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Accounting for Maintenance and Repairs

by

Arnold J. Katz

Economic Accounts Studies
Bureau of Economic Analysis
U.S. Department of Commerce
Washington, D.C. 20230
(202) 606-9632

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Abstract

The treatment of expenditures for the maintenance and repair (M & R) of capital goods proposed in the 1993 SNA differs significantly from present and past NIPA treatments. The basic issues concern how much of M & R expenditures, if any, should be capitalized. The resolution of these issues is of no little consequence. For example, depending on how one treats M & R expenditures, the NIPA estimate for gross private domestic fixed investment of \$771 billion in 1989 could be changed to anywhere between \$645 billion and \$982 billion, i.e., it could be increased by as much as 27 percent or lowered by 16 percent. This paper describes the current and proposed treatments of M & R expenditures in the SNA and the NIPA's, discusses the theoretical merits of the various treatments, and provides recommendations.

The treatment of expenditures for the maintenance and repair (M & R) of capital goods proposed in the 1993 SNA differs significantly from present and past NIPA treatments. (This paper uses a broad definition of M & R expenditures; specifically, they are defined as all expenditures that affect the condition of existing capital goods. Consequently, expenditures on additions, alterations, and other "improvements" to capital goods, as well as the major replacements of parts of them are included within this definition.) The basic issues concern how much of expenditures on M & R of capital goods, if any, should be capitalized.

The resolution of these issues is of no little consequence. Differences between possible treatments have extremely large and important effects on the measured levels of GDP and the capital stock and the extent to which these aggregates vary over the business cycle. To the extent that private M & R expenditures are capitalized, the level of GDP is higher; the level of NDP is only marginally higher because depreciation on these expenditures is probably close in magnitude to new expenditures on them. The fact that M & R expenditures are often substitutes for purchases of new capital goods would tend to cause the two types of expenditures to be inversely correlated. On the other hand, a certain false economy is often obtained by the neglect of needed M & R, particularly in downturns when finances are tight. Consequently, the capitalization of M & R expenditures not only affects the level of GDP and gross investment but also the extent to which they vary over the business cycle. As capitalizing M & R expenditures undoubtedly has a major effect on estimates of the capital stock, it could have an important impact on attempts to measure and explain productivity.

Expenditures on M & R represent a sizable part of the U.S. economy. Available data permit only a crude estimate of the magnitude of these expenditures (these estimates are explained in the appendix to this paper). Private M & R expenditures totaled more than \$337 billion in 1989, see table 1 on page 21.¹ (Public M & R expenditures are also substantial; the amount for construction alone was about \$61½ billion in 1989, see table 2 on page 22.) Of the \$337 billion, \$126 billion was already capitalized in the NIPA's. Consequently, depending on how one treats M & R expenditures, the NIPA estimate for gross private domestic fixed investment of \$771 billion in 1989 could be changed to anywhere between \$645 billion and \$982 billion, i.e., it could be increased by as much as 27 percent or lowered by 16 percent. Actually, the above substantially underestimates the magnitude of the potential impact of capitalizing M & R expenditures as this estimate does not include: own-account labor for making repairs and performing other maintenance functions to equipment (such as the labor of airline mechanics), the value of many parts that are purchased for making such own-account repairs, or the value of equipment installed by wholesalers or retailers like Businessland.²

¹ Note that all estimates used in this paper were made in the spring of 1991 before the last benchmark revision, see the appendix to this paper. (The current estimate of gross private domestic fixed investment for 1989 is about 4 percent higher than that shown here.)

² The treatment of maintenance and repair expenditures may play an even larger role than that suggested above. For example, in the December 1989 issue of the Review of Income and Wealth, Anne Harrison bases her suggested treatment of accounting for expenditures to repair the damage done to environmental assets on an analogy to the treatment of repairs to roads. Thus, the manner in which M & R expenditures are accounted for could have an important impact on influencing the accounting treatment of natural resources and environmental assets.

Three basic positions can be taken with respect to expenditures for M & R: 1) capitalize no such expenditures, (2) capitalize some of these expenditures, i.e., those that meet certain criteria, and (3) capitalize all such expenditures. Most existing and proposed national income accounting treatments of M & R expenditures are essentially variants of the second treatment. The following sections of this paper describe the current and proposed treatments of M & R expenditures in the SNA and the NIPA's, discuss the theoretical merits of the various treatments, and provide recommendations.

