Volume Title: Measuring the Nation's Wealth

Volume Author/Editor: Wealth Inventory Planning Study

Volume Publisher: U.S. Government Printing Office

Volume ISBN: 0-870-14185-6

Volume URL: http://www.nber.org/books/unkn64-3

Publication Date: 1964

Chapter Title: Appendix I-H: The Measurement of Capital

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Chapter URL: http://www.nber.org/chapters/c5206

Chapter pages in book: (p. 329 - 353)

APPENDIX I: PART H

THE MEASUREMENT OF CAPITAL

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THE MEASUREMENT OF CAPITAL

It is so easy to get one's fingers burnt trying to measure something called "capital," that only the incautious could be expected to accept the challenge of preparing a paper on this subject. Only a decade ago it was an article of faith among graduate students that capital theory was a "mess." But now that growth economics has become of commanding interest to the profession this attitude toward capital, its theory and measurement, seems to be disappearing. No matter how difficult may be the problems of dealing analytically and empirically with capital, everyone appears now to be convinced that it is important to try.

This paper will review the various methods for measuring capital that have found common acceptance in the literature. Each method measures a different aspect of capital, and each will be evaluated critically in terms of its ability to measure that concept of capital to which it is directed. In addition the paper proposes a supplementary measure of capital—value added on wealth account—based upon the net market value of establishments.

I. What Is Capital?

To me the outstanding distinguishing characteristic of things to which the term "capital" applies, is just that their presence is required by or enhances the economic activities of production and sales, and this quality of being present is not normally altered to an important degree by these activities. There is no consumption of such capital inputs in any sense similar to the consumption of raw materials and energy. For this reason I have always considered the term "capital consumption" to be somewhat misleading. It is the feature of *not* being consumed that endows capital with its uniqueness. Economic efficiency may require capital to be displaced, but not consumed. Thus knowledge (usually classified as human capital), which cannot be consumed in any sense through use (and which may even have a tendency to expand with use), is more capital-like than the most durable tangible structures. There is an alternative concept of capital which is really a corollary to the "presence" concept, viz the idea of capital being anything that increases the owner's future stream of income receipts. But this is implied by the fact of being productive and not currently consumed.

These elementary considerations point inevitably to a stock as opposed to a flow concept of capital. If capital is to be measured meaningfully, it must be measured as a stock or inventory of things present during the process of production and sale. The term "services" is a useful word for describing what it is that a capital good supplies when it is present during production, but I do not believe as a general rule that the term has very much, if any, practical operational content for productivity analysis. For many types of capital, a measure of services

such as building-hours or pipeline-hours just doesn't seem very interesting. For other types of capital such as machines that rotate and move and turn out pieces, I can't see that machine-hours provide an independent measure of anything that is not fully measured when we list the quantities of raw materials, energy, and other current inputs consumed in the process of production. Capital is something that is there when production occurs, and the intensity of its utilization is accounted for by the rates at which current inputs are consumed in the process of producing at the resulting rate of output. Machine-hours provide only the crudest measure of this intensity of utilization since it is obvious that one machine can work "twice as hard" as another, but both record the same machine-hours. But one machine cannot work harder than another without consuming more energy and more raw material. The vector of current input consumption, in cooperation with capital, seems to me to fully account for any aspect of capital that one is tempted to measure with "machine-hours." Now it may be that at some level of aggregation, for some purposes, some students may wish to use something like "plant operating hours" as a surrogate for the other current inputs. If so, and if it doesn't cost too much I see no reason not to include the appropriate questions on the census forms. But I would not give it high priority.

In what follows, therefore, our attention will be directed to the measurement of capital as a stock. Specifically, and there appears to be no practical alternative to this, we will be concerned with the measurement of the value of capital stock. Values can, of course, be put in physical-like terms by deflating or reflating for price changes. There are problems here which I hate to see swept under the rug, but the fact is that I have nothing to say about these index number problems, so I will remain silent on them.

II. Traditional Measures of the Value of Capital Stock

So far as I have been able to determine, all attempts by economists to measure the value of a stock of capital fall into one of the following three categories:

1. The gross (or undepreciated) stock, measured by cumulative investment expenditure adjusted for retirements and price changes.
2. The net (depreciated) stock measured by the current market value of the existing stock.
3. The discounted present value of the future expected net earnings attributable to the stock.

Our primary concern will be with the gross and net stock measures.

All three of these measures of capital place a valuation on something of interest to economic analysis. The gross stock is the gross real cost of capital—the value of the goods and services foregone so that society might accumulate the wealth to which this measure applies. This measure is most often applied to tangible reproducible wealth, but in principle it might be extended to other forms of capital wealth. From estimated series on public and private spending for education and training, and expenditures for research and development, one could estimate the cost of the stock of knowledge (human and "organizational" capital).

The net stock measures the alternative resource value of the existing stock. Net stock is less than gross stock, because used capital goods command a smaller market value than new capital items. There are two reasons normally cited for this: (1) Deterioration—used capital goods may be less productive than new goods of the same technology, and, more important, (2) exhaustion of economic life. Used capital goods have fewer productive years available because of declining productivity and/or the rising threat of economic displacement due to technological improvements which cannot be embodied in existing hardware.

As between gross and net stock, if an either-or choice had to be made, I would choose the former. A minor reason is that, of the practical measures available, the data used to measure gross stock are better than those used to arrive at net stock. A more commanding reason is that I believe gross stock to be the most nearly relevant for productivity and production function analysis, and it is this type of analysis for which capital data are most likely to be employed. Fundamentally, if what makes capital capital is the quality of being present when the activity of production occurs, then gross stock is the significant variable for productivity analysis. This view has a reasonably strong empirical foundation in the studies that have been made of engineering production functions involving capital goods. Some additional support for this view is provided by Barna from his sample survey studies:

> * * * there are two concepts of replacement cost: replacement cost new, and written-down replacement cost. The second concept corresponds to the value of capital in economic theory, but the first may be equally important in a study of productive relationships * * * value declines faster than efficiency, and indeed for important classes of assets efficiency does not decline at all. For this reason the relationship between replacement cost new and output may be more stable than between written-down replacement cost and output, and the first concept is more relevant in forecasting incremental requirements of capital [1, p. 80].
>
> * * * after a decision is taken to scrap, the asset is run down through lack of maintenance though in some industries maintenance has to be kept up to the end. Buildings are generally kept, through repair and modernization, in a condition which makes them comparable to new buildings of the same type [1, p. 90].

My preference for gross over net stock is the product of interests biased in the direction of productivity analysis. But if one is interested in a number which measures the alternative resource value of a region's, industry's or nation's accumulated capital stock, then net stock is appropriate.

