A COMPARISON OF SOME SHORT-CUT METHODS OF ESTIMATING REAL PRODUCT PER CAPITA

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Several recent studies of short-cut estimates comparing real income (on a purchasing power basis) of countries are reviewed, including methods comparing real income based on indicators, like electricity consumption. New estimates are presented for 101 countries which had a tradition of conventional national income estimates in 1965, and for 40 countries without extended national income series. One conclusion from the empirical analysis was that until there exist a large number of countries for which purchasing power estimates of real income are available, it is difficult to discriminate between alternative short-cut methods using indicators, and difficult to estimate real per capita incomes of low income countries without substantial errors of estimate. The paper advocates more purchasing power estimates, and institutionalizing the collection of international prices of specified items so that abbreviated market baskets can be readily compared across countries.

INTRODUCTION[1]

The most common measure used to compare the level of economic activity across countries is the conventional per capita gross domestic product, which is per capita GDP in national currencies converted to a common currency on the basis of exchange rates. Because exchange rates are an unsatisfactory measure of purchasing power, and because of the resources needed for full scale purchasing power comparisons, there has been a resort to short-cut techniques to estimate real GDP. This paper is concerned with the usefulness of short-cut techniques, and several such techniques are discussed, though the emphasis of the paper, and especially the empirical section, is on short-cut methods using indicators. The general conclusion of the paper is that satisfactory estimates of real GDP by short-cut methods must await the completion of more purchasing power comparisons, particularly for low income countries. This conclusion is hardly new, but I believe some of the points made here lend additional support to the argument.

I will refer to a number of important studies below, but since Beckerman (1966), Szilágyi (1964), Ruggles (1967), and Ehrlich (1969) have ably summarized most of the literature, my bibliographic comments will be few. Before developing our argument, it will be useful to make several distinctions that I think need to be made clear. First, our discussion will involve real consumption and real GDP per capita, as well as conventional measures of GDP converted at exchange rates

[1]This paper has been prepared as part of the International Comparison Project (ICP) being carried out under the aegis of the U.N. Statistical Office. The resources for the ICP have been provided mainly from the U.N., the Ford Foundation and the International Bank for Reconstruction and Development. In preparing this paper I would like to acknowledge comments on earlier versions by G. Szilágyi, and the assistance of Sultan Ahmad at several stages of the work. An early version of the empirical work of Part II of the paper was done jointly in 1969 with Michelle Turnovsky. I would like to acknowledge her contribution, and also express my regret that it was not possible to continue the collaboration.

to a common currency. When referring to estimates that give or purport to give estimates of GDP that would be obtained from a purchasing power comparison I will use the term real GDP or the acronym, PPY. When we are discussing estimates of national currencies converted at exchange rates we will use the term conventional GDP, or the acronym, ERY. Because the discussion will deal with both ERY and PPY, it seems useful to make one further point. In the literature on development there are fairly standard discussions (e.g., Higgins, 1968) of why the range of ERY in rich and poor countries probably overstates the differences in economic activity. The reasons given may be divided into exchange rate problems with which I purport to deal, and with conceptual problems which I will just mention. Many of these conceptual problems were treated in *Problems in the Comparison of Economic Accounts* (1957), and there has been a revival of interest with the recent critical examination of the exclusion from GDP of leisure, the inclusion in GDP of items like commuter expenses that might be considered intermediate output, or the failure to deduct negative output like pollution.[2] I do not deal with these questions here, not because I consider them unimportant, but because I think it is possible to deal with the exchange rate problems independently of the conceptual issues.

One further distinction is between the various objectives of short-cut methods as they have been applied. Some of these objectives are to extend conventional GDP estimates to countries or sub-units of countries, as regions, states, or even towns and villages; to extend estimates of real GDP to countries or areas where purchasing power estimates are unavailable; and to update international comparisons from some base date to a later period without complete replication of earlier work. The major concern of this paper is the second objective, the extention of real GDP estimates to areas where they are not now available. In Part I, I discuss a short-cut approach by use of abbreviated market baskets, and then turn in Part II to various methods involving the use of indicators. Part III presents some of our own estimates, and points out some of the present limitations on the use of indicators.

I. Abbreviated Market Baskets

If the national accounts in all countries followed, as they indeed attempt to do, a uniform system like the SNA, there would remain a problem of converting these estimates to a common base. One alternative to converting at exchange rates is to make binary and multilateral comparisons between countries by evaluation of quantities produced in terms of the prices of second countries or groups of countries, which is what we mean by PPY. Estimates of PPY may involve a sample in the hundreds of price ratios of comparable commodities distributed over the different expenditure categories for a number of countries.[3] For the purchasing power studies in the CMEA countries, for example, the

[2]See for example Nordhaus and Tobin (1972). Other important problems here include where the line is drawn in separating household activity from activity counted in GDP, and the related question of how to value non-marketed output. One recent contribution here is Usher (1968).

[3]Comparisons on the product side like the Paige and Bombach (1959) study clearly are included in this discussion.

number of consumption items compared ran over one thousand, the items themselves being chosen with the aid of many commodity experts. The ECLA-Brookings study involved several hundred items, as does the ICP. Clearly one short-cut method would be an abbreviated market basket of perhaps 50 or so items covering 20 to 30 expenditure categories. Data collection for such comparisons would be minimal—presumably the expenditure categories would be broad enough so that even countries now estimating GDP from the product side would be able to make some adaptations of existing expenditure surveys and commodity flow information to disaggregate consumption and investment. Further, a number of the required prices might be obtained as part of existing collection efforts.

One appeal of this abbreviated market basket approach is that it would continuously use data on relative prices, which have a very direct relation to any real GDP estimate. In contrast, indicators used in many short-cut methods are indirectly related to the phenomenon they are to predict. The only approach to examining the efficacy of the indicator approach is to have benchmark studies every five or ten years of a significant number (optimistically, as few as twenty) of countries representing the spectrum of world countries. If an abbreviated market basket could be determined, it could be continuously evaluated, probably from some material internal to its collection, as well as from a few studies involving many more items for several countries, undertaken every five years, perhaps. Another point about the abbreviated market basket is that the items might be region-specific, or specific to some other characteristic of countries, with links between classes of countries being determined at some base period and extended to later periods by detailed studies, or a short-cut technique.

Another advantage of maintaining some type of regional or world market basket would be to place the exercise of estimating national average prices of certain internationally "relevant", specified items as a routine item on the agenda of national statistical offices. Further, by maintaining a continuous international feedback on items priced in various countries, it would make full-fledged price comparisons in the future much easier. For example, in a rapidly changing country like Japan, perhaps 10 percent of the specifications in the consumers price index are modified each year. One implication of these remarks is that if purchasing power comparisons (including a continuous updating of specifications of items priced) are not maintained, one would have to begin substantially anew with many countries every five to ten years. This comment is in part generated (confirmed?) by the practice in many countries of making periodic expenditure surveys at which time large revisions in items priced for indexes are considered. Between expenditure surveys, changes in items are minimal. If, as I think is probably almost necessarily true because of the relatively small number of expenditure categories compared to possible items used for pricing, the weights of categories change over time more slowly than the major items consumed within the category, then countries that are interested in accurate price information should change their items much more frequently than I would guess is done. Further, it would seem to me that any international nudge that led countries to budge from center and outlet specific price relatives to national average prices is in the interest of national and international statistics. In summary, I come out

strongly for generating a mechanism for having continuously collected a set of prices on items for which specifications are common among groups, and/or all nations, and for which specifications are changed with some frequency.