Current and Proposed National Accounting Treatments of Maintenance and Repair Expenditures

Systems of National Accounts. -- The proposals for the revised SNA would not capitalize "ordinary" M & R expenditures but would capitalize other M & R expenditures. Without further elaboration, this statement is not terribly useful, however, as it amounts to defining "ordinary" M & R expenditures as those expenditures that are not to be capitalized. The latest draft of the 1993 SNA available on the BEA LAN (9/3/92) discusses the problem at length in paragraphs 27-28 of the introduction, in paragraphs 20, 26-27, and 166-169 of chapter VI, in paragraphs 59-61 of chapter IX, and in paragraphs 46-50 of chapter X. Under the proposals, in order to be capitalizable, expenditures must be avoidable. Consequently, all repairs made to a good that is broken and requires the repairs in order to be operable are to be treated as "intermediate" and not capitalized. In order to be capitalizable, expenditures must bring about significant changes in some of the characteristics of the fixed assets, i.e., they must result in

major changes in either these assets' size, shape, performance, productive capacity, or extend their previously expected service lives. Expenditures that do not change the characteristics of the capital good are not capitalizable.

Several specific examples of the applications of the proposed guidelines are presented. Capitalizable expenditures include: Enlargements or extensions to existing buildings or other structures, complete refittings or restructurings of the interior of buildings or ships, and major extensions to or enhancements of an existing software system. In contrast, expenditures to replace a defective part of a durable are not capitalizable.

The treatment of M & R expenditures on owner-occupied housing needs some elaboration. Services rendered by professional builders and decorators to owner-occupiers are considered to be intermediate inputs into the production of housing services. Consequently, payments for these services are subtracted from space rent in the calculation of gross housing product and the rental income of households (or persons). For repairs that are performed by owner-occupiers, a distinction is made between "do-it-yourself" activities (including decoration, maintenance, and small repairs of a kind normally made by tenants) and more substantial repairs, such as replastering walls or repairing roofs. As the materials for the more substantial repairs are considered intermediate inputs into the production of housing services, purchases of them are subtracted from space rent in the computation of the rental income of households. Materials for do-it-yourself activities are not so considered. Purchases of them are treated as final consumption expenditures. (Purchases of materials for do-it-yourself repairs and maintenance of consumer durables are treated in a similar manner.)

In neither case does the labor of the owner-occupier add to GDP nor are the expenditures on the materials capitalized.

The above discussion discloses an anomaly in the accounting structure. Expenditures on ordinary M & R by businesses have no effect on national income.

For example, an increase in wages and profits paid to people who repair homes by owner occupiers would be offset by a corresponding decrease in the rental income of persons. On the other hand, an increase in expenditures by tenants on M & R would increase national income as the increase in the income of the repair industry would not be offset by a corresponding decrease in any other profit-type category.

The treatment of M & R expenditures in the 1993 SNA is presented as if it were a clarification of the existing treatment rather than a revision to it. Yet, the existing treatment does differ in some important ways. In the 1968 SNA, expenditures on replacement parts must be "substantial" in order to be capitalized.

Thus, the complete replacement of engines in trucks or of motors in presses and lathes are specifically cited as expenditures that may be capitalized in paragraph 6.123 of the 1968 bluebook. Anne Harrison has described this as the "large and lumpy" rule. The 1968 SNA also specifically states that in order to be capitalizable, newly incorporated parts "should also lengthen the expected lifetime of the use of the fixed assets, or alter the character or volume of the services which they yield." The 1993 SNA does not mention that expenditures need to be "substantial" in order to be capitalized (except in the section on repairs to owner-occupied housing).

NIPA treatment. -- The NIPA treatment of M & R expenditures reflects an orientation that is completely different from that found in the 1993 SNA. The decision rules found in the 1993 SNA differentiate between different M & R expenditures on the basis of why those expenditures were made. In principle, this could result in the capitalization of some, but not all, of the expenditures on a given type of repair or part of a capital good. The NIPA's, however, treat all expenditures on a given type of repair or part identically, irrespective of why those expenditures were made. The NIPA's capitalize roughly 37 percent of what can loosely be termed private M & R expenditures.³ It is impossible to ascertain what this percentage would be if the proposals found in the 1993 SNA were followed. Nevertheless, it is clear that there are some major differences between the existing NIPA and 1993 SNA treatments of M & R expenditures, some of which reflect the aforementioned differences in orientation and others which reflect different treatments for certain specific types of goods.

