CLASSIFICATION OF SOURCES OF GROWTH

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Changes in many output determinants contribute to growth. An analysis of the sources of growth is an allocation of changes in output among these determinants. Total factor input and output per unit of input condense all determinants into two groupings. Misinterpretation of results is common because authors presenting either detailed or summary results often provide no complete or precise description of their classification of determinants, and readers ignore even the information provided. The classification suggested in this paper is detailed enough to bring out points at which description is required but often overlooked. Some effects of alternative estimating procedures on classification are described.

The relative usefulness and practicality of possible alternative classifications also need consideration and discussion. This paper is concerned with general purpose classifications, appropriate for analysis of actual series measuring a country's total output, that are suitable for present use but will also accommodate useful detail that may later become feasible. A desirable classification will so specify determinants that (1) they both unite cause with effect and correspond to the economist's method of analysis so that his set of tools can be brought to bear; (2) they do not contribute to growth if they do not change; and (3) they conform as well as possible to practical possibility of estimation. Among several points considered fundamental are that the complete contributions of advances in knowledge and of resource reallocation each appear as an entity. They should not be dispersed among inputs or other determinants. It is less clear whether economies of scale should be a separate determinant or their contribution be dispersed.

Many determinants govern the level of a country's output at any given date. Changes in these determinants cause changes in output, or growth. Analysis of the sources of growth is an attempt to measure the effect of changes in each determinant upon changes in output. When an investigator divides changes in total output between changes in total factor input and changes in total factor productivity, he groups all determinants into two summary categories. Both he and his readers must know as precisely as possible what he places in each category, and why, if results are to be informative and not misleading. A two-way classification would, of course, be too condensed to be very informative even if clearly defined, and a much more detailed classification is of greater interest.

Classification of output determinants has received too little attention in growth analysis. The result has been ambiguity, confusion, and controversies in which participants appear to be arguing about substance when classification differences are the real cause of conflicting conclusions.

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Few of the numerous articles and books on growth or production functions that have appeared in recent years, many of which present empirical results, even try to describe with any precision the detailed classification that is adopted or implied. Omission of a comprehensive and reasonably precise classification is concealed by the fact that empirical studies always have a statistical residual which includes whatever is not measured. But there should be no such thing as a *conceptual* residual. Output determinants contained in a residual need to be defined as carefully as those that are measured directly. Failure to attempt this leads to unnecessary ambiguity as to the meaning not only of the residual but also of directly measured output determinants.

One major objective of this paper is simply to encourage more careful and explicit definition and description by listing and discussing determinants whose classification is not obvious and must be explicitly stated if ambiguity is to be avoided.

My second main purpose is to share what I think I have learned about classification from my own reflection and research in this field, and to stimulate discussion so that I may benefit from the experience of others. Let me concede at the outset that any author is entitled to use any classification of growth sources that he deems useful and practical, provided only that it is consistent and clearly described. The accuracy of his quantitative estimates can justly be appraised only by reference to his own definitions.[1] But I am convinced that some classifications are more useful than others, and it is obvious that some can be implemented with actual estimates better than others.

FIVE GROUND RULES

Let me first set out five "ground rules" for the discussion which follows.

1. The paper will be concerned with analysis of actual statistical series measuring output, not theoretical or hypothetical series. This has the important implication that all changes in the economy that affect the series by which output is actually measured, but no others, can be sources of growth and hence appear in the classification. I shall assume that measurement procedures, particularly those used to deflate current-dollar series to obtain a measure of output, are those generally followed in America and Western Europe.

2. I shall be concerned with a measure of output that covers the entire economy of a country to the extent customary in national income and product series. Analysis of output changes by industry or other subdivisions of the economy that require the domestic nonresidential business sector to be broken up encounters additional problems.

My own preference as an output measure is real national income (net national product at factor cost), but only one small change in the classification is required if real net national product at market prices is used.[2] Use of gross

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[1]As an "author," I am sensitive to this point. On occasion I have been convinced that certain of my estimates were criticized not because they inaccurately measured what they were defined as measuring but because they did not conform to some different classification, usually one impossible to implement.

[2]This is inclusion of an item to measure the effect of shifts in resources between lightly and heavily taxed or subsidized products.

national product, though it greatly changes the quantitative estimates for the contributions of individual growth sources, does not further affect the classification. The series used will ordinarily be the official series for a country, or that series with small adjustments.

3. I shall be concerned with a *general purpose* classification of growth sources that is both complete and unduplicated. It must have the characteristic that the sum of the contributions of all growth sources (or the product of indexes, depending on the treatment of statistical interaction terms) equals the actual growth rate of output as measured.

4. When I discuss classification from the standpoint of *practicality*, I shall suppose that the analyst is relying to some degree—though with whatever qualifications, modifications, or adjustments he may introduce—upon marginal productivity analysis, or at least upon the use of cross-sectional data for earnings and prices to secure weights to combine different inputs.

5. I shall be concerned with a classification that will be suitable, with some contraction, for present use but will also accommodate detail that cannot be provided with present information and techniques but which we may hope will become feasible in the future.

SOME CRITERIA FOR CLASSIFICATION

Let me first suggest three criteria that help guide the development of a classification.

Causality

My judgment with respect to the usefulness of any particular classification of growth sources is dominated by my view of the chief purpose of analyzing growth altogether. This purpose is to be able to answer questions of the type: If we alter any determinant of the level of output by χ amount, how much will output be altered as a result? It is convenient to have these determinants correspond as closely as possible to the economist's way of thinking about output determinants. This permits the economist's kit of tools to be brought to bear. He is accustomed to, and skillful at, explaining output in terms of the amounts and kinds of labor, capital, or land used, the efficiency of resource allocation, the state of knowledge, the scale of operations, and the like. Use of such a classification greatly facilitates analysis of the likely effects on output of any changes in a nation's policy that might be envisaged even though it does not provide such an estimate directly. Any change in actual policy *is* likely to affect a number of these determinants and one must first try to gauge the amount by which it will alter each determinant before he goes on to estimate the effect of this alteration on output. I know of no satisfactory way to evaluate changes in tax, immigration, stabilization, or any other important policy without going through this intermediate stage.

One can try to answer questions of the type posed without any analysis of the sources of *past* growth. For example, he may estimate that labor accounts for 80 percent of total input and that economies of scale amount to 10 percent, and hence conclude that a one percent increase in every type of labor would

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raise output by about 0.88 percent. Or he may estimate that increased specialization that would result from elimination of all tariff barriers would raise output by one percent. But analysis of history, based on a similar classification of output determinants, can help. Historical experience offers the opportunity to apply the same techniques to actual changes in output determinants in the past in order to test their success in explaining past changes in output. Modifications of technique may be suggested. If the experience is broad enough one will also get some feel for the determinants that are likely to change enough to matter. For at least one determinant, the state of knowledge, historical analysis appears to offer the only way to begin to get any impression of its quantitative importance (see below). Historical analysis, unfortunately, requires more information than an attempt to answer the questions first posed: one must measure actual past changes in each determinant in addition to the effect of such changes on output.

