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Measurement of Real Product

JOHN W. KENDRICK

NATIONAL BUREAU OF ECONOMIC RESEARCH

THE only paper with a separate section addressed directly to the Department's estimates of national product in constant dollars is that by Everett E. Hagen and Edward C. Budd. All of the papers touch on relevant matters, notably the question of factor cost valuation. But since only a few of the chief problem areas involved in the deflation of national product are discussed at all, I have been asked to undertake an independent development of the topic, in addition to commenting on the points raised in the other papers.

I must confess at the outset that some of my views are in the nature of self-criticism, since I had a hand in preparing the real product estimates while employed at the Office of Business Economics. Though I shall not for that reason temper my comments, the experience of dealing with the estimates at the working level has perhaps given me a sympathetic understanding of the many difficulties faced by the national income specialists in their efforts to disentangle the price and quantity elements contained in the current value figures.

The Valuation of National Product

Three of the papers run the gamut of opinion regarding factor cost valuation of national product as contrasted with the market price valuation employed by the Department of Commerce. Raymond T. Bowman and Richard A. Easterlin maintain that "such a valuation would be preferable for many purposes," and recommend that "A factor cost valuation of the product side should also be presented or should be obtainable from accompanying data." Hagen and Budd believe that while factor cost "is perhaps conceptually superior as a gauge of the productivity of resources . . . the practical difficulties associated with a strict application of the factor cost method are so serious that a market price measure is a better 'all purpose' valuation scheme." Kenneth D. Ross, without commenting on its theoretical advantages in certain contexts, dismisses the factor cost concept as "one of the most unsatisfactory notions with which economists have tried to deal statistically."

For myself, I take a position close to that of Hagen and Budd, although I would give a more unqualified endorsement to the theoretical desirability of a factor cost valuation for purposes of production and productivity comparisons. Certainly if identical productive resources were priced uniformly throughout the economy in terms of their marginal products, important conclusions could be drawn from the output and input estimates. In such an economy product prices represent alternative costs, as stressed by Bowman and Easterlin; thus, relative values measure the relative volume of resources absorbed by products or industries. Given appropriate qualifications, resource requirements at different levels and compositions of output can be calculated. Further, with the use of constant factor prices, real factor inputs indicate temporal changes in the allocation of resources among industries.

Another advantage of this approach, not mentioned by Bowman and Easterlin, is that changes in the ratio of output (at constant factor cost) to input (valued in terms of factor prices of the same base period) indicate changes in productive efficiency, or productivity, of the factors. That is, the comparison reveals what output in period II would have cost if the technology of I had been replicated in II, relative to what the output *did* cost in II in terms of actual factor inputs. Since, as Bowman and Easterlin point out, this type of comparison involves the assumption of constant returns to scale, the productivity ratio measures the net effect of tendencies toward increasing and diminishing returns, as well as shifts in production functions due to technological innovation.

While Bowman and Easterlin consider it impractical to try to adjust prices of factors and factor costs of products to the rates that would prevail under competitive equilibrium (by eliminating monopoly profits and, presumably, rents resulting from a dynamic disequilibrium), they do think it is both feasible and desirable to adjust for disturbances created by government intervention in order to arrive at "realized factor cost." In terms of the various types of final produtcs, this would involve deducting per unit indirect business taxes and adding government subsidies (financial, or "in kind" as represented by intermediate services, if this concept is accepted).

The Bowman and Easterlin proposition would be a large statistical undertaking. It means that both taxes and subsidies on various industries would have to be traced through the various value added stages to the final impact on end products. For the large proportion of government intermediate services that are "non-product specific," or overhead in the sense that they "do not affect the relative costs of individual busi-

ness products," the adjustment would be proportional to value of product. The investigator would probably end up by allocating proportionately a sizeable part of indirect taxes, such as business property, gross receipts, franchise, and general sales taxes. Ultimately relative factor costs and relative prices would differ significantly only for those products that bear an unusually large share of indirect taxes (primarily the excises), or that receive unusually large subsidies in kind or money, unless these were offsetting.

Apart from statistical difficulties, there is not yet a consensus on the concept of realized factor cost. In a recent article, J. L. Nicholson maintains that factor costs have generally been mistakenly identified with factor rewards.[1] He points out that proportionality of marginal product of a factor and its price must relate to the cost of the factor to the *purchaser*. This means that factor cost would not only be inclusive of direct taxes on the income, but also of indirect taxes "which are directly attributable to factors or materials used up in production." Accordingly, Nicholson would include all indirect taxes in factor cost "except those which are levied *after* the final stage of production, and which cannot therefore affect the proportions in which different factors or materials have been combined in the production process."

While I agree with Nicholson in respect to indirect taxes bound up directly with factor use, I believe that he is in error regarding taxes on materials. After all, excises also indirectly affect the combination of factors. It is only the direct cost of a factor with which its marginal product is equated. I believe that the effort should not be made to trace indirect taxes on intermediate products back to the component factors, but rather that they should remain as part of the discrepancy between factor cost and market price. In any case these taxes are of minor importance in the United States. Excise and sales taxes account for well over half of all indirect business taxes, so that even if Nicholson's scheme were accepted, the statistical task of allocating indirect taxes by product would still be large.

With regard to the movement of national product at constant factor cost, several points may be made. In the first place, for purposes of deflation one would continue to deal with market value estimates, since the applicable price indexes are generally based on market prices. To convert the quantity estimates so derived—and these would be weighted automatically in terms of market prices—one could either multiply each set of constant dollar estimates by the ratio of realized factor cost to market price in the base period, or convert the constant market price

[1] J. L. Nicholson, "National Income at Factor Cost or Market Prices?" *Economic Journal*, June 1955, pp. 216-224.

series to index numbers and weight by the relative expenditures per unit at realized factor cost. The movement of the aggregates derived by the two different systems of weighting would differ only insofar as the items with significantly different relative weights showed significantly different real expenditure movements on net balance.

