7.0 Alternative Income and Cost of Capital Concepts

> "Economists and accountants, at least by implication, seem initially to agree that income is something related to capital so closely that the determination of one involves that of the other". *Frank A. Fetter*[1937; 9]

> "The literature that may be designated as accounting theory deals with (1) the choice among alternative definitions of income, and (2) the measurement rules that follow from and implement or that supplement a definition". *Myron J. Gordon*[1960; 606]

> "What is 'business income'? How should it be measured? These problems have been constantly discussed by both accountants and economists. Yet no close agreement has ever been reached. Accountants complain that economists are too idealistic and their concepts are impractical; economists charge that accountants are too mechanical and their procedures are not based on sound principle". *Emily Chen Chang*[1962; 636]

> "We are touching, of course, on the definition of income. But must we settle on one?". *Edgar O. Edwards*[1975; 238]

In this section, we shall consider alternative definitions for the concept of business income for an accounting period. Synonyms for the "business income" concept are "net earnings" and "profits".

From the 1880's to the 1930's, three broad approaches to the measurement of business income can be distinguished in the accounting and economics literature.

In the first approach, business income was simply defined as the change in asset value over the accounting period; i.e., the emphasis was on change in balance sheet values for the business unit over an accounting period. We discussed this approach earlier in section 4.1 above. This approach to the measurement of business income was a natural outgrowth of the very early "completed venture" approach to accounting.[183]

In the second broad approach, the business income of a business unit over an accounting period was defined as operating profits (current period revenues less current period variable costs) plus the net change in the value of assets held through the accounting period.[184] This second approach to income is not really that different from the first approach since any operating profits made by the business unit in the second approach would show up as increased asset holdings in the first approach. However, in the second approach, the focus shifts from the backward looking changes in asset values approach to the forward looking projection of current operating profits approach; i.e., the focus shifts from

the balance sheet (which lists asset values) to the income statement (which lists current operating profits). This second approach to the measurement of business income is due to Marshall, Schanz and Haig:

> "When a man is engaged in business, his profits for the year are the excess of his receipts from his business during the year over his outlay for his business. The difference between the value of his stock of plant, material, etc. at the end and at the beginning of the year is taken as part of his receipts or as part of his outlay, according as there has been an increase or decrease of value. What remains of his profits after deducting interest on his capital at the current rate (allowing, where necessary, for insurance) is generally called his *earnings of undertaking or management*. The ratio in which his profits for the year stand to his capital is spoken of as his *rate of profits*. But this phrase, like the corresponding phrase with regard to interest, assumes that the money value of the things which constitute his capital has been estimated: and such an estimate is often found to involve great difficulties". *Alfred Marshall*[1920;74][185]

> "If income is defined as the total accretion in one's economic strength between two points of time, as valued in terms of money, it is clear that his income will reflect every change in the value of money between those two points of time in so far as the items entered on the balance sheets at those times affect the computation. If the level of prices goes up ten per cent the money value of my assets will ordinarily follow at a like rate. That particular increase in value does not really indicate an increase in my economic strength. My power to command economic goods and services has likewise increased .... If it were possible to modify the concept of taxable income so as to eliminate this variation it would certainly be desirable to do so. The prospect for a complete solution of the difficulty pointed out, however, is identical with the prospect for a perfect monetary standard. But an approximate solution might be realized if we were able to evolve a satisfactory index of the level of prices. If it was accurately known what the change in price level in a given year had been, it might be possible to qualify the results shown by a comparison of the balance sheets for the beginning and the end of the period in such a way as to eliminate the influence of the changing standard. But even this refinement is not likely to be introduced soon. Indeed, the desirability and urgency of its introduction is dependent largely upon the complete solution of the accounting problem, which solution is certainly not imminent". *Robert Murray Haig*[1921; reprinted 1959; 67-68]

> "The broadest definition of income for taxation purposes was formulated by Georg Schanz in 1894 and was independently advanced over two decades later

by R.M. Haig, who defines income as 'the money value of the net accretion to one's economic power between two points in time'. This view is in substantial agreement with the accountant's practise of ascertaining the annual profit of an enterprise by comparing the balance sheet at the opening and the close of the year .... The widening of the income concept, however, brought forth a number of difficult problems. The first problem is that of appreciation in value. Is this income or only addition to capital? In the light of the Schanz concept it undoubtedly is income. Theoretically this view seems sound .... There are, however, some practical difficulties in the way of accepting this conclusion. In the first place, an income tax is supposed to be paid out of income. But if the taxpayer's entire wealth consists in the house that has appreciated in value, he has no funds with which to pay the tax .... A further objection is to the effect that in case of a change in the general level of prices the money worth of a commodity at the end of the period may be greater than at the beginning. The owner may then be assessed for what is nothing but a fall in the value of gold. This objection might, however, be removed by reference to an index of prices, as is done in some of the foreign unearned increment taxes".

Edwin R.A. Seligman[1932; 628-629]

The third broad approach to the period by period measurement of business income is the same as the second except that the third approach attempts to make an adjustment to the net change in the value of assets that will take into account either general price change or specific price change (or both) in the prices of assets held from the beginning to the end of the accounting period. This concept of income leads us directly into the fundamental problem of accounting: how are we to value assets which do not trade in every period? Thus the different methods for valuing assets which were discussed in section 6 above can be used in the present section in order to define alternative income concepts.[186] But, as can be seen from the quotations by Haig and Seligman above, income determination is more complicated than merely choosing the appropriate method for valuing assets; according to these authors, some value changes (due to asset price changes over the accounting period) are to be excluded from the business income concept.[187]

In sections 7.1-7.7 below, we shall outline seven alternative income concepts that have been suggested over the years, beginning with historical cost income (section 7.1) and ending with cash flow income (section 7.7). In order to focus on the essential issues, we shall assume that a business unit produces current outputs, uses current inputs but holds only a single depreciable fixed asset over the accounting period. In this highly simplified framework, we shall see that alternative business income concepts give rise to alternative user cost of capital formulae; in particular, the "economic" income concept

defined in section 7.6 gives rise to the ex post user cost of capital, formula (9) defined in section 2 above.

We conclude this introductory section with some observations made by accountants over the years on the changing nature of accounting and on the importance of defining the "correct" income concept.

Our first general observation on the importance of the income concept was made by Seligman and many others:[188]

> "An essential attribute of income therefore is that it must be so defined as to exclude the impairment of the capital. Otherwise the so-called income would include a periodic fraction of the capital, with the result that in the end there would be neither income or capital". *Edwin R.A. Seligman*[1932; 631]

A second general observation on income measures is that the income or profits measure that is chosen should not *overstate* the "true" income of the business unit, because income overstatement may lead to excessive: (i) dividend payments; (ii) wage settlements and (iii) income tax payments, all of which may deplete the capital of the business unit and hence put its long term survival in doubt:

> "The first problem created by changes in the price level is to determine how much of money profit represents an increase in the current purchasing power of the firm. Its solution has significance for tax, dividend, and wage policies particularly. The levying of taxes on money profits when prices are rising means that a part of the firm's original real investment is being taxed; a firm may be paying taxes even though its real investment has decreased over the period. If management is misled by money profits, it may bring about the same result by paying dividends that deplete the firm's real investment. Or management, on the basis of high money profits, may contract to pay higher wages even though the firm's real profit is small or negative".
>
> *Edgar O. Edwards and Philip W. Bell*[1961; 123]

A third general observation is that the chosen income measure should not *understate* the "true" income of the business unit because income understatement may lead to: (i) insiders making unfair profits on their knowledge of the business unit's "true" situation[189] and (ii) underpayment of income taxes. The understatement problem can occur if the historical cost income concept is chosen and there is asset inflation. This will lead to understated historical cost income for accounting periods during which the assets were held (and overstated income for the accounting period when the assets were sold). Thus many early accountants advocated the reporting of capital gains in the periods when they

occurred (whether realized or not) but they also advocated that unrealized capital gains should be reported separately on the income statement:

> "Income is the economic benefit coming in during a period of time. It consists of current income and of capital gains and losses. The general accounting habit of regarding income as though it were synonymous with realized income, although of some usefulness in practical affairs because it tends to substitute fact for fancy, should be more clearly recognized as both illogical and generally causative of the compilation of false information. *All* the income–realized, unrealized and the total thereof–coming into existence during a period should be credited to the period, but the realized should continue to be separated from the unrealized". *Henry W. Sweeney*[1933; 335]

Finally, the economist Haig[190] observed that income concepts (e.g., historical cost income) that were suited to the early days of business accounting (before stock markets became widespread and before the invention of the business income tax) were no longer suited to the current accounting environment:

> "While the accounting ideal as stated by the leading theorists in the accounting field is in entire harmony with the economic analysis, it should be pointed out that many so-called accounting principles which are generally accepted are little more than rules of action formulated during an obsolete period when the use of accounts for tax purposes did not exist. So long as the chief purposes of the accounts were to provide a basis for applications for credit, and for the distribution of dividends, rules which tended toward a conservative statement of profits were certainly full of virtue. The increase in the tax burden has added a new primary use for the accounts, a use which demands certain qualities which are not important in the other cases. To form an entirely satisfactory basis for the imposition of income taxes the accounts must reflect the full, true, economic position of the taxpayer; and in so far as arbitrary rules of inventory valuations operate to build up hidden reserves, or other accounting practices tend to befog the picture, they must ultimately be eliminated and they have no place in truly scientific accounting". *Robert Murray Haig*[1921; reprinted 1959; 68]

7.1 Historical Cost Income

> "The actual taking of a price by the seller and its payment by a buyer, each acting irrevocably in what he conceives to be his own interest and each

presumably having some skill in appraising *the practicable options available to him*, provides a working valuation for the land. The accountant merely adopts this 'prudent investor' figure until he obtains equally reliable evidence to support a different valuation". *John B. Canning*[1929; 197-198]

"Insofar as objectivity is regarded as an indispensible quality of an income concept which is to have any claim to being practical, accounting income is practical enough. But this is of little moment if it does not measure what we want to measure. Objectivity without relevance is not much of a virtue".

David Solomons[1961; 378]

We shall use the notation that was introduced in section 5.1 above: the vector of average market prices that the business unit faces for the N variable inputs and outputs used and produced during period 0 is $p^0 \equiv [p_1^0, \ldots, p_N^0]$, the quantity vector of net outputs that the business unit produces during period 0 is $y^0 \equiv [y_1^0, \ldots, y_N^0]$ (if $y_n^0 > 0$, then commodity n is produced during period 0 while if $y_n^0 < 0$, then commodity n is used as an input) and period 0 operating profits are $p^0 \cdot y^0 \equiv \Sigma_{n=1}^N p_n^0 y_n^0$. We shall simplify the notational complexity of section 5.1 by assuming throughout section 7 that the business unit uses only $k^0 > 0$ units of a single durable input during period 0. Again for simplicity, we assume that the units of the durable input were purchased at the beginning of period 0 at the per unit price $P^0 > 0$ and that no other durable inputs were purchased during period 0. We can now repeat the same assumptions about depreciation, asset inflation and interest rates that were made in section 2 above; i.e., define: (i) the one period depreciation rate δ^0 by (3); (ii) the period 0 inflation rate for new assets i^0 by (5); (iii) the period 0 costs of debt and equity capital by r_d^0 and r_e^0 respectively; (iv) the debt and equity financial capital at the beginning of period 0 by $D^0 \equiv f^0 P^0 k^0$ and $E^0 \equiv (1 - f^0) P^0 k^0$ respectively and (v) the overall period 0 cost of capital (or interest rate) r^0 by (10). We shall maintain these definitions and assumptions throughout section 7.

In general, following Marshall, a period 0 income definition will have the following structure: income in period 0 equals operating profits in period 0 less interest paid in period 0 plus the change in net asset value over period 0; i.e.,

$$(56) \qquad I^0 \equiv p^0 \cdot y^0 - \text{ interest } + A^1 - A^0$$

where $p^0 \cdot y^0$ equals operating profits (value of current outputs minus value of current inputs), A^0 is the beginning of period 0 value of the business unit's fixed assets less the debt D^0 and A^1 is the end of period 0 value of these same assets.[191]

Historical cost income I_{HC}^0 is defined along the lines of (56) using the historical cost valuation principle discussed in section 6.1 above:

$$(57) \quad I_{HC}^0 \equiv p^0 \cdot y^0 - r_d^0 f^0 P^0 k^0 + [(1-\delta^0)P^0 k^0 - D^0] - [P^0 k^0 - D^0]$$

$$(58) \quad = p^0 \cdot y^0 - [(r_d^0 f^0 + \delta^0)P^0]k^0.$$

Note that $P^0 k^0 - D^0 \equiv A^0$ is the beginning of period 0 net asset value for our business unit, $(1-\delta^0)P^0 k^0 - D^0$ is the end of period 0 historical cost net asset value and interest paid on asset debt is $r_d^0 f^0 P^0 k^0$. Further note that there are three terms on the right hand side of (57) involving the beginning of period 0 capital stock k^0. These three terms have been consolidated in (58) and the term in square brackets, $[(r_d^0 f^0 + \delta^0)P^0] \equiv w_{HC}^0$, can be regarded as the *user cost of capital* that corresponds to *historical cost accounting*.

If $f^0 = 0$ (so that the initial physical capital stock of the business unit is financed entirely by equity financial capital), then the above historical cost accounting user cost reduces to

$$(59) \quad \delta^0 P^0$$

while if $f^0 = 1$ (so that the initial physical capital stock of the business unit is financed entirely by debt), then the above historical cost accounting user cost reduces to

$$(60) \quad (r_d^0 + \delta^0)P^0.$$

The historical cost accounting user costs defined by (59) and (60) can be compared to our earlier end of period 0 ex post user cost defined by (9), $[r^0 - i^0 + \delta^0(1+i^0)]P^0$. Note that (59) and (60) will generally not equal (9).

The historical cost income defined by (57) was derived under the assumption that the business unit did not sell its initial capital stock during period 0. Suppose now that the business unit sold its initial capital stock at the end of period 0 at the market price $(1-\delta^0)P^1$. Under these conditions, historical cost income is no longer defined by (57); it is now defined as follows (*realized historical cost income*):

$$(61) \quad I_{HCR}^0 \equiv p^0 \cdot y^0 - r_d^0 f^0 P^0 k^0 + [(1-\delta^0)P^1 k^0 - D^0] - [P^0 k^0 - D^0]$$

$$(62) \quad = p^0 \cdot y^0 - [\{f^0 r_d^0 - i^0 + \delta^0(1+i^0)\}P^0]k^0.$$

The three terms involving the initial capital stock k^0 in (61) have been collected in (62); the term in square brackets in (62) is the *the user cost of capital* w_{HCR}^0 that corresponds to *realized historical cost income*. Note that if $f^0 = 1$ (so that the initial capital stock is financed entirely by debt), then the realized historical cost accounting user cost of capital is equal to our earlier ex post user cost of capital defined by (9) above. However, if $f^0 < 1$, then in general, neither of the historical cost accounting user costs defined in (58) and (62) will coincide with (9).

In section 6.1 above, we discussed the benefits associated with the use of historical cost accounting valuations for capital stock components. The same benefits carry over to the current situation. The main benefits that can be attributed to the use of historical cost incomes defined by (57) and (61) are their *low costs* and *objectivity* (in the sense of being *reproducible* by any accountant with the same primary data).[192]

On the negative side of the ledger, accountants have identified five problem areas associated with the use of historical cost accounting incomes:

(i) Historical cost incomes and balance sheet values are often *irrelevant*; i.e., historical cost income is often not a surplus that can be distributed to stakeholders in a costless manner without impairing the long run viability of the business unit and historical cost accounting asset values are often far from current asset values.[193]

(ii) The realization convention of historical cost accounting *distorts* period by period income: under conditions of high asset inflation, historical cost income will tend to be too high in periods when assets are held[194] and will be definitely too high in the periods when assets are eventually sold. In the realized case, the problem with historical cost accounting income is that cumulative capital gains made by the asset are recognized *only* in the period of the asset sale rather than being distributed over all prior accounting periods during which the asset was held.[195]

(iii) Attempts by historical cost accountants to improve the measurement of income by using more current values for end of the period inventory stocks (e.g., the use of Last In, First Out (LIFO) inventory valuations) generally lead to grossly *understated* values for these inventory stocks on balance sheets.[196] We shall consider the problems of inventory valuation in more detail in section 9 below.

(iv) Period 0 income should depend only on opportunity costs for assets at the beginning and end of period 0 and on period 0 prices and quantities for variable inputs and outputs. An income concept that satisfies this desirable property could be said to satisfy the *relevance property* or to satisfy *current period prices and quantities test*. Historical cost accounting income does not satisfy this property (except if assets are bought and sold every period); historical cost asset values are generally based on prices that pertain to periods in the distant past (in the case of long lived assets). The thrust of this criticism of historical cost accounting is contained in the following two quotations:

> "As applied at present, accounting techniques tend to result in an undesirable state of affairs in which firms producing the same goods, using identical plant and with no market difference in efficiency are subject to a considerable variation in costs and profit margins simply because of differing times of acquisition of plant and equipment". *J.C. Latham and others*[1952; 95]

"Traditional accounting operating profit cannot be expected to yield identical data for two different periods whose current events are identical. Current operating profit does fulfill this criterion; it depends for its determination on the events which are current in the period under consideration. The figures derived when historically oriented profit concepts are used depend only partly on current events; their measurement is influenced heavily by events of preceding periods, namely, historic costs. Yet it seems reasonable to expect that if a firm operates during two periods with the same endowment of assets, contributes the same factors to the same production and sales processes, finds the prices of its factors to be the same, and sells the same output at the same prices, the firm should report the same profit. The fact that present accounting procedures will not meet this criterion we regard as a strong argument in favor of the kind of accounting modification we propose". *Edgar O. Edwards and Philip W. Bell*[1961; 226]

(v) Historical cost accounting does not recognize (imputed) *interest on equity capital* as a valid cost of production.[197] We shall pursue this point in more detail in section 7.6 below.

In view of the above criticisms of historical cost accounting income, we now turn our attention to alternative income concepts.

7.2 Restated Historical Cost Income (CPP Income or GPLA Income)

"In his quest for certainty, the accountant has come to assume certain values as constant which are in fact variable. In particular, the value of the monetary unit has been regarded as constant and the measure of all other values. No increase in value of any other asset has, in general, been recognized until its credentials have been validated by 'realization', i.e., exchange for money. Such unquestioning faith in the monetary unit must indeed have been shaken by the great rise of prices in almost all countries during and after World War II. In some countries, where at various times the currencies have declined catastrophically in value, a rejection of the local monetary unit has been common and accounts have been kept in gold or in foreign monetary units".

Sidney S. Alexander[1950; revised 1962; 132]

"It was pointed out that even an imperfect index would give more significant results than ignoring changes in the value of the dollar altogether".