Another valid reason for analyzing past growth—or making international comparisons—is simply to satisfy one's curiosity, and perhaps to help appraise a country's past performance. Still a third reason for analysis of sources of growth in the past is that it provides a useful framework for projections of future output.

All of these reasons—but especially the first and most important—imply a heavy emphasis on causation; mere description of developments is not enough. As I see it, the primary characteristic of a desirable classification is that it identify effect with cause, and in doing so correspond to categories an economist is accustomed to use. It is convenient to be able to identify changes in the contribution of capital with changes in saving and investment, changes in the allocation of resources with changes in the way that labor and capital are allocated, and so on.

To allow the rest of my discussion to be more specific, I provide at the end of this paper a suggested classification of growth sources to which I shall frequently refer.[3] It is generally consistent with the classification I follow in my own research, although I have not attempted separate estimates for several of the categories shown. In my judgment, it comes reasonably close to meeting the "causality" criterion. To stress this even at the risk of emphasizing the obvious, I have suggested some of the ways each determinant might be altered. Any determinant can change in either direction, but for brevity I have generally used wording describing only a change that would raise output. The amount of detail shown in the classification is not fundamental; it is somewhat influenced by what can be done but the presence of an entry need not imply that the present writer knows how to obtain a separate estimate. In many categories more detail than I show is almost essential, but the appropriate detail will vary from country to country. A number of items that can reasonably be classified in different ways will be noted.

[3]The classification provides for all the main determinants but it is not absolutely comprehensive; others may be significant in particular times and places. I have purposely omitted "trick" ways of affecting output, as by deliberately restricting consumer choice. For example, a country may be able to reduce unit costs in production and distribution by prohibiting variety even though consumers would prefer to pay for variety.

The No-Change Rule

A comprehensive general purpose classification of growth sources must be designed to have the characteristic that an output determinant that does not change between two dates contributes nothing to growth and that the contribution of every determinant is measured in comparison with a no-change situation. If no determinant in the classification changes, output does not change. Any deviation from this rule introduces chaos into a classification.

Practicality for Estimation

A practical classification must take into account the possibilities of estimation. Any comprehensive classification inevitably requires some estimates that in the present state of our art can be provided only with great difficulty and a large margin of error. But some groupings require estimates that are extremely difficult or even inherently impossible to construct, and which alternative groupings do not require. This is a very important consideration in developing a usable classification. Some differences among empirical studies in the estimating procedures adopted are almost unavoidable because of differences from place to place or period to period in available data, and these often imply small and subtle differences in classification.

I shall discuss estimating procedures as little as possible in this paper but some discussion is necessary. As background, it is useful at this point to group estimates in four categories.

1. The exact or approximate contribution of certain growth sources to changes in output can be obtained directly from the details of the output estimates themselves. Failure to do so introduces errors into the estimates of the contribution made not only by these output determinants but also by others because the sum of all contributions must equal the growth rate. A classification should be adapted to take advantage of these possibilities. Items 1a, 2a, 2b, and 2c of my classification are in this category, and I shall cover all that need be said about these determinants at this point.

The output ascribed to labor employed outside the business sector in any year, and the change in such output between years, is precisely what the output estimator has determined it to be and so, therefore, is the change in measured output that is due to changes in the amount of such labor.[4] The situation is the same for output imputed to general government capital where this is included in national product; in the United States it is not included. It would also be the same for output imputed to consumer durables if this were to be included; I have omitted this item from the classification because it is usually excluded from official output series.

The output ascribed to dwellings (structures and land combined) by the output estimator can be extracted, at least approximately, from data for the

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[4] I did not myself segregate this type of labor in my most recent published estimates, contained in *Why Growth Rates Differ: Postwar Experience in Nine Western Countries* (Washington: The Brookings Institution, 1967). I have done so in the study of United States growth in which I am now engaged. The other items mentioned in this section are isolated in both studies.

"services of dwellings" industry (usually published separately in Europe). Changes in this output can be ascribed mainly to changes in the quantity of residential structures and land, but fluctuations in the occupancy ratio may sometimes affect output; if so, the investigator may wish to isolate this effect, and possibly to transfer it from item 2b to 11. Finally, the output credited to the net international flow of property income can be isolated.[5]

2. A general technique is available to measure the effects of changes in most of the remaining components of my first three output determinants (labor, capital, and land input) which jointly comprise total factor input. The technique, which is fairly standard, requires two kinds of information: quantities at different dates and relative marginal products for use as weights. Estimates of relative products are ordinarily based on the general proposition that earnings of different inputs are proportional to marginal products because of efforts by producing enterprises to minimize costs, but the investigator may properly introduce adjustments to observed relative earnings if he has reason to do so.

Analysts have tended to classify all growth sources whose contributions can be estimated by techniques 1 or 2 as inputs, and all other sources as components of output per unit of input.[6] The precedent may deserve some consideration but it does not seem fundamental. In my own empirical work I have departed from this practice to the extent of classifying in labor input the effects of changes in working hours upon output per hour as well as certain aspects (particularly health) that I have judged not to change. The classification presented here calls for inclusion in item 1b (viii) of some other characteristics of workers that cannot be measured in this way.

3. An investigator often reaches a judgment that a particular output determinant did not change significantly in some particular time period. He can then estimate its contribution to growth at zero even though he may have no method to estimate what the effect would be if the determinant were to change.

4. Procedures available to estimate the contributions of the remaining output determinants vary. Some (including those for certain aspects of resource allocation) are tolerably satisfactory, but for many determinants presently available procedures and/or information range from poor to nonexistent.

No investigator, to date, has attempted direct estimates for every determinant. In consequence, all actual estimates combine certain of the determinants that I list and portions of others into a single item, and obtain its contribution

[5]This output component can be affected by any number of influences, but it is usually measured so badly in the national product (partly because of use of payments rather than accruals to measure international flows) that it is hardly worthwhile to do more than to classify it as the contribution of international assets.

[6]This is not so very different from classifying as inputs those determinants which can be measured with the least error, and this leads me to an observation which is only tangentially related to my topic. Moses Abramovitz's widely quoted remark was that the *residual* is a measure of our ignorance. He did not say and could not have meant that output per unit of input is a measure of our ignorance. I sense that the distinction is often overlooked and that it is supposed that ignorance is reduced by transferring the effects of as many determinants as possible into the input measure.

as a residual.[7] Advances in knowledge are always in this residual because no one has yet found a suitable way to estimate their contribution directly.

SPECIFIC ASPECTS OF CLASSIFICATION

The rest of this paper examines some aspects of classification which have been controversial, have been little discussed or ignored in the literature, or are ill understood. For the most part, they concern the borderlines between the separately identified growth determinants.