My guess is that the effect of factor cost weights on real product movements—in the aggregate or by major component—would be slight. In view of the fact that the adjustment to a realized factor cost basis would be rough at best, I would not recommend that the Department give this project high priority. This type of experimental project is, however, eminently suitable for private individuals or research groups. I am sure that the Office of Business Economics would make available unpublished data and would, if the results seem promising, consider incorporating in the accounts a table on national product at factor cost. In the meantime, I agree with Hagen and Budd that real product with market price weights as an "all purpose" index may be used for comparisons of productivity, if the qualifications are made clear to the user.

Although Bowman and Easterlin seem not to be concerned with an industry approach to the accounts, this is precisely where we do have realized factor cost estimates in the sense in which they employ this term. For purposes of weighting indexes of net physical volume of output—or of gross output when these are taken to stand for net output —unit national income weights are appropriate. I agree with Bowman and Easterlin, however, that rents should be shown in the industries where the property is used.

Problems of Estimating Real Product

Hagen and Budd endorse the general method followed by the Department ". . . by which the value of each final product is deflated by the price series for that final product, or by the closest approximate substitute." Theoretically, if value and price data comprise the universe, deflation yields the same result as if the quantities of all goods and services produced were weighted by prices of the same period that serves as a base for the price indexes—which is what we are after in a "real product" measure. In practice, we cannot hope to collect all the required price and quantity data, even though the value estimates may be reasonably good. For this reason we confront several sets of problems.

The major problem of deflation in that part of the market economy where goods that are more or less identical over time are directly priced is to obtain adequate samples of prices which are representative

of the movements of all prices in the various product groupings. In the nonmarket area of the economy, consisting largely of households and nonprofit institutions, and general government (viewed as a producer), output is not directly measured or priced through bilateral transactions; here the problem is to find alternatives to product price deflation as a means of approximating output. Finally, in some parts of the market economy, nonstandardization of products over time, or the absence of conventional pricing, also calls for alternative methods.

DEFLATION OF MARKET VALUE

Since the Department must depend on price indexes collected by other organizations, the reliability of the deflators is conditioned in the first instance by the degree to which these indexes reflect average price movements over the country of the complex products and product "families" they are supposed to represent. The components of the Bureau of Labor Statistics consumer price and wholesale price indexes are the major source of the Department's data. It is my impression that these basic price indexes have been carefully constructed, particularly in more recent years.[2] The prices-paid indexes put out by the Department of Agriculture appear also to be carefully prepared, although they are based on less elaborate research.

Other indexes used by the Department of Commerce are often of unknown quality. For example, the Interstate Commerce Commission's railway equipment cost indexes, which are employed to deflate important segments of producers' durable equipment, are prepared by methods that have not been adequately described in print. The same is true of price data and indexes supplied by mail-order houses. With such indexes there are always questions as to strictness of commodity specification and other technical matters.

Even after price indexes had been taken from all available sources and combined into deflators for the various product groupings, the Department had to make some imputations of price movements to uncovered products (not to mention uncovered localities and trade outlets), and in several instances to use substitute indexes entirely. For example, the BLS price index of motion-picture theatre admissions was applied to other types of admissions; the automobile price index was applied to parts and accessories; and special-industry machinery was largely deflated by a composite of price indexes for other types of machinery.

With the limited resources at its command, the Department was not able to make studies to test the reasonableness of its imputations; it was

[2] See *Major BLS Statistical Series,* Dept. of Labor, Bull. 1168, 1954.

hoped that the homogeneity of the group according to the criteria by which it was originally set up would also hold for price movements. Clearly, it would be desirable if such studies could be undertaken; they might well be launched in cooperation with the BLS, which has a fund of experience in the realm of price measurement. Two of the BLS price economists suggested at the 1955 Income Conference that the national product groupings may not be best suited for price sampling, and that other groupings, for example by production process, might be better. Certainly, if products could be classed according to patterns of productivity change in the originating industries, superior results should emerge from the price imputations, at least over longer periods.

It hardly needs to be added that real product estimates would most probably be improved if additional price series were available. The estimates of real outlays for producers' durable equipment are much better after 1939, and again after 1947, when BLS expanded its price collection work in this area. The reliability of price indexes generally improves as coverage increases,[3] and some gaps are still serious as in the special industry machinery category of producers' equipment, and in several classes of consumers' services. This illustrates the dependence of the National Income Division, because of the eclectic nature of its estimates, on other statistical agencies. It is to be hoped that the requirements of national income work will be more fully met in the future planning of the statistical operations of the federal agencies by the budget makers.

NONSTANDARD PRODUCTS

Certain kinds of market products show little or no standardization over time. Construction and the manufacture of ships and aircraft come to mind in this connection, as do also certain types of machinery that are built to order. In the latter case, the price indexes for the standardized portion of output are applied to the value of the custom-built items. It seems reasonable to assume that unit costs and prices of custom-built items tend to move with prices of standardized products of the same industry, although productivity may be expected to rise relatively, and relative prices to fall somewhat, over the long-run for the standard products.

There is no such easy expedient for the industries whose entire product is nonstandard. The Department generally uses for these products "cost indexes" which represent averages of prices for the inputs of materials and labor. In effect, therefore, real input is substituted for real output, although actually the two should differ to the extent that

[3] *Ibid.*, pp. 92-93.

productivity changes over time. While this procedure has the advantage of objectivity, it is clearly deficient as a basis for temporal comparisons of production and productivity.