In the NIPA's, almost all categories of business expenditures that have been identified as "parts" are not capitalized. Thus, business expenditures on motor vehicle tires and parts are treated as intermediate. (This differs from the 1968 SNA's treatment, which permits the capitalization of truck engines.) Consistent with this treatment, BEA does not capitalize expenditures on these tires and parts in its estimates of tangible wealth. However, in the wealth estimates, BEA does capitalize analogous expenditures made by consumers. (This

³See table 1 in the appendix.

would appear to create some interesting accounting problems for transfers of these goods between the business and household sectors if BEA integrates its stock and flow estimates as in the 1993 SNA.)

For certain goods, however, each of the major components is considered to be, not a part of a complete unit, but a distinctly separate final good. For example, the pieces of computer peripheral equipment are considered final goods that are separate and distinct from a computer's central processing unit. Consequently, the NIPA's capitalize the replacement (by businesses) of computer disk drives but not the replacement of truck engines as the latter are not classified as final goods. (The NIPA's do capitalize the replacement of airplane engines.)

Although the 1993 SNA does not directly address this problem, nothing in it suggests that each of the major parts of a durable can be considered to be a separate final good.

David Cartwright, former Chief of the Investment Branch of the National Income and Wealth Division, believes that the treatment of computer parts may result in an undercount of investment in computers. According to Cartwright, some of this investment takes the form of field upgrades to larger and more powerful machines. A large fraction of these upgrades (which clearly count as investment in both the 1968 and 1993 SNA) may be classified as parts and, consequently, not counted as investment.⁴ Yet, it is not clear that investment in computers is undercounted in the NIPA's as the undercount due to field upgrades may be offset

⁴ The classification of computer parts has subsequently been improved as a result of a Commerce Department task force on Federal data for the computer industry.

by an overcount caused by capitalizing parts that replace those that were broken. Replacement disk drives, keyboards, and monitors are classified as "peripheral equipment" and included in the measure of investment. (In the 1993 SNA, it appears that these expenditures should not be capitalized.) In addition, intermediate purchases of peripheral equipment by computer manufacturers may not be adequately identified and removed from investment. Because peripheral equipment expenditures are not separately identified in the BEA stock estimates, they are given the same average life of 8 years that is applied to computer equipment in general. As hard disk drives only have an average life of about 2 to 3 years (according to the BEA computer experts), their capitalization may result in a substantial overestimate of the stock of computers.

In the NIPA's, most expenditure categories dealing with M & R are not counted as investment. But, there are some major exceptions. The bulk of expenditures on ship (and boat) M & R are treated as investment. Expenditures on the replacement of roofs and heating and cooling systems of homes are currently treated as residential investment. (These expenditures were not treated as investment before the last benchmark revision.) While these treatments can be rationalized under the "large and lumpy" rule of the 1968 SNA, they seem to be in direct conflict with the 1993 SNA.

Analysis of "Ordinary" M & R Expenditures

To gain insight into the theoretically proper way to account for M & R expenditures, consider the problem of establishing the net value of a single durable on which M & R expenditures are made each year, e.g., a truck.

To simplify things, let us temporarily assume that no repairs are made or are contemplated that would extend the truck's life beyond its initially expected value (at the time of purchase) or that increase its productivity beyond that initially expected. Thus, all M & R expenditures are undertaken solely to keep the truck functional and in good working order. Let us further assume that all M & R expenditures that are needed to achieve these objectives are always made.

Now, it is clear that the amount that a person would be willing to pay to purchase a truck (new or used) depends on the amount of M & R expenditures that the person expects to make in operating it. The precise relationship is spelled out in Harold Hotelling's general mathematical theory of depreciation.⁵ In developing the proper general formula for determining depreciation on a durable, Hotelling uses the proposition that the durable's value (purchase price) at any time is equal to the present discounted value of the gross revenue to be obtained from using it less the present discounted value of the costs of operating it plus the present discounted value of the amount received for the durable when it is scrapped. As the costs of maintaining and repairing the truck are part of its operating costs, their present discounted value directly determines the truck's value.

