Volume Title: Capital Consumption and Adjustment

Volume Author/Editor: Solomon Fabricant

Volume Publisher: NBER

Volume ISBN: 0-87014-034-5

Volume URL: http://www.nber.org/books/fabr38-1

Publication Date: 1938

Chapter Title: Time Allocation of Capital Consumption

Chapter Author: Solomon Fabricant

Chapter URL: http://www.nber.org/chapters/c4721

Chapter pages in book: (p. 189 - 206)

Chapter 11

Time Allocation of Capital Consumption

CURRENT computations of capital consumption involve certain principles of distribution among different time spans. This distribution helps to determine the movements of the capital consumption measures. It also tends to impose a certain time pattern upon the economic measures in which capital consumption is a term. Our measures of business profits, of national income, of business savings, and of capital formation thus behave one way instead of another because one principle of time distribution of capital consumption has been used instead of another.

Capital has been defined as the present value of a series of future services expected to be derived from the use of a durable productive instrument. Only the aggregate present value is provided by the market at the time the instrument is acquired —its cost. The determination of the number of future services and their time distribution is a matter of intra-enterprise judgment. It depends on what David Friday has called valuation processes outside the market. The number of future services, the average anticipated life of the instrument in terms of years or units of output or some combination of these, may be given by experience. The time distribution of this number is much more a matter of guess-work, of arbitrary judgment. For this reason the simplest patterns are most often selected: the straight line depreciation formula, maintenance accounting,

charges to development costs. Even among these, several alternatives are open. It is therefore necessary to turn to economic criteria, rather than mere simplicity, by which alternative methods of calculation may be examined and their advantages and disadvantages determined.

THE FISCAL PERIOD

Cyclical aspects

Many difficulties in accounting for fixed assets arise from fluctuations in the flow of goods and services. If output is steady it matters little what treatment is accorded capital equipment. Expenditures upon durable goods may be charged immediately to current output, or they may be capitalized. If capitalized, it does not matter whether depreciation upon them is charged to current costs or whether costs of maintenance (replacements and repairs) are so charged. If depreciated, any depreciation formula may be used with much the same result. But output, as well as the volume of capital goods in existence, does vary. Replacements, repairs, use made of fixed assets, wear and tear and decay do not occur simultaneously. These diverse treatments then have certain consequences. Capital charges to immediate operations, and charges for repairs, replacements, and maintenance usually fluctuate more violently than output as ordinarily measured. Depreciation charges based upon a straight line or similar formula fluctuate with less amplitude than output as ordinarily measured. Depreciation charges on the per unit basis, as well as depletion charges, move together with output. The effect of these consequences is lessened to the extent that the elements of capital consumption are complementary. The sum of straight line depreciation charges and charges for maintenance follow output more closely than either series alone. However, this compensation, even if complete, is true chiefly of industry as a whole. For single industries the degree of compensation is only partial, since there is some

tendency to record capital consumption by one or the other type of book entry rather than equally by both.

The range of these disparities in amplitude of fluctuation depends on the length of the fiscal period used, in relation to the average length of the cycles in output. If the usual fiscal period is twelve months, fluctuations in those measures of capital consumption that are not based on output will differ from the fluctuations characterizing output (also measured in twelve-month aggregates), for the average of the shorter cycles in output is over forty months. If the fiscal period approximates in length the average cycle in business these differences will be small and less regular.

If business and industry are subject to systematic fluctuations, movements that are cumulative connected processes persisting more than a year, capital consumption is measured most clearly and simply by accounts covering a complete cycle rather than by ordinary annual accounts. Difficulties of time allocation are minimized. Once the cyclical movements of industry and business are recognized as innate characteristics of a modern economy, the basis of annual estimates of depreciation is seen to be as arbitrary as, for example, that of estimates of farm income by months. Even on the basis of a longer fiscal period the accounting of economic processes is difficult because of irregularities in the duration and amplitude of cyclical movements. We are never quite sure when our 'natural' fiscal period has ended. But despite the difficulties involved, this view of economic accounting as related to an organic process seems more satisfactory than any based on an arbitrary period.[1] A period covering a whole cycle is a more natural economic 'year'.