In at least one respect the productivity argument for gross rather than net stock should be qualified. There is actually a third reason, not mentioned above, for gross and net stocks to differ. Investment expenditures are probably never precisely realized. Especially in the case of new experimental types of capital goods, the expenditures may produce forms of capital wealth considerably more, or less, productive than anticipated. The result may lead to a substantial capital gain on the initially produced goods, until their production can be adequately expanded. Or, where the assets turn out to be less productive than expected, capital values may decline sharply. In either case, I can readily appreciate that for such capital goods, net stock might be superior to gross stock for productivity studies.

The most important application of discounted present value measures has been to the category, human capital [8, 10]. This is not surprising, since this particular asset does not have a recognized market, new, used, or scrap. The hazard here is obvious from the discount formula

$$V=\sum_{t=1}^{\infty}\frac{E(R_t)}{(1+r)^t},$$

where r is the discount rate, $E(R_t)$ is the expected earnings of the capital asset in period t, and V is the asset's present value. To compute V, we have to estimate $E(R_t)$, $t=1,2,$ * * *, and choose an r. This introduces large potential errors of estimation.

1. GROSS VALUE OF TANGIBLE CAPITAL STOCK

I find in the literature two feasible alternatives for measuring gross stock. One is the use of fire insurance and similar appraisal valuations; the other is the perpetual inventory method.

How practical it would be to obtain survey information on fire insurance valuations on a grand scale, I am not competent to say. R. W. Goldsmith has noted that this is a time honored method, having been used in Germany as early as 1913 [7, p. 329]. He has further stated the opinion that such valuations are not generally enough available to produce aggregate figures based upon them [7, p. 329]. Barna reports success in obtaining information on such valuations in the United Kingdom [1, pp. 79, 80], and argues persuasively in their favor over the use of book values.

In the absence of comprehensive, continuing official estimates of U.S. wealth by the Federal Government, R. W. Goldsmith and his associates of the National Bureau of Economic Research have prepared data on the value of tangible assets from 1896 to 1958 [4, 5]. These important series have provided measures of the value of tangible capital using what Goldsmith has called "the perpetual inventory method." By this method estimates of the stock of each type of reproducible tangible asset are obtained by cumulating the capital expenditures on that asset for a period of years equal to the asset's assumed life.

Under the one-horse-shay assumption that the ith type of capital has a fixed life L_i, this is equivalent to cumulating all previous capital expenditures less retirements. Thus if $E_i(t)$ is total investment expenditures on i in year t, and $R_i(t)$ represents that part of total expenditure which "replaces" capital assets that are retired in year t, then the gross stock of i at some point of time T, can be defined

$$G_i(T)=\sum_{t=1}^{T}[E_i(t)-R_i(t)]. \tag{3.1}$$

Under the one-horse-shay assumption $R_i(t)=E_i(t-L_i)$. Since (initially) we must have $R_i(t)=E_i(t-L_i)=0$, $1\leq t\leq L_i$, the expression can be written

$$\begin{aligned} G_i(T)&=\sum_{t=1}^{T}[E_i(t)-E_i(t-L_i)]=\sum_{t=1}^{T}E_i(t)-\sum_{t=L_i+1}^{T}E_i(t-L_i) \\ &=\sum_{t-L_i+1}^{T}E_i(t) \end{aligned} \tag{3.2}$$

The Goldsmith approach is based upon the simplifying (and perhaps necessary) assumption that assets behave as if they had zero mortality up to their expected life, and then abruptly died. In fact the asset lives are obtained from Bulletin F estimates of "useful lives." A clear distinction should be made between the measure that we should like to obtain ideally, and that which necessity, or cost, has driven us to accept.

Ideally, if $F_i(t)$ is the survival rate of assets of age t, and M_i is the maximum life of assets of type i, then the ith gross capital in year T can be expressed

$$G_i(T)=\sum_{t=0}^{M_i-1} E_i(T-t)F_i(t). \tag{3.3}$$

Under the assumption that $F_i(t)=1$, $0\leq t<M_i=L_i$, this becomes

$$G_i(T)=\sum_{t=0}^{L_i-1} E_i(T-t), \tag{3.4}$$

which is equivalent to (3.2).

Barna [1, pp. 85–89, 92] has criticized the assumption, or approximation, underlying this method, viz that all facilities die at fixed ages. Barna's direct sample study of asset mortality in British manufacturing suggests a linear declining survival curve in contrast to the rectangular curve that leads to (3.4). If these findings are generally characteristic of the mortality behavior of capital assets, then one should assume the linear approximation $F_i(t)=1-\frac{t}{2L_i}$, where $M_i=2L_i$, and L_i is the average life of asset i. Instead of (3.4), the estimating equation would be

$$G_i(T)=\sum_{t=0}^{2L_i} E_i(T-t)\left[1-\frac{t}{2L_i}\right]=\sum_{t=0}^{2L_i} E_i(T-t)-\frac{1}{2L_i}\sum_{t=0}^{2L_i} tE_i(T-t) \tag{3.5}$$

Barna compares his direct estimate of $G_i(T)$ for British manufacturing in 1955 with the corresponding perpetual inventory estimates of P. Redfern. He concludes that about one-half of the 50-percent larger figure that he obtains is attributable to the mortality assumptions underlying the perpetual inventory method.

If Barna's findings are generally applicable to all capital assets, then an estimating equation such as (3.5) would be expected to provide somewhat improved estimates of $G_i(T)$. In any case, for purposes of a proposed inventory of national wealth to be undertaken by the Federal Government, such studies point to the importance of setting up procedures for gathering comprehensive data on the mortality of capital assets.

2. NET VALUE OF TANGIBLE CAPITAL STOCK

The obvious way of determining the value of net stock is from the market prices of new and used structures and equipment. But such information is likely to be available only for specialized types of capital goods, such as transport equipment (trucks, trailers, airplanes, etc.), farm machinery, and perhaps general purpose machine tools

and prime movers. Wherever possible such data should be collected, since it is the theoretically relevant measure of net stock. If net stock values could be compiled from price data, even for only limited types of hardware, it would make possible comparisons with net stock values, for the same sample of capital, obtained from book values or gross value (expenditure) adjusted for "depreciation."

The most common method of estimating net stock is from book values. A major deficiency in such data is that they tend to reflect depreciation rates that maximize after tax profits and such rates may bear little or no relationship to declines in asset market value. It is likely that many capital assets have economic lives in excess of the minimum writeoff periods allowed under the tax laws. But even without the tax law effect, business depreciation policies tend to be highly variable and arbitrary.