⁵ See Harold Hotelling, 1925. "A General Mathematical Theory of Depreciation," *Journal of the American Statistical Association*, Vol. 20, September, pp. 340-353.

This relationship between the value of a durable and the present value of the M & R expenditures that are expected to be incurred in operating it has been used to justify the use of the straight-line method of depreciation. The basic argument has been given by Jack Faucett, among others.⁶ Suppose that the relevant durable behaved as if it were a one-hoss shay with respect to output, i.e., that its services were physically identical in each year of its life. Then, if there were no M & R expenditures and the real discount rate was positive, the annual amount of depreciation on the durable would increase as the durable becomes older (precisely offsetting the decline in the forgone interest on the durable's value) and the durable's value would be greater than that implied by the straight-line method. Suppose, however, that a certain amount of M & R expenditures are needed to keep the durable fully functional, and that required amount increases as the durable ages. Ceteris paribus, the increasing M & R expenditures will cause the price of the (used) durable to decline as it ages. The proponents of the straight-line method argue that one can assume that the effects of discounting and increasing M & R expenditures precisely offset each other. If this were the case, then the durable's market value (in constant dollars) would decline in a straight-line manner and the annual depreciation charge would be the same in each year of the durable's life.

The above analysis also indicates that M & R expenditures that were expected at the time that the durable was initially purchased should not be capitalized.

⁶ See Jack G. Faucett, 1980. "Comment," In *The Measurement of Capital*, ed. Dan Usher, pp. 68-81. Studies in Income and Wealth, vol. 45. Chicago: University of Chicago Press.

Capitalizing them would raise the value of the net capital stock. However, the value of this stock is determined using a depreciation schedule that already takes these expenditures into account so that adding them to the stock is not only unnecessary but wrong.

So far we have ignored several important real-world complications. Not all M & R expenditures are expected in advance nor are all needed M & R expenditures made. We now seek to determine if these considerations affect our conclusions.

Unexpected repairs. -- Consider the situation in which required M & R expenditures are unexpectedly large or small. Assuming again that all required repairs are made, capitalizing these repairs would, ceteris paribus, cause the estimated net stock to vary with the magnitude of required repairs made in the current and recent years. By assumption, however, the actual capital stock is unaffected by the amount of required repairs. Ideally, its estimated value and the estimated value of capital input should also be unaffected by the variation in required repairs. (Unexpected repairs could be conceived as lowering the return to capital component of capital input.) Thus, the capitalization of M & R expenditures here causes estimated net stocks to vary from their actual value.

Not making required repairs. -- Suppose that some of the M & R expenditures that are needed to keep durables fully functional are not made. The actual value of the net capital stock should then be lower than if these repairs had been made. However, if M & R expenditures are not capitalized, the estimated net stock will be unaffected by the lack of the required M & R expenditures. Not capitalizing

M & R expenditures here, therefore, yields estimated net stocks that exceed their actual value.

Analysis of Enhancements to Capital Goods

Parts of durables are often replaced with others not because the original part is broken, but because the new part improves or enhances the durable in some way. The problem of accounting for such enhancements is considered here. Three such enhancements are analyzed: those that improve the productivity (or output) of durable, those that reduce its operating costs, and those that extend the life of the durable.

Suppose that some M & R expenditures were specifically undertaken to increase the productivity of durables beyond that which they were initially designed for.

An example of such an expenditure is the replacement of the engine on a truck with one that increases its horsepower. As with all voluntary expenditures, the discounted present value of the expected future benefits must exceed the expenditure. In the absence of information to the contrary, it appears most reasonable to assume that the benefits from this enhancement were not expected at the time that the truck was initially purchased. Consequently, the enhancement should cause the truck's market value to be higher than that estimated from the depreciation schedule and the expenditure on the enhancement should be capitalized.

Suppose that the enhancement to the durable is one that reduces its operating costs. For example, the truck's engine could be replaced with one that uses less

fuel to operate (at the same speed). In discussions of whether prices of durables should be adjusted to reflect changes in quality, some of the price index literature makes a distinction between this type of enhancement and the one that directly increases the productivity of the durable. From an economic accounting standpoint, there does not appear to be any valid reason for distinguishing between the two cases. Both enhancements cause the truck's market value to be higher than that estimated from the original depreciation schedule and, therefore, expenditures on both should be capitalized.