George O. May and others[1952; 54]

Restated historical cost income is defined in much the same way as historical cost income was defined in the previous section *except* that assets held at the beginning and end of the accounting period are revalued using a general index, $1+\rho^0$, of purchasing power change over the accounting period. Thus end of period values of assets are equal to the corresponding historical cost accounting values times the general inflation factor $(1+\rho^0)$. These are GPLA (General Price Level Adjusted) values which were discussed in section 6.2 above; see (54) for a definition of the end of period 0 restated historical cost value for our representative asset which cost P^0k^0 at the beginning of period 0. The justification for this method of end of period asset valuation is that it is a *low cost* and *reproducible* method for obtaining approximate current values for *assets*. However, when calculating restated historical cost *income*, we also multiply the beginning of the accounting period asset values by the accounting period inflation factor, $1+\rho^0$. This beginning of period 0 asset revaluation is justified on the grounds that *beginning* of the period monetary asset values should be converted into units of purchasing power that are equivalent to the *end* of period 0 value of money; thus if there were no general inflation over period 0 (so that $\rho^0=0$), then this conversion to units of stable purchasing power would not be necessary.

Restated historical cost income is sometimes called CPP (Constant Purchasing Power) income[198] or GPLA (General Price Level Adjusted) income.[199] This income concept is due to the accountant Middleditch [1918].[200]

The above discussion of CPP accounting has implicitly assumed that the business unit has no debt. If the business unit does have debt, then the details of CPP accounting are more complex. The beginning of the period net asset value A^0 (which is equal to the value of the physical capital stock P^0k^0 less debt $D^0=f^0P^0k^0$ which in turn is equal to equity $E^0=(1-f^0)P^0k^0$) is multiplied by the period 0 general inflation factor $1+\rho^0$ to convert the beginning of period 0 values into their purchasing power equivalents at the end of period 0. If there is no sale of the initial capital stock, the end of the period value of the (depreciated) capital stock is defined to be the (depreciated) historical cost asset value $(1-\delta^0)P^0k^0$ times the general inflation factor $(1+\rho^0)$ less the value of the initial debt D^0; i.e., we do *not* escalate D^0 by $1+\rho^0$ because the debt is already expressed in terms of the end of period 0 value of money.[201] Thus in the case where the initial capital stock is not sold during period 0, *constant purchasing power income* is defined as follows:

$$
\begin{aligned}
I^0_{CPP} &\equiv p^0\cdot y^0 - \text{interest paid} + A^1_{CPP} - A^0 \\
&= p^0\cdot y^0 - r^0_d f^0 P^0k^0 + [(1+\rho^0)(1-\delta^0)P^0k^0 - D^0] - (1+\rho^0)[P^0k^0 - D^0] \\
&= p^0\cdot y^0 - r^0_d f^0 P^0k^0 - (1+\rho^0)\delta^0 P^0k^0 + \rho^0 f^0 P^0k^0 \\
&= p^0\cdot y^0 - [\{(r^0_d-\rho^0)f^0 + \delta^0(1+\rho^0)\}P^0]k^0. \qquad (63)
\end{aligned}
$$

The term in square brackets in (63) is the *user cost of capital* w^0_{CPP} that is implied by constant purchasing power accounting in the case where the asset is held during period 0; i.e., we have

$$(64) \quad w^0_{CPP} \equiv [(r^0_d - \rho^0)f^0 + \delta^0(1+\rho^0)]P^0$$
$$(65) \quad = [r^0_d f^0 + \rho^0(1-f^0) - \rho^0 + \delta^0(1+\rho^0)]P^0$$

where (65) follows from (64) by adding and subtracting the term $\rho^0(1-f^0)P^0$.

The CPP user cost defined by (64) or (65) can be compared to our earlier ex post user cost of capital w^0_e defined by (9) and the historical accounting user cost w^0_{HC} defined by the expression in square brackets in (58) above. Recall that $r^0 \equiv r^0_d f^0 + r^0_e(1-f^0)$ where r^0_d and r^0_e are the period 0 interest rates for debt and equity respectively. Comparing $w^0_e \equiv [r^0 - i^0 + \delta^0(1+i^0)]P^0$ and w^0_{CPP} defined by (65), it can be seen that

$$(66) \quad w^0_{CPP} = w^0_e \text{ if } \rho^0 = r^0_e \text{ and } \rho^0 = i^0;$$

i.e., constant purchasing power user cost w^0_{CPP} equals economic user cost w^0_e provided that the period 0 inflation rate ρ^0 equals *both* the period 0 equity opportunity cost of capital r^0_e as well as the period 0 asset inflation rate i^0. In the unrestricted general case, we have

$$(67) \quad w^0_e - w^0_{CPP} = [(r^0_e - \rho^0)(1-f^0) - (i^0 - \rho^0)(1-\delta^0)(1-\delta^0)]P^0.$$

The above equation can be used to analyze why the two user costs might be different. Note in particular that the difference between the two user costs depends only on the initial price of capital P^0, the depreciation rate δ^0, the fraction of asset purchases financed by debt f^0 and the two *real interest rates*, $r^0_e - \rho^0$ and $i^0 - \rho^0$.[202]

Taking the difference between historical cost income defined by (58) and constant purchasing power income defined by (63) yields the following equation:

$$(68) \quad I^0_{HC} - I^0_{CPP} = (\delta^0 - f^0)\rho^0 P^0 k^0$$
$$(69) \quad > 0 \quad \text{if} \quad \delta^0 > f^0 \quad \text{and} \quad \rho^0 > 0.$$

Let us assume that $\rho^0 > 0$ so that there is general inflation in period 0. Then period 0 HC income will *exceed* CPP income due to the term $\delta^0\rho^0 P^0 k^0$ (this term indexes depreciation for inflation) and HC income will be *less* than CPP income due to the term $-f^0\rho^0 P^0 k^0$ (this term reflects the decline in the real value of debt due to period 0 inflation). Hence if the firm's debt is zero or small (more precisely, if the debt fraction f^0 is less than the depreciation rate δ^0), then historical cost income will *exceed* CPP income, as we would expect. However, if the firm is highly indebted (more precisely, if the debt fraction f^0 is greater than the depreciation rate δ^0), then HC income will be *less* than CPP income. This last result is perhaps contrary to our expectations since we would expect the indexation

of assets for inflation to lead to a lower income than historical cost income which does not index assets for inflation. However, as long as the initial capital stock is not *entirely* financial by debt, CPP income will *eventually* fall far below the corresponding historical cost income provided that the inflation persists over the life of the asset. We will prove this assertion for the case of an asset that lasts 3 periods[203] under the following simplifying assumptions:

$$\rho^0 = r_d^0 > 0; \rho^1 = r_d^1 > 0; \rho^2 = r_d^2 > 0; \tag{70}$$

$$D^0 = f^0 P^0 k^0; D^1 = f^0(1-\delta^0)P^0k^0; D^2 = f^0(1-\delta^0)(1-\delta^1)P^0k^0; \tag{71}$$

$$0 \leq f^0 < 1; \tag{72}$$

i.e., (70) means that the period i inflation rate ρ^i equals the period i debt interest rate r_d^i for each period i; (71) means that a constant fraction of the (depreciated) historical cost asset value is financed by debt in each period, and (72) means that the business unit has some equity so that not all of the initial asset value P^0k^0 is financed by debt. Note that the historical cost depreciation allowances in periods 0, 1 and 2 are $\delta_0 P^0k^0, \delta_1(1-\delta_0)P^0k^0$ and $\delta_2(1-\delta_0)(1-\delta_1)P^0k^0$ respectively and we assume that $\delta_2 = 1$ so that the asset is fully depreciated at the end of period 2.

We now define CPP incomes for periods 0, 1 and 2:

$$\begin{aligned} I_{CPP}^0 &\equiv p^0 \cdot y^0 + [(1+\rho^0)(1-\delta^0)P^0k^0 - (1+r_d^0)D^0] - (1+\rho^0)[P^0k^0 - D^0] \\ &= p^0 \cdot y^0 + (1+\rho^0)(1-\delta^0)P^0k^0 - (1+\rho^0)P^0k^0 \qquad \text{using (70);} \\ I_{CPP}^1 &\equiv p^1 \cdot y^1 + [(1+\rho^1)(1+\rho^0)(1-\delta^1)(1-\delta^0)P^0k^0 \\ &\quad - (1+r_d^1)D^1] - (1+\rho^1)[(1+\rho^0)(1-\delta^0)P^0k^0 - D^1] \end{aligned} \tag{73}$$

$$= p^1 \cdot y^1 + (1+\rho^0)(1+\rho^1)(1-\delta^0)(1-\delta^1)P^0k^0 - (1+\rho^0)(1+\rho^1)(1-\delta^0)P^0k^0 \tag{74}$$

$$\text{using (70);}$$

$$\begin{aligned} I_{CPP}^2 &\equiv p^2 \cdot y^2 + [(1+\rho^2)(1-\delta^2)(1+\rho^0)(1+\rho^1)(1-\delta^0)(1-\delta^1)P^0k^0 - (1+r_d^2)D^2] \\ &\quad - (1+\rho^2)[(1+\rho^0)(1+\rho^1)(1-\delta^0)(1-\delta^1)P^0k^0 - D^2] \end{aligned}$$

$$= p^2 \cdot y^2 - (1+\rho^0)(1+\rho^1)(1+\rho^2)(1-\delta^0)(1-\delta^1)P^0k^0 \quad \text{using } \delta^2 = 1 \text{ and (70).} \tag{75}$$

Now calculate the discounted stream of CPP incomes over the useful life of the asset using the inflation factors $(1+\rho^i)$ as the discount rates. Using (73) - (75), we find that

$$\begin{aligned} &(1+\rho^0)^{-1}I_{CPP}^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1}I_{CPP}^1 + (1+\rho^0)^{-1}(1+\rho^0)^{-1}(1+\rho^2)^{-1}I_{CPP}^2 \\ &\quad = (1+\rho^0)^{-1}p^0 \cdot y^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1}p^1 \cdot y^1 + (1+\rho^0)^{-1}(1+\rho^1)^{-1} \\ &\qquad (1+\rho^2)^{-1}p^2 \cdot y^2 - P^0k^0. \end{aligned} \tag{76}$$

Equation (76) shows that the discounted (to the beginning of period 0) stream of CPP incomes over the useful life of the asset is equal to the discounted sum of gross operating profits $p^i \cdot y^i$ less the initial purchase price of the assets P^0k^0.

We now define the corresponding period 0, 1 and 2 historical cost incomes:

$$\begin{aligned} I^0_{HC} &\equiv p^0 \cdot y^0 - r^0_d D^0 + [(1-\delta^0)P^0k^0 - D^0] - [P^0k^0 - D^0] \\ &= p^0 \cdot y^0 - \rho^0 f^0 P^0k^0 + (1-\delta^0)P^0k^0 - P^0k^0 \qquad \text{using (70) and (71);} \end{aligned} \tag{77}$$

$$\begin{aligned} I^1_{HC} &\equiv p^1 \cdot y^1 - r^1_d D^1 + [(1-\delta^1)(1-\delta^0)P^0k^0 - D^1] - [(1-\delta^0)P^0k^0 - D^1] \\ &= p^1 \cdot y^1 - \rho^1 f^0 (1-\delta^0)P^0k^0 + (1-\delta^1)(1-\delta^0)P^0k^0 - (1-\delta^0)P^0k^0 \\ &\qquad \text{using (78) and (71);} \end{aligned} \tag{78}$$

$$\begin{aligned} I^2_{HC} &\equiv p^2 \cdot y^2 - r^2_d D^2 + [(1-\delta^2)(1-\delta^1)(1-\delta^0)P^0k^0 - D^2] \\ &\qquad - [(1-\delta^1)(1-\delta^0)P^0k^0 - D^3] \\ &= p^2 \cdot y^2 - \rho^2 f^0 (1-\delta^0)(1-\delta^1)P^0k^0 - (1-\delta^1)(1-\delta^0)P^0k^0 \end{aligned} \tag{79}$$

where (79) follows from the line above using (70), (71) and $\delta^2 = 1$. Now calculate the discounted stream of HC incomes over the useful life of the asset using the inflation factors $(1+\rho^i)$ as discount rates:

$$\begin{aligned} &(1+\rho^0)^{-1} I^0_{HC} + (1+\rho^0)^{-1}(1+\rho^1)^{-1} I^1_{HC} + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1} I^2_{HC} \\ &\quad = (1+\rho^0)^{-1} p^0 \cdot y^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1} p^2 \cdot y^2 + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1} p^3 \cdot y^3 \\ &\qquad - f^0 P^0k^0 [(1+\rho^0)^{-1}\rho^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1}\rho^1(1-\delta^0) \\ &\qquad\qquad + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1}\rho^2(1-\delta^0)(1-\delta^1)] \\ &\qquad - P^0k^0 [1 - (1+\rho^0)^{-1}\rho^0 - (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1-\delta^0)\rho^1 \\ &\qquad\qquad - (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1}(1-\delta^1)(1-\delta^0)\rho^2] \quad \text{using (77) - (79)} \\ &\quad = (1+\rho^0)^{-1} p^0 \cdot y^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1} p^1 \cdot y^1 \\ &\qquad\qquad + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1} p^3 \cdot y^3 - P^0k^0 \\ &\qquad\qquad + (1-f^0)[(1+\rho^0)^{-1}\rho^0 + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1-\delta^0)\rho^1 \\ &\qquad\qquad + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1}(1-\delta^0)(1-\delta^1)\rho^2]P^0k^0 \end{aligned} \tag{80}$$

$$\begin{aligned} &= (1+\rho^0)^{-1} I^0_{CPP} + (1+\rho^0)^{-1}(1+\rho^1)^{-1} I^1_{CPP} + (1+\rho^0)^{-1}(1+\rho^1)^{-1}(1+\rho^2)^{-1} I^2_{CPP} \\ &\qquad + (1-f^0)[\alpha]P^0k^0 \end{aligned} \tag{81}$$

where (81) follows from (80) using (76) and the distortion factor α is defined as the term in square brackets in (80). Note that assumptions (70) imply that α is greater than 0. Thus the discounted sum of historical cost incomes *exceeds* the corresponding sum of constant purchasing power incomes by the amount $(1-f^0)\alpha P^0k^0$, which is positive using (72).

The above proof shows that in the high debt, low depreciation rate case (i.e., $f^0-\delta^0 > 0$), historical cost income will initially be lower than the corresponding CPP income but eventually this initial inequality will be reversed and the discounted sum of historical cost incomes will always exceed the corresponding discounted sum of CPP incomes under assumptions (70) and (71) by the positive term $(1-f^0)\alpha P^0k^0$.

We now turn our attention to the case where the business unit sells its initial capital stock at the end of period 0 at the market price $(1-\delta^0)P^1 = (1-\delta^0)(1+i^0)P^0$. Under these conditions, period 0 CPP income is no longer defined by (63); it is now defined as follows (*realized constant purchasing power income*):

$$
\begin{aligned}
(82)\quad I^0_{CPPR} &\equiv p^0\cdot y^0 - \text{ interest paid } + A^1_{HCR} - (1+\rho^0)A^0 \\
&= p^0\cdot y^0 - r^0_d f^0 P^0k^0 + [(1+i^0)(1-\delta^0)P^0k^0 - D^0] - (1+\rho^0)[P^0k^0 - D^0] \\
(83)\quad &= p^0\cdot y^0 - [\{(r^0_d-\rho^0)f^0 - (i^0-\rho^0) + \delta^0(1+i^0)\}P^0]k^0 \quad \text{using} \quad D^0 = f^0P^0k^0.
\end{aligned}
$$

In definition (82), the realized end of period 0 CPP net value of assets A^1_{CCPR} equals the corresponding realized historical cost net value of assets

$$
(84)\quad A^1_{HCR} \equiv (1-\delta^0)P^1k^0 - D^0 = (1-\delta^0)(1+i^0)P^0k^0 - D^0 \equiv A^1_{CCPR}.
$$

Note also that in definition (82), the beginning of period 0 net value of assets A^0 defined as

$$
(85)\quad A^0 \equiv P^0k^0 - D^0 = P^0k^0 - f^0P^0k^0 = (1-f^0)P^0k^0
$$

is escalated by the inflation factor $1+\rho^0$.

The term in square brackets in (83) is the *user cost of capital* w^0_{CPPR} that is implied by constant purchasing power accounting in the case where the asset is sold at the end of period 0; i.e., we have

$$
\begin{aligned}
(86)\quad w^0_{CPPR} &\equiv [(r^0_d-\rho^0)f^0 - (i^0-\rho^0) + \delta^0(1+i^0)]P^0 \\
(87)\quad &= [r^0_d f^0 + \rho^0(1-f^0) - i^0 + \delta^0(1+i^0)]P^0
\end{aligned}
$$

where (87) follows from (86) by rearranging terms.

Comparing the realized CPP user cost of capital w^0_{CPPR} defined by (86) with our economic user cost of capital w^0_e defined by (9), we see that

$$
(88)\quad w^0_e - w^0_{CPPR} = (r^0_e-\rho^0)(1-f^0)P^0.
$$

Usually, the period 0 equity opportunity cost of capital r^0_e will exceed the period 0 inflation rate and so if $f^0 < 1, w^0_e$ will usually exceed w^0_{CPPR}.

Finally, we compare realized CPP income defined by (82) or (83) to realized historical cost income I^0_{HCR} defined by (61) or (62). Comparing (61) and (82), it can be seen that I^0_{HCR} differs from I^0_{CPPR} by the inflation indexation term $\rho^0 A^0 = \rho^0[P^0k^0 - D^0] = \rho^0(1-f^0)P^0k^0$; i.e., we have

$$(89) \quad \begin{aligned} I^0_{HCR} &= I^0_{CPPR} + \rho^0(1-f^0)P^0k^0 \\ &> I^0_{CPPR} \quad \text{if} \quad \rho^0 > 0 \quad \text{and} \quad f^0 < 1. \end{aligned}$$

Thus in the case of an asset sale, realized historical cost income will exceed realized CPP income, provided that inflation is positive ($\rho^0 > 0$) and the firm has some equity capital ($f^0 < 1$).

Our overall evaluation of CPP accounting is that it is a considerable improvement over historical cost accounting as long as there is general inflation (or deflation) in the economy. *CPP incomes will more closely approximate economic incomes* that are based on current opportunity costs than the corresponding historical cost incomes, provided that there is general price change over the accounting period. Moreover, CPP accounting is a *low cost* alternative to HC accounting; with a few multiplications by the general inflation factor $1+\rho^0$, period 0 historical accounts can readily be converted into CPP accounts. Finally, CPP accounting is *reproducible* if the period by period general inflation factors $1+\rho^0, 1+\rho^1, 1+\rho^2$, etc. are given to accountants by a suitable authority.

The weakness of CPP accounting is that it assigns too many roles to the general inflation rate ρ^0; i.e., in comparing (87) to (9) and (65) to (9), we see that CPP accounting implicitly assumes that the opportunity cost of equity r^0_e equals ρ^0 and (in the unrealized case) that the asset inflation rate i^0 equals ρ^0 as well. Perhaps this lack or accuracy of CPP accounting has offended the sensibilities of many precision oriented historical cost accountants.