Studies by Stigler [8], Creamer, Dobrovolsky, and Borenstein [2], and others, usually rely upon book values compiled from corporate tax reports of the Internal Revenue Service and reported in "Statistics of Income" (or the "Source Book"), or from the census of manufacturers. Thus, Creamer, Dobrovolsky, and Borenstein use the census definition of invested capital, viz., fixed capital, composed of land, buildings, machinery, and equipment, and working capital, made up of cash, inventories, and accounts receivable [2, p. 12]. This corresponds to the definition in "Statistics of Income," except that intangibles like patents and goodwill are included in the latter [2, p. 12]. I do not think these definitions are suitable for measuring the real capital stock either tangible or intangible. If one wants to measure the stock of tangible reproducible capital wealth, then financial assets such as cash and accounts receivable should be excluded. If one wants to measure the stock of capital including intangibles, the use of book values for intangibles such as patents and goodwill is even more unreliable than the book values of depreciated property. For reporting purposes, corporations tend to be exceedingly conservative in assigning values to intangible assets.

The third method of estimating net stock is by application of depreciation rule adjustments to gross expenditures on capital assets. Thus Goldsmith [5, p. 85] estimates net stock from gross values on the assumption of constant straight line rates of depreciation for each type of asset. The resulting estimates provide series which are arrived at independently of the estimates obtained from Internal Revenue Service book values. As might be expected, Goldsmith's estimates of gross stock correspond closely to the IRS estimates, the former being consistently above the latter. The difference never exceeds 7 percent in any of the postwar years, 1945–57 [5, p. 84]. On the other hand, the perpetual inventory estimates of net stock vary from 7.5 percent below to over 6 percent above the corresponding IRS figures [5, p. 85].

III. Critique of Traditional Measures

As we have indicated, each of the above measures of tangible capital has a distinct value. However, I do not believe that they provide, by themselves, the most comprehensive set of measures that it is feasible and desirable to make available. In particular, the net stock measure contains conceptual deficiencies, which it will be my purpose

to attempt to correct by proposing a supplementary measure of net wealth.

Even if we had active markets for all classes of capital equipment and structures, and complete information on their new and used transfer prices, I would doubt whether the value of tangible capital could be adequately measured by a simple summation of component prices. For one thing, most capital goods are highly indivisible resources, once the planning stage has been passed and individual units of hardware of fixed sizes and configurations have been constructed and installed. When such capital goods are initially installed we would assume, theoretically, that the amount of capital (size of equipment, etc.) was adjusted until marginal value product and price were equal. Thus, internal value was identical with external value. However, conditions change and are almost certain to change over the life of highly durable capital goods. This does not mean that the firm continuously adjusts its capital equipment so that equality between internal and external values are maintained. In theory the firm retains any sunk investment whose contribution to the present worth of the firm is not below its going resale price. Consequently, the productive value of capital goods to a firm may be greater than their market prices. If the discrepancy is great enough, parallel production units may be installed, but this tends to occur at infrequent intervals in discrete lumps as when a new plant is added.

There is another, and, I think, more important reason why the market value of components may not sum to the productive value of an aggregate of capital employed by a firm. In modern productive organizations, capital assets tend to be installed as parts of man-machine systems whose agglomeration value may substantially exceed component value. Planning and design go into the system and these elements may add important capital values of their own. Systems must then be organized effectively for day-to-day operation under dynamic load conditions, and in environments requiring important decisions to be made almost continuously under uncertainty. The operating organization, together with the individual assets, and the planning and design infused into the system, represent an organic whole and a capital value jointly determined. The value of organizations, both in operations and in long-term planning are entirely left out of any measure confined to component tangible capital. Similarly, no account is taken of the research and development activities of firms, whose employment of hardware assets may account for a small fraction of the capital wealth, in terms of expected future earning power, that is actually represented. The knowledge of technology industries—electronics, drugs, space exploration systems, etc.—are, I suspect, drastically undervalued by measures based upon tanglible wealth. Service organizations such as management, science, and engineering consulting firms would appear with negligible capital values. Finally, the contribution of the monetary and credit system to real productive wealth by facilitating finance and exchange, is undervalued by any measure looking only at fixed real assets such as bank premises.

For all these reasons the reviewed measures of tangible capital do not provide a precise wealth account parallel to the measures now available on income account. What is needed, or so it seems to me, is a measure of wealth added (at market prices) by individual decisionmaking (pro-

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ducers') organizations, that corresponds with the value added on income account by such organizations. The former measure, by appropriate summation over establishments, would permit estimates of aggregate real productive wealth by sector, region, or national coverage, to complement present estimates of aggregate income based on value added by industry. Since value added by industry is due to capital *and* labor, the two concepts are not exact parallels. If we were to subtract from value added, all payments to households for labor, the resulting "net cash flow" of the industry would be the current account parallel of my "value added on wealth account."

A measure of value added on wealth account, at market prices that are determined under rather highly (if not perfectly) competitive conditions, is in fact available for a broad area of the economy. I refer to the securities markets in which the claims on going corporate enterprises are bought and sold in divisible units, with the result that valuations are placed continuously upon organizations as a whole at the margin. The valuations, so obtained, represent the market's opinion as to the present worth of the future expected earnings stream that will be derived from an individual organization's productive activity. It seems to me this is precisely the opinion we want. Such valuations change continuously, and sometimes drastically, but this is in the nature of the entity we are trying to measure. Expectations change; and the result is and should be reflected immediately in the valuations generated by the market for claims on corporations. Furthermore, this method of estimating present worth does not require direct estimates of future expected earnings, nor of a suitable discount rate.

It is clear that such a measure departs from the view that capital is productive means, separable from human beings and knowledge, and separately marketable. But the fact that human beings and the knowledge and skills embodied in them, are not marketable should not lead one to suppose that they fail to contribute something to organizations that is indeed capital-like. If our measure of capital is to account for a sector's or firm's value added net of payments for labor, then the productive contribution of all the intangibles that fall under the heading of "organizational capital" must not be arbitrarily excluded.

IV. A Supplementary Measure of Capital-Value Added on Wealth Account

1. Definitions of Gross and Net Wealth Added

All of the various methods of measuring the gross or net stock of capital involve entries on the asset side of the balance sheet. Where book values are used, such entries are used directly for estimating purposes. Where market values are used, one is concerned with attaching market prices to items that appear on the asset side of the ledger.

