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INCOME AND DIETARY CHANGE: INTERNATIONAL COMPARISONS USING PURCHASING-POWER-PARITY CONVERSIONS

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The effect of income growth on dietary composition is well recognized. Among the poorest people, be they individuals or nations, diets tend to be composed principally of starch: wheat, rice, potatoes, cassava, and the like. This is so because of the cheapness of these starchy staples, whether expressed as market price or production cost. Far less land and far less labor are needed to produce a thousand calories of energy value in the form of the starchy staples than in the form of any other foodstuff. As wealth increases the contribution of these starchy foods falls and a still largely vegetarian diet becomes more diversified. Then products of animal origin--meat, eggs, and dairy products--loom larger in the diet until, as in the wealthy countries of the industrialized West, they supply between 33 and 40 percent of total caloric availabilities. This dietary evolution seems to be universal, although the exact modifications which take place will vary in accordance with local circumstances such as market availability and price and cultural considerations such as religious taboos. But if income can be expressed in reasonably comparable terms, the experience of wealthier countries can provide a fair indication of what their poorer neighbors can expect to undergo as they develop.

This paper illustrates the course of diet change in countries representing the bulk of mankind. Plotted are changes in the percentage of calories contributed by the starchy staple foods (the starchy staple ratio), by products of animal origin, and total per capita energy availabilities per day. The latter figure is frequently termed "consumption," but is not. It represents the supply of energy available for human consumption, and appreciable losses occur between it and what is actually eaten. "Availabilities," "disappearance," or "apparent consumption" are more accurate descriptions.

The figures are averages for the years 1984-86 and earlier and are taken from the latest compilation of food balance sheets published by the Food and Agriculture Organization (FAO) of the United Nations (1991) and are in no sense new. What are new here are the income figures used. So that some comparability may be achieved between nations, it is necessary to convert incomes to a standard currency, in this case 1985 US dollars. The conventional practice is to convert other currencies into dollars using the prevailing exchange rates. But such a conversion does not necessarily reflect actual purchasing power; recent work has shown that most developing countries have actual incomes several times that implied by the exchange rate conversion.

The reason market exchange rates are imperfect converters of income into a common currency is that while such rates tend to equalize prices of internationally traded goods, big differences can and do remain in the prices of nontraded goods and services. Developing countries tend to have cheaper services--domestic help is the classic example--than developed ones and countries in the former Soviet bloc kept food, housing, and energy artificially cheap. Converting these countries' GDP using market exchange rates therefore has the effect of systematically understating their real output and income.

The International Comparison Program (ICP) sponsored by the United Nations attempts to correct for these biases by collecting and comparing prices for over 1,500 commodities, services, and labor inputs representing the universe of items priced in a country. The price comparisons that emerge are then aggregated into an overall purchasing-power-parity (PPP) figure used to relate income to a common currency unit (Summers and Heston 1991). ICP estimates of per capita GDP converted into US dollars using PPP conversions are available in several forms. They have appeared since 1989 among the world development indicators appended to the World Bank's annual *World Development Report*. In May 1993 the IMF began publishing regional aggregates in its quarterly *World Development Outlook*. The most complete source, however, is the Penn World Table (PWT), an annex to Summers and Heston (1991) available from the National Bureau of Economic Research on a personal computer diskette, or through the Internet. The version of that table used here, PWT (Mark 5.5) was released on 15 June 1993, covers the years 1950 through 1990 for most countries, and has 1985 as the base year.

The picture the PPP conversions paint of the global economy is strikingly different from that conveyed by using market exchange rates (IMF 1993). The developing countries' share of world output circa 1990 as calculated by the IMF jumps from 18 to 34 percent, while that of the industrialized countries drops from 73 percent to 54. (The so-called countries in transition account for the remainder.) China becomes the world's second or third biggest economy and India moves up to fifth place. Some country comparisons as of 1985 follow (PWT5.5 1993; World Bank 1987):

	Per Capita Income ($US 1985)	
	GNP Market exchange	GDP Purchasing power parity
India	270	1,116
China	310	1,811
Ghana	380	759
Egypt	610	1,859
Thailand	800	2,422
Brazil	1,640	3,951
Venezuela	3,080	6,037
Singapore	7,420	8,153
Canada	13,680	15,695

In all instances the PPP conversion points to per capita incomes considerably above those suggested by exchange rate conversions, typically by a factor of three or four among the poorest countries. As countries become wealthier (and more involved in the global economy), the differences between the two conversions lessen.