Relation of Advances in Knowledge to Capital Input, and to Labor Input and Its Education Component

Advances in knowledge of how to produce at low cost and economies of scale are the fundamental sources of productivity increase in the very long run. Other sources of productivity change refer to changes in the extent to which actual output falls below what it would be if resources could be allocated and used with perfect efficiency. They can contribute to growth only during a transition period, although this period may be long. Because of the key role in growth of advances in knowledge, it is crucial that their classification be as clear and convenient as possible.

We know far too little about this source of growth. At present its contribution can be estimated only as a residual because no way has been devised to obtain a direct estimate. In contrast to most output determinants, we have no way to judge the effect on output of altering this determinant without estimates of its past contribution. My own estimates suggest that this source has contributed in the neighborhood of three-fourths of a percentage point to one percentage point a year to the growth of output in advanced Western countries in the recent past. If accepted, this estimate permits a statement such as that the growth rate of output could be increased by about one-fourth to one-third of a percentage point a year if the rate at which knowledge advances could be increased by one-third. Weak as this statement may be, it does provide perspective that could not be secured without an estimate for the past.

It would be a big step forward in our understanding of growth if the estimated contribution, which appears in item 7 of the classification, could be divided between the contribution of advances in technological knowledge and that of advances in managerial and organizational knowledge. It would be a bigger step forward if each could then be divided by source: in the case of technological knowledge, for example, how much results from organized

[7]The number of determinants relegated to this grouping depends partly upon information available for a country and the course of events within it, and partly on the investigator's energy in ferreting out information and his ingenuity in utilizing it. It also depends upon his willingness to hazard his best guess when information is sketchy or worse. My own preference is to be venturesome. One reason is my suspicion that setting out estimates is likely to lead to improvement. The more important reason is that it is necessary in order to obtain the best possible estimate of the contribution of advances in knowledge. I hope it is unnecessary to state that the basis for every estimate should be described.

research, how much from inventions by individuals, how much from small accretions due to observation and experience in the process of production, and so on. Although fruitful investigation of these matters has been conducted, it has not yet allowed much quantification. One hopes that some brilliant mind may find ways to develop detail about kinds of advances and how they originate. A classification ought to provide for a comprehensive measure of the contribution of advances in knowledge so as to allow for convenient introduction of such detail; this could not be done if the total contribution of advances in knowledge were dispersed among other determinants as is sometimes suggested. I do not show such subdivisions under item 7 only because they are beyond the present state of the art of estimation, and establishment of the exact subcategories that will be most useful awaits the results of future research.

The contribution of advances in knowledge, as already indicated, is comprehensive in my classification. It includes all gains in measured output resulting from accretions to technical, managerial, or organizational knowledge regardless not only of their source but also of the way that they are introduced into the production process. It thus includes gains from advances that manifest themselves in improvements in the design of structures and equipment used in production—variously described as "noneconomic" or "unmeasured" quality change in capital goods or, more recently, as the difference between capital stock indexes of "J" and "K." The contribution of such advances cannot, of course, *also* be counted as contributions of capital, and to accord with this classification capital input must be measured by K, which does not reflect unmeasured quality change, rather than by J.

The classification recommended is desirable because it identifies effect with cause: changes in the contribution of capital with changes in saving and investment, and the contribution of advances in knowledge with those occurrences that advance knowledge. It is also dictated by the practical possibilities of estimation: an index of K can be calculated—not, to be sure, with precision but with tolerable accuracy—while an index of J can scarcely be estimated at all.[8]

For similar reasons, the contribution of advances in knowledge whose introduction requires that human labor learn of them (don't they all?) are not transferred to labor input. One way that labor is informed of some advances (though with a great time lag) is by incorporation of new knowledge in what is taught in formal education courses. These advances are not, of course, transferred to the education component of labor input.

If advances in knowledge affect what is taught in school, it is also true that the level of education of the labor force may affect the rate at which the stock of knowledge advances. The classification does not call for a transfer of this amount to an "education" category because this would destroy the unity of

[8]This statement may seem too strong inasmuch as a number of studies do purport to estimate the contribution of "unmeasured quality change" and transfer it to capital input. But the estimates are based either on sheer assumption as to the rate of "unmeasured quality change," or else on small differences in the degree of correlation between output and a small and very incomplete list of output determinants when alternative rates of "unmeasured quality change" are tested. Such procedures are so unsatisfactory that if the need for them can be eliminated, or the effect of errors in them can at least be minimized, the advantage is very great.

"advances in knowledge" as a source of growth. Besides this, the supposed effect depends upon the *level* of education of the labor force, rather than the change between two dates, so there is no base point to provide a criterion as to what one would wish to measure (the difference from a situation in which no one had any education at all would scarcely be interesting), and there is no basis for an estimate by any criterion.

The classification, it is to be stressed, provides no comprehensive measure of the effects of education on growth. Education enters explicitly only as an aspect of labor input, in item 1b(vi). As such, its contribution refers to the effect of changes in amount of education upon the value of work that individuals perform, taking society's stock of knowledge as given.

Components of the Gap between Actual and Best Practice and Its Relationship to Capital and Labor Input and Management Quality

The suggested classification calls for a distinction between advances in society's stock of knowledge (item 7) and the contribution to growth made by changes in the gap between the most efficient production practices permitted by the state of knowledge and average actual practice (item 8). The distinction is important because the factors governing the two are altogether different.

The same reason suggests at least a three-way division of item 8. Institutional restraints against use of efficient methods are responsible for part of the gap. These restraints can be itemized and by patient research their costs at different dates can be estimated. I provide for the contribution made by changes in the ratio of these costs to output in item 8a. Obviously, additional detail—a listing appropriate for a particular country under investigation—is desirable. The transmission of knowledge to all those who could use it is neither instantaneous nor fully pervasive, and this is a second source of the gap; the effect of changes in the gap deriving from this source fall in item 8b. The fact that capital goods are long lasting is a third reason for the gap. The ratio of the productivity of capital goods in the stock to that of goods embodying the latest technology may change from time to time, and the contribution of such a change appears in item 8c.

The main reason for distinguishing among these three possible causes of changes in the gap is that they are governed by different influences. Also, they must be estimated in quite different ways. In addition, certain kinds of institutional restraints both impair the efficiency of resources in the use to which they are actually put (item 8a) and cause misallocation of resources (item 4), and for estimation of costs it may sometimes be desirable to adjust the classification so as to combine the two.

So long as item 8c is kept separate, I have no strong feeling as to where it should appear in the classification. From the standpoint of causation it might, perhaps, be better classified as a component of capital input, rather than where I have placed it, because it can be affected by the saving rate. My reason for not doing so is that, while I believe it is usually possible to demonstrate that this item is so trivial in size that it can be estimated as zero, when this is not the case there is little basis for an estimate and it may be better to keep it out of the input series.