My proposed measure of capital is obtained by associating market prices with all items appearing on the liability side of the ledger and with the purely financial entries on the asset side. For a given establishment, I would define its gross value added on wealth account, or simply gross wealth added, as the market value of all claims on that establishment—notes outstanding, bonds, preferred stocks, common

stocks, accounts payable, accrued or deferred liabilities on taxes, dividends and employee benefit plans, and so on. To arrive at a measure of the total real productive capital contributed by the establishment, *net* wealth added, I would subtract from gross wealth added the market value of all *financial* assets held by the firm. Stated in another way, we subtract all claims by the business on other businesses (including the Government), precisely as we net out all purchases by businesses from businesses in arriving at the concept of value added on income account. This means that we must subtract cash (claims on banks), accrued tax credits and Government bonds (claims on governments), the securities of other corporations held as an asset, accounts receivable, and so on. The resulting figure is the market value of the *operating* establishment including its tangible fixed assets, inventories, goodwill, patents, and possibly most important of all, its organizational capital, i.e., its management and research organization, the network of internal communication and procedures whereby decisions are made (perhaps poorly), problems solved (or not solved), and ideas developed.[1]

Since many definitions of "capital" (notably that of the census of manufacturers) include such items as cash and accounts receivable, why do I exclude them? Certainly they are part of the liquidity and solvency of the individual establishment. But they are not part of real productive wealth in all its forms. To include the value of such financial assets in the wealth added by a given corporation would mean double counting. The real wealth represented by the given corporation's cash holdings is counted when we apply the measure to banks. The real wealth content of accounts receivable is counted in the accounts payable of other units. That the monetary and credit system provides an operating environment that contributes to real productive wealth is not denied. On the contrary our measure of wealth added includes this contribution. It is included when we apply the measure to the banking and financial sector. Theoretically, this sector cannot generate earnings unless it contributes to the productivity of the economy, and it is the capitalized value of these future earnings that our measure represents. It is also included when we apply the measure to industrial corporations, since the latter share with the financial sector some of the earnings benefits of the monetary and credit system.

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[1] It may be of interest to note at this point that our definitions of gross and net wealth added, applied by industrial sector, suggest an interindustry financial model, which is entirely analogous to the Leontief model of interindustry input-output flows. Let V_i be the gross market value of industry i, W_i be the net market value of industry i, and v_{ij} be the financial claims of industry i on industry j. Then, we can write the balance equations,

$$\begin{aligned}
V_1 - v_{12} - v_{13} - \ldots - v_{1n} &= W_1 \\
-v_{21} + V_2 - v_{23} - \ldots - v_{2n} &= W_2 \\
\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\
\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\
\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\
-v_{n1} - v_{n2} - v_{n3} - \ldots + V_n &= W_n
\end{aligned}$$

If one makes the heroic assumption, that the claims of i on j are proportional to V_j, then $v_{ij} = a_{ij} V_j$, and we get

$$(I - A)V = W$$

where $A = [a_{ij}]$ is the financial "technology" matrix, V is the column vector of $V_{i's}$, and W is the column vector of $W_{i's}$. In our measurement scheme, we observe V_i and v_{ij}, and compute W_i. But one could also compute the a_{ij}'s, and from "forecasts" of new $W_{i's}$, solve for the $V_{i's}$. The analogy with the Leontief model is clear and I think worthwhile, though the usefulness of the Leontief model does not strike me as having a clear parallel in this interindustry financial model. However, the model might be useful in imputing V_i values to individual companies in complicated holding company empires, based upon given W_i values (market or otherwise) for the operating companies.

2. SOME DIFFICULTIES

All of the traditional measures of capital are confronted by practical difficulties, and the wealth added measure is no exception. In my present inadequate state of knowledge on the matter, I would conjecture that these difficulties are no more severe for wealth added than for gross or net stock. Nevertheless they should be faced. The following provides a list which does not pretend to be exhaustive:

(1) Not all the claims on a corporation are traded.

Claims such as accounts payable would seem to present no difficulty. These represent obligations for goods and services received, which, we may assume are carried on the books at the market prices of such individual goods and services. Short-term notes and certificates of indebtedness would also presumably have market values very close to their book values. Where the firm has bonds and stocks outstanding which are closely held, and no quotations are available either on organized exchanges or over the counter, then wealth added cannot be determined by our method. In such cases the measure might be estimated by (i) assuming that the ratio of wealth added to cash flow for such firms is the same as for firms in the same industries where securities are traded, or by application of average price-earnings ratios for the industry; (ii) using an appropriate regression equation for estimating value as a function of such variables as earnings, cash flow, dividends, the firm's growth rate, and so on.

(2) Not all establishments are incorporated.

This presents the same estimating problem as (1). The only way out, it would appear, is to impute wealth to such establishments on the basis of cash flow, earnings, or regression methods.

(3) What about corporations with foreign operations?

I don't see how to get around this one neatly. The market value of, for example, American oil companies with large foreign holdings, will clearly reflect such holdings, but such market values cannot be wholly credited to net U.S. wealth. Such values are part of net wealth controlled by U.S. nationals, and this is perhaps of some interest. Adjustments might be possible, but they are likely to be very rough, though I suspect no rougher than the methods used to adjust gross stock to get net stock, or to estimate average life by type of asset.

(4) Is the "true" capital value of a company on a given date "correctly" determined by the securities markets, especially if those securities are under heavy buying (selling) pressure or wide speculative moves?

I list this as one of the objections to our measure, because many will perceive it as such. To me the fact that some corporation's securities may be subject to sudden wide moves is not an objection, but a truth about wealth which should be fully embodied in at least one of our measures of that illusive entity we call capital. In my private opinion many securities may not be worth their going exchange prices. But the simple hard fact seems to be that a thing is worth what you can get for it. We accept market prices in arriving at value added on current account. Yet the same objections could be raised. What

about speculative swings in the prices of sugar and soybeans? What is the true value of wheat, corn, and cotton when their prices are artificially supported? We value these things at their transaction prices, and I would do the same with claims on wealth. There are indeed monopoly and artificial support elements in many valuations. But these elements produce inefficiencies and resource misallocations which, theoretically, have an adverse net effect on society's income stream. This effect should be reflected in our measures of net income, *and* of net wealth. Market prices accomplish this at least as well as any substitute I can think of.

3. SOME EXAMPLES

Perhaps the best way to obtain an understanding of some of the implications of wealth added as a measure of capital is to compute it, compare it with other measures, and see what scientific sense it makes. To this end I have applied the measure to a selection of firms, engaged in widely differing activities, for the purpose of illuminating some interesting and controversial issues. In all cases the source was Moody's Industrial Manual or Moody's Bank and Finance Manual.