Suppose that a particular repair extends the life of a durable beyond that initially expected for it but does not alter its productivity during its initially expected life. The case for capitalizing such enhancements is extremely strong.

By definition, the productivity of the durable is increased in those years beyond the initially expected life. The services yielded by the durable in the extended years were, by assumption, not expected when the durable was purchased and so can not be directly associated with the initial expenditures on the durable; they must be associated with the expenditures on the repairs. Yet, it is hard to conceive of how one can claim that capital services are obtained from expenditures that, in principle, should not be capitalized. The reality of this situation is that repairs that extend the life of durables are direct substitutes for purchases of new durables. The validity of such a view appears to be recognized in paragraph 169 of the latest draft of chapter VI of the 1993 SNA, which calls for the capitalization of major renovations and enlargements that significantly extend the previously expected service lives of fixed assets.

Consider the practical consequences of not capitalizing this type of enhancement. Suppose that all trucks are deemed to have a service life of 10 years, and that for a period of 10 years no new trucks are purchased. Further, assume that during this 10-year period no trucks are actually retired and that at the end of the tenth year all of trucks are overhauled and given new engines and other parts that extend their service lives by an additional 5 years apiece.

The example can be made more compelling by assuming that the repairs are sufficient to cause the 10-year old trucks to have the same productivity (performance) as new ones. Now, if none of these M & R expenditures are capitalized, the estimated gross and net stocks of the trucks at the end of the 10-year period will both be zero. The actual stock of trucks will, however, consist of the same number of trucks yielding the same physical services that it ever did. It is difficult to see how an estimate of the stock of trucks as being zero at the end of the tenth year would be useful for any economic analysis.

Other Theoretical Considerations

Large and lumpy rule. -- The NIPA's and the 1968 SNA have utilized the criterion that certain types of repairs that are usually large and irregular are capitalized. (Thus, for example, it was decided to capitalize repairs to roofs on residences as well as replacements of heating and cooling systems.) The rationale for such a criterion appears to come out of the traditional business accounting rule that large and unusual expenditures should be capitalized in order to make comparisons of the income received in different years more meaningful. Should such a criterion have any place in "national" economic accounting? A

repair that might appear to be large and irregular to a small business that owned only a single truck might seem small and regular to a business that owned 100 such trucks. From the point of view of the economy as a whole, virtually any type of repair will seem small and regular. Also, the criterion of "smallness" has been inconsistently applied in economic accounting. For example, in the 1968 and 1993 SNA, expenditures on "small" tools are not capitalized while expenditures on calculators that are cheaper are capitalized (both are capitalized in the NIPA's, however).

Parts versus complete units. -- The problem of whether components of durable goods should be treated as separate final goods or as intermediate "parts" is exceedingly difficult to solve. George Jaszi viewed the problem as largely intractable. However, it is useful to read his assessment of what the accounting literature had to say on this subject. In his paper "The Conceptual Basis of the Accounts: A Re-examination," published in 1958, he wrote:

" ... it is reasonable to turn to the accounting literature for further light on the matter. Our findings here, however, are disturbing. For it appears from this literature that, although the distinction is made in practice, accountants have despaired of finding a sound basis for it. In principle, all expenditures on plant and equipment should be broken down in detail and capitalized separately, to the extent that they have different life cycles. For instance, there is no logical reason why a car should be regarded as a complete unit. A car is the sum of a motor, tires, a paint job, and so on. All of these items should be capitalized separately if their life cycles differ, and there is no stopping point in this process of itemization except that imposed by considerations of convenience and economy.

Accounting theory on capitalization thus offers no conceptual distinction between complete units on the one hand, and parts, repair, and maintenance on the other, but calls in principle for broadening the usual definition of capital formation to include the latter elements. The prevailing accounting designation of items as "complete" is entirely pragmatic: any item large enough or distinctive enough in periodicity to justify the bookkeeping expense of

capitalizing it is considered complete." (Studies in Income and Wealth, vol. 22, p. 82)

One criterion that, at first glance, appears to be objective is to use the prevailing market treatment. If, for example, computers are generally purchased without peripheral equipment, then this equipment should be regarded as a separate good. However, different terms of sale may be obtained by different purchasers.