If output measures are sought, one possibility is to apply some common denominator of the diverse items produced. For example, tonnage might be used in the case of ships, and square feet of floor space in the case of building construction. The drawback to this expedient is that changing product mix affects calculated unit value (the implicit deflator), apart from price change as such.

A more promising alternative is to employ what might be called "pseudo-price" indexes. A number of these are available for several major types of construction. The specifications of a typical product in the field are spelled out, and hypothetical bids are taken periodically from a representative group of producers. For example, the Bureau of Public Roads prices a standard mile of highway construction, and there is an index of prices of new houses based on estimates submitted by four contractors on standard structures.[4] The estimates reflect changes in the labor, capital, and materials costs per unit, including any savings in costs resulting from technological advances. While the Department uses the Bureau of Public Roads index, other pseudo-price indexes should be considered, since they are at least theoretically superior to cost indexes as deflators.

FINANCIAL SERVICES

This product grouping in the business sector also requires special scrutiny. Financial services are usually connected with value magnitudes, such as bank deposits, personal debt, life insurance, and security and commodity exchange dealings. The real dimensions of the services are difficult to define, especially in view of fluctuations in the value of the monetary unit. Accordingly, the prices are connected only indirectly with the "physical volume" of the services provided.

This is not the place to examine closely the procedures adopted by the Department in this area. The point is that conventions are set up to get at the real financial outlays of persons, and these inevitably involve considerable subjectivity both to determine what the real service is, and to set up statistical procedures for its measurement. For example, in the case of services furnished by financial intermediaries, the base period value is extrapolated by the estimated relevant deposits deflated by the consumer price index. The service provided by life insurance companies is broken down into the insurance and invest-

[4] See Miles Colean and Robinson Newcomb, *Stabilizing Construction*, McGraw-Hill, 1952, p. 71.

ment components, with the former extrapolated by the dollar volume of insurance in force, deflated by the consumer price index, and the latter extrapolated by the total admitted assets of the insurance companies, similarly deflated.[5]

In this area in particular, I think that prior to revision of its deflation procedures, the Department would profit by writing up detailed technical notes on present procedures and their underlying rationale, and circulating these for criticism. When complex conventions are used, it is desirable to have the advice, if not the consensus, of the specialists concerned.

NONMARKET OUTPUT

Price deflators can obviously not be applied to the value of the services of nonprofit institutions and of general government, since these services are not sold in the sense of a market *quid pro quo*. The Department follows the same procedure here that it does with much of construction: it deflates the value series by indexes of the average prices of the inputs. Thus, the constant dollar series move as do real costs, or physical inputs. Again, this expedient has the virtues of uniformity and simplicity which are at a premium in government statistical work, but the resulting estimates lend a downward bias to intertemporal comparisons of real product and productivity insofar as factor productivity may have increased in the segments so treated.

The Department's procedure might be rationalized in the case of general government by the argument that government is an ultimate consumer in the sense that its purchases are the point of the final bilateral market transaction. As is true of consumption expenditures, government purchases are not resold. But this is in fact a paradoxical position, as we see clearly when the compensation of general government employees is to be deflated. For this purpose the Department uses average compensation by groups of employees, emerging with a physical output series that parallels movements of labor input. Thus, no productivity change is attributed to government employees, and none can be unless government is looked on as a producer and its output compared with the inputs commanded in order to get at productivity change. The treatment of general government as an "industry" in the income tables seems to imply a producer view, however, in contrast to the consumer view adopted with regard to government purchases.

[5] See George Jaszi and John W. Kendrick, "Problems and Techniques of Measuring the Volume of National Output," Inter-American Seminar on National Income Reference Document, Santiago, January 5-17, 1953, processed, Dept. of Commerce, 1952, pp. 30ff.

If the producer role of government is accepted, the problem of measuring real product becomes at once simpler and more difficult. It is simpler when, as the academic economists urge, part of government output is treated as intermediate. This part would not appear separately in national product, since it is already reflected in the final outputs of the private sector. Thus, volume measures of the government intermediate services are not needed for real product estimates as such (although if production estimates by industry are attempted, there would have to be an imputation of part of private output back to the government inputs which were credited with facilitating the production in private industries). The producer approach is more difficult in that, if production comparisons are to be made, series approximating the movement of real final output must be sought, as in the case also of nonprofit institutions.

I have not made an extensive investigation of the types of series that might be used to indicate movements in the physical volume of services provided by general government and nonprofit institutions. The following possibilities are listed only to suggest the sort of solution that can be found, and I hope that better ones may be devised. For nonprofit organizations such as religious bodies, social and athletic clubs, and labor unions, the number of members might be employed. In the case of education, public and private, the number of students, or student-days of attendance, suggests itself. For public and private nonprofit hospitals, the average daily census of occupied beds is available. Social welfare agencies keep statistics on number of cases handled. The number of books circulated is a possible index of the service output of libraries, and the average number of visitors can be an index of museum service. The final output provided by public highways could be indicated by the passenger miles traveled by individuals in their role as consumers.

The shortcoming of these proposed indexes is that they fail to reflect changes in the quality of the services rendered. For example, a larger number of students per teacher might indicate a decline in the quality of service, rather than an increase in productivity of the educational industry. It is, however, also true that commodity measures do not reflect quality changes adequately. Unless the output indexes of the type suggested appear unreasonable *prima facie,* I believe their use is desirable if production and productivity comparisons are to be made.[6]

[6] Apparently the British make use of the type of output indicator I have suggested for the nonmarket sector. See J. L. Nicholson, "Problems in the Measurement of Real National Income," in *Income and Wealth, Series IV,* Milton Gilbert and Richard Stone, editors, London, Bowes and Bowes for International Association for Research in Income and Wealth, 1955.