We may restrict our measures to those covering entire business cycles. However, the advantages of a shorter fiscal period cannot be denied, and need not be lost. Measures covering periods shorter than the 'natural' economic fiscal period are

[1] For the same reasons the calendar or crop year is not an arbitrary fiscal period in an agricultural economy.

necessary for current guidance and for the analysis of processes; but the arbitrary character of these measures must be borne in mind. In constructing them we should so allocate revenues and costs as to take account of cyclical movements. Even in accounting allocations of revenue and cost, some recognition of business fluctuations is implicit; but this usually takes the form merely of a strong doubt of stability, and manifests itself simply in conservatism.

Secular aspects

In each of the various methods of handling durable goods there are implications that bear on accounting for periods exceeding a business cycle in length. Business cycles do not describe the entire organic movement of the economy. Longer cycles and secular movements are also present. For a clear conception of capital consumption we need a complete pattern of economic development. Even when a long fiscal period is used, discrepancies between movements in computed charges for capital consumption and in output will be found. And these will be systematic. For example, if expenditures on durable goods are charged to expense only upon the final retirement of the goods, computed current costs will be lower in an expanding industry, and (theoretically at least) higher in a declining industry. This will occur whether the expansion (or contraction) is part of a long cycle, or part of a secular trend. The conclusion is somewhat similar if maintenance accounting is used; for these charges tend to increase as capital goods grow older.

The element of interest is also involved. A depreciation formula that allows for interest will show lower depreciation charges in the early life of a capital good than will the straight line formula. If the volume and character of capital goods remain constant, this discrepancy will iron out. But if the volume of capital goods is changing, the secular trend and level of depreciation charges will depend on the formula used. The

element of interest is relevant also to short periods, but to a minor degree.

VARIETY OF POSSIBLE ALLOCATION METHODS

The economist, in estimating business facts, need not have the scruples of the accountant. The accuracy he strives for is related to a wider view. With the accountant he can admit that many accounting practices are inconsistent with the avowed objectives of accounting. But he can do more. He can do something to restore consistency to the accountant's figures. What modifications in the data yielded by current accounting practices are required to make our figures consistent with one another and with our objectives? Or, if modifications are not practicable, how can we qualify the figures we are compelled to use?

Values accrue concomitantly with production in the widest sense of the word. Selling, while a productive act in this sense, is only part of production. It is not the only criterion of current production. We need not wait for the moment of realization to record profits, or for the moment of loss to record losses. Revenues may be accrued. It is this, the accrual basis, that is the logical one to use in economic accounting.[2] This involves distributing costs in proportion to the gross revenue concomitant with them.

Our distinction between the actual time distribution of the dissolution process of a capital good and the time distribution of the charges made for capital consumption is important. The anticipated life of a capital good might, as a matter of fact, be entirely a function of time, as is usually envisaged when obsolescence is considered. It might be entirely a matter of rate of use. It might be a matter of chance, depending on the con-

[2] The accrual basis is, of course, purely a device and is suited primarily for calculations of income and cost. It is a method of allocation. For other purposes, the replacement method of recording capital consumption may be more suitable. For example, to measure productive capacity, an old machine, although almost entirely depreciated, is (other things being equal) as good as a new one.

juncture of random elements, as in the case of fire. Or, finally, the life of a capital good might easily be a function of all three sets of factors. Capital consumption could conceivably be allocated on the basis of this function and to some extent it is. But the mere fact that physical deterioration in capital goods is a function of time and not of output does not mean that the only logical method is to distribute the concomitant costs evenly over time. In fact, the logic of the method selected can be determined ultimately only by reference to a theory of business behavior. It may be felt, for example, that the errors of prosperity, which result in increases in capacity that are proved excessive by the experience of depression, are *sui generis*. To charge to the prosperous phase of a cycle all the costs incurred by this excessive investment is then justified. On the other hand, if the errors of prosperity are conceived of as arising out of the entire cyclical process and as economically related to errors in other phases of the cycle, such allocation is less justifiable.