The impact that use of the two conversion procedures has on the income/dietary change relationship is shown in Figure 1. The three charts on the left show GDP per capita using PPP conversions, those on the right market exchange rate conversions of GNP per capita. To facilitate comparison income is plotted as a percentage of that prevailing in the United States. These base figures are almost the same: per capita GDP--$16,559; per capita GNP--$16,690.

It is apparent that the principal effect of using PPP conversions is to diminish the slope of the curves in the low-income range, a not unexpected finding. Incomes of about a fourth those prevailing in the United States, say $4,000 in 1985 terms, are sufficient almost everywhere to complete the dietary transition if exchange rate conversions are used, whereas roughly double that is needed if PPP figures are employed.

Also apparent is the degree to which operation of the dietary transition differs from one part of the world to another. Because food was heavily subsidized in the former Soviet bloc, rather lower incomes (by either conversion) were needed to support high intakes of livestock products than was the case in the West.

Japan, Hong Kong, and Singapore are the Far Eastern countries with the highest per capita incomes. Whereas daily apparent consumption of energy levels out at ± 3,500 kilocalories in the West, the figure is more like 2,800 in the Far East. This presumably reflects smaller body size, but also probably reduced wastage, particularly of animal fats in the cooking process. At any given income level animal products contribute a significantly lower percentage of dietary energy in Japan, Hong Kong, and Singapore than in the West, and the starchy staples more.

Such regional differences are more clearly evident in Figure 2, in which are plotted individual country trends for the years 1964-66, 1969-71, 1974-76, 1979-81, and 1984-86. The income figures are for the mid-year of these averages and are PPP conversions expressed in constant 1985 US dollars. The hand-fitted trend lines from Figure 1 are reproduced in the individual panels.

Developed Countries. That dietary change in Japan has followed a course different from the other developed countries is obvious in the panels on the extreme left. At any given income level the percentage of calories from animal products is appreciably lower than would be expected and the starchy staple ratio higher. A number of explanations have been offered for this behavior, but I expect the most important one is the high price of food in Japan. That the domestic price of rice ranges between six and eight times that prevailing on the world market is well known, and to purchase animal protein in a Tokyo restaurant is to risk financial as well as digestive distress.

While the starchy staple ratio seems destined in the Western developed countries to drop to the neighborhood of 21-23 percent, there is conflicting evidence as to what the final percentage contribution of animal products will be. Denmark--where dairy and fishery products loom particularly large--is clearly an anomaly at 45 percent. But will the substitution of vegetable for animal fats in the diet bring it to the 33-34 percent range found in North America, or will it remain at the 37-39 percent level prevailing in the principal European countries?

East and Southeast Asia. It was once thought that the anomalous course of dietary change in Japan vis-a-vis the West was a reflection of the rice-based character of Japanese cuisine. That this may not be the full explanation is suggested by the experience in the other East and Southeast Asian countries charted in the next set of panels. At comparable income levels the percent of calories from animal products is higher in both Singapore and Hong Kong than in Japan and the starchy staple ratio lower. But the behavior charted for East and Southeast Asia does point to several departures from the Western pattern. Daily per capita disappearance of energy would seem to level out everywhere about 700 kilocalories below the Western average and the pervasive role of rice cannot be denied: in both Singapore and Hong Kong the decline in the starchy staple ratio appears to stop at around 38 percent, while the contribution of animal products seems to plateau in the neighborhood of 30 percent. Otherwise the experience in East and Southeast Asia is a telling confirmation of the impact rapid economic growth has on dietary change.[1]

South Asia. Incomes are still too low in the South Asian countries plotted for us to know whether the East and Southeast Asian pattern will be replicated there. Because of similar body size apparent consumption of energy may well level out at the same ± 2,800 kilocalorie level, but the prevalence of taboos against the eating of meat, particularly in India, will doubtless play a confounding role. For clues, one must look to consumption surveys, but the differences evident in the percentage contribution of livestock products to the Indian and Pakistani diets are probably significant. At similar income levels the percentage in India is about half the figure in Pakistan.

Southwest Asia and North Africa/Latin America. In Latin America and the predominantly Muslim countries of Southwest Asia and North Africa the Western model would appear to be holding. The substitution of livestock products for starchy staples would appear on course and in the wealthier countries average per capita daily disappearance is approaching 3,500 kilocalories.