However, it is quite clear that the ICP will only be in a position to propose any such short-cut approach when all the data are in. At that time, for consumption, the ICP will have specifications for about 1,000 items, and for each of the countries at least 300 prices. When we have this data together, we can explore the question that Nancy Ruggles has examined, namely, whether we can get the same answers with less information. Factor analysis, or some type of cluster analysis, might prove useful in answering such questions. These remarks also apply to another type of short-cut approach, namely the updating of benchmark comparisons on the basis of changes in prices in different countries. For example, a binary comparison in 1960 covering 100 categories of expenditure could be updated to 1970 by using price indices in each of the countries that could be applied to the different expenditure categories. Again, the ICP will be in a much better position to evaluate this approach when we look at some comparisons done in 1970 with alternative estimates generated from the 1955 OECD comparisons updated by detailed changes in prices in different expenditure categories in several of the countries. I do not know of the experience of the CMEA countries with respect to this kind of work, but I would certainly think that much could be learned from the results of their research in the last ten years.

II. Short-Cut Methods Based on Indicators

Indicators of stocks or flows of goods and services or structural characteristics of economies are frequently combined to produce synthetic indices. Often the purposes of such studies are much broader than the present paper which is concerned with real GDP. For example, some of the work of the United Nations Research Institute for Social Development (1966) has been concerned with developing a measure of welfare which combines levels of development for a number of dimensions of human well-being, like health, nutrition, and education.[4] In contrast, in the discussion below the focus is only on use of indicators for predicting real GDP.

For the purpose of relating indicators to national income, the underlying relationship is the demand relation. Given relative prices, the quantities demanded for consumption of various goods and services commonly used for indicators are related to income across individuals, families, and, with perhaps more static, countries. However, the indicator approach relies only indirectly on the demand relations since it is necessary to predict income from indicators, rather than vice versa. Unfortunately, the nature of the problem of predicting the level of income from indicators really offers very little basis in theory to guide one to any one

[4]Sometimes these indices are referred to as non-monetary measures of welfare though this distinction does not seem useful since the process of combining non-monetary indicators involves weights (in effect, prices), just as do monetary measures. Of interest to the discussion above are two very interesting research efforts by Irma Adelman. Adelman in collaboration with Cynthia Taft Morris (1967), and with George Dalton (1971), has used factor analysis as a technique for combining indicators in studies measuring and analysing the relationships between political and economic development across geographical areas ranging from nations to villages.

best method. Several recent contributions deserve mention, especially since the empirical work presented in this paper is but a variation on their approaches.

Ferenc Jánossy (1963) experimented with a technique of relating individually 16 indicators to the national income of a number of socialist and market economies, expressed in dollars at official exchange rates. The relation between indicator and income produced a predicted level of income for each indicator, and the 16 estimates for each country were combined and the geometric mean taken.[5]

Szilágyi (1964) developed an interesting variation on this approach. For a particular country, a time series of indicators and an index of GDP over time of the real per capita GDP of the country in its own currency was used. For a country the index of GDP would be regressed on the time series of indicators, like steel, electricity, and the like. Each regression equation was simple, so that, for example, the electricity equation for Poland would predict an index value of GDP for Poland, as well as for other countries if their values of electricity were plugged in Poland's equation. Further, there would be a steel equation for Poland that would produce for Poland, Bulgaria, and the other countries an index of GDP. Likewise the equations for Bulgaria and all the other countries would generate estimates for all the countries for each of the indicators used. By use of geometric means or some other aggregation procedure these estimates may be combined to produce estimates of real GDP[6] without use of exchange rates. This approach, Szilágyi argues, is most applicable to fairly homogeneous groups of countries, where the estimates were built up on the basis of relatively short time series. Also, his method is one that suggests itself as a way one would update a set of real GDP estimates.

In the work of Eva Ehrlich (1969), data for 27 countries on up to 26 indicators and ERY were collected for 1937 and 1960. Some of the indicators that were available for 1960, for data reasons or reasons of product development (like TV sets), were not available in 1937. Ehrlich asked how sensitive were the results to the availability of indicators. The procedure was to regress ERY on various numbers of the indicators in both 1937 and 1960. This provided for each year as many estimates of real GDP as there were indicators. The geometric mean of the estimates for each indicator was taken as the final estimate of PPY. Ehrlich (1969 : 9) divided the indicators into two groups, computed PPY for both groups, and compared the results for 1937. The difference between the two estimates averaged 6 percent, with the really extreme differences being 16 and 20 percent for Australia and Argentina, both of which appear to be influenced by whether or not an indicator reflecting their meat consumption is available.[7] Ehrlich (p. 11) concludes that the range of error is under $\pm$ 10 percent, for the kind of real GDP estimates combining estimates from simple regression equations.

[5]Our simple regression estimates below are essentially similar to those of Jánossy, except that we have not used the geometric mean of the estimates for a country.

[6]With respect to both Szilágyi's and Ehrlich's work and our own presented below we will refer to such synthetic estimates resulting from estimating equations as real GDP, since that is what they purport to estimate. We will also discuss below the appropriateness of this label for our estimates.

[7]These numbers were calculated from the data given in Table 2 by Ehrlich, who also reports (p. 12) that when the computation is done for 1960 the differences are less, presumably because there are more indicators available. Based on our own data, these estimates seem a bit low, but we postpone discussion until later in the paper.

In the work of Beckerman, regression relationships of PPY on from one to five indicators were estimated from 20 to 22 observations. Though an equation using steel, telephones, and stock of motor vehicles was mainly used for estimation, different estimating equations were used to estimate real consumption for 57 countries.

In the paper of Beckerman and Bacon (1966), the procedure was a little more complex, but it allowed estimates of real consumption for a total of 80 countries. In their work, two additional sets of estimates were made for countries on the basis of flow variables, one set excluding steel and the other set including steel. The final estimates weighted the best fitting equation for available indicators at 0.6, and each of the other estimates at 0.2. In addition, Beckerman and Bacon (1966 : 529) have used their sets of indicators to explain the ECLA estimates and argued that these results support the use of their indicators for prediction of real consumption.

When a multiple regression approach is used, often only a few indicators will be significant in the equation, and the addition of more variables does not add to the explained variance when adjusted for the loss in degrees of freedom. This makes some sense, since the demand relation directly or indirectly underlying the relationship of any one indicator to real GDP would be expected to provide by itself a good estimate. In fact, one might ask why more than one indicator should be necessary. One answer is that there are some omitted variables like relative prices. One might argue that the role additional indicators play in a multiple regression is to account for differences in relative prices of some goods and services across countries. The indicators that remain in the multiple regression equation may be thought of as each representing the information of the large number of indicators that are not included on tests of significance of the coefficients.