The quality of management, which doubtless also has something to do with the gap, is a troublesome item to classify. From one viewpoint, management is merely a type of labor and the quality of management no more requires a separate entry than does the quality of bricklayers. If the labor input estimates in item 1b were completely comprehensive and accurate, they would fully account for changes in all the qualifications relevant for management positions that are held by employed individuals, and for the energy that they bring to their jobs. If the "allocation of resources" estimates in item 4b were complete and accurate, they would fully account for changes in output due to changes in the economy's success in placing the most suitable people in management positions. Under these conditions nothing would be left over. Available estimates of labor input in fact handle management qualifications very incompletely, and the effects of changes in the efficiency of management selection have not been measured at all.

Because of management's crucial role in organizing production, the omissions are potentially important. Indeed, they are so important that it might be even better to separate management from other inputs and to measure its qualifications and allocation separately from that of other labor, rather than merely to remedy the omissions in implementation of the present classification.

Until one or the other of these solutions can be achieved (and I do not know how to do so), I can only recognize that most of the effects of changes in the quality of management are statistically left over in actual growth studies, and indicate that this is so in describing item 14.

Relationship of Economies of Scale to All Other Determinants,
with Special Reference to Resource Allocation

A change in a determinant by an amount that would be sufficient to raise output by one percent in an economy operating under constant returns to scale raises output by more than one percent if the economy operates under increasing returns to scale.[9] The best way to classify this extra output—whether to show gains from economies of scale that occur when an economy gets bigger as a separate growth source or to allocate its value among the other determinants that provide the initial stimulus—is debatable.

When algebraic production functions (whether theoretical or fitted by correlation analysis) allow for economies of scale at all, they commonly do so by using coefficients for the inputs that add to more than one. This procedure in effect classifies as contributions of the inputs the extra gain from scale economies that accompanies a change in total output caused by a change in inputs. Because they do not isolate separate determinants of output per unit of input, such functions usually fail to recognize explicitly that output increases caused by advances in knowledge, better allocation of resources, and other determinants of output per unit of input give rise to scale economies in the same way as do increases in inputs. But these gains are included in total output per unit of input or "time," or whatever the equivalent is called. Thus some of the gains from economies of scale are classified with inputs and some are not. However, if production functions detailed enough to treat various determinants of output

[9]Labor and capital used outside the domestic business sector are an important exception because of the way their output is measured.

per unit of input separately were calculated, they would presumably include gains from scale economies in establishing the coefficients for each determinant.

Among economists like myself who measure total factor input by weighting series for the separate inputs, the usual convention is quite different. The sum of the weights used to combine inputs is set at one, so that a one percent increase in every input increases total input by one percent. *All* gains from economies of scale then raise output per unit of input. One reason for this tradition is that the resulting estimates correspond to the language in which they are expressed; if every input increases one percent and output increases more, output per unit of input must have risen by any ordinary use of language. Another reason is that economies of scale are hard to estimate, and this convention permits total input and total output per unit of input to be obtained without knowledge of economies of scale. If, as in my own work, a more detailed analysis is attempted, a separate entry for economies of scale includes the extra gains from scale economies when output changes for any other reason—whether the latter is a change in any input or a change in any other determinant of output per unit of input.

The classification suggested here follows the latter convention. So long as we stress subtotals called "total input" and "output per unit of total input," it helps to avoid misunderstanding. Also, because in the present stage of our knowledge (or ignorance) the size of scale economies is most uncertain, it probably is somewhat preferable, for historical growth analysis, to show this weak estimate separately rather than to adopt the alternative of including in the contribution of every other determinant associated gains from economies of scale. But the practice has an inconvenient feature: the classification of output determinants for use in historical growth analysis is different from the classification requisite for answering the type of question I posed first. Thus, if we are asked how much a one percent increase in labor input or a transfer of one percent of labor from farm to industrial employment would change output, we must allow for economies of scale.[10]

I conceive of "economies of scale associated with the size and product composition of the national market for business output" (item 5 in the classification) as a purely passive factor in growth that cannot be independently influenced. If output rises because of changes in other determinants and consumers allocate their additional income to particular products in accordance with their preferences, scale economies permit an additional rise in income, but nothing can be done to affect the amount.[11] This conception is the same as that which is implicit in production functions when they include economy-of-scale effects in the coefficients for other determinants.

This determinant is a purely passive factor because the scope of other determinants covers all the ways that market size could be affected independently; these relate to conditions that prevent a country from actually realizing all of

[10]In *The Sources of Economic Growth and the Alternatives Before Us* (CED Supplementary Paper No. 13, New York: Committee for Economic Development, 1962), which dealt with both subjects, I followed this practice.

[11]Except, by interfering with consumer sovereignty, to channel increased output into products where scale economies from raising output are greatest in order to foster the statistical result of a higher growth rate.

the economies of scale that the size of its economy would permit. Most of these are covered under resource allocation (item 4). Thus, trade barriers impair international and sometimes domestic commerce and restrict the size of markets (along with their other effects); firms and establishments may be of less than optimal size, because competition is insufficient to drive out inefficient firms or for other reasons; and various other conditions relating to resource allocation may prevent a country from achieving the degree of specialization and scale economies that the size of its economy would allow. These are conditions that a country can attack directly. So are obstacles to the efficient use of resources in the use to which they are actually put—mostly relating to overmanning or to prohibition of the introduction of new techniques. These are classified in item 8a.

Thus item 5 is limited to the amounts which would be allocated among other determinants if the alternative classification suggested—that flowing from production function practice—were adopted. Gains in scale economies actually obtained that result from reducing trade barriers or transferring resources from enterprises too small to be efficient are not an incidental consequence of changes in other determinants, and could not be ascribed to them. The distinction is, I think, fundamental in growth analysis. A country cannot do much about its size but it can strive to maximize output within that constraint.

"Growth of national markets" (item 5) subsumes the growth of local and regional markets that necessarily accompanies an increase in the nation's output. Changes in the geographic distribution of population and production may also change independently, however, and such changes too may affect the scale of markets; the contribution appears in item 6. There is great interest at present in the potential effect on productivity of limiting the growth of the biggest cities and starting new cities of smaller size, an effect that would be considered under this determinant, and there is need for research on this topic.

The "Efficiency Offset" to Hours Changes and Its Relation
to Labor, Capital, and Land Inputs and Output per Unit of Input

Assume the following simplified case. All workers work full time, and their average hours are reduced 1 percent. Operations are on a single shift, so the cut in labor hours reduces the hours that capital and land are used by 1 percent. Because of a reduction in fatigue and costs of absenteeism, output drops only 0.7 percent so output per man-hour worked increases 0.3 percent.

My classification will ascribe the 0.7 percent drop in output to labor input and, in the broader grouping, to total input. Output per unit of input is unchanged. The main reason for this classification is that it keeps cause and effect closely associated; the hours reduction did cut output by 0.7 percent and the effect is not dispersed among major determinants. The behavior of total input is correct if we regard labor input as being measured in efficiency units rather than in units of time.