We conclude this section by discussing some of the objections made by accountants over the years to CPP accounting.

The first objection we list is one that we already noted in section 6.2; i.e., that the general price index $1+\rho^0$ is faulty:

> "Furthermore, the use of a general price index for the purpose of modifying dollar values and dollar results assumes that all investors are alike, having the same purchasing habits". *Stephen Gilman*[1939; 6]

The answer to this objection is that if general price change is significantly different from 0 over the accounting period, it is better to make some adjustment for the change in the purchasing power of money than make no adjustment at all.

A second objection is also due to Gilman:

"[Sweeney's] proposal has been given serious consideration by accounting thinkers. During severe inflationary periods his plan, or a variation of it, may be almost a necessity. It is, however, rather unlikely that stabilized accounting will win much acceptance until an actual inflation sets in, since there is no powerful group behind it and no tax-saving advantage inherent in it".

Stephen Gilman[1939; 6]

However Gilman's assertion that switching to CPP accounting when there is general inflation would not result in a reduced stream of income and hence lower income taxes seems to be incorrect; recall (81) and (89) above. Thus with even modest inflation, businesses would pay lower income taxes under CPP accounting than under HC account.[204]

A third set of objections is due to Dein:

"Current costs (interpreted as opportunity costs, a proper basis for an inquiry of this sort) are spuriously equated to historical investment costs restated in terms of current dollars. This equating is appropriate only if obsolescence, physical or functional, has not occurred or is not in prospect. Since the fact of obsolescence typifies American industry generally, the adjustment procedure results in adjusted changes against revenue, which exceed the properly determined current costs. The amount of this overstatement of costs may vary over a wide range, making it hazardous to use these adjusted statements".

Raymond C. Dein[1955; 15]

Dein's first objection that restated historical costs are not equal to the actual value of the asset is valid; in our notation, he is saying that ρ^0 (the general inflation rate) will not equal i^0 (the asset specific inflation rate). Our response to this objection is that some adjustment for inflation will usually be better than no adjustment. Dein's second objection is that CPP accounting does not take into account obsolescence. Thus is true but it is a charge that is equally applicable to historical cost accounting. For either system of accounting, the solution to the obsolescence problem is the same: an extra depreciation charge (or price level charge) must be made against the income of the period over which the obsolescence took place.

A final objection to CPP accounting was made by Smith:

"Books must be kept in the established monetary unit. Any attempt to adjust the books to conform to the value of the monetary unit will likely result in a hodgepodge of practices that will not be beneficial either to our business institutions or to our national economy, in my opinion".

Charles W. Smith in G.O. May and others[1952; 125]

Smith's objection to CPP accounting seem to be that: (i) comparability across firms will be lost if some firms use CPP accounting and some use HC accounting[205] and (ii) even if all firms switch to CPP accounting, there is no guarantee that the reproducibility test would be satisfied; i.e., different accountants might come up with different CPP incomes. The force of Smith's objections vanishes if a national tax authority or Accounting Standards Board were to force CPP accounting on all firms and to publish suitable inflation factors $1+\rho^0, 1+\rho^1$, etc. that would be used universally. Moreover, it seems that Smith's first objection to CPP accounting could be more properly be directed towards HC accounting; recall our discussion of the current period prices and quantities test in section 7.1 above and the quotations by Latham [1952; 95] and Edwards and Bell [1961; 226].

Inspite of our (academic) approval of CPP accounting as being an improvement over HC accounting, it must be recognized that accountants around the world, for whatever reasons, remain tremendously attached to historical cost accounting:

> "Presumably in response to the high rates of inflation experienced, legal requirements have been introduced in Brazil and Chile for the adjustment of historical cost statements to reflect general price-level changes. In Argentina, historical cost statements are accompanied by statements similarly adjusted. However, the replacement of historical cost statements with statements adjusted for the effects of *general price-level* changes is prohibited by law or by the accountancy profession in forty-three countries. The replacement of historical cost statements with statements adjusted for the effect of *specific price* changes is similarly prohibited in forty-six countries. It is required in none and minority practice in only one country–the Netherlands".
>
> *R.D. Fitzgerald, A.D. Stickler and T.R. Watts*[1979; 12]

We conclude our discussion of CPP accounting by quoting the economist Alexander and the accountant May[206] on the problems associated with historical cost accounting when general inflation is significant:

> "Occasionally tremendous changes in the general price level demonstrate the instability of the monetary measure on which business accounts are based. In extreme cases of inflation the maintenance of capital intact in money value becomes a ludicrous preoccupation. If income is to be defined as the amount a man can dispose of and yet be as well off at the end of the period as at the beginning, it is clearly inappropriate to use money value as a measure of well being in a period during which money's command over goods and services is shrinking rapidly". *Sideny S. Alexander*[1950; revised 1962; 188]

"Business accounts play a part also in the division of the income produced in an industry among suppliers of capital, management, labor, and government. In such instances business income taxes will tend to be higher on the monetary than on the purchasing power postulate. It is likely also that wages will tend to be higher: textbooks on collective bargaining include 'ability to pay' among the factors determining wages. And salaries, pension contributions, and bonuses to management may also tend to be higher".

George O. May and others[1952; 78]

7.3 Current Cost Accounting Income (Maintenance of Financial Capital)

"The gross revenue of all the inhabitants of a great county, comprehends the whole annual produce of their land and labour; the neat [net] revenue, what remains free to them after deducting the expence of maintaining; first, their fixed; and secondly, the circulating capital; or what, without encroaching upon their capital, they can place in their stock reserved for immediate consumption, or spend upon their subsistence, conveniences, and amusements".

Adam Smith[1776; reprinted 1963; 218-219]

"Income No. 1 is thus the maximum amount which can be spent during a period if there is to be an expectation of maintaining intact the capital value of prospective receipts (in money terms). This is probably the definition which most people do implicitly use in their private affairs; but it is far from being in all circumstances a good approximation to the central concept".

John R. Hicks[1946; 173]

The income concept in this section can be described as a maintenance of financial capital concept; it is basically the Schanz, Marshall [1920; 74] and Haig [1959; 67-68] income concept that was described in section 7.0 above. As the quotations leading off this section indicate, this income concept can be traced back to Adam Smith and it also corresponds to Hicks' Income No. 1. In the accounting literature, this income concept is known as Current Cost Accounting (CCA) income.

CCA income is very similar to historical cost income except that CCA income always attempts to value capital stock components at their current market value. Making the same notational assumptions for our highly simplified model as were made in sections 7.1 and 7.2 above, we define period 0 *current cost accounting income* I^0_{CCA} as follows:

$$
\begin{aligned}
(90)\quad I^0_{CCA} &\equiv p^0 \cdot y^0 - \text{ interest paid } + A^1_{CCA} - A^0 \\
&= p^0 \cdot y^0 - r^0_d f^0 P^0 k^0 + [(1+i^0)(1-\delta^0)P^0 k^0 - D^0] - [P^0 k^0 - D^0] \\
(91)\quad &= p^0 \cdot y^0 - [\{r^0_d f^0 - i^0 + \delta^0(1+i^0)\}P^0]k^0.
\end{aligned}
$$

In definition (90), the end of period 0 CCA net value of assets A^1_{CCA} is an estimate of the end of period 0 current net value of assets; i.e.,

$$
(92)\quad A^1_{CCA} \equiv (1-\delta^0)P^1 k^0 - D^0 = (1-\delta^0)(1+i^0)P^0 k^0 - D^0
$$

where $D^0 \equiv f^0 P^0 k^0$ is the beginning of period 0 value of debt and $(1-\delta^0)P^1 k^0$ is an estimate of the end of period 0 current value of the depreciated assets; (recall sections 6.3 to 6.6 above for alternative methods for estimating current values). In the case where the asset is sold at the end of period O, A^1_{CCA} is the same as the realized historical cost net asset value A^1_{HCR} defined earlier by (84).

Note that the present CCA income concept does not index the beginning of period 0 net value of assets $A^0 \equiv P^0 k^0 - D^0$ for any inflation or general price change that might have occurred between the beginning and end of period 0. This is a fatal flaw that is associated with this income concept since this lack of indexation will lead to a hugh overstatement of income in the case of high general inflation.

The term in square brackets in (91) is the period 0 CCA *user cost of capital* w^0_{CCA}; i.e., we have

$$
(93)\quad w^0_{CCA} \equiv [r^0_d f^0 - i^0 + \delta^0(1+i^0)]P^0.
$$

Comparing the CCA user cost of capital defined by (93) with the economic user cost of capital w^0_e defined by (9) leads to the following equation:

$$
\begin{aligned}
(94)\quad w^0_e - w^0_{CCA} &= r^0_d(1-f^0)P^0 \\
&> 0 \qquad \text{if } r^0_d > 0 \quad \text{and} \quad (1-f^0) > 0;
\end{aligned}
$$

i.e., the CCA user cost of capital will be *too low* compared to the economic user cost of capital (provided that the business unit has some equity so that $1 - f^0 > 0$) and CCA income defined by (90) will be *too high* compared to economic income.

Comparing CCA income defined by (91) to CPP income defined by (63) and to realized CPP income defined by (83) leads to the following relationships:

$$
\begin{aligned}
(95)\quad I^0_{CCA} - I^0_{CPP} &= [\rho^0(1-f^0) + (i^0 - \rho^0)(1-\delta^0)]P^0 k^0 \\
&> 0 \qquad \text{if } 1 - f^0 > 0 \quad \text{and} \quad i^0 \geq \rho^0 > 0; \\
(96)\quad I^0_{CCA} - I^0_{CPPR} &= \rho^0(1-f^0)P^0 k^0 \\
&> 0 \qquad \text{if } 1 - f^0 > 0 \quad \text{and} \quad \rho^0 > 0;
\end{aligned}
$$

Thus under normal circumstances where $\rho^0 > 0$ (positive general inflation), $1 - f^0 > 0$ (positive initial equity capital) and $i^0 \geq \rho^0$ (specific asset inflation is equal to or greater than general inflation), CCA income will exceed CPP income.

The CCA income concept rests on the assumptions that equity dollars at the beginning of the accounting period are equivalent to equity asset dollars at the end of the accounting period and so the difference $A^1_{CCA} - A^0$ can be regarded as income; i.e., CCA income is implicitly a maintenance of financial capital concept (unadjusted for general price level change). In periods of high inflation, it is generally recognized that maintenance of financial capital leads to a rather silly income concept.[209] Thus we turn our attention to a more sensible income concept that rests on a maintenance of physical capital assumption.[210]

7.4 Replacement Cost Accounting Income (Maintenance of Physical Capital)

Footnotes

1. Consider the following quotations:

> "The answer to the question what is the *mean* of a given set of magnitudes cannot in general be found, unless there is given also the object for the sake of which a mean value is required. There are: as many kinds of average as there are purposes; and we may almost say in the matter of prices as many purposes as writers. Hence much vain controversy between persons who are literally at cross purposes". *F.Y. Edgeworth*[1888a; 347]

> "There may be more than one *Money Value of the Social Income*, each corresponding to a different purpose of calculation".
>
> *John R. Hicks*[1940; 107]

> "The concept of business income is dependent on the ends served by the use of the income measurement. There is no one correct method of computing net profit. The question of which procedure to use can be decided only on the basis of the purpose or purposes for which the figures are to be used, not on an abstract basis. Hence, the result will vary according to the purposes for which the calculations are being made". *Albert L. Bell*[1953; 44]

> "Conceptual issues must be settled before measurement issues; we need to know *what* to measure before we can decide *how* to measure. On the other hand, serious measurement problems can severely diminish the usefulness of even the most superior conceptual approach".
>
> *John Leslie Livingstone and Roman L. Weil*[1982; 251]

> "In this article, I propose a resolution for the controversy over depreciation .... the essence of the controversy arose from two different views of what it means to maintain capital 'intact'. ... There are two objectives, not one – income and wealth accounting, and productivity measurement. Part of the depreciation controversy arose from the presumption, usually implicit, that identical capital concepts could be used for different purposes". *Jack E. Triplett*[1996; 94]

2. The following quotations illustrate this point and also indicate that the problems of allocating costs across periods become more severe as the length of the accounting period is shortened:

"Early enterprises and partners working in the main in isolated trading ventures, needed only an irregular determination of profit. But before the business corporation had been very long in operation it was evident that it needed to be treated as a continuing enterprise. For example, calculating dividends by separate voyages was found impractical in the East India Company by 1660. Profit calculation therefore became a matter of periodic estimates in place of the known results of completed ventures". *A.C. Littleton*[1933; 270]

"The difficulty of inputing expenses to individual sales or even to the gross earnings of the accounting period, the month or year, is an ever present problem for the accountant in the periodic determination of enterprise income. The longer the period for which the income is to be determined, the smaller the relative amount of error. Absolute accuracy can be attained only when the venture is completed and the enterprise terminated".

William T. Crandell[1935; 388-389]

"The third convention is that of the annual accounting period. It is this convention which is responsible for most of the difficult accounting problems. Without this convention, accounting would be a simple matter of recording completed and fully realized transactions: an act of primitive simplicity".

Stephen Gilman[1939; 26]

"*All* the problems of income measurement are the result of our desire to attribute income to arbitrarily determined short periods of time. Everything comes right in the end; but by then it is too late to matter". *David Solomons*[1961; 378]

3. "The definition of the profit of an enterprise depends upon which concept of capital we choose as our starting point". *Fritz Schmidt*[1930; 235]

4. "Every science, methodology, or other body of knowledge is oriented to some conceptual structure–a pattern of ideas brought together to form a consistent whole or a frame of reference to which is related the operational content of that field. Without some integrating structure, procedures are but senseless rituals without reason or substance ...". *William J. Vatter*[1947; 1]

5. "A productive system may be regarded as a system of transformation processes in which natural resources, other factors of production and products are combined to produce other products. These transformation processes take place in establishments and may conveniently be grouped together in industries".

Richard Stone[1956; 27]

"The activity of production is fundamental. In the System, production is understood to be a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of goods and services into outputs of other goods and services".

United Nations[1993; 4]

6. However, note that "sale" still differs from "revenue collected" and hence the traditional accounting concept of revenue is still somewhat hypothetical and differs from cash flow accounting. Some representative quotations which illustrate some of the differences between accounting and economic revenues follow.

"Some accountants and economists express the opinion that income is the result of production rather than of sale, and advance certain arguments accordingly". *Stephen Gilman*[1939; 121]

"Why do economists insist on accrual and accountants on realization? Once more we may ask if the difference is one of principle or practicality. Economists' insistence on accrual stems from the fundamental idea of income as a difference between wealth at two difference points of time. If a corporation has more valuable assets at the end of the period than at the beginning this is an increase in wealth, whether a sale has taken place or not. The accountant may reply that he cannot be sure the gain has been made until the sale has taken place".

Sidney S. Alexander[1950; republished in 1962; 171-172]

"In accounting, business income is generally conceived as the residual from matching revenue realized against costs consumed .... The main task of income accounting is to match revenue realized against costs consumed in generating the revenue". *Emily Chen Chang*[1962; 636]

7. "I believe I have had the fortune to come upon a method of analysis which is applicable to a wide variety of economic problems". *John R. Hicks*[1946; 1]

8. All three approaches are briefly surveyed in Diewert [1980a] while the first two approaches are more intensively surveyed in Diewert [1992]. For further information and references to the nonparametric approach to efficiency measurement, see Diewert and Parkan [1983], Varian [1984] and Charnes and Cooper [1985]. In the operations research and management science literature, approach (iii) is known as Data Envelopment Analysis.

9. Gilman [1939; 378] noted the early attempts of cost accountants to improve operating efficiency: "Giving but secondary consideration to the balance sheet viewpoint or to general problems of financial accounting, cost accountants, engineers, and efficiency men approached accounting problems from the engineering side with the result that they looked upon accounting data as statistical measures of operating efficiency".

10. Schmalenbach [1919; translated 1959; 17] traced this function of accounting measurement to early German legislation to prevent fraud: "The main accounting aspects of the 1884 legislation were: Companies must declare their true profits to shareholders, and those who intend to become shareholders, and may not pay out dividends which are distributions of capital and not of profits".

11. We will discuss some of the other items on the accountant's list as well.

12. "The apparent economic gain measured in dollars is often largely or entirely nominal because of the lessening value of the dollar. Many a taxpayer has felt the injustice of being obliged to pay large sums in income and profits taxes from net earnings determined by orthodox accounting methods which were fictitious as a measure of true improvement in economic condition".

William A. Paton[1920; 3]

13. We call w^0 an ex post user cost because it can be calculated only when end of period 0 information on the price of the used asset, P_u^1, becomes available. An ex ante user cost would have the same form as (2) except that the actual end of period value for the asset, P_u^1, would be replaced by a (beginning of period 0) *forecast* for the used asset price, say $\tilde{P}_u^1$. From the viewpoint of economic decision making, the ex ante concept is more relevant but there is the practical difficulty of determining how the firm made its forecasts. The ex post concept is more useful from the point of view of evaluating the actual performance of the firm over the accounting period and so we will use the ex post concept in the remainder of the paper. For discussions of the usefulness of ex ante and ex post concepts, see Hicks [1946; 178-179] and Sterling [1970; 8-9].

14. We discuss alternative methods for estimating economic depreciation rates in section 4 below.

15. "It is most convenient to express any real measure of income in items of dollars of purchasing power as of a specified time ... the real income of any year is expressed in dollars of purchasing power as of the end of the year."
Sidney S. Alexander[1950; republished 1962; 189]

16. In fact, Christensen and Jorgenson [1969; 302] derived precisely formula (9) but under the hypothesis of geometric or declining balance depreciation rates. Edwards and Bell [1961; 172] provided a verbal description of the user cost formula (7) while Griliches [1963; 120] provided a verbal description of the user cost formula (8). The technique of specializing Hicks' [1946; 193-194] general intertemporal framework in order to derive user cost formula of the form (2), (4) and (6) was repeatedly used by Diewert [1974; 503-504], [1980b; 470-475] [1983a; 211-216][1992a; 191-195]. However, the essence of this technique can be traced back to Böhm-Bawerk [1891; 344].

17. In sections 4 and 6 below, we consider alternative methods for the determination of used asset prices.

18. We will examine some of these timing problems in section 8 below.

19. Böhm-Bawerk [1888; translated 1891; 301-303 and 365-371] and Fisher [1930; 48-52] patiently refuted the Marxian exploitation theory which denied that interest was a valid cost of production.