We are thus led, by these considerations, to a variety of allocation methods, each based on another conception of business planning. In the following discussion we assume that the expectations implicit in investment plans make allowance for cycles in the rate of use of capital goods. That is, we accept the service-output basis of allocation as reasonable and devote our attention to the relation between available measures of capital consumption and those that would result from the universal and consistent application of the service-output method.[3]

The rest of this chapter is devoted to comparing each element of capital consumption with this basis, as far as possible, in order to indicate in what degree the data yielded by the prevailing accounting treatment differ from the alternative measures. We restrict ourselves to measures of business capital consumption, since for other economic spheres (government

[3] Even the straight line method is not applied universally. The application of *any* one method would require some modification of the available records.

and consumers) there is more justification for the bases of allocation that we have used.[4]

SERVICE-OUTPUT BASIS OF ALLOCATION

We are interested primarily in recognizing, in the allocation of costs, cyclical movements in business. One possible way of recognizing the rhythmic fluctuations characteristic of business is by refusing to allocate income and costs on an annual basis, on the ground that an entire cycle is the only correct accounting interval. Aggregates (or moving averages) for cycle periods would then constitute the basis of computation.

If annual periods are to be used, cyclical waves may be recognized in the allocation of costs of capital consumption by distributing these costs in accordance with the state of business, rather than equally to each time span. The time distribution of capital consumption on a service-output basis does not necessitate a forecast of amplitudes or turning points of particular business cycles. The only determination necessary is of the average use to be made of a capital good over its entire life.[5] Allowance is automatically made for differences between secular trends in particular costs and the state of business.

While we have, for convenience, used the common expression 'service-output' basis, which implies physical volume of production as the measure of the state of business, other measures are possible, and are in actual use in accounting records. Production involves, besides the number of units of output, other dimensions such as number of styles, types of material, speed of delivery.[6] There is no obvious reason for ignoring any

[4] That is, the methods we have used yield essentially the same results as would the service-output basis. However, if (for example) motor cars are laid up by consumers during a period of depression this would not be true.

[5] The accrual of interest in relation to depreciation and other charges is not considered in the subsequent discussion. To take proper account of interest would require a forecast not only of the average use to be made of the plant and equipment but also of its time distribution. This distribution could be roughly forecast; for practical purposes it need relate to the secular distribution alone.

[6] Cf. Joel Dean, Statistical Determination of Costs, with Special Reference to Marginal Costs, *Journal of Business,* Part 2, October, 1936.

of these in determining the pattern of allocation. Nor is it always desirable to keep price constant. Gross income, which summarizes the influence of changes in all the dimensions mentioned, as well as in prices, may often be the most useful measure of business and its pattern the suitable one to impose on fixed and freely variable costs.[7]

In the following pages we shall on occasion cite, as bases for comparison with measures of capital consumption, both physical volume of output and gross income.

Depreciation

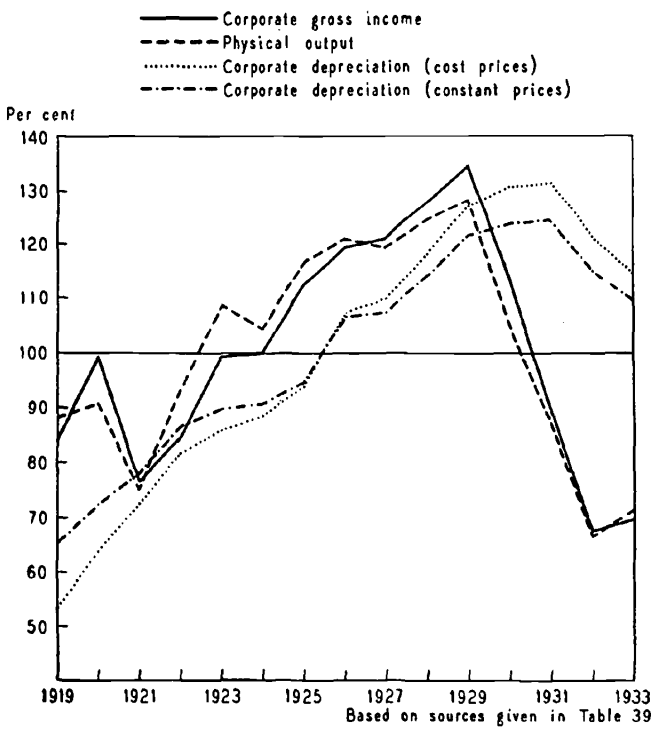
The outstanding characteristic of business measures of depreciation is their steadiness. In spite of large fluctuations in gross value of product, physical volume of output, and consequently in the use made of capital equipment, depreciation costs allocated to specific years change relatively little (Chart 5). Cyclical declines in 1921, 1924, 1927, and 1930–32 are definitely impressed even upon annual series of physical output. Gross income declined in 1921 and 1930–32, and rose only fractionally in 1924 and 1927. Depreciation charges, in terms either of original cost or of 1929 prices, declined absolutely only during the most recent period, while the rate of growth slackened in 1924 and 1927. The averages of the year-to-year changes in the last two series (Table 39) are small compared with those of the other series, and are due mainly to the secular movement, rather than to the cyclical fluctuations.