I do urge presentation of subtotals of this result: item 1b(ii) would show the minus 1 percent "contribution" from total input that would have resulted from the reduction in the absence of an offset from increased efficiency and item 1b(iv), the 0.3 percent "contribution" from the efficiency offset. This division provides additional useful information and brings out the estimator's

assumption as to the size of the offset. It also permits easy adjustment to an alternative classification that some may prefer: entry of the 0.3 percent efficiency offset as a separate component of output per unit of input, leaving the contribution of total input as a minus 1 percent. Such a classification would have the disadvantage that if one wishes to examine the effects of a change in labor hours he must consider two determinants instead of one (in addition to any others that may be affected) but this is not exceptional. A greater disadvantage is that it may invite misunderstanding of the effect of hours changes. To one who wishes to follow the tradition noted earlier, it has the slight advantage that it avoids inclusion in the total factor input series of a component (the efficiency offset) that must be estimated by a method different from that used for most other input components and is in fact difficult to estimate.

One might also prefer to isolate the roles of capital and land. Suppose we add to the original assumptions the information that labor represents 80 percent, capital 15 percent, and land 5 percent of total input. Given the earlier assumption that hours of each were reduced by 1 percent, one might wish to show that capital input contributed minus 0.15 percent and land input minus 0.05 percent to the change in output. Labor input would then be shown as contributing minus 0.50 percent, divided between minus 0.80 percent for the change in hours as such and (as before) 0.30 percent for the efficiency offset. A disadvantage of this classification is that it confuses the causation. Another is that it requires additional information—the effect of changes in labor hours upon capital and land hours—that not only is not available but also is not directly observable because capital and land hours may also change for many other reasons.[12]

Relation of Resource Allocation to Factor Inputs

The allocation of each type of input typically differs from the allocation that would maximize output, and actual output consequently falls short of the output that could be achieved with an income-maximizing allocation.[13] Improvement in resource allocation is a source of growth between any two dates if it causes the percentage by which actual output falls short of possible output to be smaller at the second date than at the first. One can appraise the effects of changes in resource allocation statistically only by looking separately at various aspects of resource allocation or reasons for misallocation, judging whether each has changed between two dates, and, if so, attempting to quantify the effects on output as measured. The reference to measured output is important here because some types of misallocation affect welfare but not actual measures of output.

Two broad categories of misallocation of resources are distinguished in the classification shown. First, the share of each type of input as a whole (labor, nonresidential structures and equipment, etc.) that is devoted to a product, industry, size of establishment, etc. may be suboptimal. Second, square pegs may be in round holes: the allocation of particular individuals among jobs,

[12]Changes for all reasons in capital and land hours cannot be grouped as separate growth determinants. See below, p. 38.

[13]For brevity, I shall henceforth refer to a situation in which the allocation differs from that which would maximize output as suboptimal or misallocation.

or of particular parcels of land or items of capital among uses, may be sub-optimal even though the allocation of total resources is not. Workers may not be allocated among jobs in the way that would maximize their output because employers lack the information required to make the best selection, or because conscious or unconscious discrimination against women, young or old people, racial groups, or other categories of workers prevents them from securing jobs which they wish and in which they could perform better than the actual occupants of these jobs. Immobility contributes to both types of misallocation, and various laws and regulations may also do so.

The distinction between the contribution of each input and the contribution of resource reallocation of that input can be stated simply. The former measures the change in output that would have resulted from the observed change in the input if the percentage reduction in total national income that is caused by its misallocation had not changed between the dates compared. The latter measures the change in output that resulted from the change in this percentage. At least three general points require amplification.

1. The reference to "each" input in the preceding paragraph is deliberate and important. It is not always recognized that what is counted as an increase in input and what is counted as an increase in output per unit of input depends on how many, and what, inputs are distinguished. An understanding of what is meant by "an" input is therefore necessary for an understanding of the estimates prepared by any investigator, and of this classification. In brief, any subcomponent of labor, capital, or land that is separately estimated and assigned a separate weight, based on relative earnings, in the computation of total input must be construed as a separate input. The importance of the wording is this: The effects on output of changes in degree of misallocation of each separate input do not affect the input series and must be measured in item 4; but gains and losses in output arising from the reallocation among the separately recognized inputs of what would be regarded as one input in some broader concept of an input are captured in the input series and cannot also be counted as gains or losses from resource allocation.

The situation is clearest for capital. Each type of capital asset distinguished within determinant 2 of the classification is treated as a separate input. The ratio of net earnings to asset values, hence the estimated marginal product of a dollar's worth of capital assets, may vary among the types. Suppose the total capital stock is unchanged, but its distribution shifts from a type of capital on which the yield is low to one on which it is high so that total output increases; in many countries a shift from dwellings to nonresidential business fixed or inventory capital has this effect. The output increase appears as a contribution of capital (the positive contribution from business capital will exceed the negative contribution from dwellings) and cannot also be counted as a gain from improved allocation of resources despite the fact that there has been no net investment and that the reallocation of total capital has raised output.

Users who regard capital as a single entity will find this result inconvenient, and I am not happy with it myself because it slightly compromises the identification of the contribution of capital with investment. The more types of capital one distinguishes in the classification and estimating procedure, the more he

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brings effects of resource allocation into the contribution of capital. I have used as little detail as seems to me consistent with accurate estimation. Unfortunately, I see no way to develop an accurate capital input measure without distinguishing between business fixed capital and business inventories, nor to take advantage of the estimates for dwellings, international assets, and, where present, government capital that are inherent in the output measure with use of less detail than I have shown. But it might be possible, subsequently, to estimate the effect of such shifts among types of capital input, and to show it as a separate deduction item in the capital input composite and as a positive item (if the change is a gain) under the resource allocation heading. The information thus added would be of interest.

From the resource allocation standpoint, I would definitely prefer to regard all labor in the business sector as a single input so as to avoid this type of difficulty. If hourly earnings differentials among categories of employed workers distinguished in the calculation of item 1b are not affected by misallocation in job assignments, the procedures actually followed to measure labor input permit this interpretation. No gains from an improved allocation of labor are counted as an increase in labor input if this condition is met.