20. "In our science there are three views in circulation as to the formation of capital. One finds its origin in Saving, a second in Production, and a third in both together. Of these, the third enjoys the widest acceptance, and it is also the correct one". *Eugene von Böhm-Bawerk*[1888; translated 1891; 100]

21. For the case of one (spot) commodity and two periods, his geometric analysis was particularly compelling. Fisher [1930; 246] introduced a family of "willingness lines" (i.e., indifference curves over combinations of consumption today and consumption tomorrow) and in Fisher [1930; 265], he introduced the "opportunity line" (i.e., the combinations of consumption today and consumption tomorrow that the economy could produce–the intertemporal production possibilities set). Unfortunately, Fisher [1930; 57] viewed interest as a capital gain and hence interest payments were not negative "income" for a producer and hence could not be a "cost" in his view. Fisher's "income" was what everybody else called "consumption" and so his terminology caused great confusion in the economics literature of his time.

22. The Hicksian model of temporary equilibrium can be viewed as a generalization of a model of capital formation due to Walras [1874; translated 1954; 267-306]. In order to justify a demand to save or defer present consumption, Walras [1954; 274] assumed the existence of a single future period commodity that would be consumed in fixed proportions indefinitely and hence had a price which was proportional to the reciprocal of the one period interest rate, which was assumed to be constant over time. In deriving the price of this future composite commodity, Walras assumed that the spot price of the composite commodity would remain constant over future periods; i.e., he made a static expectations assumption. Hicks [1946; 227-232] was able to dispense with these restrictive assumptions by assuming general intertemporal preferences for consumers and definite expectations about future prices. Walras' [1954; 239-240] theory of production was also somewhat primitive. He essentially assumed: no joint production, constant returns to scale and fixed coefficient or no substitution production functions (which have come to be known as Leontief [1941] production functions). On the other hand, Hicks [1946; 325-6] had a perfectly general intertemporal production function. For a modern interpretation of Walras' theory of capital formation and interest rate determination, see Diewert [1977].

23. "In the muddy pool of controversy over the question of 'interest on the investment' , one finds all kinds of slippery arguments about what rate is to be employed. Most who discuss the question seem to think that, given a correct rate, there is little to object to except the arbitrariness of the rate chosen and of the valuations that result, and the clerical labor involved in the calculating and recording .... But the present writer wishes to urge a somewhat different objection. If interest is to be charged at some agreed rate, into what quantity shall that rate be multiplied? Into book value of the assets? But look at these book values. Consider how they are themselves determined and consider how far they are likely, under any valuation rule yet discovered, to miss the ideally useful and convenient figure. To go through the book valuations found by the simple [accounting depreciation] formulas in Appendix A, where exact prevision of events is supposed, and begin charging interest upon them, is as absurd as trying to correct for the earth's rotation in a snowball fight. To attempt a 5% alternation of an amount which may be 50% in error in a direction unknown to us, is what the kindergarten teachers call 'busy work"'.

John B. Canning[1929; 297]

24. "Cost-of-capital is seldom recognized when practical men calculate depreciation. This is not unreasonable if the rate is low or the life is short. But cost-of-capital alters the figures materially if the rate is high or the life is long

(as they often are): its recognition then gives useful extra information about asset values, income and costs". *William T. Baxter*[1975; 159]

25. "The whole question of whether actual historical costs or imputed costs (this includes all costs that are not actual, from the point of view of explicit transactions entered into between the particular enterprise and other parties) should constitute accounting data is that of whether the accountant can or should attempt to account for enterprise income on the basis of the same set of concepts that the economist uses. The inclusion of imputed costs of any variety, in the accounts, invariably results in a confusion of expenses with aspects of business income or its distribution". *William T. Crandell*[1935; 387]

"Although few would assert that equity interest is not a cost, many persons argue that it is an imputed cost and that accounting does not record imputed costs". *Robert N. Anthony*[1973; 90]

26. Economists who are social or national income accountants tend to resist inputing an interest cost for the use of equity capital as the following quotations indicate:

"The amounts of rents and interest actually payable on rented land and borrowed funds are recorded in the allocation of primary income account, and the entrepreneurial income account, but the implicit rents on land owned by the enterprise and the implicit interest chargeable on the use of the enterprise's own funds are not recorded in the accounts of the System".

United Nations[1993; 175]

"The volumes of intermediate consumption, consumption of fixed capital and any taxes on production measured at the prices or rates of the previous year or the fixed base year should be added to obtain a comprehensive volume measure covering all inputs". *United Nations*[1993; 402-3]

The last quotation indicates that the current U.N. System of National Accounts does not recognize interest, either imputed or paid, as a period cost that should be associated with the use of capital inputs–only depreciation and tax costs are recognized by the System.

27. If the enterprise is also a lender of funds as well as a borrower, then we let the corresponding B_j^0 and b_j^0 be negative (so that r_j^0 defined by (11) is still positive). We assume that all $B_j^0 \neq 0$ and $B^0 > 0$, so that the enterprise is a net borrower in period 0.

28. We include any repayments of principal in B_j^1 that may have occurred for the jth debt instruments over period 0.

29. Overall ex ante debt interest rates $\tilde{r}_j^0$ and $\tilde{r}_d^0$ could be defined in a manner analogous to (14) and (15) except that the actual market values of the firm's bonds at the end of period 0, the B_j^1, would be replaced by anticipated or forecast values for these market values, say $\tilde{B}_j^1$ for $j = 1, \ldots, J$. However, in keeping with our ex post evaluation framework explained in footnote 13 above, we will use ex post actual effective interest rates rather than ex ante forecasted effective interest rates.

30. We will consider an alternative treatment of debt instruments in section 15 below.

31. See Nagorniak [1972; 351] for an example of this approach.

32. For more recent discussions of the equity premium puzzle, see Benninga and Protopapadakis [1992; 770] and Burnside and McCurdy [1992].

33. New financial instruments have recently come onto the market place that create the equivalent of indexed (for inflation) bonds. However, there will still be some small risk elements associated with the use of these instruments since the indexation may not be perfect.

34. I believe that ex ante interest rates of the form defined by (13) are more relevant than ex post interest rates of the form defined by (15) in providing an approximation to the business unit's beginning of period 0 opportunity cost of equity capital, which seems to me to be an inherently ex ante concept.

35. Moreover, these authors pointed out that the Moody's bond yield for the entire private sector economy could be used as the cost of capital in an economy wide total factor productivity study so that the cost of capital for a regulated utility and the entire private sector economy could be treated in a symmetric manner using this exogenous bond rate approach.

36. Recall the above quotation by Hotelling. It should be noted that the statistician Hotelling [1925; 345] deduced a continuous time counterpart to the user cost formula (7).

37. Of the three factors identified by Griliches, only the first two are factors in determining depreciation rates as we have defined them; the third factor, obsolescence, would tend to decrease both P_u^1 and P^1, leaving the depreciation rate δ^0 defined by (3) approximately unchanged. It is interesting to note that Pigou identified more or less the same three factors affecting depreciation as Griliches:

> "Allowance must be made for such part of capital depletion as may fairly be called 'normal'; and the practical test of normality is that the depletion is

sufficiently regular to be foreseen, if not in detail, at least in the large. This test brings under the head of depreciation all ordinary forms of wear and tear, whether due to the actual working of machines or to mere passage of time – rust, rodents and so on – and all ordinary obsolescence, whether due to technical advance or to changes of taste. It brings in too the consequences of all *ordinary* accidents, such as shipwreck and fire, in short of all accidents against which it is customary to insure. But it leaves out capital depletion that springs from the act of God or the King's enemies, or from such a miracle as a decision tomorrow on the part of this country to forbid the manufacture of whisky or beer. These sorts of capital depletion constitute, not depreciation to be made good before current net income is reckoned, but capital losses that are irrelevant to current net income". *A.C.Pigou*[1935; 240-241]

38. "*Bookkeeping Modernized* by John Mair (2nd edition, 1768). The same general procedure is described as in *Bookkeeping Methodiz'd* (17) and there are no illustrations of depreciation but the inference might be made that if the 'value' of the property were less than cost, this decrease in value would be included in the change of Profit and Loss". *Perry Mason*[1933; 210-211]

"There is little reason to doubt that depreciation was originally calculated on the basis of appraisals. The appraisal, it may be conjectured, was originally on a market price basis in order to obtain a figure roughly equivalent to what would have been realized at the date of the appraisal had the asset actually been sold .... After general adoption of the accounting period convention, such appraisals were probably made at the end of each accounting period. It must, however, soon have been obvious that such periodic appraisals gave erratic results depending, of course, upon who made them, how they were made and the general state of business at the time they were made". *Stephen Gilman*[1939; 488]

39. See Hotelling [1925; 350].

40. See Canning [1929; 276-7].

41. See Christensen and Jorgenson [1969] and Jorgenson [1996a][1996b].

42. 'It is undoubtedly true that the methods now in use for the systematic accounting for depreciation and many of the now generally accepted concepts of depreciation have a comparatively recent origin, and that much of the development of the subject has taken place since and as a result of the establishment

of governmental regulation of public utilities and the enactment of income tax legislation". *Perry Mason*[1933; 209]

"Under the impetus of increased income tax rates due to World War I, the interest in depreciation calculation increased. The first edition of Bulletin *F* issued by the Bureau of Internal Revenue in August 31, 1920, advocated the straight-line age-life method". *P.D. Woodward*[1956; 74]

"Rates of depreciation must of necessity conform to Internal Revenue edicts– on documents submitted to the Internal Revenue Service. Unfortunately, the same rates are often used in accounts which do not have to be submitted to the IRS, with attendant undesirable influences on business decisions .... The writer advises engineering students as follows: 1. Disregard official rates of depreciation. 2. Estimate economical length of life for the type of service originally intended for the asset ...". *William F. Berkow*[1964; 380]

43. "Finally, a word should be said about the professional responsibility for valuation. Many accountants assert that valuation of fixed tangible assets is a job for appraisal engineers. Others say that it is the job of the management themselves and that accountants have discharged their whole duty when they avoid certifying statements in which the assets have been negligently or fraudulently valued. The engineers are not too happy with the burden thrust upon them. They say, at least many of them do, that it is impossible to make valuations unless the operating policy, particularly that of maintenance, upkeep and repairs, is foreknown". *John B. Canning*[1929; 307]

44. Wright contrasted the accountant's allocation approach with the economist's change in value approach as follows:

"There have been two distinct approaches to the solution of the depreciation problem which might be designated the 'accounting approach' and the 'economic approach', respectively. The accounting approach requires the cost of an asset less salvage, if any, to be distributed over the life of the unit 'in a systematic and rational manner'. The economic approach, on the other hand, ignores cost as an irrelevant datum: the value of an asset at any point of time is simply the sum of its discounted future services (including salvage if any).

It seems clear that the accounting approach does not really represent an attempt at valuation: indeed, it has been officially described as 'a process of allocation, not of valuation' ". *F.K. Wright*[1964; 81]

45. "For a specific asset, objective verifiable values based upon external transactions are available at only two points of time: at the moment of acquisition, and at the moment of disposal. If these two events occur within the same accounting period, no depreciation problem arises. But when the events are widely separated in time (as is usually the case with fixed assets), determination of periodic income is impossible without establishing a value for the asset at the end of each intervening period. The problem of depreciation accounting is the problem of establishing these needed values without the objective verifiable basis which only external transactions can provide". *F.K. Wright*[1964; 81]

46. "The interminable argument that has been carried on by the text writers and others about the relative merits of the many formulas for measuring depreciation has failed, not only to produce the real merits of the several methods, but, more significantly, it has failed to produce a rational set of criteria of excellence whereby to test the aptness of any formula for any sub-class of fixed assets". *John B. Canning*[1929; 204]

47. "If historic cost is to be allocated among the asset's services as time passes, it is necessary to know in advance the total stock of these services. Otherwise there can be no basis for apportionment. Current cost depreciation, on the other hand, requires in theory no such clairvoyance. We need only know the services used or foregone this period and the price this period of those services". *Edgar O. Edwards and Philip W. Bell*[1961; 175]

48. 'A thousand new Ford cars, regardless of prior statistics, may last five years, eight years, or ten years, a fact which no one can determine from examining statistics of old Ford cars". *Stephen Gilman*[1939; 513]

49. "The research reported upon in this article involved comparing measures of asset book value under conventional accounting practice with a specific type of market value, namely, exit value. The comparison has been with respect to the criteria of comparability and objectivity, operationally defined in such a way as to be fully consistent with a widely held public view that like assets should be shown at like amounts in financial statements ... the findings are unequivocal: (1) Exit values exhibited greater comparability than did book values. (2) Exit values were more objective than book values. (3) The major cause for the lack of objectivity in book values was dispersion in accounting estimates [i.e., in estimates of asset life and salvage value] – not accounting methods". *James E. Parker*[1975; 523]

50. 'But as a practical matter the quantification and valuation of asset services used is not a simple matter and we must fall back on estimated patterns as a basis for current cost as well as historic cost depreciation. For those fixed assets which have active second hand markets the problem is not overly difficult. A pattern of service values can be obtained at any time by comparing the market values of assets of different ages or degrees of use. The differences so obtained, when related to the value of a new asset, yield the proportions of asset value which are normally used up or foregone in the various stages of asset life".

Edgar O. Edwards and Philip W. Bell[1961; 175]

51. We suppose that all units of the durable input have been retired by the time they reach N periods of use.

52. Definition (22) is the same as definition (3): our old P^1 and P_u^1 are now P^{t0} and P^{t1} respectively for $t = 1$. We also redefined our old δ^0 as δ_0.

53. Beidleman [1973] [1976] and Hulten and Wykoff [1981a][1996; 22] showed that equations (24) must be adjusted to correct for early retirement of assets; i.e., equations (24) assume that all units of the asset are retired at the end of N periods of use. Schmalenbach [1959; 91] noted that neglect of the survival problem leads to serious errors in the estimation of depreciation rates.

54. See Jorgenson [1996c; 27-28] for a nice summary of the methods that have been used to date.

55. "The findings of this chapter provide extensive evidence regarding the predominant role of age in the decline in value of certain fixed assets and the relative unimportance of valuation parameters other than age. The initial rapid decline in second hand value calculated for the regression models supports the use of accelerated depreciation techniques and the approach to finite scrap value favors declining balance methods of depreciation. The range of possible asset lives endorses the need for probability life depreciation".

Carl R. Beidleman[1973; 51-52]

56. "We have used this approach to study the depreciation patterns of a variety of fixed business assets in the United States .... The straight-line and concave patterns are strongly rejected; geometric is also rejected, but the estimated patters are extremely close to (though steeper than) the geometric form, even for structures. Although it is rejected statistically, the geometric pattern is far closer to the estimated pattern than either of the other two candidates. This leads us

to accept the geometric pattern as a reasonable approximation for broad groups of assets ...". *Charles R. Hulten and Frank C. Wykoff* [1996; 16]

57. This criticism of depreciation theory dates back to Saliers [1922; 172-174] at least. Many other authors noted this problem:

> "The question of charging depreciation as a function of output rather than of time has been discussed of late. It is more natural to consider the depreciation of an automobile in terms of miles than of years".
>
> *Harold Hotelling* [1925; 352]

> "While there is much to be said in favor of depreciating automobiles and trucks on a mileage basis, rather than by the number of years of use, and while a similar expedient may well be adopted in distributing the depreciation of other machinery and equipment, it must be observed that depreciation is seldom a sole function of use or time. Generally it is a combination of the two, and it is often desirable to check one method by applying the other".
>
> *Stephen Gilman* [1939; 345-346]

> "The two main defects of depreciation data are found to be that they ignore variations in the degree of utilisation, and that they are largely based on original rather than reproduction cost". *L.M. Lachmann* [1941; 375]

58. "A truck used to haul logs in timber country is not likely to yield the same pattern of services as one used to haul produce over superhighways. Physically identical assets having sharply different uses should be placed in separate categories and treated as different assets, for example, logging trucks and produce trucks. How fine a distinction should be drawn is a matter of practicality".
Edgar O. Edwards and Philip W. Bell [1961; 174]

59. The first approach could be viewed as a special case of the second if we allowed discrete classification variables in place of continuous ones. In his study of used automobile prices, Hall [1971] used the first approach, which Jorgenson [1996c; 27] termed the "analysis of variance approach". Beidleman [1973][1976] used the second approach, which Jorgenson [1996c; 28] termed the "hedonic approach".

60. If the business unit produces more than one output, the additional outputs can be absorbed into the x^t vector as negative inputs.

61. For a review of duality theory and the associated functional form problems, see Diewert [1993b].

62. Pigou [1935; 238] clearly distinguished exhaustion (or decline in useful life) from physical deterioration:

> "A distinction should be drawn between physical changes which, while leaving the element as productive as ever, bring nearer the day of sudden and final breakdown, and physical changes which reduce its current productivity and so rentable value."

63. If we assume a flexible functional form for the production function F, the number of parameters to be estimated will grow approximately as the square of the number of inputs and outputs that are distinguished in the model. If we do not assume a flexible functional form for F, then our a priori restrictive assumptions on the substitution possibilities for the technology will generally lead to biased estimates for the depreciation rates. These difficulties with the production function approach are discussed in more detail by Diewert [1992a; 177].

64. Diewert [1983a; 212] [1983b; 1100-1102] discussed these expectational difficulties with ex ante user cost formulae and noted that equation (27) could be used to estimate the producer's anticipated price $\tilde{P}_u^1$. Similarly, given r^0, P^0, an observed rental price $\tilde{w}^0$ and an estimate for the depreciation rate δ^0, (28) could be solved for $\tilde{i}^0$, the anticipated inflation rate.

65. Observing the rental price $\tilde{w}^0$, the price of a "new" asset at the beginning of the period P^0 and the opportunity cost of capital r^0 allows us to form an estimate of the end of period value of the used input, $\tilde{P}_u^1$ by solving (27). This estimated value $\tilde{P}_u^1$ incorporates depreciation and expected capital gains which is all we need for accounting purposes; i.e., it is not necessary to separately estimate δ^0 and $\tilde{i}^0$.

66. This is more or less a verbal description of the used asset prices approach outlined in section 4.4 above.

67. "They (entrepreneurs) buy goods of remoter rank, such as raw materials, tools, machines, the use of land, and, above all, labour, and, by the various processes of production, transform them into goods of first rank, finished products ready for consumption. ... Goods of remoter rank ... are incapable of satisfying human want; they require first to be changed into consumption goods; and since this process, naturally, takes time, they can only render their services to the wants of a future period–at the earliest, that period distant by the time which the productive process necessarily takes to change them into consumption goods". *Eugen von Böhm-Bawerk*[1891; 299-300]

68. Hicks [1973; 5-6] [1965; 238-250] attributed the Austrian model of this section (i.e., the model of Hicks [1961] and Edwards and Bell [1961]) to von Neumann [1937] and Malinvaud [1953], but von Neumann's model is at best only a special case of our Austrian model. Diewert [1977; 108-111] [1980b; 472-475] made extensive use of the Austrian model of production but he regarded it as a special case of the intertemporal production model of Hicks [1946; 193-194] to be studied in the following section.

69. In section 6 below, we will consider various alternative market opportunity costs concepts that might be used. However for now, we think of P_m^0 as being the net realizable value at the beginning of period 0 for a unit of durable input m if no additional units of m are purchased by the business unit during period 0 (this will typically be the case for fixed capital stock components) or P_m^0 is the beginning of period 0 purchase price for a unit of durable input m if additional units of m are purchased during period 0 (this will typically be the case for circulating capital stock components).