III. Some Results of Using Indicators

In this section I will present estimates that to some extent combine the methods of the studies described above. Since the above studies are important, I would like to say briefly why I think some additional estimates would be useful in evaluating the use of indicators. First, with respect to the studies of Jánossy, Szilágyi, and Ehrlich, the range of countries in their studies is not as large as desirable, particularly as to the inclusion of low income countries. With respect to the work of Beckerman and Bacon the situation is a little different. The equations are estimated over a small group of countries, but the predictions are extended to a very large group of countries.

In fact the only reason I feel it desirable to experiment with alternative estimates to those of Beckerman and Bacon is that I am unhappy with their results.[8] In particular, let us look at the following numbers for 1960:

[8]The index numbers quoted in this section from Beckerman or Beckerman and Bacon refer to consumption, which was the dependent variable and variable of prediction in their work. Beckerman (1966 : 242) has estimated real GDP for some countries on the basis of the ratio of C/GNP in the currencies of each country. Because C/GNP tends to be larger in poor countries, this means that disparities in PPY will be greater than disparities in consumption. Therefore in the discussion in the text, where we will be referring to dispersions of distributions of both consumption and GDP, it may be presumed that the dispersion of a GDP series will be greater than that of a consumption series calculated on the same basis.

	U.S.	U.K.	Italy	Mexico	Burma	Ethiopia
Beckerman and Bacon	140	100	53	22	2	1
Index of ERY	200	100	45	32	5	—

Source: Index of ERY from Beckerman (1966 : 36–7). Index of Beckerman and Bacon (p. 33).

First, as between Italy and the United States the Beckerman and Bacon estimates tend to increase the position of Italy (namely 53/140 > 45/200), which is in accord with expectations. That is, in the Gilbert–Kravis study the estimates of real GDP put Italy much closer to the U.S. than did conventional estimates. Now this relation, which is made explicitly in the writings of Hagen (1968, Chapter 1) would be expected to hold over the whole range of countries of the world. But as we can see above, when the estimates of Beckerman and Bacon are extended to Mexico, both their estimate and conventional estimates put Mexico at 16 percent of the United States. Further down the line conventional estimates put Burma at 2.5 percent of the United States, while Beckerman and Bacon put Burma at 1.4 percent of the United States. And Ethiopia is put by Beckerman and Bacon at 1/140 of the United States, an estimate which seems to me very much counter to expectation (for 1963–1965 the ERY of Ethiopia was $\frac{1}{64}$ of the United States).[9]

The above remarks illustrate what Beckerman (1966 : 33) himself makes perfectly clear, namely that more purchasing power observations on low income countries are needed.[10] However, there were not, and are not now, many estimates available for low income countries of real GDP. The estimate used by Beckerman and Bacon for China is probably as good as can be expected, given the very limited data, while the estimate used for India was quite *ad hoc*, and capable of improvement. The empirical work presented below is essentially based on the following proposition: one can estimate PPY as well from equations estimated over many countries where the dependent variable is ERY as from equations estimated over a few countries where the dependent variable is PPY.

[9]In addition to this systematic factor in the Beckerman and Bacon estimates, there is a very curious result that they produce for India and the Peoples Republic of China, namely that the consumption of the former with respect to the latter is in the ratio 3.1/9.4 (Beckerman, 1966 : 37). This result is not curious because I believe the real world is different—indeed, I would expect that real GDP per capita was greater in China than in India, though not necessarily in the above ratio. The result is curious because Beckerman (1966 : 55) gives on a per capita basis steel consumption in kilograms as 7.4 in India, and 5.9 in China, letters sent as 7.2 and 0.2 and cement production in tons as 0.12 and 0.07, and the estimates of consumption he uses puts India at $70 and China at $60. What is to be noted is that the estimating equations used by Beckerman must be very sensitive if on the basis of the inputs mentioned above, China can be placed at three times the level of India, when every indicator used as an input puts India above China. The reason is clear enough. China is estimated from an equation where steel is the only variable (which if used for India would have put it above China), whereas the estimating equation for India uses steel, telephones, and motor vehicles.

[10]Beckerman (1966 : 33) says, "Inspection of the predictions shown below will reveal that, for some of the low income countries, the estimates are rather dubious. This reinforces the point made earlier to the effect that one improvement to this method will be the recalculation of the equations when independent direct control estimates of relative real per capita consumption are available for a few more low-income countries."

If there were many more observations on real GDP available, some variation of the Beckerman and Bacon estimates or those of Jánossy would seem to me to be appropriate. But in the empirical work below, the following choice has been made. To gain more observations I have used as the dependent variable in the estimating equations conventional GDP. The cost, of course, is that the object of the empirical work is to estimate real GDP, so that we begin with the wrong dependent variable. A test of the method, I argue, is whether our resulting estimates based on equations for 101 observations do as well as the Beckerman and Bacon equations with 22 observations with the right dependent variable. We now turn to this question.

We began with a sample of 102 countries (later reduced to 101 since Kuwait seemed to contribute little but anomalies to the exercise) for which ERY was available in 1963–1965. Eight countries using the material product approach to estimating output are included in the sample.[11] An average was taken of the ERY figures and of the indicators, and if for some reason not all three years were available, those available were used. We also collected data on another 46 countries and territories without ERY but with some of the indicators. Both simple and multiple regression techniques were employed as follows.

Of about thirty indicators tried, 24 produced simple correlations ($\bar{R}^2$) of above 0.50, and for 14 of these indicators there were over 70 observations. It was this latter group of indicators that we used to produce an estimate of real GDP. Each of the 14 indicators produced estimates of PPY for each of the countries for which there existed an indicator. The average number of indicators per country was 12.36 out of the 14, the low being 7 indicators for Liberia, with only 5 other countries having under 10 indicators. The equations were in double log form, but the estimates of each country were converted to dollar estimates and then combined. The estimating equations are given in Table 1.

In combining the estimates from the various indicators, several weighting schemes were tried, though the one presented here is simply the arithmetic mean of the other estimates. My judgment, based on some experience with the geometric mean, a mean weighted inversely to the distance from ERY, and a mean jointly weighted inversely from the arithmetic mean and ERY, is that differences are small. Also, the standard error of the arithmetic mean has been calculated from the 14 or less estimates of PPY for each country. Expressed as a percent of the arithmetic mean, the standard error ranged from about 4 per cent for Chile to up to a high of 32 percent for the Congo (produced entirely by an apparently large supply of hospital beds). For countries with ERY of under $100, the error estimate is between $15 and $20. For ERY of $100 to $250, the error runs $30, for ERY of $250 to $1,000 the error is quite variable, averaging about $50, and for ERY over $1,000 the error runs about $90. While there is a tendency for the percentage error to decrease as income rises, the overall impression is of considerable variation in the estimates. Further since the errors are relatively larger

[11]The procedure used here was essentially to use an index of the MPS countries, and to link these indices to other countries by the level of the material product of Hungary converted to dollars at its non-commercial exchange rate. Generally, this procedure produced higher $\bar{R}^2$'s than using estimates at official rates. Also when separate intercepts were used, they were not usually significant or consistent in direction and were not used for making estimates. A fuller discussion is given in the Appendix.

