated. Geary Khamis comparisons yield consistently higher estimates of real GDP in poor countries than Fisher comparisons because the weight of the country's own price structure is much bigger in the latter. Kravis therefore made a rough estimate of what China's per capita product might have been on a Geary Khamis basis. This involved raising his Fisher estimate by 18.7 per cent (which was the average ratio of the Geary Khamis to Fisher measures for the four lowest-income countries in the ICP2 comparisons). The end result was a Kravis estimate of Chinese per capita GDP 12.3 per cent of that in the USA in 1975. One can see from our Table 4 that US per capita GDP was $16,905 in 1975 in 1990 prices. 12.3 per cent of this yields an estimate of 2079 for China. I estimate Chinese per capita GDP in 1990 to have been 215.9 per cent of 1975, yielding a 1990 per capita product of $4,490, and a total 1990 Chinese GDP of $5,089 million.

A significantly modified version of the Kravis estimates was used in the Penn World Tables (5.5) of Summers and Heston (1993). They estimate Chinese GDP in 1990 at 1990 prices to have been $3,061 million. Instead of updating the Kravis benchmark with the subsequent growth recorded for China and the USA, as we have done above, they extrapolated price changes in China and the USA. For China they used the official consumption deflators, together with a geometric average of PPPs they derived from Ren and Chen (1993). These they combined in a geometric average. The Summers and Heston estimate is therefore a hybrid, and is not significantly different from what one would obtain by taking a simple geometric average of the Kravis and Ren-Chen estimates shown on the next page. See Appendix A to A. Heston,

D. Nuxoll, and R. Summers, "Issues in Comparing Relative Prices, Quantities and Real Output Among Countries", processed, World Bank, 1994.

The third estimate is that of Ren Ruoen and Chen Kai, "An Expenditure-Based Bilateral Comparison of Gross Domestic Product between China and the United States", May 1993 (processed). This estimate was made by a group of researchers in Beijing supplemented by a further two years of research by Ren Ruoen in MIT, the University of Maryland and the World Bank during 1991-3.

The basic procedure of this study is binary and similar to that of Kravis, except that it is for 1986, and the research team had better access to Chinese price and expenditure detail than Kravis had. They also had prices for over 200 items compared with the 93 which Kravis had. The threefold spread between the results at US weights ($1818) and Chinese weights ($571) was large, but not as wide as Kravis found for 1975. The results are stated in terms of the Fisher geometric average and show Chinese GDP per capita to have been $1,044 in 1986, implying $1,114 billion for GDP. If this is adjusted for the rise in the volume of GDP (30.42 per cent) and in the US GDP deflator (15 per cent) from 1986 to 1990 this yields an estimate of GDP in 1990 at 1990 US prices of $1,670.7 billion. Ren Ruoen and Chen Kai do not make the adjustment from a Fisher to a Geary Khamis basis, but if one applies the same (1.187) ratio as Kravis did, the end result is a Chinese GDP of $1,983 billion in 1990, or $1,749 per capita. This comparison may understate Chinese real product to some extent because it uses a shadow price for Chinese house rents (based on cost) rather than the very low rents actually charged in China. In this respect the procedure has some resemblance to the adjusted factor cost method developed by Abram Bergson in his work on USSR/USA comparisons, but it is not a normal procedure in ICP comparisons. Furthermore, the use of these shadow prices for housing should have been matched by an increase in the estimate of Chinese housing expenditure, and it is not clear that this was done. To this extent Ren and Chen understate Chinese per capita product. However, if the 1986 Ren-Chen PPP for GDP is applied to the World Bank, *World Tables 1994*, estimate of Chinese GDP in 1986, one arrives at a figure of $ 1,494 billion for GDP (1,301.5 billlion Yuan divided by .8709). This is more than 34 per cent higher than the estimate Ren-Chen derived by adding their more detailed expenditure categories. If this were adjusted to produce an equivalent Geary-Khamis estimate for 1990, it would raise the Ren-Chen estimate from $ 1,983 billion to $ 2,661 billion ($ 2,347 per capita).