70. In some cases, it may be necessary to distinguish the same "physical" commodity by its time of production within the accounting period; e.g., electricity produced during the peak time of a day is more valuable than offpeak electricity; strawberries supplied during off seasons are more valuable than strawberries supplied during the local growing season, etc.

71. These new purchases would show up as (negative) components of the vector y^0. Note that we have assumed that the number of components of k^0 is equal to the number of components of k^1, M. Since we allow components of k^0 and k^1 to be zero, this restriction involves no real loss of generality.

72. Notation: $k^0 \geq 0_M$ means that each component of the M dimensional vector k^0 is nonnegative.

73. Notation: $x \in S^0$ means "x belongs to the set S^0".

74. This assumption was used by Hicks [1946; 193-194].

75. This is the intertemporal profit maximization problem that Hicks [1946; 326] considered.

76. Of course units of capital can be bought or sold during period t; these purchases or sales are components of y^t.

77. The reader who is not interested in the technical details of our demonstration can skip to the end of section 5.3.

78. We assume that the technology sets S^t are nonempty closed convex sets subject to free disposal. This will imply that $\pi^t(p^t, k^t, k^{t+1})$ will be jointly concave in the components of k^t and k^t+1, nondecreasing in the components of k^t and nonincreasing in the components of k^{t+1}; see Diewert and Lewis [1982; 303] or Diewert [1985; 226]. For duality theorems between S^t and π^t and references to the literature, see Diewert [1973] [1993b; 165-168].

79. The assumption that S^0 is a convex set will imply that $\pi^0(p^0, \bar{k}^0, k^1)$ is a concave function in the components of k^1; see Diewert [1973] [1985; 226]. Thus conditions (42) are also sufficient to imply that $\hat{k}^1$ solves (41).

80. The convexity of S^1 implies that conditions (44) and (45) are sufficient for $\tilde{k}^1 >> O_M$ and $\tilde{k}^2 >> 0_M$ to solve (43).

81. Intertemporal profit maximization problems of this type are studied in much greater detail in Diewert and Lewis [1982] and Diewert [1985; 225-228].

82. Since $\pi^0(p^0, \bar{k}^0, k^1)$ is nonincreasing in the components of k^1, $P^{1*} \geq 0_M$.

83. These regularity conditions are not insignificant. In particular, the following assumptions may not be satisfied: (i) convexity of the one period technology sets S^t; (ii) differentiability of the variable profit functions π^t and (iii) the assumption of interior solutions to (46); i.e., that $k^{t*} >> 0_M$ for each t.

84. This observation is due to Edwards and Bell [1961; 174]; recall footnote 58.

85. We will examine the treatment of inventory capital stock components more closely in section 9 below.

86. "The economic object of industry consists in transforming commodities, machinery, and labor, which are for the time being relatively cheap, into products which, because they are scarce, will be valued relatively high. The difference between the value of the cost-goods and the value of the final products represents the value increase". *Fritz Schmidt*[1930; 235]

87. "Just as industry serves society by changing the material form of goods, so commerce serves by the exchange of finished products .... Goods are distributed quite unevenly in different national and international areas .... The value difference between such markets is the cause of commerce .... Profits are also found in differences in time-values (Zeitwerte). While the entrepreneur can measure the degree of his success in buying and selling if the sale of his goods brings him returns which would permit him to buy or produce an additional quantity of the

same goods at the moment of selling, the purpose of the speculator is differently orientated. The latter wishes to make money produce money by investing it in such goods as will show an increase in value during the investment".

Fritz Schmidt[1930; 236]

88. "A business firm can strive to earn profit by combining factors of production having one value into a product which has a greater value, and it can attempt to make gains by holding assets while their prices rise".

Edgar O. Edwards and Philip W. Bell[1961; 272]

89. "It therefore does not seem to be realistic to suppose that holding gains or cost savings are a class apart from sellers' margins. They all, if positive, make the firm better off, that is, able to command more goods and services than before". *R.J. Chambers*[1965; 740]

90. "There is another kind of speculation, which we may call *simple* or *productive* speculation. A man who does not consider himself to have any influence on the market price but who believes that the price is going to rise or is going to fall quite independently of his own actions, and who buys or sells in an attempt to make a profit, is a *simple* or *productive* speculator. If he guesses right he makes a profit, if wrong he makes a loss .... He takes a single product available at another time .... The same thing applies to the man who transports a good firm one *place* to another .... these are perfectly legitimate production activities ...". *Abba P. Lerner*[1946; 69-70]

91. "The idea that a good or a service available at a certain date (and a certain location) is a different commodity from the same good or service available at a different date (or a different location) is old". *Gerard Debreu*[1959; 35]

92. More generally, the reader should refer to Lerner's [1946; ch. 8] analysis of the benefits to society from competitive speculation.

93. "Net realizable value is considered significant because it purports to reveal an alternative available to a firm in which the firm, as a periodic (year end) opportunistic calculator, ever seeks to exploit by selling the assets. However valid this might be in the minds of many profit seekers, it tends to misdirect the energies of management from production and the creation of values to the trading function alone. Such misdirection could well result in limited production and thus a lower standard of living".

Norton M. Bedford and James C. McKeown[1972; 336]

94. This quotation illustrates one of the three main differences between business accounting and social (or national income) accounting: the former emphasizes the realization of revenues or the sale of products while the latter emphasizes the creation of production of products. The other two main differences are: (i) social accounting never recognizes capital gains (realized or unrealized) in income statements whereas business accounting recognizes realized capital gains and (ii) business accounting uses a historical cost accounting treatment of depreciation whereas social accounting uses a current price approach to depreciation – in principle, the approach outlined in section 4.4 above (see United Nationals [1993; 147-150]).

95. "In effect, present accounting data are predicated on the assumption that holding activities do not represent a purposeful means by which management can enhance the market position of the firm. To the extent that the firm attempts to make gains in this fashion, traditional accounting data fail to inform management, owners, and outsiders as to the progress the firm has made during the current period. A second consequence of not counting gains when they arise is that when such gains are in fact realized, the gains earned over the entire time span during which the assets where held by the firm are attributed entirely to the period in which the gains are realized".

Edgar O. Edwards and Philip W. Bell[1961; 222]

"The third consequence of the failure to report capital gains and losses as they occur is the badly distorted balance sheet values which result".

Edgar O. Edwards and Philip W. Bell[1961; 223]

96. However, historical cost accountants can claim that their procedure of excluding unrealized capital gains from periodic income is more "objective" and "verifiable" than any procedure that includes them in periodic income. This claim means that in section 6 below, we must pay careful attention to the "objectivity" and "verifiability" of alternative methods for valuing the assets of a business unit that are held at the end of an accounting period.

97. The same logic would justify a separate listing for depreciation expense since it too is hypothetical.

98. The problem of unrealized capital gains on an asset attracting income tax can be solved by the tax authorities allowing deferral of accrued tax until realization through sale or retirement of the asset.

99. There is a vast literature on these questions that we can only touch on.

100. This is sometimes called an establishment.

101. See the quote above by Wilson [1975; 184].

102. "Analysis of production functions over the last twelve years has suggested strongly that (a) a major proportion of the increase in per capita income cannot be explained by increases in the capital-labor ratio, and (b) production functions differ strongly among nations and indeed among regions .... An economist could just leave the analysis at that, asserting that the causes which determine the amount of technological knowledge at any one time and place lie as much outside his province as the tastes which determine consumption patters. But in fact, we know that significant quantities of resources are being expended by profit-making institutions on research and development .... Hence, it is suggested, we must regard the body of technological knowledge as the result as well as the cause of economic changes". *Kenneth J. Arrow*[1969; 29]

103. "... the basic assumptions of economic theory are either of a kind that are unverifiable–such as that producers 'maximise' their profits or consumers 'maximise' their utility–or of a kind that are directly contradicted by observation–for example, perfect competition, perfect divisibility, linear-homogeneous and continuously differentiable production functions, wholly impersonal market relations, exclusive role of prices in information flows and perfect knowledge of all relevant prices by all agents and perfect foresight. There is also the requirement of a constant and unchanging set of *products* (goods) and of a constant and unchanging set of *processes of production* (or production functions) over time .... The latest theoretical models, which attempt to construct an equilibrium path through time with all prices for all periods fully determined at the start under the assumption that everyone foresees future prices correctly to eternity, require far more fundamental 'relaxations' for their applicability than was thought to be involved in the original Walrasian scheme".

Nicholas Kaldor[1972; 1238-1239]

"Dynamic general equilibrium models with state contingent goods and convex production sets may be useful for some purposes, but the critics are right that there is something fundamental and important about the evolution of an economy that equilibrium models based on convex sets cannot capture".

Paul Romer[1994; 14]

104. "Knowledge arises from deliberate seeking, but it also arises from observations incidental or other activities. Haavelmo, Kaldor and I ... have all stressed

that the activities of production and investment may lead to increases in productivity without any identifiable allocation of resources to that end".

Kenneth J. Arrow[1969; 30]

"The Horndal iron works in Sweden had no new investment (and therefore presumably no significant change in its methods of production) for a period of 15 years, yet productivity (output per manhour) rose on the average close to 2% per annum. We find again steadily increasing performance which can only be imputed to learning from experience". *Kenneth J. Arrow*[1969; 156]

105. See Allen [1983] and the references in Arrow [1962; 156].

106. "Who invents? Why do they invent? In attempting to answer these questions, economists have identified and studied three kinds of institutions–nonprofit institutions like universities and government agencies, firms that undertake research and development, and individual inventors. In this paper, it is proposed that a fourth inventive institution be recognized. This institution is called collective invention". *Robert C. Allen*[1983; 1]

107. "Again, it is to his interest also that the secrecy of business is on the whole diminishing, and that the most important improvements in method seldom remain secret for long after they have passed from the experimental stage. It is to his advantage that changes in manufacture depend less on mere rules of thumb and more on broad developments of scientific principle; and that many of these are made by students in the pursuit of knowledge for its own sake, and are promptly published in the general interest". *Alfred Marshall*[1920; 285]

108. Smith [1963; 8-9] illustrated this general statement by the following specific example:

"In the first fire-engines, a boy was constantly employed to open and shut alternately the communication between the boiler and the cylinder, according as the piston either ascended or descended. One of those boys, who loved to play with his companions, observed that, by tying a string from the handle of the valve which opened this communication to another part of the machine, the valve would open and shut without his assistance, and leave him at liberty to divert himself with his play-fellows. One of the greatest improvements that has been made upon this machine, since it was first invented, was in this manner the discovery of a boy who wanted to save his own labour".

109. "We are thus led to a general rule, the action of which is more prominent in some branches of manufacture than others, but which applies to all. It is, that any manufacturing operation that can be reduced to uniformity, so that exactly the same thing has to be done over and over again in the same way, is sure to be taken over sooner or later by machinery .... Thus the two movements of the improvement of machinery and the growing subdivision of labour have gone together and are in some measure connected". *Alfred Marshall*[1920; 255]

110. "It is generally agreed that Adam Smith, when he suggested that the division of labour leads to inventions because workmen engaged in specialised routine operations come to see better ways of accomplishing the same results, missed the main point. The important thing, of course, is that with the division of labour a group of complex processes is transformed into a succession of simpler processes, some of which, at least, lend themselves to the use of machinery. In the use of machinery and the adoption of indirect processes there is a further division of labour, the economies of which are again limited by the extent of the market. It would be wasteful to make a hammer to drive a single nail; it would be better to use whatever awkward implement lies conveniently at hand. It would be wasteful to furnish a factory with an elaborate equipment of specially constructed jigs, gauges, lathes, drills, presses and conveyors to build a hundred automobiles; it would be better to rely mostly upon tools and machines of standard types, so as to make a relatively larger use of directly-applied and a relatively smaller use of indirectly-applied labour. Mr. Ford's methods would be absurdly uneconomical if his output were very small, and would be unprofitable even if his output were what many other manufactures of automobiles would call large".

Allyn A. Young[1928; 530]

111. Nakamura and Lawrence [1994; 248] have a nice analysis of some of the institutional differences between machines and workers that might cause managers to substitute machines for workers:

"The comparative advantages of using machine labour are readily apparent. Computers and computer controlled machines are consistent in their responses, time after time. Machines are vulnerable to feelings of boredom, fears that techological change may render them obsolete, or inopportune promotion aspirations. They never get pregnant, ask for maternity leaves, file discrimination or harassment suits, object if they are not given training opportunities, demand to be paid time-and-a-half for overtime work, or strikes. When parts of machines wear out, they can be replaced (or the whole machine can be replaced) without concerns

about Workers' Compensation or disability claims being filed. Machines may not always perform as desired, but this is never a consequence of hard-to-handle attitudes or substance abuse problems. Rather, straight-forward methods of scientific and engineering inquiry can usually be relied on to solve the performance difficulties of mechanical devices. And machines *never* have to be monitored to prevent them from intentionally shirking or stealing".

112. Allen [1983; 10] pointed out that increasing the height of blast furnaces eventually ran into diminishing returns: "These tall furnaces proved to be disasters".

113. For example, vehicles used to transport goods (trucks) cannot be constructed above and below certain capacities.

114. "As was shown above, not all causes of increasing returns can be attributed to indivisibility of one kind or another and there is no reason to suppose that 'economies of scale' become inoperative above certain levels of production. There is first of all the steady and step-wise improvement in knowledge gained from experience–the so-called 'dynamic economies of scale' which have nothing to do with indivisibilities. But even in the field of 'static' or 'reversible' economies, there is the important group of cases which I described above as being due to the three dimensional nature of space–i.e., the fact that the capacity of, say, a pipeline can be quadrupled by doubling its diameter while the costs (in terms of labour and materials) are more nearly related to the diameter than to its capacity". *Nicholas Kaldor*[1972; 1253]

115. "A ship's carrying power varies as the cube of her dimensions, while the resistance offered by the water increases only a little faster than the square of her dimensions; so that a large ship requires less coal in proportion to its tonnage than a small one. It also requires less labour, especially that of navigation: while to passengers it offers greater safety and comfort, more choice of company and better professional attendance". *Alfred Marshall*[1920; 290]

116. This example of a fixed cost is of course due to Adam Smith [1963; 7]. A classic example of a returns to scale effect due to the existence of fixed costs is the square root inventory replenishment rule discovered by Harris [1915; 48-52], Allais [1947; 238-241], Baumol [1952], Tobin [1956] and many others; see Whitin [1952; 503] [1957; 32 and 230] and Hadley and Whitin [1963; 3-4] for additional references to the literation.

117. This application of probability theory to the determination of adequate bank reserves dates back to Edgeworth [1888b; 122]; for additional applications and references

to the literature, see Whitin [1952; 506-511] [1957; 234-236] and Hadley and Whitin [1963; chapters 4-8]. Edgeworth [1888b; 124] also applied his statistical reasoning to the inventory stocking problem faced by a restaurant or club and noted that optional inventory stocks are proportional to the square root of anticipated demands: "Suppose now the number of members in the club to be doubled or trebled, while their habits are unaltered. At first sight it might appear that the reserve of provisions which the manager requires should increase proportionately. But the corrected theory is that the ratio of the new reserve to the old should not be two or three but the *square root* of two or three".

118. Bulk purchasing means that the supplying firm can achieve internal economies of scale and thus can offer lower selling prices.

119. This observation is of course due to Adam Smith as we have seen. Krugman summarizes Marshall's elaboration of Smith as follows:

> "It was Alfred Marshall who presented the basic classic economic analysis of the phenomenon. (Actually, it was the observation of industry localization that underlay Marshall's concept of external economies, which makes the modern neglect of the subject even more surprising). Marshall [1920] identified three distinct reasons for localization. First by concentrating a number of firms in an industry in the same place, an industrial center allows a pooled market for workers with specialized skills; this pooled market benefits both workers and firms .... Second, an industrial center allows provision of nontraded [i.e., non internationally traded] inputs specific to an industry in greater variety and at lower cost .... Finally, because information flows locally more easily than over great distances, an industrial center generates what we would now call technological spillovers ...". *Paul Krugman*[1991; 36-37]

120. Adam Smith [1963; 15] was well aware of this factor:

> "As by means of water-carriage a more extensive market is opened to every sort of industry than what land-carriage alone can afford it, so it is upon the sea-coast, and long the banks of navigable rivers, that industry of every kind naturally begins to subdivide and improve itself, and it is frequently not till a long time after that those improvements extend themselves to the inland parts of the country".

121. "... every increase in [population] is likely for the time to be accompanied by a more than proportionate increase in their power of obtaining material goods. For it enables them to secure the many various economies of specialized skill and specialized machinery, of localized industries and production on a large scale: it

enables them to have increased facilities of communication of all kinds; while the very closeness of their neighbourhood diminishes the expense of time and effort involved in every sort of traffic between them, and gives them new opportunities of getting social enjoyments and the comforts and luxuries of culture in every form. No doubt deduction must be made for the growing difficulty of finding solitude and quiet and even fresh air: but there is in most cases some balance of good". *Alfred Marshall*[1920; 320-321]

122. As tariffs were reduced in the years following World War II, trade between countries grew faster than GDP growth. The North American Free Trade agreement led to a 75% increase in trade between Canada and the U.S. in 5 years. However, since World War II, domestic commodity and labour taxes have increased in most countries a factor which tends to limit the growth of the market.

123. Advertising makes potential purchasers aware of new products and thus stimulates market growth. A particularly effective recent innovation in this area is use of targetted mailing lists.

124. Particularly important today are the improvements in telecommunications technology (fax machines, the internet, etc.). Communications improvements were also important in Marshall's time:

"Meanwhile an increased in the aggregate scale of production of course increases those economies, which do not directly depend on the size of individual houses of business. The most important of these result from the growth of correlated branches of industry which mutually assist one another, perhaps being concentrated in the same localities, but anyhow availing themselves of the modern facilities for communication offered by steam transport, by the telegraph and by the printing-press". *Alfred Marshall*[1920; 317]

125. It is here where basic information on science and engineering can be obtained:

"Let us then look at those elements of the wealth of a nation which are commonly ignored when estimating the wealth of the individuals composing it .... Scientific knowledge indeed, wherever discovered, soon becomes the property of the whole civilized world, and may be considered as cosmopolitan rather than as specially national wealth. The same is true of mechanical inventions and of many other improvements in the arts of production ...".

Alfred Marshall[1920; 59]

126. "For External economies are constantly growing in importance relatively to Internal in all matters of Trade-knowledge: newspapers, and trade and technical publications of all kinds are perpetually scouting for him and bringing him much of the knowledge he wants–knowledge which a little while ago would have been beyond the reach of anyone who could not afford to have well-paid agents in many distant places .... Although therefore the small manufacturer can seldom be in the front of the race of progress, he need not be far from it, if he has the time and the ability for availing himself of the modern facilities for obtaining knowledge". *Alfred Marshall*[1920; 284-285]

127. "But perhaps a greater though less conspicuous hindrance to the rise of the working man is the growing complexity of business. The head of a business has now to think of many things which he never used to trouble himself in earlier days; and these are just the kind of difficulties for which the training of the workshop affords the least preparation. Against this must be set the rapid improvement of the education of the working man not only at school, but what is more important, in after life by newspapers, and from the work of co-operative societies and trades-unions, and in the other ways".