Those who favor further expansion of the imputations for nonmarket activity to increase the invariance of national income movements to institutional differences should bear in mind, however, that such expansion would aggravate the difficulties just discussed and would probably detract from the quality of the estimates for intertemporal comparisons.

REAL PRODUCT BY SECTOR AND INDUSTRY

It would be helpful for a number of purposes if the Department were to publish a more elaborate sector breakdown of the real product estimates. I am thinking particularly of the following detail, estimates for which either are presently available or could readily be obtained:

National product	
less:	Product originating in the rest of the world
equals:	Domestic product
less:	Government product
equals:	Other domestic product
less:	Household and institutional product
equals:	Business product
	Farm
	Nonfarm

Not only would there be interest in the relative movements of output in the various sectors, but for purposes of productivity comparisons it is preferable to deal with business product. Only around 5 per cent of real gross business product in 1953 was composed of input measures instead of outputs proper, whereas approximately 20 per cent of real gross national product was so constituted; all three reconciliation items shown above are represented primarily by input estimates. Net product measures would be generally preferable to gross, if the Department can estimate meaningful capital consumption allowances in current and constant prices. There seems to be little disagreement with the proposition that consumption of capital should be treated in the same manner as consumption of nondurable intermediate products.

With regard to income originating in the rest of the world, I should like to back up the proposal of Hagen and Budd that this be shown as a separate line in the summary national product tables in constant as well as in current dollars, so that a further line for geographic or "domestic" product may be derived. In this way geographic location of the factors becomes the criterion for inclusion of income, rather than residence of the owners. The difference is important chiefly in relation to capital, since residence and location are practically coterminous for labor. The deduction of net payments of factor incomes from abroad,

which are part of net foreign investment in the national product estimates, means in effect that income payments to capital located in the domestic area but owned abroad are added, while income to United States residents from their capital investments abroad is subtracted.

For the analysis of the relationship of real product to real capital stocks, real domestic product is superior. Even if capital estimates could be adjusted to a nationality basis, the flow of real income from foreign-owned capital would bear an erratic relationship both to the output of the activities in which the capital was involved, and to the real capital stock itself. This would tend to distort capital coefficients, although as Hagen and Budd point out, net payments of factor income have not loomed large in the United States. In the first decade of this century, they averaged a minus 0.5 per cent, whereas in the past few years they have averaged close to a plus 0.5 per cent. Yet this is not a good reason not to make the theoretically desirable distinction between national and domestic products.

Since domestic product is estimated for purposes of production comparisons, the domestic concept is consistent with the estimation of real net foreign investment as deflated exports of goods and services less deflated imports, which is the Department's current practice. This method of deflation is consistent also with a presentation of national product gross of exports, with a separate line for the imports deduction, as has been recommended in some of the papers. Hagen and Budd point out, however, that for welfare comparisons it is more appropriate to deflate net foreign investment (including net factor payments from abroad) directly, so that the effects of changing terms of trade may be reflected in the purchasing power of the nation. If a single measure is to be shown, I believe that the Department's estimates are more consistent with its general emphasis on the production aspects of the national accounts.

REAL PRODUCT BY INDUSTRY

If we are to compare the divergent movements over time of industrial output and productivity on a basis comparable with real domestic product, we shall require estimates of net industrial output. The physical volume of net output, or the real product originating in various industries is, as has become more widely understood since the work of Fabricant and Geary, the real value of gross output less the real value of the intermediate products consumed in the production process. For a number of purposes this measure is superior to the gross output indexes. It reflects savings in purchased materials, increasing degrees of fabrication, and it automatically adjusts for changes in the scope of an

industry's operations. These changes over a period of time may cause a gross output index to be misleading, particularly for purposes of productivity analysis. Estimates of real farm product indicate that on the net basis farm production has increased considerably less than when measured gross.[7] It seems probable that the reverse is true outside of the extractive industries, but we need direct estimates before we can know whether the net measures diverge significantly from the gross.

I hope that the Department and other research groups will push forward the preparation of estimates of this sort, at least for census years when sufficient information is available. Eventually, it may be possible for the Department to publish at least a partial elaboration of Table 13, showing real product by industry at factor cost for selected years. In the meantime, I urge that at least the farm-nonfarm breakdown of the real product table be published on a regular annual basis, since even this detail is informative and has found increasing use.

COMPARISON OF INDUSTRY OUTPUT AND REAL PRODUCT ESTIMATES

Table 1 presents a comparison of a major portion of real private domestic product (the total exclusive of estimated real product originating in finance, service, and construction) with a composite of physical volume of output indexes for the corresponding industries. When due weight is given to major inherent differences which might cause a moderate discrepancy in the movements of the two types of series, the comparison provides a rough check on the reasonableness of the estimates.

The sources and methods employed in making the estimates are described in the Appendix to this discussion. Here it will suffice to point out that whereas the weighting systems underlying each composite measure have been made comparable, the methodologies are basically different. That is, the real product series are composed of deflated value of final product estimates; the physical volume series (with a few exceptions noted in the Appendix) are made up of physical units of various types of output, weighted by unit values, adjusted to represent full coverage of the various industries. While the industry output indexes, with the exception of farming, are gross of intermediate products as well as of depreciation, they have been combined with unit factor cost weights.