The fourth significant comparison of China/USA is that of J.R. Taylor, "Dollar GNP Estimates for China," Centre for International Research, US Bureau of the Census, CIR Staff Paper, March 1991. Taylor's PPP is estimated only on a Paasche basis, at US prices. This is a comparison by industry of origin for 1981, using a double deflation approach and deriving producer price information from a variety of sources. The service sector prices are inferred by use of input-output tables. He shows 1981 GDP in 1981 prices to be $417.81 billion. If we update this to 1990 allowing for the rise in Chinese GDP (206.16 per cent of 1981) and the rise in the US GDP deflator (1.49338), we arrive at a 1990 GDP in 1990 prices of $1,286.3 billion or $1135 on a per capita basis.

Thus we have four estimates for China which, when updated, yield the following results for 1990 in terms of 1990 prices:

	GDP billion $	GDP per capita

Kravis (1981)	5,089	4490
Summers and Heston (1993)	3,061	2700
Ren Ruoen and Chen Kai (1993)	1,983	1749
Taylor (1991)	1,286	1135

Recently, the World Bank has been moving away from its previous preference for adjusted exchange rate converters towards use of ICP type estimates and in its *World Development Report 1993* adopted the estimate of Ren Ruoen and Chen Kai, which showed a Chinese per capita GDP of $1680 for 1991. This differs from my update for two reasons: (a) it is updated from the 1986 benchmark by using the official Chinese estimate of GDP growth, which is faster than that which I use; (b) it does not adjust the Ren-Chen estimate from a Fisher to a Geary-Khamis basis.

The IMF has now adopted ICP type estimates for measuring world output. For China it used Taylor's estimate, without explaining why it made this choice, see IMF, *World Economic Outlook*, May 1993, pp. 116-9. The IMF do not show the actual figure they used. However, *Time* magazine (May 31, 1993) reported the IMF figure for China's GDP in 1991 as being $1,660 billion, which is a good deal higher than my updated version of Taylor. If *Time* magazine is correct, the IMF obviously updated Taylor's benchmark in a different way than I did.

In deciding which of these estimates to use as a benchmark, I had two main criteria in mind. One of these was the scientific quality of the basic estimates. On these grounds one must give preference to the estimates of Kravis, and Ren-Chen which are the most transparent and conform, more or less, to traditional ICP methodology. I would rate the Taylor estimates lowest of the four on these grounds as it is not very clear how they were made. The Summers and Heston estimates obviously deserve respect because they are the guardians of ICP methodology and are more concerned than the other researchers to choose measures of level which are compatible with growth indicators. Nevertheless, in this instance, their procedures are not crystal clear.

My second criterion is indeed the compatibility of the benchmark level with the time series estimates of growth. If one used the Kravis benchmark with my time series, then one would have a Chinese per capita GDP 3.4 times as high as in India in 1990 and 1.7 times the Indian level in 1950 which seems unreasonably high. With the Ren-Chen estimate we have a GDP per capita about a third higher than in India in 1990 and only two thirds of that in India in 1950, which seems too low. Taylor's estimate is below that of India for 1990, and would produce an estimate for 1950 only 40 per cent of that in India, which seems unacceptable. I have therefore used the Summers and Heston version which seems the most plausible.

China's economy has in recent years moved towards a market system and has a substantial private sector, but it still has important features of a planned economy and administered prices. Hence there is a mix of price systems which makes international comparisons of growth and level very difficult. There is a strong case for augmenting the ICP type comparisons by the industry of origin approach which Ren Ruoen has now undertaken in cooperation with A. Szirmai of Groningen University. So far this research is in a preliminary stage, but it should strengthen the basis for future assessments considerably.

It should be stressed that all the growth estimates for China are relatively weak. The World Bank, *China: Statistical System in Transition*, September 1992, gives a good idea of the problems of measuring both growth and levels. It makes clear that the old official MPS

estimates tended to understate the level of output and exaggerate growth, and it is also clear that in moving towards the SNA concept of national accounts some of these problems are still significant. They are described in more detail in A. Keidel, "How Badly Do China's National Accounts Underestimate China's GNP?", Rock Creek Research Inc., December 1992. In the old MPS accounting system, the service sector was considered unproductive and not included; township and village industry was also neglected. Agricultural output was understated because of the exclusion of grains and vegetables directly consumed by producers. The weight of manufacturing (the most rapidly growing sector) was overstated because of the incidence of taxes and the inclusion in the weights of the value of miscellaneous in-kind allocations to those employed in this sector. The rate of growth of manufacturing was overstated by the reporting firms, and by the treatment of new products which are usually marked up excessively when they are first introduced.