The infrequency of large movements in depreciation charges is a consequence of the widely prevalent use of the straight line depreciation formula or other formulas that do

[7] But *secular* movements in selling prices would complicate the problem. If these are part of a general movement of all prices, the preferable course is to impose the pattern of 'physical' output on fixed costs, the latter expressed in constant prices. These modified costs are then multiplied by current prices, which follow the general level of prices. If selling prices fall or rise relatively to other prices, the problem is really one of capital gains or losses and these are preferably handled as capital adjustments. The above suggestions are intended to apply to cyclical movements.

Chart 5

Physical Output, Gross Income, and Depreciation Charges, 1919–1933
Business Corporations
(1919–1933: 100)



not take into account fluctuations in output. The longevity of a machine or a building seems, to the limited vision of business men, to be more readily and accurately predicted in terms of years than the use, in terms of volume of output, that will be made of it. Another contributing factor may be the habit, in many business computations, of working with rough magnitudes. This, in turn, may be a consequence of the relatively high cost of fine measurements, or of the belief, already men-

Table 39

Average Annual Absolute Changes in Physical Output, Gross Income, and Depreciation Charges, 1919–1933[1]

All Corporations in the United States

	AVERAGE ANNUAL CHANGES AS A PERCENTAGE OF	
	1919–33 average value	1929 value
Physical volume of output	10.9	8.5
Gross income	11.8	8.8
Depreciation charges expressed in		
Original cost prices	6.8	5.4
1929 prices	4.9	4.0

[1] The index of physical volume of output, computed by Persons and Foster (*Review of Economic Statistics,* August 15, 1933, p. 155), covers industrial production and trade. Gross income, taken from *Statistics of Income,* does not include tax-exempt income. The depreciation charges are also from *Statistics of Income,* and were expressed in 1929 prices by dividing the accounting figures by the index given in Ch. 10.

tioned, that more accurate measures are impossible. A further factor may be the continuous decay that to some extent goes on in capital goods whether they are used or not, coupled with the business conception of cost which allows this relation of decay and lapse of time to influence financial computations.

What if depreciation is distributed, not on a straight line basis, but in relation to output? It would be necessary, of course, to forecast the average rate of use of any given equipment or other facilities, as well as the average useful length of life to be expected. As a matter of fact, this is inevitably done in the computations underlying the decision to purchase. No additional information not available would really be required. Depreciation charges would then be computed on the basis of the ratio of actual rate of use to 'normal' (anticipated average) rate of use. This method is, in fact, occasionally found in accounting practice. It would modify the depreciation charges presented in Tables 29 and 30 very greatly. At the bottom of

the recent depression, for instance, the depreciation charges on a per unit of output basis would be about 60 per cent of the depreciation charges as currently computed (both expressed in 1929 prices). This would amount to a difference, in dollars, of more than two billion.

The estimate cited was obtained by fitting trend lines to depreciation charges in 1929 prices (Table 30) and to the physical volume of output (Chart 5 and Table 39) and imposing the pattern of relative deviations from trend revealed by the latter series on the trend of depreciation charges. If desired, the resulting series could be expressed in current prices by multiplying it by an index of current prices of capital goods. This final series would thus take into account fluctuations in both replacement costs and use. The estimates obtained by using a trend line and volume of output for determining the pattern are, of course, crude. A line fitted by least squares or moments yields results different from those obtained by the use of a moving average. A preferable method of determining the pattern to impose upon depreciation charges is, as mentioned, that occuring in accounting practice—the method of actual output as a percentage of normal output. But no reasonably accurate data are at present available with which to apply it.

Another difficulty must be noted. In obtaining the estimate above the pattern of *total* production was imposed on *total* depreciation charges. A more correct procedure would be to impose the production pattern of a single industry (or firm) on its depreciation charges and then obtain total (modified) depreciation charges by summating the charges of individual industries. This is not possible since depreciation charges expressed in constant prices are not available for individual industries. If those industries in which depreciation charges bulk large are also those in which output fluctuates more than the average, the pattern we have used is somewhat too stable.