Alfred Marshall[1920; 308-309]

128. "While mass media play a major role in alerting individuals to the possibility of an innovation, it seems to be personal contact that is most relevant in leading to its adoption. Thus, the diffusion of an innovation becomes a process formally akin to the spread of an infectious disease". *Kenneth J. Arrow*[1969; 33]

129. Having an easily accessible local airport that has direct flights to many international destinations seems to be important in this respect.

130. "Other things being equal, one person has more real wealth in its broadest sense than another, if the place in which the former lives has a better climate, better roads, better water, more wholesome drainage; and again better newspapers, books and places of amusement and instructions".

Alfred Marshall[1920; 58-59]

131. It seems likely that internet services will eventually be substitutes for virtually all of the knowledge transmission activities (i) - (vi) listed above.

132. Romer's [1994; 13] Figure 3 presents a single (but incomplete) paradigm for modeling innovation:

"Every real economy is presented with an almost incomprehensible number of new goods that can be introduced. Some of these goods are like good Z in Figure 3. They would increase utility. Many others, perhaps the great majority of all possible new goods, would not be worth introducing. The fixed costs are too high and the benefits too low. Out of the enormous set of possible new goods, a very small number are somehow selected and introduced".

Paul Romer[1994; 14]

133. This point was made by Hicks [1973; 120] many years ago:

"I have so far been telling the story in the conventional terms, of shifts in technology and switches within the technology; but, at the point we have reached, do not the 'technology' and the 'technological frontier' themselves become suspect? They are essential tools of static analysis; but in dynamic analysis, such as this, do we need them? .... The notion of a 'technology', as a collection of techniques, laid up in a library (or museum) to be taken down from their shelves as required, has been deservedly criticized; in itself it is a caricature of the inventive process .... Why should we not say that every change in technique is an *invention*, which may be large or small? It certainly partakes, to some degree, of the character of an invention; for it requires, for its application, some new knowledge, or some new expertise. There is no firm line, on the score of novelty, between shifts that change the technology and shifts that do not".

134. On the other hand, if the business unit actually sold the asset at the end of an intermediate accounting period in inflationary conditions, income would suddenly be much larger for that period under the realization conventions of historical cost accounting. This discrepancy in historical cost incomes depending on whether an asset is held or sold should alert us to the possibility that something is wrong with historical cost accounting. We will explore these problems in more detail in section 7 below.

135. The accountant William A. Paton [1920; 2-3] was not far behind in making a similar observation:

"The significance of the dollar–the accountant's yardstick-is constantly changing .... One of the fundamental limitations of accounting arises here. The units of physical science are always the same; and hence direct comparisons of situations and phenomena arising at different times can be made in this field. Accountants deal with an unstable, untrustworthy index; and, accordingly, comparisons of unadjusted accounting statements prepared at different periods are always more or less unsatisfactory and are often positively misleading".

136. Morgenstern [1963; 66] uses the term "meaningless statistics" to describe historical cost incomes during periods of rapid inflation.

137. " 'Conservatism', especially when it merely means 'highly probable understatement', is not meritorious' ". *John B. Canning*[1929; 1054]

"Conservation infers understatement and understatement infers falsity. Falsity cannot be characterized as fundamental truth".

Stephen Gilman[1939; 204]

138. " It is, of course, unlikely that balance sheets will be drawn up in the indicated manner; this is a matter for the future. But it is clear that present balance sheets already contain an element of expectation and speculation".

Oskar Morgenstern[1963; 78]

139. "The accountant of the future will be a distinctly different type .... Accounting and statistics will be his tools; the entire scope of internal and external business problems that are reducible to mathematical measurement will be his field". *H.C. Daines*[1929; 109]

"It is necessary for the accountant to realize that his measures of income or financial position are actually probability distributions".

Harold Bierman[1963; 504]

140. Sweeney [1964; 8-11] reviews the early history of this method.

141. "Current value accounting is easy to explain and meaningful, but hard to audit. It requires estimates of the current values of all assets and liabilities. More often than not, prices for 'used' assets are hard to get. Auditors would be required to make substantial judgemental decisions in implementing current value accounting. But we live in a litigious age, and auditors are reluctant to exercise judgement in such situations because, occasionally, subsequent events might not bear out these judgements, and costly and embarrassing lawsuits may result .... GPLA financial statements are easy to audit and are objective. Two auditors given the same historical records and the same data for the GNP Deflator are likely to derive the same general price level adjusted statements".

Sidney Davidson, Clyde P. Stickney and Roman L. Weil[1976; 225]

142. At times, various short term emergency adjustments to historical cost accounting as a consequence of rapid inflation have been made:

"In Germany, during the severe inflation period, the orthodox practice of calculating depreciation on the basis of original book costs was eventually swept aside because accountants and businessmen came to perceive that, in maintaining the substance of capital, it was no longer useful. At first various supplementary measures were adopted, such as charging all new fixed asset costs to expense ...". *Henry W. Sweeney*[1931; 166]

143. "The only problem left is the selection of the index. In view of the motivation of the enterprise, it should be obvious that we think the Consumer Price Index is the most appropriate. It is the closest substitute for a utility measurement that is currently available .... The other indices which are often described as general, e.g., the implicit GNP deflator, include intermediate goods. Intermediate goods should be excluded from the purchasing power concept, because they are only indirectly productive of utility". *Robert R. Sterling*[1970; 340-341]

144. This choice was used by German accountants during the German hyperinflation of 1923; see Sweeney [1927] [1928].

145. This alternative has also been used; see Wasserman [1931; 10].

146. See Diewert [1976; 117]. Diewert [1992b; 214-222] also shows that the Fisher ideal index has very good properties from the viewpoint of the test or axiomatic approach to index number theory.

147. Diewert [1996; 100-103] discusses the first three problems and gives references to the literature.

148. "The simplest way to convert a money measure into a real measure is through an accepted index of the general price level. No perfectly satisfactory index of the general price level exists, nor can one be conceived. It is not only that price indexes are imperfect because of poor price reporting and inadequate coverage, but even in theory it is impossible to construct a perfect price index no matter how much information one has. Since all prices do not move together it is necessary to use an average of different price movements. The average must be weighted, and the appropriate weights change as between the beginning and end of the period over which price change is being measured .... But for practical purposes, the theoretical imperfection of index numbers need not worry us too much". *Sidney S. Alexander*[1962; 188]

149. In many cases, seasonal commodities are not available in all seasons and thus there will be no prices for these out of season commodities.

150. The problem of making general price level adjustments when the business unit operates in several countries are complex and require more research. Maurice Moonitz [1970; 470] comments on this problem as follows:

> "How generalized is the money we are referring to? ... In virtually all the discussions with which I am familiar, the assumption is made, usually implicitly, that we are concerned solely with a domestic currency and with changes in its exchange value in the domestic economy .... Katano argued that price level accounting is not restricted to the sphere of a single currency, such as the U.S. dollar or the Japanese yen. The proper index, he asserts, should make accounting data comparable and consolidatable between different monetary spheres and over time".

151. "The appropriate index to use in restating accounting measurements in units of purchasing power is an index of prices of goods consumed by investors".
George J. Staubus[1975;45]

152. "When accounts expressed in 'diverse amounts of general purchasing power', as in historical dollar financial statements, are restated in terms of the dollar of a single point of time, nothing new is being said. No 'change' has occurred, except in the size of the units of measurement employed".
Maurice Moonitz[1970; 466]

153. For a discussion, see Sweeney [1964; 45-47].

154. "A difference between net realizable value and replacement cost, other than that related to direct costs of buying and selling such as commissions, transportation and taxes, indicates that the firm buys in a different market from that in which it sells .... Net realizable value of an asset is the preferable basis for measurement in this type of situation because it takes into consideration the destination of the asset rather than its source". *George J. Staubus*[1961; 36-37]

155. "We reach the conclusion that opportunity cost, and not the authors' current cost, is the appropriate asset measurement basis. *Opportunity costs (market resale prices) are relevant to the firm always".* *R.J. Chambers*[1965; 736]

156. "Edwards and Bell also build a case for exist prices, but then reject them in favor of entry prices. We were not convinced by their reasons for rejecting exit values, and we particularly disagree with the idea that exit values would be less useful to external users of the data". *Robert R. Sterling*[1970; 328]

157. The distinction between entry and exit values was recognized by the Prussian legal system in the 1880's according to Schmalenbach:

> "There is no basis whatsoever for the opinion held by the old school of tax jurists that the user-value allegedly meant is the value in the open market, i.e., the value on a sale. In Prussian land law the user-value was something quite different; it was the value of the property to the average person for use in its present state and therefore approximated in general to the price at which an equivalent property could be acquired". *Eugen Schmalenbach*[1959; 20]

Economists have also long made the distinction between entry and exit prices:

> "There are three entirely separate concepts of the basis on which capital can be measured, namely *market value, replacement value* and *cost price*".
> *Colin Clark*[1940; 375]

Clark's market, replacement and cost values are the exit, entry and historical cost values of Edwards and Bell respectively.

158. Essentially appraisers encounter the same sort of difficulties that were mentioned in the previous sentence.

159. "Under ordinary circumstances the accountant can rely upon the operation of economic forces to determine market values; he is therefore not usually concerned with the discounting process. Market values when obtainable are also objective in character". *H.C. Daines*[1929; 99]

160. There are some additional more minor reproducibility problems with historical cost accounting: (i) if certain asset values are "known" to fall below historical cost, then the offending assets are to be valued at "market" value; (ii) there can be some ambiguity as to when exactly a sale is realized; i.e., it is sometimes difficult to allocate revenues to specific accounting periods and (iii) there can be uncertainty about what proportion of overdue payments will eventually become bad debts. Gilman [1939; 541] noted the inconsistency of historical cost accounting practices with respect to point (ii) above:

> "It would appear that those who condemn revaluations upward should, in all consistency, condemn downward revaluations. With some exceptions such consistency is not observed".

161. This point did not originate with Ijiri as the following quotations indicate, but Ijiri phrased the point in the most elegant fashion:

"By and large, the reason why these writers [on asset valuation principles] could not arrive at a satisfactory theory was their premise, that the object of the balance sheet was the ascentainment of the status of capital. They did not realize that it is not possible to arrive at a value for a capital composed of a number of parts, merely by adding together the values of the individual parts".

Eugen Schmalenbach[1959; 20-21]

"Capital instruments used jointly with others in turning out goods for sale do not, properly speaking, have separate *capital* values at all".

John B. Canning[1929; 233]

"Although the correspondence between this definition of current cost and the data produced under the above rules of measurement is far from perfect, use of its alternative–market value–would raise far more formidable problems. First, an objective set of rules for measuring the market value of plant assets could not easily be established. Next, although the plant account could be assumed to be at market value, there would still remain the problem that with market value the sum of its parts is not equal to the whole". *Myron J. Gordon*[1953; 376]

162. More elaborate solutions to the additivity problem could be obtained by adapting the techniques used in the axiomatic cost allocation literature to this revenue allocation context. For references to the cost allocation literature, see Young [1985] [1994] and Moulin [1995].

163. "I do not object to current cost accounting if one can show that its benefit to society is greater than its cost of implementation. Remember, however, the bill to society for establishing and running such a system can be enormous, considering the cost of assessment, calculation, and auditing (all of which must be done every year) as well as the cost of solving disputes if the firm or the accountants are challenged on the reliability of data or are accused of intending to mislead the public". *Yuji Ijiri*[1979; 71]

164. "In some cases, such as permanent investments, plant sites, construction jobs, etc., almost no reliable data may be obtained for use in market valuation".

H.C. Daines[1929; 101]

"There is no active trading market for large aggregates of fixed assets which have been put together into a specialized production design for specialized use. Any attempt to assign a market value to the aggregate of land, buildings, machinery, equipment and motive power constituting the average industrial plant is obviously impossible". *Stephen Gilman*[1939; 80]

165. Statistics Canada has used this methodology for years to estimate a construction price index; i.e., engineering and construction firms are asked to provide estimates for the cost of building a specific asset in the current survey period.

166. Social accountants can use replacement costs as a basis for asset valuation because their efforts are never audited or questioned. This situation is starting to change in the European Union as Eurostat (the central Statistical Agency of the EU) tries to harmonize the statistical practices of its member countries.

167. Robert R. Sterling [1970; ix] seems to have been the first accountant to argue along these lines:

> "It seems clear, for example, that one can postulate a continuing firm which is operating in two different markets (say, a retailer) and make a good case for valuing inventory at replacement cost. Under those circumstances the 'opportunity' of a unit is the cost of replacing it, since the firm *must* restock".

Edwards [1975; 240-241] argued for the use of entry values for those markets where a firm is usually a buyer and exit values for those markets where the firm is usually a seller; Davidson, Stickney and Weil [1976; 211] endorsed this argument.

168. "The non-availability of the future series of data, except for certain fragmentary items attaching to the near future, not only prevents the systematic development of realized income statistics to the point of large usefulness but prevents also a full development of capital valuation. For without reliable estimates of all future series to be discounted, reliable present valuations are impossible".

John B. Canning[1929; 321]

169. "If [the capitalization of the income producing value of the net assets] is impractical of application, since from the very nature of the case, the earnings of a business are the joint product of all the assets, conditions and services which the business possesses and uses. It is impossible, therefore, to impute on the basis of total earnings any particular value to any given asset".

H.C. Daines[1929; 98]

170. "The familiar accounting dilemma of relevance versus reliability emerges for the question of how do you produce another unique asset, such as *Snow White* or a particular oil field".

John Leslie Livingstone and Roman L. Weil[1982; 253]

"Much of the discussion of changing prices at the conceptual level has assumed or implied a manufacturing environment. Different sorts of measurement problems arise for the natural resources, in financial companies, and service industries. These are often the most challenging measurement issues and these latter industries represent a considerable portion of our economy. Therefore we encourage theorists to focus added attention on these key areas".

John Leslie Livingstone and Roman L. Weil[1982; 255]

171. "Inasmuch as the price level is not stable for any great length of time, and since this calculation is contemplated for each fiscal period, the only feasible procedure for a company with thousands of assets is the use of price index numbers". *Albert L. Bell*[1953; 49]

"Where no market exists for new fixed assets of the type used by the firm, two means of measuring current costs are available: (1) appraisal, and (2) the use of price index numbers for like fixed assets to adjust the original cost base to the level which would now have to be paid to purchase the asset in question".

Edgar O. Edwards and Philip W. Bell[1961; 186]

172. More generally, P^0 can be the estimated beginning of period 0 current value for the asset.

173. "Fixed assets, as distinguished from current assets, had to be revalued by means of index corrections. The indices ..., which had to be used for any given fiscal year, were published in an official government publication. These index coefficients were computed on the basis of the wholesale price indices for construction materials, lumber and steel products".

H. Peter Holzer and Hans-Martin Schönfeld[1963; 383]

174. "The fact that the purchasing power shown will be in terms of the index used, and not in terms of the actual purchasing power available to a given enterprise for making its purchases, is a decided limitation to the use of the index numbers in accounting". *Donald K. Griffith*[1937; 126]

"Not many years ago standard telephone cables consisted of numerous wires encased in a lead sheeting. In the present microwave era it would be just as wrong to apply replacement-cost index numbers to the cost of the old cable and call the result value for the purpose of arriving at depreciation expense as it would be to apply price-index numbers to the cost of the famous twenty mule team and call

the result the cost of automotive transportation".

Charles W. Smith in G.O. May and others[1952; 126]

175. Note that GPLA accounting is not subject to this problem since there is only one asset class. Of course, the countervailing problem associated with GPLA accounting is that it is less relevant or accurate as an approximation to actual current values:

> "A simple general purchasing power index is proposed, but that has no real relevance to the value of capital goods".
>
> *Solomon Barkin in G.O. May and others*[1952; 115]

176. Suitable rules of thumb would have to be developed. Gilman raises similar timing and domain of definition issues in the context of finding suitable estimates for end of period values for the inventory components of a business unit's capital stock:

> "Another cause of profit distortion is to be found in the methods used for determining selling prices as the preliminary basis for the proportional cost calculation. Should market quotations on the last day of each month be used? Should the daily quotations for the entire month be averaged? Should the averages for the past three months be used? Under mercurial market conditions these questions become important. The purpose of the popular three months' average plan is, according to McKee, 'to eliminate temporary market fluctuations, and reflect costs by market trends instead' ". *Stephen Gilman*[1939; 333]

177. "Accountants are fully aware of the difference between 'dollar accounting' and a conceivable 'purchasing power accounting', and would prefer just as the economists do, a purchasing power accounting. But the adjustment data can never become available at the time records are originally made, nor do they become available in time for report making. Whether or not it would pay to make such an accounting currently, is doubtful; but the cumulative effect of a depreciating currency upon valuations of long-lived assets and debts may be such as to require partial readjustments at relatively long intervals".

John B. Canning[1929; 196-197]

178. "In order to make the accounts reasonably reflect current conditions and to avoid abrupt value changes, numbers of accountants have recommended that fixed asset accounts be regularly adjusted by means of an index number. Gradual changes thus computed would be better than the irregular revaluations which have occurred in the past, but the recording of index number adjustments on the books conceals historical costs and at best constitutes only a partial solution to

the general problem of valuation. Even though fixed asset values were satisfactorily determined by index numbers, the more important problem of inventory valuation would still remain". *Ralph C. Jones*[1935; 172]

179. "For each account requiring adjustment the price index is of a homogeneous class of assets which includes those in the account. The use of a specific index for each account rather than a general index for all accounts follows from the use of current cost rather than purchasing power historical cost as the basis of valuation. The appropriateness of the index used for each account is, of course, limited by the knowledge of the assets included in the account, the index numbers available, and by the criterion of objectivity .... This [specific index number adjusted] quantity differs from market value in that (1) historical deferred cost is arrived at by means of arbitrary, generally straight-line, depreciation charges; (2) an index of the cost of new assets is used to adjust used assets; and (3) the impact of technological change on a firm's assets may differ radically from the recognition of technological change in an index number designed to cover a broader group of assets". *Myron J. Gordon*[1953; 375]

180. This alternative will probably be too expensive.

181. We have noted earlier that standard historical cost accounting procedures do not lead to reproducible estimates of depreciation.