TABLE 1

REGRESSION EQUATIONS OF GROSS DOMESTIC PRODUCT ON PHYSICAL INDICATORS

EQUATIONS ARE DOUBLE LOG—STANDARD ERRORS IN PARENTHESES

Indicator	Number of Countries	Slope Coefficient	Intercept	$\bar{R}^2$
1. Steel Consumption	64	0.616	0.741	0.864
		(0.031)	(0.022)	
2. Energy Consumption	99	0.607	0.092	0.859
		(0.025)	(0.024)	
3. Electric Energy Production (Industrial and Private)	93	0.546	0.771	0.873
		(0.022)	(0.054)	
4. Motor Vehicles in Use	96	0.585	−0.133	0.851
		(0.025)	(0.033)	
5. Cement Production	84	0.673	−0.781	0.766
		(0.040)	(0.085)	
6. Tractors in Use	89	0.380	−0.613	0.724
		(0.025)	(0.080)	
7. Telephone Stock	97	0.574	−0.779	0.904
		(0.019)	(0.046)	
8. Radio Stock	95	0.740	−0.940	0.722
		(0.047)	(0.097)	
9. Newsprint Consumption	92	0.599	0.707	0.760
		(0.035)	(0.025)	
10. Population per Physician	95	−0.635	2.734	0.689
		(0.044)	(0.152)	
11. Population per Hospital Bed	101	−0.898	2.766	0.729
		(0.054)	(0.137)	
12. Percent Calories from Cereals	63	−2.700	5.212	0.714
		(0.214)	(0.362)	
13. Motor Spirit Consumption	70	0.450	−0.164	0.515
		(0.052)	(0.097)	
14. Percent of Population 5–19 in Primary and Secondary Schools	98	0.811	−1.422	0.636
		(0.062)	(0.151)	

Multiple Regression Estimating Equation ($\bar{R}^2 = 0.933$):

$$\underset{(0.185)}{\text{Log}_{10}\,GDP} = \underset{(0.185)}{0.260} + \underset{(0.039)}{0.210}\log(\text{No. 4}) + \underset{(0.054)}{0.174}\log(\text{No. 7}) - \underset{(0.036)}{0.136}\log(\text{No. 10}) + \underset{(0.045)}{0.146}\log(\text{No. 2}).$$

for the low income countries for which better estimates are needed, this further reflects the limitations of the indicator approach.

Table 2, column (1), gives per capita ERY in dollars at the average of 1963, 1964 and 1965 values, in current prices as taken from the National Accounts Yearbooks. Columns (2), (3) and (4) are each indexes of GDP, with the base being the average of column (1), namely, $570. Column (2) is the index of column (1); columns (3) and (4) are the indexes of our estimates of per capita GDP based on simple and multiple regression equations respectively. In the previous paragraph we explained the method of estimating PPY from the simple regression equations in Table 1. Also given in Table 1 is the multiple regression estimating equation which used as variables on a per capita basis estimated energy consumption, the

TABLE 2

MEASURES OF PER CAPITA GDP AT OFFICIAL EXCHANGE RATES AND ESTIMATES FROM SIMPLE AND MULTIPLE REGRESSION EQUATIONS
101 COUNTRIES FOR 1963–1965

	GDP at Official Exchange Rates	Indexes of GDP, $570 = 100			Ordinal Ranking of Indexes in Columns			Change in Rank	
		At Official Exchange Rate	Simple Regression Estimates	Multiple Regression Estimates	(2)	(3)	(4)	(6)–(5)	(7)–(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Malawi	39	6	14	12	1	4	7	3	6
Ethiopia	48	8	10	7	2	2	2	0	0
Nigeria	65	11	13	10	3	3	3	0	0
Chad	65	11	9	7	4	1	1	−3	−3
Burma	65	11	20	10	5	11	5	6	0
Tanzania	71	12	20	15	6	11	15	5	9
Congo	74	13	25	15	7	15	14	8	7
Uganda	77	13	22	18	8	14	17	6	9
Indonesia	84	14	17	14	9	7	11	−2	2
Haiti	85	15	15	11	10	6	6	−4	−4
Togo	87	15	15	10	11	5	5	−6	−6
Kenya	87	15	31	28	12	20	23	8	11
India	92	16	26	17	13	17	16	4	3
Pakistan	94	16	22	15	14	13	13	−1	−1
Sudan	97	17	21	14	15	12	12	−3	−3
South Vietnam	102	18	26	13	16	16	10	0	−6
South Korea	105	18	38	25	17	28	20	11	3
Thailand	112	19	27	19	18	19	18	1	0
Cameroon	113	19	20	13	19	9	10	−10	−9
Cambodia	117	20	27	13	20	18	8	−2	−12
Sierra Leone	132	23	18	21	21	8	19	−13	−2
Ceylon	138	24	33	29	22	22	24	0	2
Bolivia	142	25	41	31	23	30	27	7	4

Taiwan	153	27	55	34	24	46	30	22	6
Syria	164	28	50	33	25	41	28	16	3
Egypt	169	29	44	36	26	33	35	7	9
Morocco	176	31	38	36	27	27	35	0	8
Zambia	186	32	35	37	28	24	36	−4	8
Jordan	189	33	50	40	29	42	40	13	11
Ecuador	190	33	47	30	30	38	26	8	−4
Tunisia	193	34	47	39	31	38	39	7	8
Paraguay	195	34	38	30	32	29	25	−3	−7
Honduras	199	35	33	27	33	23	22	−10	−11
Algeria	211	37	49	46	34	40	43	6	9
South Rhodesia	227	39	63	63	35	49	53	14	18
Iran	227	39	42	38	36	31	37	−5	1
Brazil	229	40	57	52	37	47	47	10	10
Philippines	232	40	44	35	38	33	32	−5	−6
Peru	233	41	59	58	39	48	50	9	11
Ghana	238	41	36	26	40	25	21	−15	−19
Iraq	244	42	48	38	41	39	38	−2	−3
El Salvador	245	43	55	47	42	45	44	3	2
Mauritius	245	43	64	48	43	50	45	7	2
Turkey	247	43	47	36	44	36	33	−8	−11
Liberia	253	44	31	34	45	21	29	−24	−16
Dominican Republic	256	45	52	43	46	43	42	−3	−4
Malaysia	260	45	53	51	47	44	46	−3	−1
Colombia	263	46	64	54	48	51	49	3	1
Guyana	281	49	71	61	49	52	52	3	3
Guatemala	288	50	38	35	50	26	31	−24	−19
Nicaragua	304	53	45	41	51	35	41	−16	−10
Yugoslavia	329	57	77	66	52	56	54	4	2
Portugal	345	60	80	88	53	58	62	5	9
Costa Rica	369	64	71	59	54	54	51	0	−3
Barbados	370	65	84	69	55	60	55	5	0
Surinam	375	65	72	81	56	55	59	−1	3
Lebanon	379	66	87	97	57	62	65	5	8
Bulgaria	381	67	106	92	58	69	64	11	6
Malta	389	68	105	130	59	68	75	9	16
Mexico	416	73	71	72	60	54	57	−6	−3