Estimates of GDP Level in Africa

ICP estimates are available for 6 of our African countries (Cote d'Ivoire, Ethiopia, Kenya, Morocco, Nigeria and Tanzania) for the ICP 4 exercise. 7 Countries (including Egypt as well) were included in ICP5. However, I used R. Summers and A. Heston, Penn World Table 5.5 of June 1993, for all the African countries, as I presumed they had access to the 1990 results of the survey carried out by EUROSTAT.

Table C-15a
African Results of ICP4 for 1980 updated to 1990

GDP in 1980	GDP 1980 in million national currency units	1980 ICP4 Geary-Khamis PPP: units of national currency per dollar	1980 GDP in 1980 Geary-Khamis $ (million)	1990 GDP in 1980 Geary Khamis $ (million)	1990 GDP in 1990 Geary Khamis $ (million)
Cote d'Ivoire	2,149,900	197.2	10,902	10,151	16,027
Ethiopia	8,505.0	1.002	8,488	10,590	16,721
Kenya	53.910	4.918	10,962	16,668	26,316
Morocco	74,090	2.866	25,851	37,631	59,444
Nigeria	50,900	.605	84,132	101,249	159,853
Tanzania	42,120	5.778	7,290	4,003	14,214

Table C-15b
African Results of ICP5 for 1985 updated to 1990

	GDP in 1985 in million national currency units	1985 ICP Geary-Khamis PPP: units of national currency per dollar	1985 GDP in 1985 Geary-Khamis $ (million)	1990 GDP in 1985 Geary-Khamis $ (million)	1990 GDP in 1990 Geary-Khamis $ (million)
Cote d'Ivoire	3,136,800	187.1	16,765	15,439	18,523

Egypt	33,130	0.2828	117,150	139,995	167,956
Ethiopia	9,890	0.7562	13,079	15,536	18,639
Kenya	100,750	4.859	20,735	27,220	32,657
Morocco	129,510	2.300	56,309	69,762	83,696
Nigeria	72,360	0.8603	84,110	110,266	132,290
Tanzania	120,600	12.31	9,797	11,865	14,234

Appendix D

LEVELS OF GDP PER CAPITA

The tables in this appendix were derived by dividing tables 3 in Appendix B on GDP level by tables 1 in Appendix A on Population.

Appendix E

GDP, POPULATION AND PER CAPITA GDP IN 143 NON-SAMPLE COUNTRIES IN 1950 AND 1990

In order to get a picture for the world as a whole, I supplemented the estimates for my 56 country sample, with cruder estimates for the 1950-90 period for 143 non-sample countries, using information in the OECD Development Centre's data files. Then I backcast the non-sample regions to 1820 as explained in the notes to Table 2-1a. The proportionate importance of the non-sample regions is shown in Table E-1. The detailed country information for 1950 and 1990 is shown in Table E-2, and the annual country information for 173 countries is shown in the annex.

Table E-1
Percentage Share of the Non-Sample Countries in the Regional and World Totals

	1820	1900	1950	1973	1990
	Gross Domestic Product				
Western Europe (11 countries)	0.3	0.3	0.4	0.3	0.4
Western Offshoots (0 countries)	0.0	0.0	0.0	0.0	0.0
Southern Europe (2 countries)	0.9	0.9	0.9	0.7	1.0
Eastern Europe (2 countries)	10.1	14.0	7.8	5.2	3.6
Latin America (37 countries)	18.3	18.3	17.7	13.7	12.8
Asia (45 countries)	9.0	9.0	13.4	15.6	11.6
Africa (46 countries)	41.6	41.6	44.3	42.4	39.5
Total (143 countries)	8.8	6.5	6.6	7.1	6.6
	Population				
Western Europe (11 countries)	0.3	0.3	0.3	0.3	0.4
Western Offshoots (0 countries)	0.0	0.0	0.0	0.0	0.0
Southern Europe (2 countries)	1.1	1.1	1.1	0.9	0.9
Eastern Europe (2 countries)	6.7	6.2	6.9	5.1	4.5
Latin America (37 countries)	22.4	22.4	21.7	20.3	20.0
Asia (45 countries)	9.0	9.0	9.0	9.6	10.6
Africa (46 countries)	41.6	41.6	41.6	40.7	41.6
Total (143 countries)	10.3	9.5	10.8	11.5	13.2

Derived from Tables 2-1a and 2.2.