Some may be able to purchase the components of durables separately while others may have to purchase them as a complete unit. Further, the terms on which a given durable is offered for sale may change greatly over time. Also, contracts for the purchase of some durables may contain an amount for the purchase of spare parts. The use of the terms of sale criterion here would result in the capitalization of parts whose replacement is generally thought of as being covered by "ordinary" repairs and maintenance. Consequently, it is difficult to see how the use of the terms of sale criterion results in a treatment that is any less arbitrary than any of the other treatments advanced to solve the problem of what parts and repairs should be capitalized.

Recommendations

The above analysis, when taken as a whole, leads me to the conclusion that **BEA's purposes would be best served by capitalizing all expenditures on M & R.** Capitalizing expenditures that, in theory, ought not to be capitalized can lead to errors that are probably small and which can be made smaller. Conversely, not capitalizing M & R expenditures that should be capitalized can

lead to very large errors. Attempts to capitalize some types of M & R expenditures and not others leads to the development of decision rules that are at best subjective and somewhat arbitrary. These have the potential to result in large discrepancies between the theoretical ideal and the actual estimates. The following details these arguments.

The theoretical analysis indicated that there are two general cases when M & R expenditures ought not to be capitalized. In both the expenditures are "ordinary" in the sense that they do not extend the life of the durable beyond its initially expected life, do not increase the productivity of the durable, or do not reduce its cost of operation. The two cases result from the division of this general case into one subcase where the repairs are expected and one where they are not. In the former, the problem with capitalization results from the fact that the depreciation schedule already reflected the expected amount of repairs. This problem can be mitigated by adopting some form of accelerated depreciation. The capitalization of the repairs would then result in an estimated value of the net stock not much different from the value using the straight-line method when these repairs are not capitalized. As for the latter case, the law of large numbers should ensure that, for the economy as a whole, those repairs that are unexpectedly large will be roughly equal in value to those that are unexpectedly small. In sum, there is no reason to believe that the capitalization of M & R expenditures will lead to large errors in the stock estimates.

In contrast, there is good reason to believe that the failure to capitalize M & R expenditures can lead to large errors in the stock estimates. First, when economic times are not good, "required" M & R expenditures may not be performed.

(Anecdotal evidence suggests that this may occur on a widespread basis.) This may cause the stock to have a service life shorter than originally thought and may reduce the productivity of the stock in any given year. In any event, it will surely cause the estimated value of the net stock to be much larger than its true value. Similarly, M & R expenditures that extend the life of the durable beyond its initially expected value, increase the productivity of the durable, or reduce its cost of operation also increase the actual value of the net stock. Not capitalizing them will also lead to a large difference between the actual value of the net stock and its estimated value.

Attempts to treat different types of M & R expenditures differently lead to the adoption of rules that are subjective and arbitrary. As indicated in the theoretical analysis, repairs may be "ordinary" (and either expected or unexpected) or they may extend the life of the durable, increase its productivity, or reduce its operating costs. Attempts to distinguish between the three types of non-ordinary repairs appear to have no theoretical justification. Attempts to distinguish between ordinary and other repairs face insurmountable obstacles. The plain fact is that the replacement of a given engine on an truck could have been undertaken for any of the reasons cited above. There is no hope of ever obtaining objective data on why every repair was made although one can attempt to get data on this using questionnaires.⁷ In practice, national economic accountants necessarily treat all expenditures on a given product in the same way. That is, all repairs of truck engines will be either capitalized or not

⁷ Apparently, the Canadians have obtained data on the service lives of various types of equipment using questionnaires.

capitalized. Attempts to divide parts of durables into those components whose repair or replacement will generally increase the productivity of the durables and those that will not increase it appear to be exercises that are at best highly subjective.⁸ At worst, they lead to arbitrary rules that may produce estimates that deviate substantially from the theoretical ideal. Similarly, the attempt to distinguish repairs that are "large" or "irregular" from other repairs uses criteria that may have no meaning from the point of view of the economy as a whole.