East and West Africa. Only data for 1964-66 and 1984-86 are plotted in the panels for East and West Africa. It is not just that the figures are of questionable accuracy; incomes have grown so little and the changes in diet have been so modest that to show the intervening years would serve only to obfuscate. About all that can be said is that the dietary transition has hardly begun in this unfortunate part of the world.

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[1] Provisional data for 1990 for Japan and Hong Kong show little deviation from the trends noted through 1985:

	Japan	Hong Kong
PPP GDP/capita ($US 1985)	14,836	14,410
Energy availabilities/capita (Kcal)	2,926	2,857
Percent calories from animal products	21.2	30.0
Percent calories from starchy staples	42.4	36.0

TECHNICAL NOTE

Obtaining the Penn World Table

An IBM-PC compatible 3.5 disk with the tables and a copy of the *Quarterly Journal of Economics* article are available from:

Publications Department
National Bureau of Economic Research (NBER)
1050 Massachusetts Ave.
Cambridge, MA 02138

Please enclose a check for $US5 (US and Canada) or $US15 (other).

The files may also be obtained from an anonymous FTP server at the NBER without charge by those with Internet access. A copy of the *QJE* article will still be required to make use of the data. The files available from FTP from directory/pub/pwt55 on nber.harvard.edu are:

File	Bytes
PWT55.ASC	1365300
README.DOC	4646
DESCRIP.DOC	11451

PWT55.ASC, the main data file, is an ASCII file. The data are provided in successive country blocks: the rows refer to years and the columns refer to variables.

An electronic mailing list devoted to discussion of the Penn World Table is available to any person capable of receiving Internet mail. To subscribe send the one-line message:

SUB PWT-L firstname lastname

to listserv@nber.harvard.edu, substituting your own first and last names for firstname and lastname. Do not place your email address in the body of the message. Subscribers to the list will receive timely notice of new data and may post questions and comments for the other members of the list to see.

CITATIONS

FAO (Food and Agriculture Organization). 1991. *Food Balance Sheets, 1984-86 Average*. Rome.

IMF (International Monetary Fund). 1993. *World Development Outlook*. May.

Penn World Table (Mark 5.5). 1993. Annex to Summers, Robert and A. Heston. 1991.

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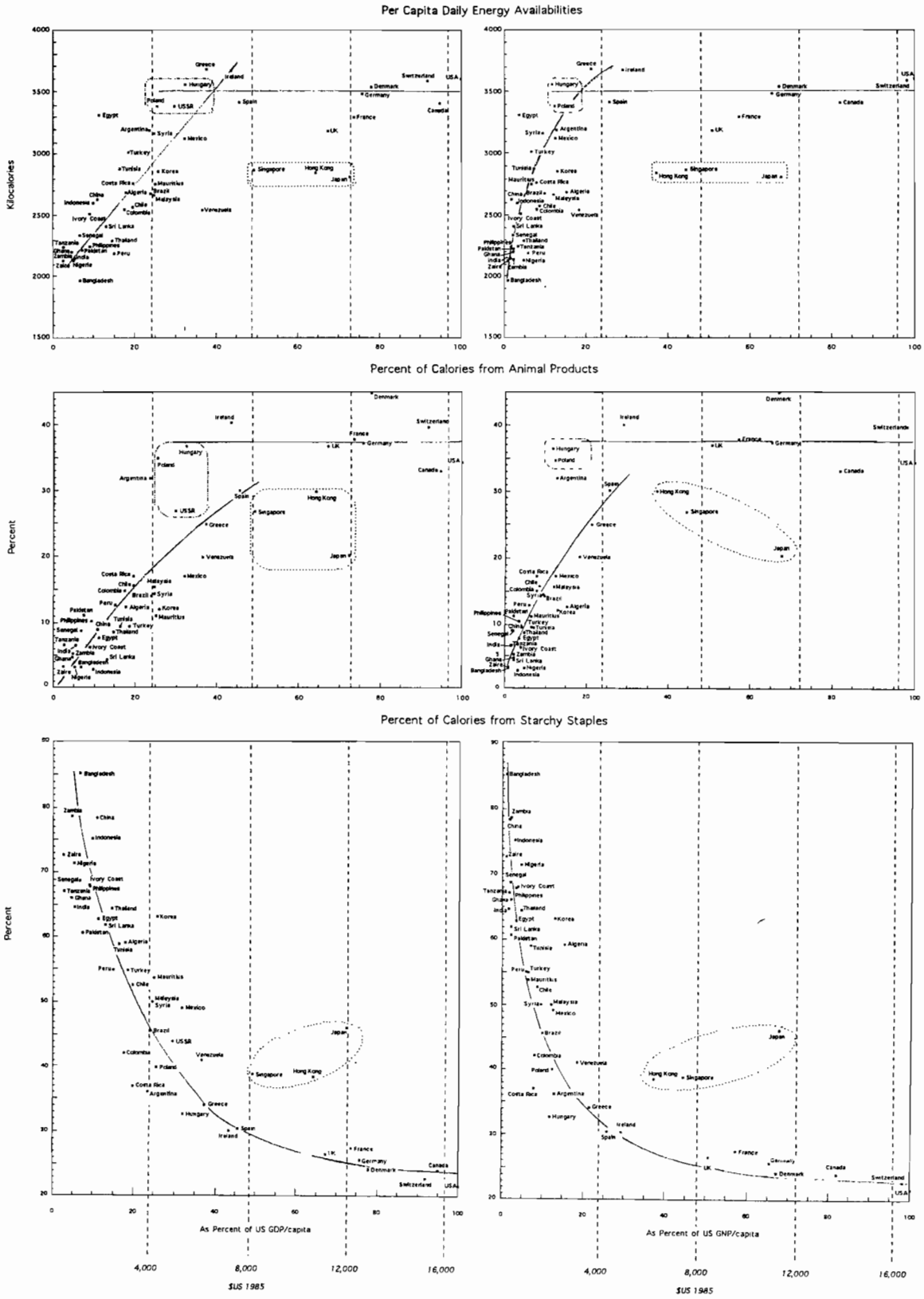
World Bank. 1987. *World Development Report, 1987*. New York: Oxford University Press.