Table 1 computes wealth added for General Motors, 1961. The source of valuation, book or market, is shown in parentheses for each entry. Most entries are taken at book value in these calculations. In more sophisticated computations some of these items could be adjusted where data permits. For example, accounts receivable could be adjusted for bad debts by application of a default rate discount, Government securities could be valued at market where the maturity structure of the company's holdings is known, and similarly for such items as miscellaneous investments. Such sophistication would seem to be hair splitting in the General Motors case, since the adjustments would be slight, and the items involved are not a large proportion of net wealth added. But such need not be the case for all companies. For convenience of illustration, stock and bond prices were taken as the average of their high and low values for the year. Normally, one would apply quotations as of a given date. For General Motors we see that net wealth is about $12½ billion. In the absence of the resources needed to build up direct measures of gross and net tangible and/or intangible property, I have provided the book value of net real (nonfinancial) assets (net property, patents, goodwill, and inventories) for comparison purposes (about $4.9 billion). It will be no surprise that in the case of a strong, growing, blue-chip company, net productive wealth is over twice the depreciated value of physical structures, equipment and inventories, plus the modest accounting values typically imputed to intangibles like patents and goodwill.

As of 1961 the Syntex Corp. (table 2) was primarily a pharmaceutical research organization. It provides a rather extreme example of an organization whose market value is determined almost exclusively by the kind of organizational capital associated with research and development activities. In this instance, net wealth added is over eight times book net asset value.

TABLE 1.—*General Motors, 1961*

[Millions of dollars]

A. Calculation of gross wealth added:	
1. Total current liabilities (book)	1,425
2. Foreign subsidiary debt (book)	144
3. Employee benefit plans reserve (book)	26
4. Credits under stock option plan (book)	22
5. Miscellaneous liabilities (book)	241
6. Miscellaneous reserves (book)	25
7. General foreign reserve (book)	142
8. Debentures 3¼, 1979, V=221,322,000×0.89$\frac{3}{16}$ (market value)	197
9. Preferred stock, $5, V=1,835,644×107¼ (market value)	197
10. Preferred stock, $3.75, V=1,000,000×83 (market value)	83
11. Common stock, V=285,563,322×49$\frac{5}{16}$ (market value)	14,001
Gross wealth added	16,503
B. Calculation of claims on other establishments:	
1. Cash (book)	405
2. Government securities (book)	1,291
3. Accounts and notes receivable (book)	987
4. Subsidiary companies not consolidated (book)	433
5. Other security investments and miscellaneous (book)	18
6. Loans and advances to, and stock of steel suppliers (book)	32
7. Treasury stock, V=1,986,539×49$\frac{5}{16}$ (market value)	98
8. Prepayments and deferred charges (book)	73
Total claims on other establishments	3,337
Net wealth added	13,166
Net property, patents, goodwill (book)	3,092
Inventories (book)	1,800
Net real assets (book)	4,892

TABLE 2.—*Syntex Corp., 1961*

[Thousands of dollars]

A. Calculation of gross wealth added:	
1. Total current liabilities (book)	1,376
2. 6 percent convertible preferred (convertible at 10 common for each share of preferred. Shares not traded. Price assumed to be 10×common price=357.5). V=4,601×357.5 (estimated market value)	1,645
3. Common stock, V=1,430,470×35¾ (market value)	51,139
Gross wealth added	54,160
B. Calculation of claims on other establishments:	
1. Cash (book)	847
2. Marketable securities (book)	36
3. Accounts receivable (book)	2,263
4. Prepayments (book)	101
5. Deferred charges (book)	775
Total claims on other establishments	4,022
Net wealth added	50,138
Net property, patents, goodwill (book)	2,563
Inventories (book)	3,677
Net real assets (book)	6,240

When applied to establishments with natural resources holdings such as timber, oil, and coal, our measure of capital includes the wealth attributable to such exhaustible capital resources. Table 3 shows the net wealth added by the Standard Oil Co. of Indiana to be about $1.9 billion. But net real assets have a book value of nearly $2.4 billion not counting the company's reserves of crude oil and natural gas. If we include the value of estimated crude oil reserves at $1 per barrel (less than a third of the going price), real assets have a paper value of $2.6 billion. There are two reasons for this very large discrepancy between the paper value of real assets and the market value of the company's productive wealth: (i) the market is not so naive as to impute a value as high as even $1 per barrel of oil still in the ground, and for which there may be little use for 25 to 50 years. Within that time, oil might become obsolete as a major source of energy. Consequently, the market discounts very sharply the value of oil (and gas) reserves; (ii) the oil industry in 1961 was experiencing depressed equity values, and severe price weakness, due to oversupplies. One result has, of course, been a decrease in drilling activity—a response to be expected when the market signals a decline in the present worth of future earnings.

Table 4 summarizes the results of the computation of net wealth added for a bank (First National City Bank of New York), a holding company (Mission Development Co. which directly controls Tidewater Oil through ownership of about one-half of Tidewater common), and an investment company, American Research & Development).

TABLE 3.—*Standard Oil of Indiana, 1961*

[Thousands of dollars]

A. Calculation of gross wealth added:	
1. Total current liabilities (book)	263,584
2. Notes, subsidiary debentures, miscellaneous obligations (book)	206,523
3. Bonds, 3⅛s, 1982, V=13,961,900×1.14¾ (market)	16,021
4. Bonds, 4½s, 1983, V=200,000,000×1.01⅝ (market)	203,250
5. Minority interest (book)	2,108
6. Common stock, V=35,784,220×51 (market)	1,824,995
Gross wealth added	2,516,481
B. Calculation of claims on other establishments:	
1. Cash (book)	133,024
2. Marketable securities (book)	111,318
3. Accounts and notes receivable (book)	285,035
4. Prepaid items (book)	9,497
5. Holdings in Standard Oil Co. of New Jersey (market)	80,724
Total claims on other establishments	619,598
Net wealth added	1,896,883
Net property (book)	2,136,922
Inventories (book)	225,635
Net real assets (book)	2,362,557
Value of crude reserves 2,618,000,000 barrels×$1 (estimated market value)	2,618,000
Net real assets including reserves	4,980,557

TABLE 4.—*First National City Bank of New York, Mission Development Co., and American Research and Development, 1961*

[Thousands of dollars]

Company	Year	Gross wealth added	Net wealth added	Net real assets (net property, patents, goodwill, inventories)
First National City Bank of New York	1961	9,888,750	473,500	115,793
Mission Development Co	1961	128,395	−38,302	0
American Research & Development	1961	39,565	2,477	0

As you would expect for a bank, net wealth added is a very small portion of gross (about 5 percent), but substantially above net real assets (bank premises). A holding company is included, because the equity claims on such institutions typically sell at a discount on the order of some 30 percent below the market value of their holdings in operating companies. In the case of Mission Development, net wealth added is a negative $38 million. Hence, by our measure of wealth, an operating company would contribute a smaller net capital value if it were controlled through a holding company. Why is this? And should our measure of wealth contain this discount? Views will differ, but I would tend to take such results at their face value. Apparently the market is saying that a negative capital value should be imputed to any institution whose sole or primary purpose is to concentrate managerial control and prevent that control from being effectively challenged. The result is to reduce the value of the "organizational capital" contained in the operating-holding company system. If this interpretation is correct, then net wealth added should reflect these discounts.