Capitalization of all M & R expenditures makes the parts versus complete unit problem moot. The purchase of a given component of a durable will be capitalized regardless of whether the component is considered a part or a separate good. If, however, any repairs are excluded from the measure of investment, it will be necessary to develop objective criteria that can be used to determine when a good should be considered a "part". I have grave doubts about whether suitable criteria can be developed.

In conclusion, I believe that the capitalization of all M & R expenditures will lead to estimates that are more objective, closer to the theoretical ideal, and less likely to mislead policymakers.

⁸ This strict dichotomy between expenditures to replace and expenditures to improve durable goods is not analytically useful. Many failed parts of durables are replaced with parts that are improvements over the original ones. In this situation, the true cost of the "improvement" is not the cost of installing the new replacement part, but the difference between that cost and the cost of replacing the failed part with one that is identical to it. Further thought along these lines suggests that the true cost of any improvement is the difference between the out-of-pocket cost of making the improvement and the market (or depreciated) value of the part that is being supplanted.

Note, written comments that Professor Robert Eisner provided on a preliminary draft of this paper were in general agreement with its conclusions but differed on two important points. First, Eisner advocated that only those M & R expenditures that have a life of more than one year should be capitalized. While I agree with this point in theory, I do not think that it can be implemented in practice because there appears to be a paucity of information about the lives of such expenditures.

Moreover, it is not clear how the life of some maintenance expenditures should be defined in theory. For example, suppose that the engine oil on a truck should be changed four times a year. One would probably conclude that the life of this type of expenditure is 1/4 year and not capitalize it. But, suppose that the truck's oil was changed only twice a year and that this seriously diminished the actual life of the truck's engine. If expenditures on oil changes are not capitalized, there would seem to be no way of causing the lack of "required" maintenance to affect the measured value of the net capital stock.

Eisner also suggested that unanticipated M & R expenditures or unanticipated M & R requirements could be handled as capital gains and losses, which, in the 1993 SNA, would appear in the other changes in assets accounts. As stated above, I do not believe that we can satisfactorily measure what part of M & R expenditures are anticipated nor do I believe that satisfactory estimates of M & R "requirements" can be made. Nevertheless, it is possible to statistically determine a "normal" level of M & R expenditures and to account for differences between the normal level and the actual level in the other changes in volume of assets account.

While I do not personally advocate this position, I recognize that others may do so, especially as it can be viewed as following the spirit of Eisner's comments.

In his comments on my preliminary draft, Robert Eisner wrote: "Your paper, it seems to me, makes an important contribution in recognizing the major significance of M & R for our measures of investment and capital. Without an analytically sound and consistent handling of M & R, examination of vital issues of the productivity of capital may well be fatally flawed. You point up well the magnitude of the matter and glaring inconsistencies in varying rules and practice in accounting for M & R." Having recognized that there is a problem, what will we do about it? I hope that this paper will stimulate discussion of the problem within BEA and that a consensus on how to account for M & R expenditures can be reached. Then, we should attempt to implement our preferred treatment on a consistent basis. One of the obstacles we face in doing this is that the Census Bureau does not currently collect all of the data we need and uses definitions of M & R that may not closely match our theoretical concepts.

APPENDIX
 Table 1 - PRIVATE EXPENDITURES ON MAINTENANCE AND REPAIR IN 1989
 (in billions of dollars)

	Total	Amount currently capitalized
1. Total	337.2	125.9
2. M & R of structures, total	247.2	118.1
3. Nonresidential construction ..	146.3	59.9
4. Improvements to nonresidential buildings	51.4	51.4
5. Upkeep for nonresidential buildings	29.2	0.0
6. Maintenance and repair for public utilities	21.1	0.0
7. Improvements to structures other than buildings	8.5	8.5
8. Maintenance and repair for other structures	36.1	0.0
9. Residential construction	100.9	58.2
10. Additions and alterations ..	39.8	39.8
11. Major replacements	18.4	18.4
12. Maintenance and repair	42.7	0.0
13. M & R of equipment, total	90.0	7.8
14. Motor vehicle repair	27.5	0.0
15. Motor vehicle parts	15.7	0.0
16. Tires and inner tubes	8.7	0.0
17. Misc. repair shops	23.9	0.0
18. Electrical repair shops	6.4	0.0
19. Computer storage peripherals (replacement)	7.5	7.5