FIGURE 1. INDICATORS OF DIETARY CHANGE RELATED TO PER CAPITA INCOME USING PURCHASING POWER PARITY AND EXCHANGE RATE CONVERSIONS, SELECTED COUNTRIES, ABOUT 1985



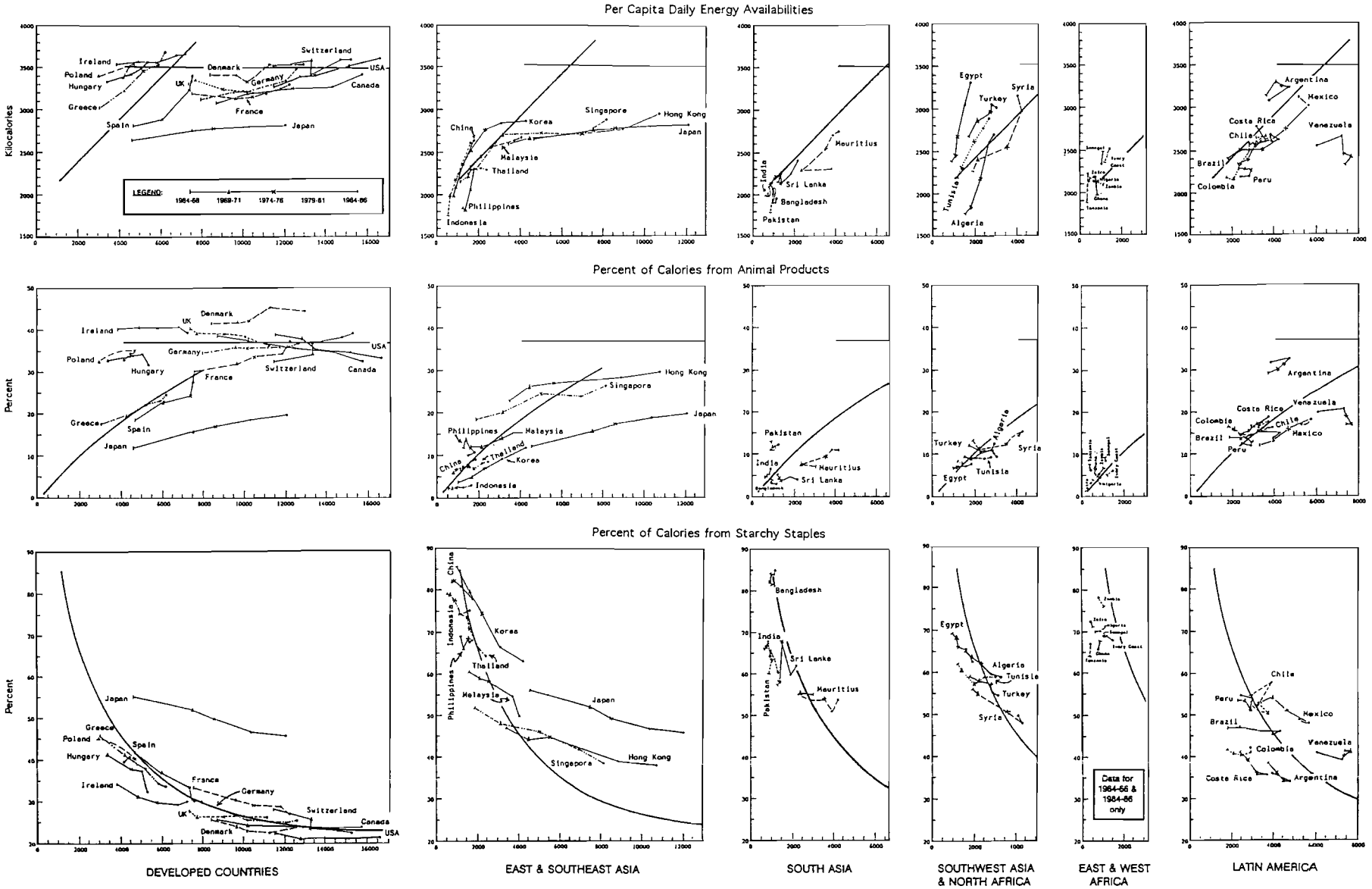
Dietary indicators are 1984-86 averages calculated from: FAO. 1991. *Food Balance Sheets, 1984-86 Average*. Rome.