If earnings differentials are systematically affected by misallocation, it is probably the result of systematic discrimination against certain groups, because effects of misallocation for other reasons are likely to be random and offsetting. If discrimination does contribute to the earnings differentials, the situation becomes complicated. Thus employer discrimination may deny women (or any other group) access to some of the more skilled jobs that they could perform better than their male (or middle-aged, or white) occupants, and the national product is lower in consequence. A reduction in the cost of misallocation because the degree of discrimination against women (or any other group) decreases will, of course, be counted in item 4b as a gain from reallocation of resources. It is when the relative size of the group changes that the classification is affected. Although most of the differential between male and female earnings is presumed to be due to a difference in the work that males and females are able and especially, willing to do, given their other responsibilities, and consequently an indication of a difference in labor "quality," some part probably is due to employment discrimination.[14] In combining hours worked by males and females to measure labor input in the business sector, I use observed average hourly earnings as weights. If the proportion of total hours that are worked by women increases, labor input rises less than it would if the hourly earnings differentials had been reduced to eliminate the (unknown) portion due to discrimination. If there is no change in the degree of discrimination against women between two dates, the labor input series will accurately measure the change in output resulting from the actual addition to male and female hours, and nothing can be counted as resulting from a change in misallocation. This is a tenable classification, but it introduces an oddity. Even though discrimination has not changed, the percentage of potentially available national income that is sacrificed will

[14]A part may also be due to pay discrimination—failure to pay the same rate for identical work. If so, this part should be eliminated from the differentials before they are used as weights because it pertains to the distribution rather than the amount of national income.

have risen between the two dates because women are now a larger part of the total. Because this increase in the cost of misallocation will have been captured in the labor input series (it is equal to the difference between the contributions of labor input when the earnings differentials are, and are not, adjusted), it cannot also be counted in item 4 as a negative contribution from increased misallocation of labor. This does not correspond to the general distinction between input changes and reallocation effects, but it could be remedied only if the effect of employment discrimination on earnings differentials were known.

2. It is very important to note that the classification does not call for identifying or subdividing an input (as defined) by the use to which it is put. For example, in measuring labor input in the business sector, I give full-time farm and nonfarm workers who are otherwise similar (i.e., with respect to sex, age, and education) equal weight, despite the fact that farm workers earn less than nonfarm workers because of overallocation of labor to farming. Similarly, a dollar's worth of nonresidential structures and equipment in farm and nonfarm use is given equal weight in obtaining an index for the input of fixed capital, and farm and nonfarm inventories are similarly weighted to secure an index of inventory input, despite the fact that the ratio of earnings to asset values appears to be lower in farming. Thus my input indexes are the same whether an increase in labor or capital appears in farm or nonfarm industries.

The result is that the contribution of each input refers to the increase in output that would have resulted from the increase in that input if there had been no change in the total cost of misallocation (as a percentage of total output). Consequently, a shift in the allocation of any input among uses gives rise to no difficulties in classification. The total gains from improved allocation of any input appear in item 4.

Separate weighing of employment, or of capital assets, used in farm and nonfarm activities, or in accordance with other use categories such as legal form of organization, industry, or (in the case of labor) occupation, would change the meaning of the classification substantially by transferring gains or losses from reallocation of resources among uses to the contributions of the inputs. This seems to me to be highly undesirable. In any case, it is very important to recognize the classification change involved in such a procedure because some investigators would like to introduce detailed subdivisions of inputs and their separate weighting.

3. Two special classification questions arise when labor is redistributed among farm work, nonfarm self-employment, and nonfarm wage and salary employment.

First, in the United States and most Western countries the reported average hours of full-time workers of either sex who are engaged in farming, or in nonfarm self-employment, are much longer than those of full-time nonfarm wage and salary workers of the same sex. Employment shifts from the first two groups to the third reduce their combined average hours. My classification does not permit a reduction in hours for this reason to reduce labor input. In my labor input estimates, I count a *week* of full-time employment by an individual with given characteristics as representing the same input in the three

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groups, rather than counting an *hour* of work as the same input. Consequently, the shift of a full-time worker from farm employment to paid nonfarm employment does not reduce labor input if he worked the average hours of full-time farm workers of his sex before the shift, and works the average hours of his new group after the shift. Item 1b(v) in the classification is introduced to achieve this result. It simply offsets that part of the decline in average hours measured in item 1b(ii) that results from such shifts in the composition of employment. In my view this convention is both realistic (farm hours would be highly inefficient in a factory) and convenient. It also avoids errors in the measurement of labor input arising from the probability that reported hours of the three groups distinguished are not really comparable. But the alternative of counting an hour's work as equivalent input is preferred by some investigators, and I do not suggest it is "wrong." Its adoption leads to a smaller contribution from labor input and to a larger contribution from resource reallocation, since the latter must then refer to the increase in output per man-hour rather than to the gain in output per man as in my classification. The difference is quantitatively significant in the United States. Either procedure may be acceptable, but that adopted should be specified clearly.

Second, in measuring gains from the shift of labor out of farming or non-farm self-employment, some analysts break out the part of the gain that results from a reduction in "concealed unemployment" and classify it as a contribution of labor input. The estimated amount is sometimes very large. The classification suggested does not require this separation because the entire gain is classified in the resource allocation category.[15] The whole gain results from the same cause, the transfer of labor out of farming or nonfarm self-employment, and it seems to me better to count it all in one place.

Relation of Inputs to Intensity of Utilization

The intensity with which employed resources in the business sector are used varies with fluctuations in the pressure of demand. This is true of labor input, even though account is taken of changes in working hours, because there is an overhead element in labor. If the movement of capital and land inputs is measured by the stock of these assets (as called for by the classification presented), the intensity of use of these inputs fluctuates even more. For short-term analysis, the series for total input may be regarded as a measure of the time that labor, capital, and land are physically present in business establishments and available for use in production. The classification provides for the effects of short-term fluctuations in intensity of utilization as a separate determinant. This item is difficult to estimate, except as between dates that can be regarded as comparable so that the estimate is zero, but its isolation is essential for proper interpretation of the results of any empirical study of growth. It appears as item 11 in the classification.

It would be still more difficult to subdivide this determinant among the separate effects of fluctuations in the intensity of use of labor, of capital, and

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[15]In *The Sources of Economic Growth in the United States, ibid.,* I made such a separation myself, but I did not transfer the "concealed unemployment" portion to labor input.

of land, but if this can be done interesting information is added. Also, in that case some analysts would wish to classify these determinants in the respective input series rather than in output per unit of input. Provided that the estimates are shown separately, I would have no strong preference as to whether or not this was done. The classification suggested here is intended to minimize the estimation problem, by avoiding the need to subdivide the estimate among the separate inputs, without impairing the usefulness of the results for most purposes.

The hours that capital and land are used may change in the longer run as an incidental result of changes in other determinants. However, even if data on average capital and land hours were available, they could not be entered as a separate output determinant into a classification such as this without double counting because they are merely a manifestation of changes in other determinants.[16] An exception (although even in this case there are ambiguities) is changes in the hours that capital is used as a result of changes in the prevalence of shift work. Changes in capital hours from this cause must be measured with the weight attached to each type of capital in every use held constant; otherwise the contribution of changes in capital input already measured at item 2 will be duplicated.[17] Item 13 provides for this estimate.