20.	Aircraft engines (replacement)	0.3	0.3
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Table 2 - PUBLIC MAINTENANCE AND REPAIR EXPENDITURES FOR STRUCTURES IN 1989
(in billions of dollars)

1.	Total	61.5
2.	Federal defense (contract)	8.0
3.	Federal nondefense (contract) ..	4.2
4.	State and local (contract)	23.2
5.	Force account (noncontract) ...	26.1

DATA SOURCES FOR TABLES⁹

Estimates for lines 4 and 5 of table 1 were obtained by taking estimates of expenditures on upkeep and improvements, respectively, of private nonresidential buildings in 1986 (as reported in the Census Bureau's special study, Expenditures For Nonresidential Improvements and Upkeep: 1986), dividing them both by the Census Bureau's estimate of total expenditures on the construction of nonresidential buildings for 1986 (as reported in the value put in place survey, i.e., the C30 series), and multiplying the resulting ratios by BEA's estimate of expenditures on new nonfarm nonresidential buildings in 1989 (from line 5 of table 5.4 of the NIPA's.) Line 6 was estimated from values reported for 1987

⁹ The estimates presented in this paper were made prior to the last benchmark revision. They have not been updated because the time required to do so is far from trivial, the revisions would not qualitatively affect the arguments, and the paper is only for internal use.

in table S2 of the Census C30 series issued in August 1989, which were compiled by the Census Bureau from other agencies, that were extrapolated by the percentage increase in residential M & R expenditures from 1987 to 1989 as reported in the Census Bureau's Current Construction Reports C50 series. Line 7 was estimated by taking the ratio of expenditures on improvements to total expenditures on new nonresidential buildings that was used in the estimates for line 4 and multiplying it by the value of expenditures on new nonresidential structures other than buildings in 1989, which was obtained by subtracting line 5 from line 4 of table 5.4 of the NIPA's. Line 8 was obtained by taking the sum of intermediate output in 1977 for M & R construction for industries 12.0202, 12.0203, 12.0209, 12.0210, 12.0211, 12.0213, 12.0215, and 12.0216 from table 1 of the 1977 BEA input-output study and extrapolating the result by the percentage increase in residential M & R expenditures from 1977 to 1989 as reported in the Census C50 series. Lines 9 through 12 of Table 1 are taken from the Census Bureau's C50 series. (The estimates for lines 10 and 11 differ by about \$1 billion from the comparable values that are currently published in the NIPA's.) Estimates for lines 14, 17, and 18 are extrapolations from BEA's 1977 input-output table 1 using the percentage increase in PCE for motor vehicle repair, greasing, washing, etc. (from line 69 of table 2.4 of the NIPA's) from 1977 to 1989 as an extrapolator. Similarly, the 1977 values for lines 15 and 16 were also obtained from the 1977 input-output table 1. For each industry, sales to the motor vehicles and equipment industry and sales to the auto repair industry, the latter multiplied by the ratio of intermediate output of the auto repair industry to its total output, were subtracted from the total amount of intermediate output for the industry. The estimates for each of these industries was extrapolated by the percentage increase in PCE

for tires, tubes, accessories, and other motor vehicle parts from 1977 to 1989 from line 68 of table 2.4 of the NIPA's. Line 19 is a value for 1988 taken from the October 1989 issue of Current Industrial Reports, which was extrapolated to a 1989 level by the percentage increase in PDE for office, computing, and accounting machinery, and then adjusted by an estimate of the fraction of computer storage peripherals that are purchased for replacement purposes (5/8, which is based on an average life of 8 years for computers and 3 years for storage peripherals). Line 20 was taken from unpublished detail for the 1977 input-output tables that was extrapolated by the percentage increase in PDE for aircraft from 1977 to 1989 (from line 18 of table 5.6 of the NIPA's).

Lines 2, 3, and 4 of table 2 are unpublished data from BEA's Government Division. Line 5 of table 2 is from unpublished detail for the forthcoming 1982 input-output table that was extrapolated to a 1987 level by the percentage increase in public expenditures on the M & R of highways and electric light and power utilities (from values reported in table S2 of the Census C30 series issued in August 1989, which were compiled by the Census Bureau from other agencies) and then further extrapolated by the percentage increase in residential M & R expenditures from 1987 to 1989 as reported in the Census C50 series.

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