If there is a cyclical swing in output, to impose its pattern on charges for depreciation tends to impose the same relative

pattern on net income. Let $G =$ gross income $(=$ output$)$; $D =$ depreciation charges, assumed to be the only cost; and $G - D =$ net income. If D is so allocated as to follow the same time pattern as gross income, then $D = aG$, a being equal to the average ratio of D (before change) to G. Then net income $= G - aG = G\ (1 - a)$, or net income has the same relative pattern as G. This, of course, would be of smaller amplitude than net income as previously measured, but it would not be of zero amplitude.

Under- and over-maintenance

A certain average level or rate of maintenance is always implicit in the forecast of service life and the determination of the depreciation rate. Within limits, the actual rate of maintenance may fluctuate about this normal level without appreciable effect upon the service life. Actual expenditures upon maintenance fall, on occasion, outside these limits. It is possible, therefore, to define under- and over-maintenance as the discrepancy between normal maintenance and actual expenditures on maintenance; or as the discrepancy between nonpostponable maintenance (the lower limit) or anticipatable maintenance (the upper limit) and actual expenditures on maintenance. But we are not directly interested in these discrepancies. For measuring capital consumption we wish an accounting charge to maintenance expense that is based on the product of: (1) the ratio of current volume of output to normal output; (2) the theoretical or normal aggregate volume of maintenance implied in the forecast of service life; (3) the current price of maintenance. If the actual accounting entries for maintenance expense are identical in amount with current expenditures on maintenance (and, with few exceptions, this is so), then, for our purpose, under- or over-maintenance is best defined as the discrepancy between actual expenditures on maintenance and the theoretically desirable accounting charge just defined.

The theoretical charge does not necessarily fluctuate within

the two limits set by postponable and anticipatable maintenance. The actual capital decline involved when current expenditures on maintenance fall below the limit set by the amount of postponable maintenance is not current capital consumption; it is implicit capital adjustment. It will occur, barring ignorance of the limits set by postponability, only when a capital decline is already accepted as having occurred. In other words, current maintenance expenditures will fall below the rate necessary to avoid decline in service life only when the prospects for the future are so poor that the old capital goods have already lost all or part of their value. This sort of implicit capital adjustment occurs most frequently during depressions. There are closer physical limits to the amount of over-maintenance.

Since the accounting charges for maintenance that are placed on the books of business enterprises are based on actual expenditures for maintenance, we may expect them to fall, during depressions, because of the desire not only to avoid making investments that may be postponed and to avoid sending good money after bad, but also in order to maintain the apparent rate of profits. Expenditures on maintenance, even when made, may be charged to depreciation reserves rather than to current expense. For these reasons the available figures are few and difficult to interpret: secret reserves and secret drafts upon capital are not made public.

Indirect evidence alone can enable us to detect the phenomenon of over- and under-maintenance. We may use the ratio of expenditures on maintenance to volume or value of output and compare it with the ratio in some base year or longer period or with its trend value. The comparison is not easily made. The difficulties of determining inadequacy of repairs and renewals during depressions are stated in an Interstate Commerce Commission report:

"The extent to which maintenance charges to operating expenses were abnormal is difficult to state because no precise standard for measuring normal maintenance is available. To develop

such a standard would require not merely a comparison with the average of what was spent in some period of years taken as normal, but would also require an allowance for changes in wages, prices of materials, the effect of changing volume of traffic, which affects certain items of repair but not all, and finally the effect of improved methods of performing the maintenance work and of additional capital investment." [8]

In other words, two sets of difficulties arise, those related to secular movements in prices and technology[9] and those related to cyclical lags and differing cyclical amplitudes of price movements. When the year is taken as the time unit, however, cyclical lags tend to be eliminated.

The most adequate figures bearing on the question of under- and over-maintenance in business establishments are those compiled by the Interstate Commerce Commission from the reports of steam railways (Table 40). During the 1920's a declining trend is evident in the ratio of maintenance expenditures to gross operating revenue. The trend is probably due to diverse price movements and to change in technique. But the fluctuations in 1919–21 and in 1930–34 are pronounced. Further evidence is afforded by the ratio of man-hours of maintenance employees to car-miles of traffic. Use of this ratio avoids the difficulties arising from diverse price movements. The element of secular decline arising from changing technical methods remains, however, and obscures the conclusions to be drawn from the data. But even if we assume that the trend apparent in the preceding ten years continued through 1930–33, there is definite evidence of under-maintenance of some 15 per cent in 1933 relative to 1929.[10]

[8] *Statistics of Railways*, 1933, p. S59.