[7] For a description of concept and methodology used in the initial estimates, see John W. Kendrick and Carl E. Jones, "Gross National Farm Product in Constant Dollars, 1910-1950," *Survey of Current Business,* September 1951, pp. 13-19. For more recent estimates employing different price weights, see L. Jay Atkinson and Carl E. Jones, "Farm Income and Gross National Product," *Survey of Current Business,* August 1954, pp. 18-24.

The real product series in 1953 had risen to 221 per cent on a 1929 base, compared with a 205 per cent rise in the physical volume composite. The greater rate of increase in real product is evident in the three subperiods as well over the quarter century as a whole. The

TABLE 1

Comparison of Composite Industrial Production Index with Real Product Originating in the Corresponding Economic Sector, Selected Years, 1929-1953

Sectors and Industries	Factor Income, 1929 (*billions*)	Index Numbers (*1929=100*[a]) 1937	1948	1953	Link Relatives 1937-1948	1948-1953
		DEFLATED GROSS PRODUCT				
National economy	$87.8	103	166	210	161	126
Rest of world	0.8	42	89	110	212	125
Domestic economy	87.0	104	167	210	161	126
General government	4.3	164	232	340	142	147
Private domestic economy	82.7	101	164	204	162	125
Construction	3.8	61	135	174	223	129
Finance	12.7	84	142	178	168	125
Services	10.3	95	126	152	133	121
Residual	55.9[b]	108	177	221	163	125
		INDUSTRIAL PRODUCTION[c]				
Composite[c]	55.0[b]	105	169	205	161	121
Agriculture[d]	8.3	105	121	124	116	102
Mining	2.0	101	141	155	140	110
Manufacturing	21.9	102	181	238	177	131
Durable	(11.3)	92	178	255	193	144
Nondurable	(10.6)	114	185	214	162	116
Trade	13.4	108	164	189	152	115
Transportation	6.6	105	205	217	195	106
Railroad	(4.6)	81	142	132	176	93
Other[d]	(2.0)	176	402	499	229	124
Communications and public utilities[d]	2.8	113	251	346	222	138
Telephone and telegraph	1.1	92	183	205	199	112
Electric and gas utilities	1.6	128	306	498	239	163

[a] Although 1929 is the comparison base for the indexes, the weight bases used were 1929-1937, 1937-1948, and 1948-1953.

[b] These totals are not equal here because the $0.8 billion national income originating in government enterprises was not distributed among the private industrial divisions. The remaining error is due to rounding.

[c] The industrial production indexes are all weighted aggregates of physical units, with the exception of agriculture, trade, and a few manufacturing industries prior to 1939. All are gross output measures, except for agriculture. See Technical Notes in Appendix.

[d] Physical volume indexes were not available for the following industries (income originating in 1929 shown in parentheses): agricultural services, forestry, and fisheries (0.2); services allied to transportation (0.3); radio broadcasting and TV, and local utilities and public services, n.e.c. (0.1).

NOTE: I am indebted to Maude R. Pech, John Myers, and George Philip of the National Bureau of Economic Research for valuable assistance in the preparation of this table.

divergence and its direction are not unreasonable in view of several major differences in the two approaches.

The major factor is that the ratio of net to gross output except in the extractive industries, has probably increased over time. This is suggested by exploratory work in estimating net output in manufacturing industries, and by fragmentary studies in other industrial areas.[8] It stands to reason that constant competitive pressures on management would lead to innovations resulting in savings of materials as well as in factor costs per unit of output; while a growing complexity of products would mean greater processing per unit—both factors tending gradually to reduce the gap between gross and net.

Another possibly important factor is that whereas deflated value estimates tend fully to reflect the shifts from lower to higher value items within the same product class or family, physical volume measures do not, insofar as the basic product units used are more or less heterogeneous. If there is a secular tendency toward more expensive grades of products as real income increases over time, the physical volume indexes would tend to have a downward bias on this score.

It has been suggested that the coverage adjustments applied to the physical volume indexes hold the possibility of significant downward bias.[9] That is, if part of the uncovered areas consists of new products whose prices typically fall and whose productivity rises relative to the established products which are covered, the coverage adjustment based on an imputed price, unit value added, or on productivity, would result in too small an increase in physical volume. On the other hand, this source of downward bias is present in the real product estimates, since price indexes of new products do not generally become available until well after the fact of the introduction to the market of the new products.

These arguments point to the probability that physical volume series have a downward bias as indicators of net output, rather than that the real product series are biased upward. Since both sets of estimates rely on many of the same basic sources, it is of course quite possible that both have various errors in common. But given the sources and the rather plausible rationalization of the discrepancy, the secular correspondence is gratifying as one test of the reliability of the real product series.

[8] See *Thirty-fifth Annual Report* National Bureau of Economic Research, May 1955, p. 47; also Jacob M. Gould, *Output and Productivity in the Electric and Gas Utilities, 1899-1942,* NBER, 1946, pp. 172-183.

[9] Cf. Irving H. Siegel, "Concepts and Measurement of Production and Productivity," National Conference on Productivity Working Paper, processed, Bureau of Labor Statistics, 1952, pp. 63-69.

In the following tabulation, the two series are compared from peak to trough of three business cycles on an annual basis. The real product measure consistently shows somewhat less decline than the physical volume composite, although the amplitude of each cycle is quite different. This result runs counter to what might have been expected on the basis of a priori reasoning.[10] On the one hand, the deflators are usually based on quoted prices which fail to incorporate all relevant terms of sale, and show less amplitude than the more appropriate "net realized price;" on the other, insofar as there is a shift to lower-value qualities of products in depression, physical unit series would understate the drop in output. Evidently the presumed effect of these two factors is outweighed by the net effect of other factors—among which a cyclical, as well as a secular, tendency for the ratio of net to gross output to increase on the downswing may be important.