Purchasing-power-parity GDP per capita figures are expressed in 1985 U.S. dollars and are from: Penn World Table (Mark 5.5). 1993. Annex to Summers, Robert and A. Heston. 1991. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988." *Quarterly Journal of Economics*. May.

Exchange rate GNP per capita figures are expressed in 1985 U.S. dollars and are from: World Bank. 1987. *World Development Report, 1987*.

FIGURE 2. INDICATORS OF DIETARY CHANGE RELATED TO PURCHASING-POWER-PARITY GDP PER CAPITA, SELECTED COUNTRIES BY REGION, ABOUT 1965, 1970, 1975, 1980, AND 1985

(PPP GDP/capita in *$US 1985*)



Source: Appendix Table 1.

APPENDIX TABLE 1. DIETARY INDICATORS AND PURCHASING-POWER-PARITY GDP PER CAPITA, SELECTED COUNTRIES, ABOUT 1965, 1970, 1975, 1980, AND 1985.

Country	1964-66			1965 PPP GDP/ capita	1969-71			1970 PPP GDP/ capita	1974-76			1975 PPP GDP/ capita	1979-81			1980 PPP GDP/ capita	1984-86			1985 PPP GDP/ capita
	Kcal	SS (%)	Animal (%)		Kcal	SS (%)	Animal (%)		Kcal	SS (%)	Animal (%)		Kcal	SS (%)	Animal (%)		Kcal	SS (%)	Animal (%)	
Algeria	1745	65.1	9.2	1,551	1829	63.7	8.7	1,837	2160	62.0	10.2	2,311	2596	59.5	10.6	2,778	2680	59.0	12.2	2,951
Argentina	3143	38.4	29.2	3,720	3317	36.0	29.8	4,165	3259	34.1	31.3	4,475	3243	33.9	32.6	4,745	3186	36.0	31.7	3,887
Bangladesh	2009	81.7	3.8	974	2065	82.3	3.4	919	1918	84.2	3.2	973	1906	84.2	3.1	1,098	1963	85.0	3.1	1,116
Brazil	2405	47.9	14.1	1,843	2504	47.0	13.8	2,401	2507	46.2	15.3	3,470	2623	46.2	15.0	4,254	2667	45.3	13.9	3,951
Canada	3077	25.7	39.1	8,709	3180	24.3	37.8	10,175	3251	24.0	36.0	12,348	3266	23.7	35.2	14,231	3400	23.8	32.8	15,695
Chile	2635	53.0	16.4	3,256	2659	50.4	17.8	3,687	2576	54.5	16.5	2,906	2658	50.8	16.6	3,900	2565	52.5	15.4	3,238
China	1914	79.9	6.0	--	1989	82.2	5.9	825	2070	82.6	6.3	952	2328	81.0	7.2	1,241	2622	78.2	8.8	1,811
Colombia	2176	41.6	16.4	1,782	2167	40.7	15.9	2,097	2340	40.3	14.7	2,435	2491	40.9	14.5	2,892	2539	41.8	14.6	2,893
Costa Rica	2328	41.0	14.5	2,368	2410	39.3	15.3	2,796	2563	36.3	16.9	3,185	2610	35.6	18.4	3,694	2757	36.8	16.9	3,258
Denmark	3415	26.0	41.8	8,433	3410	24.2	42.0	9,675	3327	23.0	42.4	10,185	3530	22.5	45.7	11,234	3528	24.1	44.7	12,884
Egypt	2376	69.4	6.4	975	2447	68.2	6.8	1,105	2673	65.9	6.9	1,222	3031	65.5	7.0	1,572	3310	62.6	7.5	1,859