The same phenomena occur in applying the measure to investment companies. Our example, American Research & Development Co., shows a positive net wealth added, but many investment companies may show a negative value. American Research & Development has a reputation for finding small new companies that need capital, and that turn out to be winners. If this is true, I would think such skills should command a positive capital value. On the other hand, investment companies who can demonstrate no such skills would appear to make zero or negative net contributions to wealth.

4. CONCLUDING REMARKS

What is provided by net wealth added, as a measure of capital, which might be of use in economic analysis, and which is not reflected in the traditional measures of gross and net stock? Fundamentally, it provides a measure of expectations about future earnings. These expectations are supported by the perceived earning power of a firm's or industry's capital in the widest sense of the term. Capital in this sense includes tangible reproducible wealth and organizational capital in the form of knowledge, research productivity, and administrative systems. Theoretically, these expectations are an important determinant of present or near term investment behavior. Net stock figures, particularly if supplemented by cumulative outlays for research and development and training, provide depreciated measures

of capital input. If net wealth added by any industry exceeds net stock, it means that the expected rate of return on investment in that industry exceeds the market rate of interest. That is, net wealth added at t, $W(t)$, is the discounted value of future net earnings $n(x)$, $t \leq X \leq \infty$:

$$W(t) = \int_t^\infty n(x) e^{r(t-x)} dx.$$

But the rate of return, ρ, on the present net stock $N(t)$, which is implied by the earnings stream $n(x)$, is given by

$$N(t) = \int_t^\infty n(x) e^{\rho(t-x)} dx.$$

Therefore, if $W(t) > N(t)$, then $\rho > r$, and one would expect investment to expand. Similarly if $W(t) < N(t)$, $\rho < r$ and investment should contract.

Grunfeld's paper [6] is the only study of which I am aware that uses a concept resembling net wealth added as an expectations variable in explaining corporate investment behavior. For this purpose, Grunfeld uses the "market value of the firm," defined as the market value of outstanding shares and debt where the latter is approximated by book values [6, pp. 224–227]. If all debt both short and long term are included, this corresponds to what I have called gross wealth added. I would consider net rather than gross wealth to be the superior expectations variable in accounting for *nonfinancial* corporate investment outlays. Of course, market expectations need not correspond to those of corporate decisionmakers, but it seems unlikely that the two groups could have widely differing expectations for extended periods of time. In any case Grunfeld finds his measure, the "market value of the firm," to be superior to either current or lagged profits in explaining investment behavior. This provides some evidence to suggest that net wealth added may be an important measure of expectations and that data on such a concept of capital should be compiled along with series on gross and net capital stock.

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COMMENTS ON PROFESSOR SMITH'S PAPER

By Edward F. Denison

The paper we just heard summarized by Professor Smith was not only interesting but provocative; it certainly raises some new matters. I shall discuss it in three parts.

On the first section, "What Is Capital," I shall say only a few words. Professor Smith feels that measures of the use of capital are of low priority and have little value. I am not so sure this judgment is correct. Smith assumes there is a constant ratio between machine-hours and either power consumption or raw material consumption so that the latter can serve as proxies for the former. Even if this were true, it would not permit aggregation of different types of machines. But there are also questions of changing efficiency in the use of machinery and of power or materials, a subject that probably deserves more attention that it has received. The article by Murray F. Foss in the June 1963, "Survey of Current Business" is an example of the careful use of electric power consumption to try to derive indirectly a measure of the use of machinery. Foss clearly does not conclude that direct data for machinery utilization is unnecessary. In any case I suspect there is considerably less than general agreement that data on capital utilization are not needed. The question is incidental to the main issue of the day, the valuation of capital, so I will just drop it here.

Let me now jump to the latter part of the paper, which offers a proposal for measuring the market value of corporations as going concerns. By some adaptation of the technique one could perhaps add noncorporate enterprise, but if he wanted to obtain a national wealth total he would presumably have to use other techniques to get at non-enterprise values.

Professor Smith's discussion should make it quite clear that this is at best a supplementary measure of wealth. It could not replace valuation of capital goods as the heart of a wealth study for a number of reasons, of which two are central. First, it provides no way of getting at any kind of breakdown of tangible capital by type of assets, a classification that is of great interest. Nor does it lend itself to the obtaining of information on age distribution or other characteristics of tangible capital assets. Second, if one were to compile the value of going-concern estimates on successive dates, it appears that there would be no way to deflate them. Hence one would know nothing about changes over time in the real value of the capital stock, with or without inclusion of intangibles.

As I see it, Smith's proposed wealth measure is the capital counterpart to nonlabor income in the corporate sector of national income. Corporate national income can be divided between compensation of employees (I think this would be the correct term, rather than Smith's term "labor payments to households") and a residual consisting of net interest, rents, royalties, and corporate profits. The market value of the asset counterpart of this nonlabor income is the object of Smith's interest. Since the nonlabor income component is a number I have used myself, this approach holds a certain inherent attraction for me. However, we must ask what we could do with such data if we had them.

An unduplicated asset value aggregate of this type lends itself only to certain breakdowns, viz., those for which the enterprise is an appropriate unit of classification: (*a*) industry of major activity of the enterprise; (*b*) size of enterprise; and, if the coverage is greater than corporations, (*c*) legal form of organization.

We already have such distributions of nonlabor income for corporations. Percentage distributions of asset values of corporations presumably would differ from similar distributions of nonlabor income for two main reasons. First, the market might not like the way profits are measured and appraise current profits as something different from what appears on the books, or even on the books as adjusted by the National Income Division. Second, as Professor Smith points out, they might differ because of the expectation that the future profits distribution is going to differ from the present one. Before one puts many resources into this undertaking, he might ask whether this evaluation is really what he wants, whether he could interpret the difference between this distribution and a distribution of property income if he had it, and, if so, whether it is really worth the cost. That the answers are affirmative is not obvious.

One use of income share data is in the derivation of production functions to analyze sources of economic growth. This use encounters the problem that what we call nonlabor or property income is a combination of the earnings of tangible capital, of intangible capital, and of land, together with pure profit, including the results of uncertainty and of monopoly positions of all sorts. Use of the nonlabor share as if it were a return only to real capital overstates the rate of return on real capital and leads to overstatement, possibly a gross overstatement of the contribution of capital to economic growth. Professor Smith properly stresses the things other than the real capital owned that affect income and hence the value of a going concern. If one could divide Smith's capital values of concerns between the value of real

reproducible capital and land, and the capitalized value of intangibles and expected pure profit, this would (assuming some kind of equalization of returns) give a measure of the fraction of nonlabor income that is really a return to tangibles. Presumably this would require comparing Smith's proposed values with independent but consistant data for the value of tangibles. Whether there is any promise that this might be possible I put as a question.