PRIVATE DOMESTIC ECONOMY[a]

	Link Relatives	
Period	Real Product	Physical Volume
1929-1932	70.7	69.8
1937-1938	92.4	90.0
1948-1949	97.9	96.5

[a] Excluding finance, services, and construction (see Appendix).

Finally, it is recognized that both series are subject to a secular downward bias in that neither the physical units nor the price deflators underlying the real product figures are, or could well be, adjusted to take account of the many improvements in quality that have taken place over the period. Shifts from lower to higher value items are reflected in the real product estimates, however. While the problem of quantifying complex qualitative changes may be "insuperable," as Ross maintains, the physical volume series are still tremendously useful even though they do not tell the whole story.

THE WEIGHT-BASE PROBLEM

For purposes of the preceding comparison, the national product estimates in 1947 dollars were reweighted by changing sets of average prices for the successive pairs of years of high level business activity: 1929-1937, 1937-1948, and 1948-1953, and the resulting real product figures were chained to form a continuous series. The comparison could as well have been made on the basis of 1947 price weights so long as both series were consistently weighted. As a practical matter, however, it was easier to reweight the 200 product categories of the Commerce estimates than it would have been to go back and reweight the still

[10] Cf. Jaszi and Kendrick, *op. cit.*, pp. 19, 40.

larger number of product components of the industrial production indexes, as well as the indexes themselves, which are largely chain indexes with weight bases approximating those designated above.

Actually, changing weights did not make a large difference in the movements of real product, as the following tabulation shows:

REAL GROSS NATIONAL PRODUCT

	Link Relatives		
Weights	1929-1937	1937-1948	1948-1953
Fixed (1947) weights	102.8	158.9	125.7
Changing weights	103.3	160.8	126.2

The greater increase in real product based on changing weights is to be expected in the two earlier periods, since it is usual for relative quantity and relative price changes to be negatively correlated. For the same reason, it is surprising that the divergence in the 1948-1953 period, while relatively less than in the preceding periods, was still in the same direction. This suggests that 1947 prices were in relative disequilibrium: we know that in that year there were still shortages of many types of durables at prevailing prices. Since then, both output and prices of many of the same goods have shown greater than average increases, which may explain the greater increase in the chain index for the period 1948-1953.

Apart from the statistical requirements for the comparison, I should like to suggest that a chain output index involving occasionally changing unit value weights has some advantages over a fixed-base series as represented by the Department's real product estimates. Changing weights have generally been used in the National Bureau output series, and also in the Federal Reserve Board index of industrial production.

I recognize, of course, that there is no "solution" to the index number problem, and that ideally all the component value and price estimates should be shown so that users can apply methods which best suit their purposes. Particularly for binary comparisons, the user may wish to weight the output series in terms of prices in each of the two periods compared. If publication of the detailed deflation worksheets is not feasible, I suggest that the Department add these series to the national income "source book" proposed by Martin R. Gainsburgh and Morris Cohen.

The weighting of the real product time series still poses a difficult problem. If the prices of a single recent period are used for weights, the base must be shifted occasionally. The Department has shifted from a 1939 to a 1947 base since inaugurating the real product estimates. This results in some inconvenience and possible confusion to the un-

wary user, since the movement of the series as well as its level is affected. With a system of changing weights, the real estimates for past periods are fixed in terms of prices prevailing in selected years, and only the estimates for recent years are affected as new weight bases are added. Apart from this advantage, it seems more reasonable to weight output indexes by prices which are relatively contemporaneous with the industrial structure of the various subperiods. The chain index also makes it easier to add or drop products without extensive extrapolation of prices on an hypothetical basis.

Use of successive price bases means that the real product estimates could not be described in terms of the "dollars" of a particular year. But if it were desired to tie the deflated estimates into a particular year for comparison purposes, the current value estimates of that year could be extrapolated by the real estimates. A footnote could make it clear that the particular year, also used as the base for presenting the implicit deflators, was a "comparison base," and the price weight bases could be spelled out. Actually, there would be some advantage if the deflated estimates were given in terms of index numbers. The user could convert to any particular comparison dollars he wished, although he should not believe that he was thereby shifting the weighting system.

Deflation of Income

In general, I think it is not desirable to convert the income flows in the national accounts to constant dollars in terms of purchasing power. For special purposes it may be desired to deflate some of the income flows—notably in the case of disposable personal income, as suggested by Hagen and Budd, although in this context the implicit deflator for personal consumption expenditures is more appropriate than the consumer price index. But if each income flow were deflated by an index of the prices of the items for which it is believed the income is spent (which is usually an arbitrary determination, especially for the part of income that is saved), it would be only by coincidence or by forcing that the accounts would balance. If all income streams were deflated by a general price index, the meaning of each would be of dubious significance, and since the cross-sectional relationships would remain the same as in current dollars, the case for such a correction is questionable. While there will be uses for such "*ad hoc* deflation" of income elements, as Jaszi termed it at the 1955 Conference, it is preferable that this should be done by the users.