TABLE 2—*continued*

	GDP at Official Exchange Rates	Indexes of GDP, $570 = 100			Ordinal Ranking of Indexes in Columns			Change in Rank	
		At Official Exchange Rate	Simple Regression Estimates	Multiple Regression Estimates	(2)	(3)	(4)	(6)–(5)	(7)–(5)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Romania	429	75	103	103	61	66	66	5	5
Jamaica	438	77	78	83	62	57	61	−5	−1
Panama	456	80	84	79	63	61	58	−2	−5
Libya	494	86	44	53	64	34	48	−30	−16
Poland	495	87	111	91	65	72	63	7	−2
Chile	509	89	81	71	66	59	56	−7	−10
South Africa	526	92	109	133	67	70	76	3	9
Greece	536	94	89	82	68	63	60	−5	−8
Uruguay	537	94	116	119	69	74	72	5	3
Spain	547	96	97	108	70	64	68	−6	−2
Cyprus	559	98	99	107	71	65	67	−6	−4
Trinidad and Tobago	661	116	128	114	72	75	70	3	−2
Argentina	672	118	110	126	73	71	74	−2	1
Hungary	705	123	111	112	74	73	69	−1	−5
Japan	732	128	130	121	75	76	73	1	−2
Ireland	763	134	141	161	76	79	79	3	3
Czechoslovakia	803	141	160	177	77	83	83	6	6
Venezuela	851	149	104	117	78	67	71	−11	−7
U.S.S.R.	884	155	154	201	79	81	87	2	8
Italy	911	160	135	177	80	78	83	−2	3
Puerto Rico	1,008	177	163	154	81	84	78	3	−3
Austria	1,032	181	163	199	82	85	85	3	3
Israel	1,068	187	132	138	83	77	77	−6	−6
Netherlands Antilles	1,072	188	152	187	84	80	84	−4	0
East Germany	1,195	209	165	165	85	86	80	1	−5
Netherlands	1,250	219	167	200	86	87	86	1	0

Finland	1,434	251	158	176	87	82	81	5	−6
Belgium	1,450	254	179	228	88	89	90	1	2
France	1,450	254	170	211	89	88	88	1	−1
United Kingdom	1,478	259	199	258	90	95	96	5	6
West Germany	1,539	270	187	230	91	91	91	0	0
Norway	1,556	273	195	224	92	94	89	2	−3
Luxembourg	1,700	298	190	244	93	93	93	0	0
Australia	1,750	307	205	279	94	97	97	3	3
New Zealand	1,771	311	211	279	95	98	98	3	3
Iceland	1,826	320	204	244	96	96	92	0	−4
Denmark	1,850	324	189	250	97	92	95	−5	−2
Switzerland	1,994	350	187	245	98	90	94	−8	−4
Canada	2,018	354	243	320	99	100	100	1	1
Sweden	2,026	355	218	289	100	99	99	1	−1
United States	3,028	531	280	382	101	101	101	0	0

stock of passenger vehicles, telephones, and the variable, population per physician. One drawback to the use of multiple regression equations is that all indicators for all countries may not be available. We have created values of all variables for the 101 countries as *one* way to deal with missing observations. The countries were ranked by ERY as in Table 2, and if an indicator was missing, the value of that indicator for the first country above it in rank that had an observation on that indicator was used. For the final equation used for our estimates, it was necessary to assign 17 values of the various indicators of the 404 observations needed. The estimated values from this equation, put into an index based on \$570 = 100, is given in column (4). Columns (5), (6), and (7) give the ordinal ranking from low to high of the countries as given by the indexes in columns (2), (3), and (4) respectively. Columns (8) and (9) reflect the change in rank from ERY, a positive value meaning that a country had risen in rank by that number if its position were judged on the basis of columns (3) or (4). After describing Table 3 we will turn to an analysis of the results of Table 2.

In Table 3, columns (1) through (4) are the same as those of Table 1 for a group of countries and territories for which there were no available estimates of ERY for the 1963–1965 period, or the available estimates of ERY did not seem solid enough to use as a basis for the estimating equations presented in Table 1.[12] The bases for the indexes in columns (2) through (4) of Table 3 are the same as for those columns in Table 1. The estimate in column (2) is obtained by taking the arithmetic mean of the estimates obtained using the equation in Table 1 for the indicators available for each country. The average number of indicators available for the 46 countries in Table 3 was 7.9 out of a possible 14 indicators.

The multiple regression estimates for 45 of the 46 countries given in column (3) of Table 3 are obtained in the same way as those in Table 1, but there were many more observations to be filled in, namely 31 of the total of 180.[13]

We will make no further comments about the estimates of Table 3, except to note that further work is clearly needed. For example, a number of the regression estimates are quite low. This occurs, as I interpret the data, because with respect to energy consumption and telephones, most of the low countries on our list are substantially below the range of these variables for the countries over which the equations were estimated. I believe this illustrates precisely the problem faced by Beckerman and Bacon in getting satisfactory estimates for low income countries, when there were few observations available. When we go beyond the

[12]More exactly, for those countries for which ERY estimates are given in Table 3, there were no estimates given by the United Nations in the National Accounts Yearbook.

[13]As mentioned, for multiple regression estimates we have assigned for missing observations the value of the variable for the country above it (on the basis of ERY). For the estimates of Table 3, we have done the same thing except the countries had to be ranked on some other basis, since ERY was not usually available. The initial basis was per capita total energy, and if that failed, per capita electric energy, and if that were not available, any variable or combinations that were available for the country. The order of countries in Table 3 corresponds to this ranking. For Lesotho, no observations were available on any of the variables entering the multiple regression, so no estimate was included. Also, no simple regression estimates were made for countries with less than four indicators, which led to the elimination of three of the original 49 countries.

range of the indicators, the error of forecast does increase, and this seems especially apparent in Table 3.

IV. Analysis of Results of Individual Countries and Groups of Countries

In the discussion below, I interpret the difference between ERY and PPY as due to an influence that operates systematically throughout the range of countries, and factors that in any particular range of GDP tend to shift countries up or down. The systematic influence can be seen from columns (2), (3), and (4) of Table 2, where the spread or range of countries in columns (3) and (4) is much smaller than that in column (2). Now this narrowing of the spread of incomes is in the "expected direction", where expected means the direction most writers suggest. On the question of whether the narrowing of the spread is too large or too small, we regretfully have little to say.

The position of any particular country in column (5) versus columns (6) and (7) in Table 2 may be unchanged by the process of narrowing the spread. A country is likely to change relative position if for some reason its exchange rate is inappropriate, in relation to other countries, to estimate its ERY. I at first thought this would mean that countries with overvalued exchange rates ought to find their relative position lower in columns (6) and (7) than in column (5). However, the countries that change their relative position downward are hardly those continually seeking help from the IMF—rather they are poorer countries thought to have strong currencies. This may be seen by looking at which countries have large drops in rank as given in columns (8) and (9) of Table 2.