My 56 country sample covered 93.4 per cent of world GDP in 1990 and 86.8 per cent of world population. The sample leans heavily towards big countries and except for Africa, is confined to countries for which long term series are available for GDP. The sample is biased towards richer countries. Average GDP per head in the 56 country sample (i.e. total GDP divided by total population) was $ 5,598 in 1990, i.e. 7.6 per cent higher than the world average of $ 5,204. The difference between GDP per head in my sample and in non-sample countries was much wider. In the 143 non-sample countries, average GDP per head was $ 2,607 in 1990, i.e. 46.6 per cent of that in the 56 sample countries (see Tables 2-1, 2-1a and 2-2).

In 1950 my 56 country sample included 93.4 per cent of world GDP and 89.2 per cent of world population. The average GDP per capita for the sample was 4.6 per cent higher than the world average. The growth of GDP and GDP per capita was somewhat faster in my 56 country sample than in the rest of the world, and population growth was slower. In 1973 my sample covered 92.9 per cent of world GDP and 88.5 per cent of world population. Average per capita GDP in the sample was 5 per cent above the world average.

Appendices A, B, C and D describe in detail how the estimates for the 56 country sample were derived. These involved detailed scrutiny of the source material and were carried back to 1820 so far as possible. For the other 143 countries shown in Table E-2 I relied mainly on the OECD Development Centre's time series (for 117 of these countries).

The Development Centre data bank was started in 1964 and is based on questionnaires sent annually since then to the countries on which it reports. It has been established longer than the data set collected by the World Bank for its publication *World Tables* (which goes back to 1960 at best). The United Nations Statistical Office also has such a data bank, with data from 1960 onwards. There are discrepancies between the three data banks, but as the Development Centre bank has better coverage, is better documented, has had continuity of management and was more accessible, there were considerable advantages in using it. For 26 other non sample countries estimates of population were available but not their GDP movement. For these countries I assumed that GDP per capita movements were parallel to the average movement for the sample countries in the same region.

In Table E-2, Group 2 countries are those for which I had indicators for population, GDP growth, and 1990 per capita GDP in 1990 Geary Khamis dollars. Group 3 countries are those where I had population and and GDP indicators and had to use proxy measures for levels of GDP in 1990 Geary Khamis dollars. Group 4 countries are those for which I only had population estimates and otherwise had to use proxies.

For 94 of the non-sample countries, benchmark estimates of GDP in 1990 Geary Khamis dollars were available (mostly from Summers and Heston, 1993). For 49 other countries (which together accounted for about 1 per cent of world GDP) I generally assumed that per capita real GDP levels were the same as the average for the sample countries in the same region in the benchmark year 1990. For 8 countries (Afghanistan, Cuba, Gaza, Kampuchea, Libya, Macao, Vietnam and West Bank) I made an *ad hoc* assumption about the 1990 benchmark level, because it seemed probable that they deviated from the regional averages, e.g. for Macao I assumed the 1990 benchmark per capita GDP to be half of Hong Kong's, for Libya I assumed it to be the same as in Algeria, Cuba the same as Peru, etc.

Appendix F

REGIONAL AND WORLD TOTALS

The tables in this appendix provide estimates for 7 major world regions and the corresponding world aggregates.

Tables F-1a, F-1b, and F-1c refer to the totals (population, GDP level and per capita GDP level) for Group 1, i.e. my 56 sample countries, for 1820-1993. This table required some interpolation, as indicated in the notes to Table 2-1.

Tables F-2a, F-2b and F-2c refer to the totals for 1950-90 for the 143 non-sample countries. Details for these can be found in the notes to Table 2-1a.

Tables F-3a, F-3b and F-3c refer to the totals for 199 countries for 1950-90.