There is, however, another sense in which I think it is important to attempt to deflate national income in the aggregate and by industries. This is the deflation by factor prices (paid) to yield measures of the

physical volumes of factor inputs, or "real costs." At the first Conference on Research in Income and Wealth almost twenty years ago, Morris Copeland suggested this approach:

> "Income derived from an area may be deflated to show changes in the physical volume of services of labor and wealth employed by the economic system from time to time. If we may neglect net income from abroad as relatively small, the deflated distributive shares may be compared with the deflated consumed and saved income to show changes in the efficiency of operation of the economic system."[11]

Since the war more economists have become interested in measuring total real input, usually as a means of determining changes in "total factor productivity," although it is useful also for the study of changes in factor shares, factor substitution, and price-cost relationships. The suggestion of Gainsbrugh and Cohen that estimates of man-hours and of national wealth would be desirable elaborations of the national accounts is a step in this direction, for such estimates would provide the necessary raw materials for measures of real factor input. While it might be fairly generally accepted that man-hours weighted by average hourly labor compensation in the various industries provide an acceptable measure of labor input, the problem of contriving a generally acceptable measure of capital input is more difficult. It is not my present assignment to go into these intricacies, although I should like to say that the Hagen and Budd analysis of the relationship between capital stocks and capital services is an important contribution to the subject. If net capital stocks are so estimated as to regularize the rate of return, this would open the way to estimating real capital services, or "inputs," via estimates of real net capital stocks.

The estimation of factor input is another area in which further exploration by nongovernmental individuals or research groups would be desirable. If the results prove fruitful, I hope that by the time of the next Conference review the Department may have seen fit to incorporate into the national accounts supplementary tables showing real factor costs and prices,[12] as well as the real product and price series which have already become an indispensable part of the accounts.

[11] Morris A. Copeland, "Concepts of National Income," in *Studies in Income and Wealth, Volume One,* National Bureau of Economic Research, 1937, p. 31.

[12] I am encouraged by Jaszi's remark on the subject "we can make useful progress along these lines if we advance gradually, guided and restrained by clear-cut analytical purposes" in *Problems in the International Comparison of Economic Accounts* (Studies in Income and Wealth, Volume Twenty, Princeton University Press for NBER, 1957, p. 210).

APPENDIX

Technical Notes to Table 1.

A. REAL NATIONAL PRODUCT

The indexes of gross national product, government product, and gross private product, in constant dollars, are based on the Department's deflated estimates. Product originating in the rest of the world was deflated by the over-all implicit deflator for private product. For consistency with the physical volume indexes, we reweighted all estimates in terms of the following sets of price averages: 1929-1937; 1937-1948; 1948-1953; and then chained the real product aggregates.[13]

In order to estimate the portion of real private domestic product that corresponds to the industry divisions for which physical volume indexes are available, it was necessary to estimate real gross product originating in finance, service, and construction, and to deduct this from the total. The general procedure followed was to build up current dollar gross product estimates for the three industrial divisions from the available national income figures, and then to deflate these directly by price indexes believed to approximate those implicit in the Department's real product estimates for the final products originating in each of the three segments.

There are several possible sources of error in this procedure. First, the charges against gross national product other than factor costs for the three industry divisions were obtained by applying to the total of such charges for the economy the ratios to total national income of the national income in each of the three divisions. If capital consumption allowances and indirect business taxes could have been estimated properly for each, the movement of gross product in each division would probably have differed a bit from the movements underlying the present estimates.

Second, our price deflators approximate a variable weighted average of those used by the Department to deflate the final products originating in these sectors. This procedure is necessary if the industry real products estimates are to be reasonably consistent with total real product. In the case of finance and services, a minor but significant por-

[13] I am indebted to George Jaszi of the Office of Business Economics for making available worksheets that enabled us to carry out the reweighting in 205-product detail.

tion of the services produced is intermediate. We are thus assuming implicitly that the prices charged business in these areas have changed proportionately with those charged consumers. Finally, the deflators should properly be applied to total value of product in order to obtain a gross output measure, with deflated intermediate product inputs being deducted to give us net. The procedure followed here involves the assumption that the ratio of net to gross has not varied significantly. Since intermediate inputs are small in the finance and service segments, it is unlikely that the assumption produces a serious error.

B. PHYSICAL VOLUME INDEXES

The sources of the various indexes, listed below, describe the estimating methodology for each. With the exceptions noted, the industry series are based on physical units weighted by unit values. Industry indexes were usually combined by unit value-added weights. Coverage adjustments were applied in the manufacturing and some other groups. The group and segment indexes were generally combined by unit national income weights for the periods 1929-1937, 1937-1948, and 1948-1953. This set of weights is roughly consistent with the internal weighting system applied within the group indexes. A coverage adjustment was applied to the indexes for the entire sector to take account of the slight variations in national income originating in the four small industrial groups not covered (see note to Table 1) which accounted for about 1 per cent of national income in 1929.

1. Agriculture

These indexes are based on the estimates of deflated gross farm product published in *Survey of Current Business* (August 1954, pp. 22-23), but with the price weights changed to 1929-1937, 1937-1948, and 1948-1953 for the four groups of gross output and the two groups of intermediate products as published. This is the only industrial division for which a net output measure was used, although it is consistent with the others in being gross of depreciation.

2. Mining

Estimates were made in terms of the five major component groups, as presented by Harold Barger and Sam H. Schurr in *The Mining Industries, 1899-1939* (National Bureau of Economic Research, 1944, Appendix A), for the period 1929-1939; these series were estimated for 1947 based on the same sources and methods described by Barger and Schurr. They were extrapolated to 1953 by the corresponding com-

ponents of the Federal Reserve Board index of mineral production. The series were combined by changing unit value-added weights.

3. Manufacturing

Indexes of the physical volume of production in nineteen major manufacturing groups from 1939 to 1947 are those contained in *Indexes of Production* (Bureau of the Census, 1952). They were extrapolated to 1953 by the Federal Reserve Board indexes of manufacturing production. They were extrapolated back to 1929 by the estimates of Fabricant, as reproduced in the census volume, with the following exceptions: "textiles and apparel," and "lumber and furniture" were subdivided into the component groups; and the underlying physical volume series was supplemented by deflated value series in the case of textiles and of furniture; deflated value series were also used to supplement the available physical volume series in the fabricated metal products, machinery, and miscellaneous groups in order to provide sufficient coverage to justify separate group indexes. The group indexes were then combined over the entire period by changing unit national income weights, both for the segment as a whole and for the durable and nondurable subdivisions as defined by the Federal Reserve Board.