Those countries with drops in rank of over ten places in both columns (8) and (9) are Honduras, Liberia, Ghana, Guatemala, Nicaragua, and Libya. The common characteristic of these countries is that they are small and their foreign trade is a large proportion of their national product. The estimating equations place the estimated PPY for these countries lower than the ERY. This is a phenomenon associated mostly with the countries in the upper third of the distribution. Still, for all of these countries their position relative to the U.S. improves, so clearly the relative upward movement of these countries is less than for their peers. Why? I would argue that the systematic effect in the use of exchange rates that overstates the income of the rich also overstates the income of any countries highly integrated (including mono-cultures) in the world economy. The heuristic argument is that when a large portion of the output of a country is exchanged on the world market, the exchange rate is a much better approximation of what one would find with a purchasing power comparison than for large countries with more inscrutable exchange rates. So, when we adjust such countries to a "purchasing power" basis, their position relatively declines.

When we ask what countries moved up over ten positions in columns (2) and (3) relative to column (1), the three countries are Southern Rhodesia, Brazil, and Taiwan. I see no common or simple explanation of the upward movement of these countries. If we add those countries, which while not moving upward ten places in both columns (8) and (9), are close to that, we would add Syria, Kenya, the U.A.R., Jordan, Peru, Bulgaria, and Malta. I see no pattern to these countries

TABLE 3

MEASURES OF PER CAPITA GDP AT OFFICIAL EXCHANGE RATES AND ESTIMATES FROM SIMPLE AND MULTIPLE REGRESSION EQUATIONS 49 COUNTRIES AND TERRITORIES FOR 1963–1965

	GDP at Official Exchange Rates[1]	Indexes of GDP, $570 = 100			GDP Estimates in Dollars	
		At Official Exchange Rate	Simple Regression Estimates	Multiple Regression Estimates	Simple Regression Estimates	Multiple Regression Estimates
	(1)	(2)	(3)	(4)	(5)	(6)
Lesotho	55	10	17	11	98	—
Botswana	55	10	20	12	115	67
Portugese Timor	—	—	9	6	50	32
Nepal	66	12	10	5	55	30
Upper Volta	51	9	8	6	48	34
Niger	70	12	9	7	49	38
Burundi	45	8	11	7	65	39
Rwandi	33	6	10	6	59	32
Mali	60	11	10	8	58	48
Afghanistan	65	11	11	8	62	45
Somalia	48	9	15	11	85	63
Dahomey	74	13	15	14	86	78
Central African Republic	99	17	18	13	104	73
Gambia	85	15	16	7	92	38
Madagascar	117[2]	21	26	13	146	76
Laos	63	11	14	11	78	64
Mauritania	116	20	13	17	74	96
North Vietnam	88	15	20	21	111	117
Portugese Guinea	—	—	16	22	92	126
New Guinea	175[3]	31	37	22	211	126
West Irian	—	—	26	31	149	174
Papua	—	—	43	31	246	177
Swaziland	236	41	38	46	218	260

Mongolia	380	67	88	62	501	353
Mainland China	85	15	47	25	266	143
South West Africa	—	—	68	28	389	161
Guinea	72	13	18	16	102	93
Angola	168	29	23	24	134	137
Mozambique	—	—	24	23	139	129
Ivory Coast	206	36	25	25	140	141
Senegal	204	36	31	28	177	162
Congo (Brazzaville)	163	29	36	44	203	252
Reunion	—	—	69	62	391	355
Gabon	365	64	43	34	243	193
Macao	—	—	67	40	385	225
Saudi Arabia	179[2]	31	36	29	203	167
North Korea	187	33	87	67	498	383
Guadaloupe	274	48	73	75	414	429
Albania	—	—	61	62	350	355
Martinique	—	—	86	81	489	462
Fiji Islands	—	—	56	59	318	338
Ryukyu Islands	—	—	82	63	467	360
Hong Kong	486	85	89	77	510	440
Cuba	323	57	80	80	458	456
Singapore	504	88	91	94	521	537
South Yemen	—	—	93	56	532	318

[1]Unless otherwise noted, data are from the World Bank, World Tables of Resources, Product and Income, Economics Department, 1968. Data apply to 1965

[2]Data from Banks (1971)

[3]Including Papua

since several also combine the characteristics of being small, as well as having a large dependence on foreign trade.[14]

The remainder of this section attempts to apply some weak tests of consistency to our estimates by comparing them to the results of other studies. The basic data for these comparisons and some other estimates are contained in Table 4, where columns (1), (2), and (3) are the same as columns (2) to (4) of Table 2, namely indexes of ERY, our simple regression estimate of PPY on column (2), and our multiple regression estimate in column (3). In column (4) we present the OECD estimates, in columns (5) and (6) the estimates of Beckerman and Bacon of consumption, in column (7) the estimates for some CMEA countries by Szilágyi (1968), in column (8) the estimates of Madison (1970), in column (9) the estimates for ECLA countries (from Beckerman and Bacon, 1966), and in column (10), the estimates of Ehrlich (1969).

The series in Table 4 are all in index form. The average value of each index is the average value of the index of ERY in column (1) of Table 4 over the range of countries included in each of the studies taken separately.

In the table below we present correlations of short-cut estimates with the independent real GDP estimates of ECLA, the OECD and Maddison. For example, there are 19 ECLA countries for which indexes exist for 1960. We have correlated our short-cut estimates of real GDP for these countries with the estimates from the ECLA study. To see how well our short-cut estimates did in comparison with those of Beckerman and Bacon, we have 13 observations of Beckerman and Bacon overlapping with the ECLA study, and have also run correlations over these countries. The same has been done for the OECD and Maddison studies, where the correlations reported are of the short-cut estimates of GDP with the independent real GDP figure.

		Short-cut Estimates		
		Beckerman and Bacon Estimates	Simple Regression Estimates	Multiple Regression Estimates
ECLA	$n = 13$	0.865	0.941	0.941
ECLA	$n = 19$		0.922	0.941
OECD	$n = 9$	0.910	0.906	0.920
Maddison	$n = 27$	0.928	0.980	0.960

I would draw several conclusions from the above comparisons. First, all of the correlations (R^2) are high, which I believe tells more about the weakness of correlation measures for such comparisons than about the quality of the various

[14]We have examined these countries in the context of the typology developed by Chenery and Taylor (1968, p. 407) where they find different structural patterns as between large, small manufacturing and small primary producing countries. Their study covers fifty-four countries. In terms of the countries whose rank fell in Table 1, all are small, and most would be termed primary producing. However, the countries who rose also included small primary countries (Kenya), and small manufacturing countries (Taiwan, Rhodesia, and Peru) as well as several large countries.

estimates. By this I mean that the various estimates give widely different ranges of real GDP, but nothing in the correlation measures above can discriminate very much between the explanatory value of more or less elongated series of estimates.