France	3180	33.5	30.3	7,540	3137	30.4	32.0	9,621	3148	29.2	33.8	10,467	3244	28.8	34.6	11,798	3285	27.2	37.6	12,186
Germany, Fed. Rep.	3096	30.0	34.6	7,999	3207	26.8 —	36.0	9,557	3205	25.6	35.8	10,127	3337	25.0	36.1	12,013	3473	25.4	37.1	12,543
Ghana	1969	67.8	4.5	857	2200	65.2	5.9	1,012	2164	62.0	5.9	876	1953	69.0	5.2	921	2196	65.9	4.6	759
Greece	3021	45.8	17.7	3,066	3221	41.3	19.7	4,234	3467	38.1	22.3	5,198	3540	34.4	23.5	5,895	3678	33.9	24.7	6,184
Hong Kong	2557	46.8	22.7	3,457	2648	44.2	26.2	4,456	2666	44.6	26.7	5,567	2758	39.2	28.2	8,801	2831	38.2	29.6	10,653
Hungary	3189	47.4	29.7	--	3331	41.5	33.1	3,382	3419	38.0	34.1	4,538	3478	37.6	34.6	5,051	3550	32.5	36.1	5,309
India	1988	66.1	4.8	644	2016	66.4	4.7	704	1989	66.7	5.1	716	2091	67.7	5.1	763	2143	64.4	6.4	899
Indonesia	1778	79.1	2.1	593	1982	78.8	2.2	700	2155	77.7	2.3	935	2375	74.4	2.4	1,252	2589	75.0	2.7	1,626
Ireland	3530	34.4	40.6	3,862	3567	31.4	40.8	4,884	3561	29.7	41.0	5,756	3641	29.4	41.0	6,785	3663	30.2	39.8	7,215
Ivory Coast	2356	69.1	5.0	1,199	2392	66.5	6.2	1,320	2322	65.6	6.3	1,593	2543	66.3	7.2	1,563	2506	67.9	6.1	1,499
Japan	2636	56.2	12.1	4,600	2741	52.1	15.8	7,500	2768	49.3	17.3	8,572	2791	46.9	18.9	10,292	2805	45.8	20.0	12,004
Korea, S.	2240	85.7	3.7	1,058	2528	79.4	4.8	1,688	2757	74.4	6.7	2,338	2829	66.6	9.2	3,123	2848	63.0	11.8	4,267
Malaysia	2320	60.4	11.8	1,645	2445	59.1	11.8	2,117	2552	58.2	13.9	2,616	2623	54.6	15.3	3,772	2655	49.9	15.2	4,073
Mauritius	2320	55.0	7.2	3,082	2293	55.4	7.5	2,348	2549	54.3	9.4	3,585	2721	50.9	11.4	3,892	2747	53.6	10.8	4,136
Mexico	2580	52.9	12.3	3,320	2622	54.3	13.0	3,950	2748	51.3	15.8	4,639	3014	48.2	17.9	5,707	3118	48.9	16.9	5,289
Nigeria	2179	70.3	3.3	628	2133	69.3	3.5	769	2084	68.5	3.6	1,034	2255	68.3	4.5	1,196	2127	71.3	3.1	860
Pakistan	1795	60.0	13.2	862	2031	63.5	11.5	997	2141	65.6	11.0	893	2231	63.6	10.7	1,076	2214	60.5	10.9	1,221
Peru	2295	53.4	14.4	2,382	2289	53.4	13.8	2,648	2271	51.3	12.7	2,959	2196	54.2	12.2	2,889	2181	54.8	12.5	2,481
Philippines	1832	69.2	11.4	1,232	1819	66.2	13.4	1,368	2048	68.4	11.5	1,623	2299	68.2	10.7	1,869	2239	67.7	10.1	1,521
Poland	3285	49.8	29.8	--	3390	45.1	32.6	2,999	3539	40.4	35.1	4,680	3516	40.7	34.8	4,465	3377	39.8	34.4	4,204
Senegal	2491	68.8	9.2	1,104	2380	67.9	9.2	1,104	2267	67.6	7.8	1,082	2401	65.6	7.5	1,087	2338	68.5	8.7	1,109