In short, my general reaction is that this is an interesting proposal which ought to be explored further. Its use would be as a supplementary estimate which might be prepared inexpensively. It could not be the primary effort in the wealth survey.

I turn now to Professor Smith's classification of valuation procedures used in more conventional measures of the value of capital. I would approach the classification a little differently. It seems to me that there are three basic distinctions that must be made. There are certainly a great many more distinctions, but these three seem fundamental.

The first distinction is the obvious one between gross stock and net stock.

The second, the distinction I have drawn elsewhere,[1] goes to the heart of the problem of valuing depreciable assets. By almost any approach the value of a capital good newly produced and sold today is the price at which it is sold. The problem is to value the many older assets which are still in use but not produced today. In general, there are two reasonable, but fundamentally different, ways to equate their value with those of newly produced goods. (For this distinction I ignore physical exhaustion of used capital goods.) One is to equate old capital goods with the new goods in terms of what both would cost to produce at the same date, presumably the present date. The second is to try to equate goods produced at an earlier date with new goods by their relative abilities to contribute to production at the present date. For brevity, let me call the first way "values equated by cost," and the second "values equated by productivity.' The first value exceeds the second because of obsolesence.

The third distinction refers to the methods of arriving at the valuation. These also fall loosely into two types. One, which I shall call the price index method, is to find the original cost of the assets and bring it up to the present by the use of price indexes.[2] The other is to attempt to get a present market value of the asset more directly by any of several procedures. If the asset actually is sold, one finds out the price. Or one obtains an imputed value based on sales prices of similar assets. Or one obtains an appraisal. Or one secures fire insurance valuations. Let me call all of these direct valuation. I am not suggesting that in fact one can really solve the whole national wealth estimation problem by these techniques, but one could go a certain distance.

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[1] Edward F. Denison, "Theoretical Aspects of Quality Change, Capital Consumption, and Net Capital Formation," in "Problems of Capital Formation," vol. 19, "Studies in Income and Wealth," New York, National Bureau of Economic Research, 1957, pp. 215–284.

[2] This is the valuation procedure used in the perpetual inventory method, but the perpetual inventory method also implies a particular approach to determining what capital goods are in the stock and hence must be valued.

These three distinctions would give eight combinations for wealth estimates if all combinations were possible, but I think that in reality there are at the most only four.

Consider first the use of direct valuations based on sales prices, or on insurance valuations or appraisals in lieu of them. I would think that this is possible only for net stock estimates since only goods as they actually exist can be sold. You do not ordinarily get a valuation of an unused 1950 automobile in 1962 except, perhaps, as a curiosity. Thus this approach is not available for estimation of gross stock. Professor Smith classifies fire insurance valuation under gross rather than net stock estimates, but this appears to be wrong.

Next, direct estimates of the present market price of assets must, in principle, be estimates of the type where value is equated by productivity, rather than by cost, because the current price must reflect what an older capital good can contribute to production now, relative to a new good, rather than by what it would cost to produce.

Finally, the price index method lends itself to either a gross or net stock estimate. In the case of the gross stock, it lends itself only to estimates of the type where value is equated by cost, not by productivity. This is determined by the characteristics of price indexes available for deflation. In the case of the net stock it leads to estimates where value is equated by cost if the depreciation patterns applied to capital goods reflect only physical deterioration without regard to obsolescence. It leads to estimates where value is equated by productivity if the depreciation patterns used reflect obsolescence as well as physical factors.

So only four possibilities, not eight, remain from this classification. These are direct estimates of the net stock, with value equated by productivity; price index estimates of gross stock with value equated by cost; price index estimates of net stock with value equated by cost; and price index estimates of net stock with value equated by productivity. I am not stating that it is in fact possible to obtain accurate estimates of these types but only that these are the only possibilities that seem to me available for examination.

If a wealth survey is to be undertaken, it ought to yield better estimates of the capital stock than we can prepare now, in addition to providing new detail. Some of the questions I would raise about a wealth survey are these: First, can we in fact get enough relevant data to make a comprehensive and reasonably accurate direct estimate of the net stock with value equated by productivity? Second, can we obtain information on what actually is in the stock better than the quantities used in the perpetual inventory method, so as to be able to improve on existing estimates using the price index method? Third, what can we learn about service lives and depreciation patterns that would enable us to get estimates of the net stock by the price index method that correspond more exactly to either or both of the cost and productivity valuations?

Let me simply end up with one small footnote. It is essential to balance what we would like to have with what there is some reasonable hope of obtaining. We have to think about both throughout the inquiry.

(SUPPLEMENTAL PAPER)

MEASUREMENT OF NATURAL RESOURCES WEALTH

By W. Hochwald and H. J. Barnett

1. WEALTH ACCOUNTS AND OTHER SOCIAL ACCOUNTING SYSTEMS

The ultimate purpose of a wealth inventory, we presume, is to better understand the complex interrelations of income flows and the "wealth of nations." We take the following as given:

1. National income and expenditure accounts (national income proper, interindustry, flow of funds) are our most important quantitative tool and set of data in national economic analysis.

2. These accounts rest primarily on business accounting records of actual transactions and estimated depreciation, following American accounting principles and conventions.

3. The present interest in "wealth accounts" derives from the belief that, analogous to business accounting, it would be useful for economic analysis if balance sheets could connect the flow accounts.

The only national double-entry system now in use is the flow-of-funds approach to social accounting which records changes in the ownership of liquid assets resulting from the flow of funds. It is no coincidence, of course, that liquid assets lend themselves most readily for such a double-entry system as they minimize the problems of valuation and imputation. Private business accounting, too, has first developed double entries for the cash account; attempts to include fixed assets in this process through depreciation reserves have remained arbitrary to the present day.

Business and social accounting again have in common that a balance sheet of net wealth is most meaningful where it is possible to establish current market prices and to impute income flows to a change in specific assets, as illustrated by inventories. As evaluation of assets moves away from current markets, and the imputation of income flows to specific assets becomes more difficult, conventional balance sheets may lose some of their analytic usefulness. Along a spectrum of increasing difficulty in this respect, at least four categories may be distinguished:

1. Market values are established at infrequent intervals, rather than currently, and the asset "inputs" have a somewhat arbitrary relation to the product "outputs," as illustrated by tangible fixed assets, such as real estate, plant and equipment.

2. Market values are, if at all, established only incidental to valuing a "going concern," and the relation between specific inputs and output is even more remote, as illustrated by intangible assets, such as goodwill or capitalized research and development expenditures.