The range of our simple regression estimates put Chad at 9 and the U.S. at 280, while the multiple regression estimates put Chad at 7 and the U.S. at 382. The range of ERY is 6 to 531 for Malawi to the U.S., and for Beckerman and Bacon, the range from Ethiopia to the U.S. is 3 to 464. Is the distance between the 101 countries in this study in the ratio of 1 to 40, 1 to 90, or 1 to 140? Unfortunately, the above correlations are little guide to answering this question.

A second point is that we have run our estimates in one race loaded against us, namely when we compare our estimates with those of Beckerman and Bacon for the OECD estimates, which in fact were observations in their equations. Now there is not just one way this race could be run. As mentioned, the OECD numbers in Table 4 have been updated from 1950 on the basis of the growth in per capita real output within each country during the period to 1964. Since the Beckerman and Bacon estimates were for 1960, it seemed appropriate (and it did improve the correlation of their estimates with the OECD figures) to update their figures to 1964 which was done on the basis of the growth in output per capita between 1960 and 1964.[15] As may be seen by the correlation measures, OECD estimates based upon real GDP for the OECD countries plus others are no closer to the original OECD estimates than our ERY estimates for the OECD countries.

I would argue that the results presented, if not terribly strong, are at least consistent with our story. In particular, the correlations of the estimates of Beckerman and Bacon with the ECLA and Maddison estimates point again to the real need of more estimates of real GDP for low income countries. The Maddison estimates involve most of the rich and some of the poor countries entering the estimating equations of Beckerman and Bacon. The ECLA estimates involve mostly countries not included in the estimating equations of Beckerman and Bacon. The fact that the correlations of Beckerman and Bacon with ECLA are lower than their correlations with Maddison, both absolutely and relative to our estimates, is consistent with the proposition by now oft repeated that the Beckerman and Bacon estimates seem less reliable the lower the level of per capita income.[16]

In concluding this section on physical indicators, I believe these estimates using physical indicators suggest the following points:

(1) Estimates for countries very much outside the range of the independent variables are problematical. These countries are also least likely to have real product estimates.

[15]Therefore the figures in Table 4 are not those underlying the above correlation, which are Italy (66), Netherlands (84), Belgium (106), France (108), U.K. (107), W. Germany (105), Norway (108), Denmark (119), and the U.S. (171).

[16]Another point of interest in the above correlations is that both the Beckerman and Bacon and our estimates are more highly correlated with Maddison than with the OECD countries. Why should this be so? The answer is that the variance to be explained between the OECD countries is comparatively small, so that estimates have to be fairly sharp to produce high correlations. Because the variance between countries entering Maddison's estimates is much larger, many measures besides ours or those of Beckerman and Bacon could produce high correlations.

TABLE 4

	Indexes of GDP, $570 = 100			Indexes of GDP from Other Studies						
	At Official Exchange Rate	Simple Regression Estimates	Multiple Regression Estimates	OECD	Beckerman	Beckerman and Bacon	Szilági	Maddison	ECLA	Ehrlich
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Malawi	6	14	12	—	—	—	—	—	—	—
Ethiopia	8	10	7	—	—	3	—	—	—	—
Nigeria	11	13	10	—	—	13	—	—	—	—
Chad	11	9	7	—	—	—	—	—	—	—
Burma	11	20	10	—	—	7	—	—	—	—
Tanzania	12	20	15	—	—	—	—	—	—	—
Congo	13	25	15	—	—	17	—	—	—	—
Uganda	13	22	18	—	—	—	—	—	—	—
Indonesia	14	17	14	4	—	13	—	—	—	—
Haiti	15	15	11	—	—	7	—	—	13	—
Togo	15	15	10	—	—	—	—	—	—	—
Kenya	15	31	28	—	—	—	—	—	—	—
India	16	26	17	—	—	17	—	32	—	—
Pakistan	16	22	15	—	—	13	—	27	—	—
Sudan	17	21	14	—	—	7	—	—	—	—
South Vietnam	18	26	13	—	—	—	—	—	—	—
South Korea	18	38	25	—	—	20	—	45	—	—
Thailand	19	27	19	—	16	20	—	45	—	—
Cameroon	19	20	13	—	—	—	—	—	—	—
Cambodia	20	27	13	—	—	20	—	—	—	—
Sierra Leone	23	18	21	—	—	—	—	—	—	—
Ceylon	24	33	29	—	22	30	—	48	—	—
Bolivia	25	41	31	—	—	20	—	—	42	—
Taiwan	27	55	34	—	—	40	—	—	—	—
Syria	28	50	33	—	—	46	—	—	—	—
Egypt	29	44	36	—	—	33	—	52	—	—

Morocco	31	38	36	—	34	43	—	—	—	—
Zambia	32	35	37	—	—	—	—	—	—	—
Jordan	33	50	40	—	—	36	—	—	—	—
Ecuador	33	47	30	—	—	27	—	—	43	—
Tunisia	34	47	39	—	—	43	—	—	—	—
Paraguay	34	38	30	—	—	23	—	—	36	—
Honduras	35	33	27	—	—	—	—	—	30	—
Algeria	37	49	46	—	—	73	—	—	—	—
South Rhodesia	39	63	63	—	—	—	—	—	—	—
Iran	39	42	38	—	—	40	—	—	—	—
Brazil	40	57	52	—	55	66	—	85	42	—
Philippines	40	44	35	—	—	—	—	47	—	—
Peru	41	59	58	—	43	—	—	70	49	—
Ghana	41	36	26	—	21	27	—	40	—	—
Iraq	42	48	38	—	—	50	—	—	—	—
El Salvador	43	55	47	—	—	—	—	—	40	—
Mauritius	43	64	48	—	—	53	—	—	—	—
Turkey	43	47	36	—	39	53	—	51	—	41
Liberia	44	31	34	—	—	—	—	—	—	—
Dominican Republic	45	52	43	—	—	27	—	—	36	—
Malaysia	45	53	51	—	—	60	—	93	—	—
Colombia	46	64	54	—	60	66	—	66	48	60
Guyana	49	71	61	—	—	—	—	—	—	—
Guatemala	50	38	35	—	—	—	—	—	42	—
Nicaragua	53	45	41	—	—	—	—	—	35	—
Yugoslavia	57	77	66	—	—	73	—	129	—	—
Portugal	60	80	88	—	70	93	—	—	—	81
Costa Rica	64	71	59	—	—	—	—	—	67	—
Barbados	65	84	69	—	—	—	—	—	—	—
Surinam	65	72	81	—	—	—	—	—	—	—
Lebanon	66	87	97	—	—	103	—	—	—	—
Bulgaria	67	106	92	—	—	60	94	—	—	—
Malta	68	105	130	—	—	116	—	—	—	—
Mexico	73	71	72	—	49	73	—	74	74	78
Romania	75	103	103	—	—	73	79	—	—	—
Jamaica	77	78	83	—	—	—	—	—	—	—
Panama	80	84	79	—	—	—	—	—	73	—