182. "These factors may account for the present status of the index number accounting practice in Europe. It had its start in seemingly fertile soil, because the monetary system in Europe at that time was completely broken down, but the index number methodology has failed to develop and bear fruit. It seems reasonable to conclude that, since the index methodology has become dated, it failed to meet the fundamental and lasting needs of business. If it had met a fundamental need it would surely not have disappeared from business usage". *Donald K. Griffith*[1937; 131]

183. "There were, therefore, three stages in the development of fixed asset accounting, the first involving actual realization, followed by the second involving fictitious realization by valuation, and third a recovery of original cost based upon a preliminary estimate of the length of the asset's life. Unlike the first two, the third is not influenced by varying market prices and attempts merely to distribute the cost of the asset over the years which benefit from its use". *Stephen Gilman*[1939; 87]

184. New asset purchases made during the accounting period could be included in current period costs (in which case, these new asset purchases would be included in the end of the period value of all assets) or the new asset purchases could be segregated and added to next period's starting value of assets held.

185. Pigou [1924; 34-35] interpreted Marshall's business income or earnings concept as follows:

> "For the dividend may be conceived in two sharply contrasted ways as the flow of goods and services which is *produced* during the year, or as the flow which is *consumed* during the year. Dr. Marshall adopts the former of these alternatives .... Naturally, since in every year plant and equipment wear out and decay, what is produced must mean what is produced on the whole when allowance has been made for this process of attrition .... In concrete terms, his conception of the dividend includes an inventory of all the new things that are made, accompanied, as a negative element, by an inventory of all the decay and demolition of old things".

186. "If the excess of assets over liabilities at the end of the period was greater than at the beginning, all of the excess represented profit capital. This method provided for the maintenance of asset capital as a quantum, a measure of wealth. This idea of profit was conceptually associated with the final liquidation of a company. There was not full agreement as to the proper value to put upon the assets at each balance sheet date. One leading accountant thought the single account system would require the valuing of all assets according to the market value of the capital shares; others advocated the use of the current market value of the assets themselves; and still others supported cost less actual deterioration to date as the proper value". *D.A. Litherland*[1951; 476]

187. Many economists and accountants wish to exclude holding gains or capital gains on assets held through the accounting period from their income concept; recall our discussion of this issue in section 5.4 above.

188. "Moreover, all stakeholders in the firm must be interested in such key measures as profitability (however measured) and solvency, because the interests of all are affected by the entity's ability to survive".

Kenneth W. Lemke[1982; 303]

189. "Profit-and-loss statements should be designed to exhibit, in proper classification, *all* profits and losses incurred during a given period whether capital or

current, realized or unrealized. In no other way can stockholders and creditors be placed on an equal footing with informed insiders, and be given a truthful basis of present fact upon which they can base their own estimates of the future". *Kenneth MacNeal*[1939; reprinted 1962; 69]

190. The accountant MacNeal made similar observations:

"During this [early] era accounting practices were fairly well suited to the conditions then existing. The owner was not deceived because he knew his business intimately. The banker and trade creditors disregarded all balance-sheet values except those for current assets, and rested secure in the knowledge that these assets were worth at least as much as represented and perhaps a great deal more. The man who lent the owner money and took a mortgage on the fixed assets disregarded the accountant's valuations altogether and made his own appraisals. The small stockholder or bondholder who might place confidence in the entire balance-sheet and profit-and-loss statement did not exist. Each party looked after his own interest in his own way, and the system worked, after a fashion". *Kenneth MacNeal*[1939; reprinted 1962; 64]

"Accountants now have an obligation to three parties–the small security holder, the management and the creditor; but they still continue to certify financial statements prepared in accordance with practices suited only to conditions existing before the advent of the small security holder".

Kenneth MacNeal[1939; reprinted 1962; 65]

191. Recall our discussion of the three basic forms of productive activity in section 5.4 above. The profits resulting from transformation and transportation productive activities are embedded in $p^0 \cdot y^0$ while the gross profits (before interest payments) from asset holding activities less depreciation are embedded in $A^1 - A^0$ if $A^1 - A^0$ is positive.

192. "The first reason is that cost, if properly stated in the first instance, records fact rather than conjecture. It is ordinarily easier and much less expensive to maintain plant records based on cost than on other valuations".

M.B. Daniels[1933; 311]

"The accountant had several reasons for disliking and misunderstanding the case for reform. The very ease with which historical costs can be gathered in a ledger gave him something of a vested interest in such figures so that he might well find it hard to admit their limitations. Again, he probably was confused by the intermixing of general with special price change; this clouds the problem by

raising questions of whether inflation charges are costs or appropriations".

William T. Baxter[1975; 62]

193. "Countless instances have occurred in which a company's land, its plant, or its security holdings have increased in value to a tremendous extent over many years, while this fact has been concealed from stockholders because the assets have been exhibited in the company's balance sheet only at their historical cost, in accordance with accepted accounting principles. As a result, insiders cognizant of the facts misrepresented upon the balance sheet have been enabled to accumulate the company's stock up to the date when such assets were sold, and an enormous dividend declared. This state of affairs constitutes a vicious, although perfectly legal, defrauding of stockholders, and is exactly the sort of thing that certified public accountants are theoretically supposed to prevent".

Kenneth MacNeal[1939; reprinted 1962; 66]

"Each of us knows of the numerous aberations in our financial reporting which are created by and condoned in the name of the realization concept. A few examples, not necessarily related to mere price level changes, are: ... the innumerable situations in which publicly owned shares are traded appreciably below the net realizable values of the underlying properties owned by the entity, only because the shareholders did not know of such underlying values (nor could they find out from the financial statements prepared on a basis consistent with generally accepted accounting principles". *Abraham J. Brilloff*[1961; 604]

"There can be little doubt that many, to their sorrow, have failed to understand the conventional limitations of accounting. Losses have been suffered by investors who believed that asset valuations appearing on balance sheets were realizable amounts". *Stephen Gilman*[1939; 3]

"The same belief and fear which lie beneath the reiteration of the importance of objectivity have been responsible for the abandonment of the idea that balance sheets represent values. Although he admits that many users of accounting statements are interested in asset values, Professor Littleton thinks that these people may be dismissed; they are simply misinformed".

R.J. Chambers[1956; 588]

"The conventional balance sheet is no more useful than last year's news with this year's dates superimposed". *R.J. Chambers*[1964; 271]

"The mixed nature of amounts appearing in conventional revenue accounts and balance sheets makes it very difficult shortly to frame a hypothesis, other

than that they are the summaries resulting from applying certain operations to certain abstractions. It seems to be preferable to formulate a hypothesis which takes account of observable realities such as, for example, (a) the fact that many users of financial statements believe that income is a disposable surplus and that balance sheet figures represent values; (b) the fact that the relationship between income and the present value of the resources employed to earn it is an important test of accomplishment". *R.J. Chambers*[1956; 589-590]

194. We shall show this in section 7.6 below. In the realized case, we can compare I^0_{HCR} defined by (62) with the corresponding economic income $I^0_E \equiv p^0 \cdot y^0 - w^0_e k^0$ where w^e_0 is the economic user cost defined by (9). Algebra shows that $I^0_{HCR} = I^0_E + r^0_e(1-f^0)P^0k^0 > I^0_E$ if r^0_e and $1 - f^0 > 0$.

195. "Then why not recognize appreciation also, as it accrues, instead of waiting until a sale is made .... If this appreciation were not recognized in 1914 the item of appreciation would become revenue in 1915; and net revenue would not be correctly stated in either period". *William A. Paton*[1918; 43]

"The insistence of accountants upon the importance of differentiating between realized and unrealized income has probably proved a wise one. But the artificial showing that it causes should be clearly understood. For, as a consequence, a period may be credited with income that it did not earn, and be charged with a loss that it did not suffer". *Henry W. Sweeney*[1933; 334]

"Some limitations of accounting profit as a managerial tool can now be briefly indicated .... Capital gains are counted only when realized. This means that some of the events of past periods, notably price changes and the gains and losses associated with them, are treated as though they were events of the current period. If an asset has been held for five years and then sold, all of the gains and losses arising over the five year period are credited to the year of sale". *Edgar O. Edwards and Philip W. Bell*[1961; 116]

196. "First, the last-in-first-out method of inventory valuation has been well established and accepted by the profession. It is an improvement in the measurement of economic income but at the price of leaving an unrealistic inventory figure for balance sheet purposes. The merchandise inventory at the end of any fiscal period may be stated at costs that are outdated by years .... Thus LIFO does not seem to be the correct method. The balance sheet and income statement are complementary. Anything that improves one should naturally and logically improve the other". *G. Fred Weber*[1960; 642]

197. "Virtually all economists view interest on capital, proprietary as well as borrowed, as an effective cost of production". *William A. Paton*[1931; 94]

"If the machine is bought with the help of a loan, then the interest is part of the whole cost; and a similar adjustment for cost of capital should be made even where the machine is not financed by a loan". *William T. Baxter*[1971; 100]

"In accounting, interest refers only to the cost of using *debt* capital; accountants do not record a change for the use of equity capital .... Here I wish to argue that accounting should adopt the economics concept of interest–that is, regular accounting procedures should take cognizance of the cost of using equity capital". *Robert N. Anthony*[1973; 88]

198. See Tweedie and Whittingon [1984].

199. Sweeney [1936; reissued 1964; 42] referred to this method of income accounting as general purchasing power accounting or stabilized accounting. Sweeney had another version of stabilized accounting (which will be studied in section 7.5 below) which he called stabilization based on replacement cost.

200. Knowledge of this income concept diffused remarkably rapidly; recall our earlier quotation by the economist Haig [1921; reprinted 1959; 67-68] in section 7.0 above. See Sweeney [1964; 38-39] for additional early references to the use of this income concept, including the third edition of Schmalenbach [1959] (which was published in 1925).

201. Alternatively we can interpret the debt interest rate r_d^0 as the inflation factor for debt; i.e., instead of subtracting $r_d^0 f^0 P^0 k^0$ directly from $p^0 \cdot y^0$, we could subtract this term indirectly by defining the end of period 0 value of debt to include interest payments so that the end of period 0 interest inclusive value of debt could be defined as $(1+r_d^0) f^0 P^0 k^0$, which in turn would be subtracted from the gross end of period 0 value of assets to obtain the corresponding net value.

202. Thus the difference between the two user costs should be approximately invariant to (anticipated) inflation that occurs over period 0. This follows from Fisher's [1896; 69] observation that nominal rates of interest are approximately equal to real rates of interest plus the rate of inflation.

203. The restriction to 3 periods is made only to simplify notational complexity; the same proof works for an arbitrary number of periods.

204. There is at least one significant qualification to this statement. Firms that have substantial holdings of nondepreciable assets (such as land) may not benefit from a switch

to CPP accounting under conditions of general inflation. However, if such a firm were ever sold, its income tax liability would be reduced by a switch to CPP accounting.

205. G. Edwardd Philips [1963; 704] made the same point:

> "Usual arguments against making price level adjustments in financial statements include: (a) difficulties of defining and measuring the 'price level' and of measuring asset values give any calculations too great a margin of error relative to the amount of the adjustments unless price level changes are extreme, (b) the cost of making the adjustments exceeds their significance, and (c) if, as is probably inevitable, adjustments are made by some firms and not others, the loss in comparability will outweight the improvement in the adjusted figures".

206. The accountant Schmidt made observations similar to those of May:

> "The question, whether appreciation ... is a profit, is not merely the concern of bookkeepers .... Wage policies are also affected, and, of course, the computation of income taxes". *Fritz Schmidt*[1931; 289]

207.

208. See Tweedie and Whittington [1984; 7] or Whittington [1992; 400].

209. Recall the quotation by Alexander [1962; 188] at the end of section 7.2 above.

210. The accountant Schmidt clearly distinguished between the maintenance of physical (or real) capital and maintenance of financial (or abstract) capital concepts of in come:

> "It is important to a definition of profit to have a definite capital concept, or property concept. The capital or assets of an enterprise can be: 1. The stock of real property including money and money due, or 2. The *value* of all real property expressed in abstract money units. We call the first the real, capital of the enterprise, the second the abstract capital". *Fritz Schmidt*[1930; 235]

211.

REFERENCES

Afriat, S.N. [1972], "Efficiency Estimation of Production Functions", *International Economic Review* 13, 568-598.

Alexander, S.S. [1950], "Income Measurement in a Dynamic Economy", pp. 1-95 in *Five Monographs on Business Income*, Study Group on Business Income, New York: The Macmillan Company; a revised version was published as pp. 126-200 in *Studies in Accounting Theory*, W.T. Baxter and S. Davidson (eds.), London: Sweet and Maxwell, 1962.

Allais, M. [1947], *Economie et Intérêt*, Paris: Imprimerie Nationale.

Allen, R.C. [1983], "Collective Invention", *Journal of Economic Behavior and Organization* 4, 1-24.

Anthony, R.N. [1973], "Accounting for the Cost of Equity", *Harvard Business Review* 51, 88-102.

Arrow, K.J. [1962], "The Economic Implications of Learning by Doing", *The Review of Economic Studies* 29, 155-173.

Arrow, K.J. [1969], "Classificatory Notes on the Production and Transmission of Technological Knowledge", *American Economic Review* 59 (May), 29-35.

Baumol, W.J. [1952], "The Transactions Demand For Cash: An Inventory Theoretic Approach", *Quarterly Journal of Economics* 66, 545-556.

Baxter, W.T. [1971], *Depreciation*, London: Sweet and Maxwell.

Baxter, W.T. [1975], *Accounting Values and Inflation*, London: McGraw-Hill.

Bedford, N.M. and J.C. McKeown [1972], "Comparative Analysis of Net Realizable Value and Replacement Costing", *The Accounting Review* 47, 333-338.

Beidleman, C. [1973], *Valuation of Used Capital Assets*, Sarasota, Florida: American Accounting Association.

Beidleman, C.R. [1976], "Economic Depreciation in a Capital Goods Industry", *National Tax Journal* 29, 379-390.

Bell, A.L. [1953], "Fixed Assets and Current Costs", *The Accounting Review* 28, 44-53.

Benninga, S. and A. Protopapadakis [1992], "Equity Premium," pp. 768-771 in *The New Palgrave Dictionary of Money and Finance*, Vol. 1, P. Newman, M. Milgate and J. Eatwell (eds.), London: The Macmillan Press.

Berkow, W.F. [1964], "Need for Engineering Influence Upon Accounting Procedure", *The Accounting Review* 39, 377-386.

Bierman, H. [1963], "Measurement and Accounting", *The Accounting Review* 38, 501-507.

Boer, G. [1966], "Replacement Cost: A Historical Look", *The Accounting Review* 41, 92-97.

Böhm-Bawerk, E.V. [1891], *The Positive Theory of Capital*, translated by W. Smart, New York: G.E. Stechert (originally published in German in 1888).

Burnside, C. and T.H. McCurdy [1992], "Equity Premium Puzzle," pp. 771-773 in *The New Palgrave Dictionary of Money and Finance*, Vol. 1, P. Newman, M. Milgate and J. Eatwell (eds.), London: The Macmillan Press.

Canning, J.B. [1929], *The Economics of Accountancy*, New York: The Ronald Press Company.

Carsberg, B. [1982], "The Case for Financial Capital Maintenance", pp. 59-74 in *Maintenance of Capital: Financial versus Physical*, R.R. Sterling and K.W. Lemke (eds.), Houston: Scholars Book Co.

Chambers, R.J. [1956], "Some Observations on 'Structure of Accounting Theory", *The Accounting Review* 31, 584-592.

Chambers, R.J. [1964], "Measurement and Objectivity in Accounting", *The Accounting Review* 39, 264-274.

Chang, E.C. [1962], "Business Income in Accounting and Economics", *The Accounting Review* 37, 636-644.

Charnes, A. and W.W. Cooper [1985], "Preface to Topics in Data Envelopment Analysis", *Annals of Operations Research* 2, 59-94.

Christensen, L.R. and D.W. Jorgenson [1969], "The Measurement of U.S. Real Capital Input, 1929-1967," *Review of Income and Wealth* 15, 293-320.

Christensen, L.R., P.E. Schoech and M.E. Meitzen [1995], "Total Factor Productivity Methods For Local Exchange Carrier Price Cap Plans," December 18, 1995, Madison, Wisconsin: Christensen Associates.

Clark, C. [1940], *The Conditions of Economic Progress*, London: The Macmillan Press.

Crandell, W.T. [1935], "Income and its Measurement", *The Accounting Review* 10, 380-400.

Daines, H.C. [1929], "The Changing Objectives of Accounting", *The Accounting Review* 4, 94-110.

Daniels, M.B. [1933], "The Valuation of Fixed Assets", *The Accounting Review* 8, 302-316.

Davidson, S., C. P. Stickney and R.L. Weil [1976], *Inflation Accounting*, New York: McGraw-Hill Book Company.

Debreu, G. [1959], *Theory of Value*, New York: John Wiley and Sons.

Diewert, W.E. [1973], "Functional Forms for Profit and Transformation Functions", *Journal of Economic Theory* 6,284-316.

Diewert, W.E. [1974], "Intertemporal Consumer Theory and the Demand for Durables", *Econometrica* 42, 497-516.

Diewert, W.E. [1976], "Exact and Superlative Index Numbers", *Journal of Econometrics* 4, 115-145.

Diewert, W.E. [1977], "Walras' Theory of Capital Formation and the Existence of a Temporary Equilibrium", pp. 73-126 in *Equilibrium and Disequilibrium in Economic Theory*, G. Schwödiauer (ed.), Dordrecht: D. Reidel Publishing Co.

Diewert, W.E. [1980a], "Capital and the Theory of Productivity Measurement", *The American Economic Review* 70, 260-267.

Diewert, W.E. [1980b], "Aggregation Problems in the Measurement of Capital", pp. 433-528 in *The Measurement of Capital*, Dan Usher (ed.), Chicago: University of Chicago Press.

Diewert, W.E. [1983a], "The Theory of the Cost-of-Living Index and the Measurement of Welfare Change", pp. 163-233 in *Price Level Measurement*, W.E. Diewert and C. Montmarquette (eds.), Ottawa: Statistics Canada.

Diewert, W.E. [1983b], "The Theory of the Output Price Index and the Measurement of Real Output Change", pp. 1049-1113 in *Price Level Measurement*, Ottawa: Statistics Canada.

Diewert, W.E. [1985], "A Dynamic Approach to the Measurement of Waste in an Open Economy", *Journal of International Economics* 19, 213-240.

Diewert, W.E. [1992a], "The Measurement of Productivity", *Bulletin of Economic Research* 44, 163-198.

Diewert, W.E. [1992b], "Fisher Ideal Output, Input and Productivity Indexes Revisited", *The Journal of Productivity Analysis* 3, 211-248.

Diewert, W.E. [1993b], "Duality Approaches to Microeconomic Theory", pp. 105-175 in *Essays in Index Number Theory*, Vol. 1, W.E. Diewert and A.O. Nakamura (eds.), Amsterdam: North-Holland.

Diewert, W.E. [1996], "Seasonal Commodities, High Inflation and Index Number Theory", pp. 71-147 in *International Conference on Price Indices: Proceedings*, J. Dalèn (ed.), Stockholm: Statistics Sweden.