3. Market values are not established because property rights are inalienable, though the relation of inputs and outputs may be quite direct, as illustrated by the human "wealth" of the national labor force.

4. Market values are not established because "output" does not enter the national income stream, as conventionally measured, though these assets may be the *source of substantial* social benefits, illustrated by the public domain, such as air, water, wilderness areas, etc.

The last category is of special importance in the natural resources field and suggests the need to include in the wealth inventory physical data describing assets outside any of the conventional accounting systems.

II. PHYSICAL DATA

A detailed physical inventory of natural resources appears desirable, partly as a base for valuation, partly to cover resources essential to the "wealth" of nations though at present outside any conventional system of economic accounts, such as water and air. Major purposes of such a physical inventory would be in either case to record resource endowments and their changes over time, with the ultimate objective of relating these to national productivity and consumer welfare.

Land can be identified by area and other characteristics. Forest stands and rangeland can be brought up to date in terms of timber growth, etc. More difficult is a meaningful physical inventory of recreational resources. Approaches are suggested by estimates of visitor "capacity," number and miles of hiking paths and beaches, itemization of outstanding scenery, etc. Wildlife can be listed by major species. Special problems may arise where there is free movement across national boundaries, illustrated by migratory birds and fish.

Minerals, as "resources" and "reserves," are available in some cases from the U.S. Bureau of Mines and other sources, kept up to date by proper adjustments for depletion and new discoveries. Yet for tax reasons, reserves are frequently not divulged, and comparable data are difficult to compile in any case because of wide "quality" differentials in terms of access, chemistry and physical makeup of ore, etc.

Water resources should be listed to reflect their multiple uses for human and industrial consumption, irrigation, transportation, etc. Thus a physical inventory should include data on water flow and purity, subsurface water levels and volume, etc. Perhaps there should be a negative adjustment for potential flood and other damages.

Air is a vital resource which had become subject to pollution in many metropolitan areas. Data on air purity and climate, such as temperature, sunshine, rain and humidity, wind velocity, etc., are important as they affect production costs and consumer welfare.

Human resources are obviously the most essential component of national wealth though they may be covered in a separate inventory of the Nation's skills and knowledge.

III. VALUATION PROBLEMS

Two different methods of valuation may be used in business and social accounting systems: book values and market values. Both have their merits but it is important to realize that the two methods are based on quite different assumptions about the basic purpose of valuation. Paucity of data may preclude a consistent choice between these two methods though a wealth inventory should ideally plan for the simultaneous application of both methods to serve the widest variety of analytic purposes.

1. Book values provide the most direct link with the business accounting records from which most of our private and social accounts are presently derived. They reflect our prevailing accounting con-

ventions and for this very reason are in many cases more readily available than market values. They may offer the most consistent way to connect balance sheet and flow accounts as presently constructed.

At the same time, book values have obvious disadvantages. After years of price changes, innovation, obsolescence, population movements, new tastes, etc., their meaning and use for economic analysis are obscure. Though all this may be of minor consequence for inventories and short-life equipment where book and market values are close, the problems for long-life assets are quite serious. Neither arbitrary depreciation deductions nor the use of price indexes—usually compiled for quite different purposes—can overcome these basic defects of book values in a dynamic economy. Some additional and distinct problems emerge for the book values of natural resources:

(*a*) In most cases book values will combine natural resources and capital improvements. Where a separate estimate of resources as such is desired, it is important to recognize that resources and capital may be substitutes rather than complements. Thus, a high book value may reflect poor rather than rich resources, illustrated by irrigated land, the cost of waterworks, etc.

(*b*) Where resources are part of the public domain, no conventional book values may have been established. Usually, the "output" of these resources will not be counted as conventional "income" either, and no meaningful connection could therefore be made in any case between stocks and flows. It is this type of resource which, though included in the physical inventory, might well be excluded from valuation for the present, as illustrated by wilderness, etc.

2. Market values would recognize the continuous change in a dynamic economy where innovation destroys old wealth and creates new wealth in a never-ending process of "creative destruction." They would permit and require the accounting for "unrealized" gains and losses in our income flows by sectors; the resultant refinements in the measurement of income flows might conceivably be more important additions to national economic accounting than wealth estimates as such.

The difficulties of estimating market values are obvious. Four cases may be distinguished:

(*a*) Some resources are actively traded and can be priced, readily, once their physical inventory has been established. Illustrations are provided by timber stands, agricultural land, and urban real estate.

(*b*) Some resources are traded only intermittently but can be priced indirectly through proxy variables. Mineral reserves may be valued by the shares of the companies owning them. Public forests may be valued by comparable property in private hands.

(*c*) Where no current market prices exist, values can be derived from the capitalization of expected future income. Such a valuation is subject to wide margins of error, of course, both in estimating future net income and in estimating the proper rate of discount. It is important in this context that the net income from natural resources is essentially rent, determined by the cost savings made possible by the resource. Any innovation offering

ready substitutes may drastically change the size of the future income stream flowing from this particular resource and thus eliminate the "wealth" represented by this particular asset. Illustrations are provided by the technological changes in the use of mineral sources of energy. Another illustration is provided by the "rent" of climatic advantage which "saves" the cost of air conditioning or heating. As these costs go down as a result of technological advances in climate control this will change the local comparative advantage of differential climates.

(*d*) Where resources are held in the public domain, any analogy with private income streams may be misleading, as the very rationale of public ownership is often the holding of natural resources for distinct benefits and purposes. Thus, still another approach is suggested by the discounted capitalization of future public benefits. Yet this approach introduces all the problems of pricing public benefits, compounded by the need to find an appropriate rate of discount which presumably depends on the time horizon of the community for whose benefit the resource is held. Where the very purpose of public ownership is to preserve natural resources for future generations, it may suggest the need to distinguish between "spot" and "future" market values. All this is highly speculative, of course, which only serves to emphasize the great difficulty of valuing what may be the bulk of our "natural wealth." Here again, for the present, these resources should be included in a physical inventory but should probably be excluded from the financial accounts.

IV. REGIONAL DETAIL

Regional analysis is concerned with understanding the impact of imperfect spatial factor mobility on economic growth. These imperfections are most obvious in the case of natural resources, which therefore may call for substantial regional detail to understand spatial cost differentials within the national economy. The very existence of these regional differential rents may offer an approach to the valuation of resource assets as was outlined above.

The same rationale also suggests that some local pilot project might well experiment with alternative methods to relate income flows with their resource base. While the accounting of income flows has originated on the national level, tracing the essentially closed national income circuit, the accounting for fixed assets in the national balance sheet may well start on the local level because of the spatial immobilities inherent in many natural resources.

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