TABLE 4—*continued*

	Indexes of GDP, $570 = 100			Indexes of GDP from Other Studies						
	At Official Exchange Rate	Simple Regression Estimates	Multiple Regression Estimates	OECD	Beckerman	Beckerman and Bacon	Szilági	Maddison	ECLA	Ehrlich
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Libya	86	44	53	—	—	—	—	—	—	—
Poland	87	111	91	—	—	73	101	—	—	—
Chile	89	81	71	—	85	90	—	151	94	85
South Africa	92	109	133	—	122	139	—	—	—	128
Greece	94	89	82	—	54	70	—	119	—	78
Uruguay	94	116	119	—	—	100	—	—	122	—
Spain	96	97	108	—	86	113	—	171	—	83
Cyprus	98	99	107	—	—	70	—	—	—	—
Tripoli	116	128	114	—	—	—	—	—	—	—
Argentina	118	110	126	—	104	129	—	223	124	123
Hungary	123	111	112	—	—	70	108	—	—	114
Japan	128	130	121	—	—	170	153	257	—	125
Ireland	134	141	161	—	92	156	—	—	—	171
Czechoslovakia	141	160	177	—	—	149	161	—	—	—
Venezuela	149	104	117	—	101	103	—	222	116	—
U.S.S.R.	155	154	201	—	—	116	—	262	—	—
Italy	160	135	177	173	—	176	—	236	—	140
Puerto Rico	177	163	154	—	—	—	—	—	—	—
Austria	181	163	199	—	217	219	—	—	—	211
Israel	187	132	138	—	122	149	—	235	—	127
Netherlands Antilles	188	152	187	—	—	—	—	—	—	—
East Germany	209	165	165	—	—	126	159	—	—	—
Netherlands	219	167	200	219	252	242	—	—	—	251
Finland	251	158	176	—	227	222	—	—	—	228
Belgium	254	179	228	276	247	246	—	—	—	266
France	254	170	211	282	268	249	—	349	—	240

United Kingdom	259	199	258	280	299	332	—	348	—	311
West Germany	270	187	230	274	307	285	—	370	—	273
Norway	273	195	224	282	362	275	—	—	—	277
Luxembourg	298	190	244	—	—	—	—	—	—	—
Australia	307	205	279	—	315	352	—	—	—	—
New Zealand	311	211	279	—	282	315	—	—	—	—
Iceland	320	204	244	—	—	159	—	—	—	—
Denmark	324	189	250	311	296	289	—	—	—	286
Switzerland	350	187	245	—	301	319	—	—	—	300
Canada	354	243	320	—	355	358	—	—	—	—
Sweden	355	218	289	—	415	415	—	—	—	—
United States	531	280	382	446	510	464	—	558	—	—

The Indexes in columns (4) through (10) are adjusted so that the sum of the index over the countries in a column is equal to the sum over those countries of the index in column (1).

(2) What is the trade-off between using observations on real GDP as the few dependent variables, versus using the larger number of observations on conventional GDP? The answer is twofold. First the correlation comparisons presented here show no significant differences in the two methods. Second, the alternative estimates produce larger differences in the range of real GDP between the rich and poor countries.

This last feature of our results I think deserves emphasis, namely that when estimating equations are generated from data for most countries of the world, they do tend to systematically reduce the range of per capita incomes. The mechanics of this phenomenon are simple enough; most indicator series available over a large range of countries are those which if not income inelastic, probably have a lower elasticity for the more affluent countries. An implication of this last point is that an estimate of an elasticity of income with respect to an indicator does not adequately explain the most affluent country, the United States. This tends to squeeze the distribution of income estimated from a level of an indicator, for all indicators considered, and this is why using physical indicators to generate estimating equations of some composite variable that we have called real GDP produces results in accord with the received literature.

Conclusion

Much of the space in this paper has been devoted to comparing short-cut methods using physical indicators. I believe existing short-cut results point to a strong need for more estimates of real GDP, especially for low income countries. The sad state of the art is that the number of real GDP estimates are too few to allow satisfactory short-cut estimates for low income countries. Further, as shown in the empirical section of the paper, a short-cut approach based on conventional GDP figures collapses the range of dispersion of estimated real GDP in accord with expectation, and does no worse in estimating real GDP for sub-groups of countries than estimates based on the few real GDP observations. However, while the approach used here appears to reduce apparent differences in real GDP, there is no way to judge if the reduction is too large or too small. I take this all to mean that short-cut methods based on indicators do not at present produce satisfactory results for the range of world countries, and will not until more estimates of real GDP become available.

Further, the indicator approach is at best a less direct approach than alternatives like abbreviated purchasing power studies. One reason an indicator approach has probably found favor is that the statistical agencies do report physical indicators for many geographical units. This is certainly not true for price information. To collect material that would allow one to compare, say, the prices of 20 specified items over 40 countries would be much more difficult than to assemble material on 50 indicators for 100 countries. And to further adopt some type of weighting system for the price data would present a substantial research effort. However, I think it is precisely this type of effort that needs to be fostered, in order that breakthroughs be made in this area. Considering the fact that the U.N. is a price-collecting agency for the purpose of determining allowances for personnel, and that the State Department in the United States, as well as national

agencies in other countries like Germany, also collect price data, really without any consideration for their alternative uses, it seems to me clear that there are incentives enough to produce resources for some regularization of price collection across countries. I would certainly argue in favor of more effort in this direction.

Appendix on MPS Estimates

The methods we have used with respect to the MPS countries are different from those used with other countries, though it is my suspicion that a geographically defined area, like Africa, might show more homogeneity than the MPS countries. In any event I perceived a problem with MPS countries on two possible scores; first, the MPS concept might call for special treatment relative to GDP, and second, of the many exchange rate problems of the countries in the sample, there might be some identified with the MPS countries that would justify special treatment.[17] It is not at all clear that either of these ideas has any validity, but let me describe the procedure.

I computed a relative index of the MPS countries from indices of components of income as given in *Studies in Comparison of Levels of Economic Development of the Socialist Countries*, a translation of Chapters 5, 6, 7, 8 and the major part of 9 of the Russian-language book entitled *Sopostavleniye Urovney Edonomicheskogo Razvitiya Sotsialisticheskikh Stran* (Comparison of Levels of Economic Development of the Socialist Countries), Moscow, 1965, pp. 127–202 and 204–226, Economic Institute of Gosplan, ed. by J. Kotkovsky, U.S. Department of Commerce, Clearinghouse for Federal Scientific and Technical Information, 1966. To translate this index level to a per capita monetary measure some exchange rate could be used, or the adjustment could be made by a dummy intercept. We decided to use an exchange rate of one of the countries, namely, the non-commercial rate for Hungary, so that the dummy variable should mainly reflect any difference due to differences in income concept. Since these dummy coefficients differed in sign and were often not significant, I concluded that errors from income concept or exchange rate are less for the MPS countries than the errors in the basic relationships posited by the regression equations. In the text, the separate intercept terms have been omitted, since they seem to add little to the analysis. While I think these remarks are substantially correct when the MPS countries are considered with respect to a total of 101 countries, it is also clear that our estimation methods give rise to relative rankings for the different countries that are certainly open to question.

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[17]G. Szilágyi has pointed out to me a 1968 comparison of Hungarian GDP following MPS and SNA procedures, for the period 1959–65, the difference being that the SNA figure was about 9 percent larger than the MPS figure. (Csernok; 1968).

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