Detailed Components of Labor Input in the Business Sector

A detailed breakdown of labor input in the business sector is useful despite the facts that (1) the meaning of the detailed estimates is somewhat artificial or "iffy," which is well known; and (2) the detailed estimates themselves depend—usually but not necessarily to only a small degree—upon the order in which characteristics are introduced, a fact which may be less well known.[18]

The order of characteristics shown in parts (i) through (vi) of item 1b is that followed in a study on which I am currently engaged.[19] I start with employment, so the "contribution" of changes in employment measures what the effect upon output of a change in employment of the size observed would have been *if* there had been no change in average hours or in the composition of employed persons. The contribution of changes in average hours is introduced next, and the contributions of employment and hours together measure what the effect of the change in total hours would have been if there had been no change in the composition of total hours worked and no efficiency offset to changes in average hours. The change in the age-sex composition of hours is introduced next. The combined contributions of the first three determinants measure what the effect on output would have been if the total number of hours worked by each age-sex group had changed as it did but there had been no efficiency offset to changes in average working hours and no change in composition within age-sex groups. Thereafter each age-sex group must be treated separately, and

[16]The explanation is rather lengthy and is provided elsewhere. See Edward F. Denison, "Some Major Issues in Productivity Analysis: An Examination of Estimates by Jorgenson and Griliches," *Survey of Current Business*, Vol. 49 (May 1969, Pt. 2), pp. 18–21, 27.

[17]For explanation, see *ibid*.

[18]The contribution of *total* labor input, of course, is not affected by the order in which characteristics are introduced if the investigator keeps track of interrelationships properly.

[19]I estimate the contribution of item 1b(vii), health, at zero and do not attempt to estimate item 1b(viii).

appropriately weighted for consistency with the previous steps in the procedure. Additional weighting must be introduced as one proceeds.

With the order I have used, changes in male and female employment and average hours receive equal weight per person in estimating items 1b(i) and 1b(ii), but because weighting by sex is introduced in item 1b(iii), changes for females receive less weight than those for males in estimating items 1b(iv) to 1b(vi). In the postwar United States, the number of female workers in the business sector has increased by a larger percentage than the number of males, their average hours have declined more, and their education has increased less. In consequence, if weighting by sex were introduced at the beginning rather than third, the size of the positive contribution obtained for employment and that of the negative contribution obtained for the reduction in average hours would both be smaller than the contributions I obtain. If weighting by sex were deferred until after education is introduced, the contribution of the education component would be increased slightly.

I know of no principle to determine the order except convenience in preparing the estimates, and all that can reasonably be asked of the investigator is that he describe his procedures and, if possible, indicate the changes that would result from use of a different order.

The contribution of increased education of employed persons, it may be noted, measures the net gain from additional education over the loss from the associated reduction in experience that results from longer education. The age-sex measure does not capture this loss of experience so the components are consistent. This classification results from the use of age as a measure of classification in both the education estimates (to develop weights for otherwise comparable persons with different education) and in the age-sex measure. If length of experience were substituted for age in both computations, the education component would then measure the gross gain from additional education and the age-experience measure would capture the loss of experience. My procedure is dictated by data availability in the United States and in other countries. From a classification standpoint there is little to choose, but experience is a better criterion than age for distinguishing ability, especially among women because their work experience is usually intermittent, and I would have a slight preference for substituting experience for age if necessary data existed.

Capital and Labor

Some enthusiasts for the "human capital" concept might wish to transfer from the general heading of labor input to that of capital input the contributions that result from changes in acquired skills—education, age or experience, and perhaps other characteristics—leaving only changes in "raw" labor, somehow defined, in the labor input category. It seems to me better, because less likely to lead to misunderstanding, to leave in labor input all those qualities that are an inseparable part of the worker and account for earnings differentials among workers. To the best of my knowledge, the choice is *solely* a matter of classification of these detailed components between the two broader groupings; nothing in the human capital approach would suggest use of a different method

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of deriving the estimates.[20] The value of this approach to growth analysis lies, instead, in the computation of rates of return that contribute to judgments as to how alternative uses of current output—to raise the level of education, to expand the quantities of various forms of capital for research, to increase mobility, etc.—will affect future output.

Some Aspects of the Milieu within Which Production Takes Place

National product is measured by use of two conventions: that purchases of goods and services by business are not final product; and that purchases by government and individuals are final product. Measured output is reduced if business must divert resources, which would otherwise be used to produce for sale, to the collection of taxes, the filing of census forms, or the provision of other services for government. Conversely, measured output is increased if government provides services that eliminate a need for business to use its own resources in providing goods and services for sale.[21] Item 9 provides for changes in these determinants.

Partly as a result of the same conventions, but also for other reasons, output is affected by the framework of laws and the human environment within which business operates. I provide for the effects of changes in these conditions in item 10. Several changes that fall in this category are beginning to, or shortly will, affect measured output in the United States adversely. New laws that require business to reduce greatly its pollution of air and water impose more costly production practices that absorb resources that would otherwise produce measured output. Introduction of more stringent laws to protect workers against accidents on the job and against industrial disease have the same effect. New legislation to inform consumers better, protect them against fraud, and increase the safety of products similarly increase business costs and reduce business output for sale. In the sphere of the human environment, an increase in robberies and pilfering has forced many establishments to add guards, other security personnel, and protective devices that formerly were not required. Some establishments located in particularly crime-ridden areas have had to abandon self-service or even to move to what would be less advantageous locations in the absence of the increase in crime. The effects of changes such as I have just described can be estimated—though scarcely with precision—if information that can be collected is in fact obtained.

Growth in any country takes place against a background of more general and pervasive human conditions: attitudes toward income and leisure, and toward work in general and of particular kinds; belief in the possibility of getting ahead by one's own efforts; religious beliefs; a like or dislike for change and innovation; a spirit of enterprise or its absence. These conditions often change so slowly that they can be assumed not to change at all, but this is not always so.

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[20]However, if, in conformity with a suggestion made above, gains obtained by shifting the allocation of total capital among types on which returns differ were to be transferred from the capital input to the resource allocation category, the scope of capital would then be broadened to include "human capital."

[21]George Jaszi has noted correctly that, strictly speaking, this is the consequence of a misspecification of product in deflation rather than of using the second convention in current dollar measures of national product or income, but the result is the same.

When they do change, their effects will in principle be reflected in determinants shown in the classification, but some of those most likely to be affected—notably, "how hard people work" which appears in item 1b(viii), and certain aspects of labor allocation which appear in item 4b—are extremely hard to measure. I can only comment that they raise problems which we cannot as yet handle very well.

CONCLUDING REMARKS

If this paper accomplishes nothing else, I hope it convinces the reader that in growth analysis there are many borderline cases whose classification must be specified by anyone providing estimates, and that users of estimates have an obligation to read carefully. If it helps others engaged in growth analysis to formulate usable and practical classifications, and through discussion helps me in my own work, I shall regard this as a bonus. The classification suggested here is a compromise between what is desirable and what appears feasible. I have indicated a number of points at which alternatives are entirely reasonable, but a few characteristics are fundamental and I have tried to say why I regard them as such. If there is ever a proposal for a standard classification of growth sources, this might perhaps serve as an initial basis for discussion.