Singapore	2301	51.9	18.4	1,931	2693	48.0	20.0	3,155	2714	45.9	24.5	5,006	2707	41.7	23.9	6,958	2861	38.6	26.6	8,153
Spain	2805	42.0	18.9	4,692	2875	37.0	22.8	6,017	3221	33.6	24.6	7,389	3325	30.8	27.9	7,495	3403	30.3	29.9	7,547
Sri Lanka	2165	57.5	5.1	1,223	2256	58.3	4.3	1,315	2152	67.8	3.8	1,350	2256	59.8	4.6	1,851	2404	61.8	4.3	2,152
Switzerland	3518	28.4	32.7	11,425	3,577	25.8	34.3	13,274	3420	23.8	37.3	13,228	3582	23.1	38.8	14,653	3580	22.6	39.5	15,209
Syria	2245	56.0	13.1	1,936	2393	54.9	11.3	2,201	2539	50.5	12.0	3,538	2968	47.8	15.2	4,286	3157	49.8	14.1	4,075
Tanzania	1837	63.7	7.6	372	1813	62.2	8.7	429	2089	67.4	7.2	516	2254	66.3	6.2	482	2236	66.9	6.5	452
Thailand	2140	74.4	6.9	1,121	224	73.6	7.5	1,508	2285	70.9	6.9	1,662	2305	66.1	8.0	2,146	2286	64.3	8.4	2,422
Tunisia	2178	62.0	8.0	1,219	2291	60.4	7.6	1,398	2594	57.1	9.0	2,002	2759	58.8	8.8	2,473	2874	58.9	9.2	2,704
Turkey	2673	59.0	11.8	1,793	2851	57.7	10.9	2,179	2954	57.2	10.8	2,832	3042	55.1	10.4	2,853	3006	54.6	9.3	3,059
USSR	3204	53.5	21.7	--	3323	49.0	24.6	2,873	3364	46.0	26.2	3,609	3370	44.6	25.8	4,270	3375	43.6	26.7	4,894
UK	3307	27.8	40.6	7,378	3352	26.4	39.5	7,695	3236	26.5	39.4	9,014	3215	26.6	38.9	10,028	3178	26.3	36.6	11,137
USA	3252	22.4	39.3	11,492	3390	21.0	38.2	12,725	3398	21.3	35.6	13,479	3510	21.1	34.9	15,097	3595	21.5	34.1	16,559
Venezuela	2325	41.0	16.8	7,349	2413	41.3	16.8	7,624	2446	40.1	18.8	7,341	2652	39.0	20.6	7,233	2536	40.8	19.8	6,037
Zaire	2175	71.0	3.9	514	2256	68.9	3.8	644	2289	69.1	3.4	603	2108	70.4	2.9	450	2124	72.5	3.2	422
Zambia	2094	76.1	6.7	1,088	2192	70.0	7.4	1,091	2322	71.5	7.1	1,217	2205	76.0	5.7	930	2130	78.4	5.1	774

Dietary indicators are: Kcal--per capita daily energy availabilities; SS (%)--percent of calories from starchy staples; Animal (%)--percent of calories from animal products, and are calculated from FAO. 1991. *Food Balance Sheets, 1984-86 Average*. Rome.

Purchasing-power-parity GDP per capita figures are expressed in 1985 U.S. dollars and are from Penn World Table (Mark 5.5). 1993. Annex to Summers, Robert and A. Heston. 1991. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988." *Quarterly Journal of Economics*. May.

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