[9] Improvement in technical methods of maintenance, etc., while primarily important from a secular point of view, may also be related to the cycle. Declining profits may force improvements in times of depression. Such changes in efficiency may therefore trace out a step like movement over time, the horizontal portions of which are found in times of improving business, the vertical parts in times of decline or depression.

[10] In a study by W. S. Lacher, Engineering Editor of the *Railway Age* (Outlay for Maintenance of Way largest since 1931, *Railway Age*, January 4, 1936),

Table 40

Maintenance Ratios, 1919–1935

Class I Steam Railways

	MAINTENANCE CHARGES OTHER THAN DEPRECIATION, RETIREMENTS, AND INSURANCE, AS A PERCENTAGE OF OPERATING REVENUES	MAN-HOURS OF MAINTENANCE EMPLOYEES PER 100 CAR-MILES [1]
1919	36.20	
1920	39.77	
1921	33.20	
1922	32.21	8.52
1923	32.62	8.74
1924	30.77	8.00
1925	29.90	7.46
1926	29.70	7.16
1927	29.76	6.97
1928	28.50	6.47
1929	28.31	6.39
1930	27.69	5.93
1931	26.49	5.32
1932	23.93	4.95
1933	22.95	4.67
1934	24.45	4.83
1935	25.17	4.75

SOURCE OF ORIGINAL DATA: *Statistics of Railways*

[1] Comparable data are not available for 1919–21.

Data on maintenance by industrial companies are few. For 27 of the 32 companies mentioned in Chapter 4 it is possible to compute the ratio of repairs and maintenance to sales in

an attempt was made to take into account such factors as technological changes and increase in efficiency of maintenance. Mr. Lacher's conclusion is that, after allowances for these and other factors, "the expenditure for maintenance of way and structures during each of the last four years (1931–35) has amounted to not more than 60 to 70 per cent of the outlay that would have been required to maintain the condition of the properties" (p. 29). These figures overstate the decline in which we are interested since our standard of normal maintenance would, in this case, be lower than that based on physical maintenance.

It must be noted, also, that expenditures fell off more for maintenance of ways and structures than for maintenance of equipment.

1929 and in 1932. With a few exceptions the changes in the ratio from 1929 to 1932 are negligible: in 14 of the 27 concerns they are slightly upward; in 13 they are slightly downward. The conclusion from this slender sample is that, for industrial concerns during the short period covered, maintenance and repairs seem to have fluctuated directly and in the same proportion as value of sales. If per unit selling prices did not deviate very much from per unit maintenance costs, physical volume of maintenance fluctuated in the same proportion as physical volume of sales.

Other elements of capital consumption

Depletion charges are computed chiefly on an output basis, and if not, then usually as a percentage of gross income. They therefore tend to follow the allocation basis with which we are concerned.[11] In expressing depletion charges in constant dollars we have in fact already used the output basis. Consequently, no further discussion is necessary here except to note that the output basis of allocating capital consumption does on occasion appear in business accounts. Accounting procedure is not entirely divorced from the economic concept of capital consumption.

Development charges tend to follow the fluctuations of business, probably with an even greater amplitude. The nature of the item also implies an anticipation of charges for capital consumption; this may mean relatively high charges in the early history of an industry or firm. An adjustment must therefore be made. It is difficult, however, to make any adjustment that will transform these figures into a form comparable with those of depreciation and depletion. Representing, as do development charges, a form of gross capital formation, it would be necessary to express them in constant prices, cumulate them, apply depreciation rates (varied, of course, in accord-

[11] Except for the limitation imposed by the federal tax regulations, that in certain cases depletion may not rise above a certain percentage of net income; see Ch. 5.

ance with output), and then express them in current prices. But the material needed for this transformation is lacking.

The capital consumed through accident tends, as we have seen, to be allocated on a straight line basis. Whatever the level of output may be, provision for accidental loss is set aside on an actuarial basis, and charged to current expenses. No effort is made to allocate the costs that arise from this provision in accordance with the volume of business. But these costs also may be modified to allow for fluctuating production and sales. This adjustment may be made by methods already discussed.