APPENDIX

A SUGGESTED CLASSIFICATION OF SOURCES OF GROWTH

Components of Total Factor Input

1. Changes in labor input, i.e., in employment of and hours worked by individuals classified by personal characteristics that affect their contribution to the value of measured output. For consistency with output measures, it is important to divide labor input between:

   (a) Workers employed by general government, households, and institutions, sectors in which the output of labor is separately and conventionally measured and necessarily the same as the contribution of labor input; and

   (b) Workers employed in the business sector, whose input can be measured by considering:

      (i) Employment
      (ii) Average hours worked
      (iii) The composition of total hours worked classified by sex and by age (or total work experience) of workers
      (iv) The effect upon the efficiency of an hour's work of changes in the length of the work year of homogeneous groups of workers
      (v) Changes in average hours resulting from changes in the weight of labor force groups whose hours differ
      (vi) Formal education

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(vii) Health

(viii) Other personal characteristics of workers, such as effort exerted, experience on present job, training other than formal education.

This determinant can be altered by increasing labor force participation rates; by immigration; by reducing unemployment and lost time; by lengthening hours of work; by increasing or improving education and training, health, or incentives to work hard; by reducing labor turnover; and in numerous other ways.

2. Changes in capital input, divided among:
    (a) General government capital (but this is a determinant only if the output measure includes an imputed return from such capital)
    (b) Dwellings, including residential land
    (c) International assets
    (d) Nonresidential capital in the business sector, divided among:
        (1) Nonresidential structures and equipment, with changes in input measured without allowance for "noneconomic" or "unmeasured" quality change
        (2) Inventories.

This determinant can be altered mainly by changing the amount of net investment in each of these types of capital.

3. Changes in the quantity of nonresidential land in the business sector. Improvement or deterioration in the quality of farm, mineral, and forest lands can be classified here but are better counted in 2d if they result from human action rather than natural causes.

This determinant usually can be altered very little, mostly by shifting land in or out of governmental and residential use, unless quality factors are counted here.

Components of Output per Unit of Input

4. Changes in the degree to which the actual allocation of employed human and property resources departs from the allocation that would maximize national income.[1] It is convenient to distinguish two broad aspects of allocation, each of which can be further subdivided in detail.
    (a) The extent to which the allocation—among industries or products, or among firms categorized by size, degree of risk, or other significant characteristics—of each type of input *in the aggregate* departs from that which would maximize national income. (Each type of capital input distinguished in item 2 is regarded as a separate input.)
    (b) The extent to which the allocation of individual workers among individual jobs departs from that which would maximize national income. There is a less important counterpart for individual capital goods and parcels of land.

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[1]Distortions produced by wartime destruction or the division of countries provide a special subdivision of this determinant when they are present.

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A wide variety of changes (including aspects of tax, wage, and labor market policy) to increase correspondence between rewards and the value of contributions to output, to identify the abilities and potentialities of workers better, to eliminate discrimination—particularly in hiring and promotion of workers, or for or against risky investments—can affect this determinant. Since economic change itself causes misallocation as a result of lags in adjustment, an increase in mobility of resources or a reduction in the pace of change in demand patterns or technology also affects this determinant.

5. Changes in economies of scale resulting from changes in the size and product composition of the national market for business output.

The size of the national market is determined by all the other income determinants listed, and cannot be altered directly. Neither can composition of the market if free consumer choice is allowed.

6. Changes in economies of scale resulting from changes in the geographic concentration of domestic customers (for intermediate as well as final products, hence of production as well as of individuals).

This determinant can be changed by policies that alter the geographic distribution.

7. Changes in the state of knowledge—technical, managerial, or organizational—that govern the amount of output that business can obtain by use of a given quantity of resources.

In general, changes in the state of knowledge occur on an international basis, but this determinant may vary from country to country because of differences in economic structure. This determinant is greatly affected by the mere passage of time because knowledge once obtained is rarely lost, but it may be affected by such factors as the amount of resources devoted to research, the level of education and training, and the character of patent laws.

8. Changes in the amount by which output obtained with the average production technique actually used falls below what it would be if the best technique were used, because of:

   (a) Changes in obstacles imposed (usually by government or labor union regulation) against efficient utilization of resources in the uses to which they are actually put. This determinant can be altered by changing the restrictions.

   (b) Changes in the extent to which existing knowledge is available to those in a position to apply it. This determinant can be altered by improving channels of communication.

   (c) Changes in the time lag between the dates at which business structures and equipment are installed (incorporating knowledge of design at that date) and the dates at which they are in use. This determinant can be altered by modernizing capital goods, and this may occur if investment in business structures and equipment is increased.

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9. Changes in the cost of "business services to government," such as collecting taxes or filing statistical reports, and changes in the adequacy of "government services to business," such as provision of law courts or roads for business use.

This determinant can be altered by transferring the costs of functions between business and government.

10. Changes in aspects of the legal and human environment within which business must operate that affect costs of production by business. One example is the honesty of the public in general and customers or suppliers in particular, which affects business costs of protection against robbery, fraud, etc., and may even govern the determination of whether or not certain types of business operation, such as self-service, are feasible. Another example, currently important in many countries, is changes in requirements imposed to limit polluting in the process of production.

These determinants may be altered by policies that affect public behavior, or by changes in laws that affect the conditions under which production may take place, or in the distribution of costs of environmental protection and the like between business, on the one hand, and consumers and government, on the other.

11. Changes in the intensity with which employed resources are used that result from fluctuations in the pressure of demand.

The chief reason that this determinant, as well as number 12, requires isolation is to make it possible to disentangle transient from continuing forces. However, this determinant may be affected by aggregate demand management policies.

12. Changes in irregular factors that affect output per unit of input, particularly in the weather and/or in the impact of strikes.

This determinant may be altered by measures to affect the weather, or to promote labor peace.

13. Changes in the extent to which the use of multiple labor shifts permit economizing in the use of capital in particular uses, apart from changes resulting from variations in the pressure of demand.

This determinant may be affected by changing the use of multiple shifts.

14. Changes in productive efficiency that take place independently of changes in any of the other determinants. Economists are sometimes reluctant to admit existence of this determinant because it is inconvenient. I am convinced that efficiency, so defined, differs among countries and surmise that it may vary over time within a country. One plausible explanation is that efficiency actually achieved is affected by the strength of competitive pressures upon firms to minimize costs.

So closely linked that, for empirical studies, I include it here is the quality of management. This is conceptually covered under the classifications of

labor input and resource allocation, but I do not think it can be comprehensively handled in this way at present.

We would need to know more about this determinant to identify with any certainty the types of policy that would affect it, but if my surmises are correct they would include intensification of competitive pressures, and policies to improve the selection and training of management and to stimulate the replacement of unsuccessful managers.