4. Trade

This series is based on the sources and methods described in Harold Barger's *Distribution's Place in the American Economy since 1869* (Princeton University Press for NBER, 1955), except that more recent estimates of commodity flows were substituted for later years. Basically, this series represents the constant dollar value of products flowing through trade channels, weighted by distributive margins in the various types of outlets. The constant dollar estimates were converted from fixed to changing weights.

5. Transportation

The physical volume indexes are those contained in *The Transportation Industries, 1899-1946,* by Harold Barger (NBER, 1951, Appendixes B, and D through I), for steam railroads and the six other industry groups in terms of which the indexes were constructed. The group indexes were combined by changing unit national income weights and extended to 1953 by the sources used by Barger.

6. Communications and Public Utilities

Indexes of output for the electric light and power, manufactured gas and natural gas industries for the period 1929-1942 are those con-

tained in *Output and Productivity in the Electric and Gas Utilities, 1899-1942* by Jacob M. Gould (NBER, 1946, Appendix A), extended to 1953 by the same sources and methods. Revision of some of the earlier estimates was made possible by subsequent data. The indexes were combined by changing unit value added weights.

For telephones, the number of message units in local, in toll, and long-distance categories were weighted by average revenue per unit for each in the base years. For telegraph, the number of revenue messages transmitted in the domestic telegraph, ocean cable, and radio telegraph categories were weighed by the corresponding unit revenues. The data were taken from the *Annual Statistics of the Communications Industry in the U. S.* (Federal Communications Commission, various years).

COMMENT

GEORGE JASZI, Department of Commerce

As can be seen from my paper, I am in substantial agreement with John W. Kendrick on most of the important issues with which he deals. I shall comment only on certain aspects of his discussion which, in my opinion, would gain by further elaboration.

1. On page 406 Kendrick writes as though measures of aggregate output divided by aggregate factor input were a more immediately attainable goal than they appear to be from his subsequent discussion of the difficulties of measuring aggregate factor input (pages 421 ff.).

2. The discussion of nonstandard products should be pursued further to explore its bearing on the familiar problem of comparisons between times or places characterized by qualitatively different standard products. Kendrick recommends wider use of what he calls "pseudo-price" indexes, in lieu of the cost indexes now in use. "The specifications of a typical product in the field are spelled out, and hypothetical bids are taken periodically from a representative group of producers." The device he recommends might well be useful also in connection with this second type of problem. It would be interesting to have a precise statement of the neressary and sufficient conditions of its applicability to either or both.

3. Kendrick recommends a thorough airing of the problems involved in the deflation of financial services. I would like this done also for other items of consumer expenditure to which conventional deflation procedures do not seem applicable. Most of the troublesome items are in the category of services. The investigation should determine

whether the difficulties encountered are really different in kind from those encountered in the deflation of commodities. Some of the same difficulties may be common to both areas but can be banished from consciousness in the case of commodities as long as one is willing to adopt an uncritical attitude. For when one deals with commodities rather than services, some obvious sort of physical unit is always present to be priced, and the question of which unit to price does not usually force one into an analysis of the real content of the product involved.

4. Kendrick's discussion of the problems of deflation posed by nonprofit institutions and government would gain if he took account of the fact that they are not unique to these areas of the economy. His general proposition is that in these areas a deflation of purchases is not adequate and that one ought to substitute external measures which are a closer approximation to the services these organizations render. For instance, he would use the change in the number of members of social clubs as the indicator of the change in the volume of services rendered by these clubs. In measuring the services rendered by nonprofit hospitals he would make similar use of the number of occupied hospital beds.

However Kendrick's logic might equally be applied to households, where it would equally require change in the established procedures of deflating purchases. If the services of a country club providing a swimming pool and a golf course are to be approximated by membership, why should we not be on the lookout for a similar extraneous measure —say, size of family—in the case of a family backyard equipped with a rubber wading pool and a croquet set? If nonprofit hospital services are to be measured by occupied beds rather than by current operating expenditures, why is it satisfactory to rely on family expenditures for medical care instead of looking for an external indicator that comes closer to the ultimate service received? An attempt to give a reasoned answer to these questions would improve our ability to evaluate Kendrick's proposals and would throw light on the proper treatment of government services in the final product aggregate—a problem which has much exercised this conference.

5. I agree with Kendrick that the calculation of constant-dollar national product by industry should be encouraged. However, I think that constant market prices would represent the simplest basis of valuation, and I am surprised that Kendrick recommends constant factor cost. To measure an industry's output at constant market prices, we subtract the industry's inputs, valued at their market prices in the base period, from its outputs similarly valued. To derive a measure at constant factor cost we would have to value these inputs and outputs in

terms of their base-period factor costs, an approach which involves the extremely difficult task of allocating capital consumption, indirect taxes, and subsidies among interindustry product flows.

6. Although I find the discussion and table on page 420 hard to follow, I appreciate the many practical reasons that prompt Kendrick's advocacy of the use of shifting price weights to deflate national product, instead of the fixed weights now employed. However, existing index number theory lends itself only to the interpretation of fixed-weighted measures, and the adoption of shifting weights, however convenient, would bar a precise theoretical interpretation of the statistical results. I wish that this apparent conflict between the theoretically desirable and the practically useful could be bridged.

PART VII