Diewert, W.E. and T.R. Lewis [1982], "The Comparative Dynamics of Efficient Programs of Capital Accumulation and Resource Depletion", pp. 301-325 in *Economic Theory of Natural Resources*, W. Eichhorn, R. Henn, K. Neumann and R.W. Shephard (eds.), Vienna: Physica-Verlag.

Diewert, W.E. and C. Parkan [1983], "Linear Programming Tests of Regularity Conditions for Production Functions", pp. 131-158 in *Quantitative Studies on Production and Prices*, W. Eichhorn, R. Henn, K. Neumann and R.W. Shephard (eds.), Vienna: Physica Verlag.

Diewert, W.E. and A.M. Smith [1994], "Productivity Measurement for a Distribution Firm", *The Journal of Productivity Analysis* 5, 335-347.

Doms, M.E. [1996], "Estimating Capital Efficiency Schedules within Production Functions", *Economic Inquiry* 34, 78-92.

Edgeworth, F.Y. [1888a], "Some New Methods of Measuring Variation in General Prices", *Journal of the Royal Statistical Society* 51, 346-368.

Edgeworth, F.Y. [1888b], "The Mathematical Theory of Banking", *Journal of the Royal Statistical Society* 51, 113-127.

Edwards, E.O. [1975], "The State of Current Value Accounting", *The Accounting Review* 50, 235-245.

Edwards, E.O. and P.W. Bell [1961], *The Theory and Measurement of Business Income*, Berkeley, CA: University of California Press.

Epstein, L.G. and M. Denny [1980], "Endogenous Capital Utilization in a Short Run Production Model: Theory and Empirical Application", *Journal of Econometrics* 12, 189-207.

Epstein, L.G. and S.E. Zinn [1990], " 'First Order' Risk Aversion and the Equity Premium Puzzle," *Journal of Monetary Economics* 26, 387-407.

Farrell, M.J. [1957], "The Measurement of Production Efficiency", *Journal of the Royal Statistical Society, Series A*, 120, 253-278.

Fetter, F.A. [1937], "Reformulation of the Concepts of Capital Income in Economics and Accounting", *The Accounting Review* 12, 3-12.

Fisher, I. [1896], *Appreciation and Interest*, New York: Macmillan.

Fisher, I. [1897], "The Role of Capital in Economic Theory", *Economic Journal* 7, 511-537.

Fisher, I. [1924], "Comment on President Plehn's Address", *The American Economic Review* 14, 64-67.

Fisher, I. [1930], *The Theory of Interest*, New York: The Macmillan Co.

Gilman, S. [1939], *Accounting Concepts of Profit*, New York: The Ronald Press Company.

Goldberg, L. [1955], "Concepts of Depreciation", *The Accounting Review* 30, 468-484.

Gordon, M.J. [1953], "The Valuation of Accounts at Current Cost", *The Accounting Review* 28, 373-384.

Gordon, M.J. [1960], "Scope and Method of Theory and Research in the Measurement of Income and Wealth", *The Accounting Review* 35, 603-618.

Gordon, M.J. and E. Shapiro [1956], "Capital Equipment Analysis: The Required Rate of Profit," *Management Science* 3, 102-110.

Griffith, D.K. [1937], "Weaknesses of Index Number Accounting", *The Accounting Review* 12, 123-132.

Griliches, Z. [1963], "Capital Stock in Investment Functions: Some Problems of Concept and Measurement", pp. 115-137 in *Measurement in Economics*, Carl Christ et. al (eds.), Stanford, CA: Stanford University Press.

Hadley, G. and T.M. Whitin [1963], *Analysis of Inventory Systems*, Englewood Cliffs, N.J.: Prentice-Hall.

Haig, R.M. [1959], "The Concept of Income–Economic and Legal Aspects", pp. 54-76 in *Readings in the Economics of Taxation*, R.A. Musgrave and C.S. Shoup (eds.), Homewood, Illinois: Richard D. Irwin (originally published in 1921).

Hall, R.E. [1971], "The Measurement of Quality Change from Vintage Price Data", pp. 240-271 in *Price Indexes and Quality Change*, Z. Griliches (ed.), Cambridge, MA: Harvard University Press.

Hall, R.E. and D. W. Jorgenson [1967], "Tax Policy and Investment Behavior", *American Economic Review* 57, 391-414.

Harris, F.W. [1915], *Operations and Cost*, Chicago: A.W. Shaw Company.

Hayes, H.V. [1913], "Original Cost versus Replacement Cost as a Basis for Rate Regulation", *Quarterly Journal of Economics* 27, 616-629.

Hicks, J.R. [1940], "The Valuation of the Social Income", *Economica* 7, 105-120.

Hicks, J.R. [1942], "Maintaining Capital Intact: a Further Suggestion", *Economica* 9, 174-179.

Hicks, J.R. [1946], *Value and Capital*, Second Edition, Oxford: Clarendon Press, first edition, 1939.

Hicks, J.R. [1961], "The Measurement of Capital in Relation to the Measurement of Other Economic Aggregates", pp. 18-31 in *The Theory of Capital*, F.A. Lutz and D.C. Hague (eds.), London: Macmillan.

Hicks, J. [1965], *Capital and Growth*, London: Oxford University Press.

Hicks, J. [1973], *Capital and Time: A Neo-Austrian Theory*, Oxford: Claredon Press.

Hicks, J. [1973], *Capital and Time: A Neo-Austrian Theory*, London: Oxford University Press.

Holzer, H.P. and H.-M. Schönfeld [1963], "The French Approach to the Post-War Price Level Problem", *The Accounting Review* 38, 382-397.

Hotelling, H. [1925], "A General Mathematical Theory of Depreciation", *Journal of the American Statistical Association* 20, 340-353.

Hulten, C.R. and F.C. Wykoff [1981a], "The Estimation of Economic Depreciation using Vintage Asset Prices", *Journal of Econometrics* 15, 367-396.

Hulten, C.R. and F.C. Wykoff [1981b], "The Measurement of Economic Depreciation", pp. 81-125 in *Depreciation, Inflation and the Taxation of Income from Capital*, C.R. Hulten (ed.) Washington, DC: The Urban Institute Press.

Hulten, C.R. and F.C. Wykoff [1996], "Issues in the Measurement of Economic Depreciation: Introductory Remarks", *Economic Inquiry* 34, 10-23.

Ijiri, Y. [1979], "A Defense of Historical Cost Accounting", pp. 62-74 in *Readings in Inflation Accounting*, P.T. Wanless and D.A.R. Forrester (eds.), New York: John Wiley and Sons.

Jones, R.C. [1935], "Financial Statements and the Uncertain Dollar", *The Journal of Accountancy* 40, 171-197.

Jorgenson, D.W. [1963], "Capital Theory and Investment Behavior", *American Economic Review* 53, 247-259.

Jorgenson, D.W. [1996a], *Investment*, Volumes 1 and 2, Cambridge, MA: The MIT Press.

Jorgenson, D.W. [1996b], *Productivity*, Volumes 1 and 2, Cambridge, MA: The MIT Press.

Jorgenson, D.W. [1996c], "Empirical Studies of Depreciation", *Economic Inquiry* 34, 24-42.

Kaldor, N. [1972], " The Irrelevance of Equilibrium Economics", *The Economic Journal* 82, 1237-1255.

Krugman, P. [1991], *Geography and Trade*, Cambridge, MA: The MIT Press.

Lachmann, L.M. [1941], "On the Measurement of Capital", *Economica* 8, 361-377.

Latham, J.C. and others [1952], *Accounting for Inflation*, A Study by the Taxation and Research Committee of the Association of Certified and Corporate Accountants (U.K.), London: Gee and Company.

Lemke, K.W. [1982], "Financial versus Physical Capital Maintenance: A Review of the Arguments", pp. 287-323 in *Maintenance of Capital: Financial versus Physical*, R.R. Sterling and K.W. Lemke (eds.), Houston: Scholars Book Company.

Leontief, W. [1936], "Composite Commodities and the Problem of Index Numbers", *Econometrica* 4, 39-59.

Leontief, W. [1941], *The Structure of the American Economy 1919-1929*, Cambridge: Harvard University Press.

Lerner, A.P. [1946], *The Economics of Control*, New York: The Macmillan Company.

Lintner, J. [1965], "Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics* 47, 13-37.

Litherland, D.A. [1951]," Fixed Asset Replacement a Half Century Ago", *The Accounting Review* 26, 475-480.

Littleton, A.C. [1933], "Socialized Accounts", *The Accounting Review* 8, 267-271.

Livingstone, J.L. and R.L. Weil [1982], "Accounting for Changing Prices in the U.S.: An Explication and Evaluation of SFAS No. 33", pp. 225-257 in *Maintenance of Capital: Financial versus Physical*, R.R. Sterling and K.W. Lemke (eds.), Houston: Scholars Book Company.

Lutz, F. and V. Lutz [1951], *The Theory of Investment of the Firm*, Princeton, N.J.: Princeton University Press.

Machina, M.J. [1992], "Expected Utility Hypothesis," pp. 856-862 in *The New Palgrave Dictionary of Money and Finance*, Vol. 2, P. Newman, M. Milgate and J. Eatwell (eds.), London: The Macmillan Press.

MacNeal, K. [1962], "What's Wrong with Accounting?", pp. 56-69 in *Studies in Accounting Theory*, W.T. Baxter and S. Davidson (eds.), London: Sweet and Maxwell Ltd. (originally published in 1939).

Malinvaud, E. [1953], "Capital Accumulation and the Efficient Allocation of Resources", *Econometrica* 21, 233-268.

Marshall, A. [1920], *Principles of Economics*, Eighth Edition (first edition 1890), London: The Macmillan Co.

Mason, P. [1933], "Illustrations of the Early Treatment of Depreciation", *The Accounting Review* 8, 209-218.

Mason, P. [1955], "The Price Level Study of the American Accounting Association", *The Accounting Review* 30, 37-44.

Matheson, E. [1884], *Depreciation of Factories, Mines and Industrial Undertakings and their Valuations*, London, Spon.

May, G.O. and others [1952], *Changing Concepts of Business Income*, Report of Study Group on Business Income, American Institute of Accountants, New York: The Macmillan Company.

Maynard, G.P. [1952], "Business Income and National Income: A Contrast of Concepts", *The Accounting Review* 27, 189-194.

Mellen [1925]

Mehra, R. and E.C. Prescott [1985], "The Equity Premium: A Puzzle," *Journal of Monetary Economics* 15, 145-161.

Middleditch, L. [1918], "Should Accounts Reflect the Changing Value of the Dollar?", *The Journal of Accountancy* 25, 114-120.

Moonitz, M. [1970], "Price Level Accounting and Scales of Measurement", *The Accounting Review* 45, 465-475.

Mossin, J. [1966], "Equilibrium in a Capital Asset Market," *Econometrica* 34, 768-783.

Morgenstern, O. [1963], *On the Accuracy of Economic Observations*, Second Edition, Princeton, N.J.: Princeton University Press.

Moulin, H. [1995], "On Additive Methods to Share Joint Costs", *The Japanese Economic Review* 46, 303-332.

Myers, S.C. [1992], "Cost of Capital," pp. 486-489 in *The New Palgrave Dictionary of Money and Finance*, Vol. 2, P. Newman, M. Milgate and J. Eatwell (eds.), London: The Macmillan Press.

Nadiri, M.I. and I.R. Prucha [1996], "Estimation of the Depreciation Rate of Physical and R and D Capital in the U.S. Total Manufacturing Sector", *Economic Inquiry* 34, 43-56.

Nagorniak, J.J. [1972], "The Application of the Capital Asset Pricing Model to Debt and Equity Markets," pp. 344-366 in *Mathematical Methods in Investment and Finance*, G.P. Szegö and K. Shell (eds.), Amsterdam: North-Holland Publishing Co.

Nakamura, A.O. and P. Lawrence [1994], "Education, Training and Prosperity", *John Deutsch Institute for the Study of Economic Policy* (March), 235-279.

Nordhaus, W.D. [1969], "Theory of Innovations: An Economic Theory of Technological Change", *American Economic Review* 59 (May), 18-28.

Oliner, S.D. [1996], "New Evidence on the Retirement and Depreciation of Machine Tools", *Economic Inquiry* 34, 57-77.

Pakes, A. and Z. Griliches [1984], "Estimating Distributed Lags in Short Panels with an Application to the Specification of Depreciation Patterns and Capital Stock Constructs", *Review of Economic Studies* 51, 243-262.

Parker, J.E. [1975], "Testing Comparability and Objectivity of Exit Value Accounting", *The Accounting Review* 50, 512-524.

Paton, W.A. [1918], "The Significance and Treatment of Appreciation in the Accounts", pp. 35-49 in *Twentieth Annual Report of the Michigan Academy of Science*, G.H. Coons (ed.) Ann Arbor: Michigan Academy of Science. Reprinted in *Asset Appreciation, Business Income and Price-Level Accounting: 1918-1935*, S.A. Zeff (ed.), New York: Arno Press.

Paton, W.A. [1920], "Depreciation, Appreciation and Productive Capacity", *The Journal of Accountancy* 30, 1-11.

Paton, W.A. [1922], *Accounting Theory*, New York: The Ronald Press Company.

Paton, W.A. [1931], "Economic Theory in Relation to Accounting Valuations", *The Accounting Review* 6, 89-96.

Pigou, A.C. [1924], *The Economics of Welfare*, Second Edition, London: Macmillan and Company.

Pigou, A.C. [1935], "Net Income and Capital Depletion", *The Economic Journal* 45, 235-241.

Pigou, A.C. [1941], "Maintaining Capital Intact", *Economica* 8, 271-280.

Plehn, C.C. [1924], "The Concept of Income, as Recurrent, Consumable Receipts", *The American Economic Review* 14, 1-12.

Preinreich, G.A.D. [1938], "Annual Survey of Economic Theory: The Theory of Depreciation", *Econometrica* 6, 219-241.

Romer, P. [1994], "New Goods, Old Theory and the Welfare Costs of Trade Restrictions", *Journal of Development Economics* 43, 5-38.

Saliers, E.A. [1922], *Depreciation: Principles and Applications*, New York: The Ronald Press Co.

Schmalenbach, E. [1959], *Dynamic Accounting*, G.W. Murphy and K.S. Most (translators), London: Gee and Co. (originally published in Germany under the title *Dynamische Bilanz*, first edition 1919).

Schmidt, F. [1930], "The Importance of Replacement Value", *The Accounting Review* 5, 235-242.

Schmidt, F. [1931], "Is Appreciation Profit?", *The Accounting Review* 6, 289-293.

Seligman, E.R.A. [1932], "Income Tax", pp. 626-639 in *Encyclopedia of the Social Sciences*, Volume 7, E.R.A. Seligman (editor-in-chief), New York: The Macmillan Company.

Sharpe, W.F. [1964], "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," *Journal of Finance* 19, 429-442.

Smith, A. [1963], *The Wealth of Nations*, Volume 1 (first published in 1776), Homewood, Illinois: Richard D. Irwin.

Solomons, D. [1961], "Economic and Accounting Concepts of Income", *The Accounting Review* 36, 374-383.

Staubus, G.J. [1961], *A Theory of Accounting to Investors*, Berkeley: University of California Press.

Staubus, G.J. [1975], "Price Level Accounting: Some Unfinished Business", *Accounting and Business Research* 6 (Winter), 42-47. Reprinted as pp. 118-130 in *Readings in Inflation Accounting*, P.T. Wanless and D.A.R. Forrester (eds.), New York: John Wiley and Sons, 1979.

Sterling, R.R. [1970], *The Theory of the Measurement of Enterprise Income*, Lawrence: The University Press of Kansas.

Sterling, R.R. [1982], "Limitations of Physical Capital", pp. 3-58 in *Maintenance of Capital: Financial versus Physical*, R.R. Sterling and K.W. Lemke (eds.), Houston: Scholars Book Company.

Stone, R. [1956], *Quantity and Price Indexes in National Accounts*, Paris: The Organization for European Cooperation.

Sweeney, H.W. [1927], "Effects of Inflation on German Accounting", *Journal of Accountancy* 43, 180-191.

Sweeney, H.W. [1928], "German Inflation Accounting", *Journal of Accountancy* 45, 104-116.

Sweeney, H.W. [1931], "Stablized Depreciation", *The Accounting Review* 6, 165-178.

Sweeney, H.W. [1933], "Income", *The Accounting Review* 8, 323-335.

Sweeney, H.W. [1934], "Approximations of Appraisal Values by Index Numbers", *Harvard Business Review* 13, 108-115.

Sweeney, H.W. [1935], "The Technique of Stabilized Accounting", *The Accounting Review* 10, 185-205.

Sweeney, H.W. [1964], *Stabilized Accounting*, New York: Holt, Rinehart and Winston (reissue of the 1936 original with a new foreword).

Taylor, J.S. [1923], "A Statistical Theory of Depreciation Based on Unit Cost", *Journal of the American Statistical Association* 18, 1010-1023.

Tobin, J. [1956], "The Interest Elasticity of Transactions Demand for Cash", *The Review of Economics and Statistics* 38, 241-247.

Triplett, J.E. [1996], "Depreciation in Production Analysis and in Income and Wealth Accounts: Resolution of an Old Debate", *Economic Inquiry* 34, 93-115.

Tweedie, D. and G. Whittington [1984], *The Debate on Inflation Accounting*, London: Cambridge University Press.

United Nations [1993], *System of National Accounts 1993*, New York: United Nations.

Varian, H.R. [1984], "The Nonparametric Approach to Production Analysis", *Econometrica* 52, 579-597.

Vatter, W.J. [1947], The Fund Theory of Accounting and Its Implications for Financial Reports, Chicago: University of Chicago Press.

Von Neumann, J. [1937], "Über ein ökonomisches Gleichungssystem und eine Verallgemeinerung des Brouwerschen Fixpunktsatzes", *Ergebnisse eines Mathematische Kolloquiums* 8, 73-83; translated as "A Model of General Economic Equilibrium", *Review of Economic Studies* [1945-6] 12, 1-9.

Walras, L. [1954], *Elements of Pure Economics* [first edition published in 1874], W. Jaffé (translator), Homewood, Illinois: Richard D. Irwin.

Wasserman, M.J. [1931], "Accounting Practice in France During the Period of Monetary Inflation", *The Accounting Review* 6, 1-32.

Weber, G.F. [1960], "Price Level Accounting", *The Accounting Review* 35, 641-649.

Whitin, T.M. [1952], "Inventory Control in Theory and Practice", *Quarterly Journal of Economics* 66, 502-521.

Whitin, T.M. [1957], *The Theory of Inventory Management*, Second edition, Princeton, N.J.: Princeton University Press.

Whittington, G. [1992], "Inflation Accounting", *The New Palgrave Dictionary of Money and Finance*, Volume 2, P. Newman, M. Milgate and J. Eatwell (eds.), London: Macmillan.

Williams, J.B. [1938], *The Theory of Investment Value*, Cambridge, MA: Harvard University Press.

Wilson, R. [1975], "Informational Economies of Scale", *The Bell Journal of Economics* 6:1, 184-195.

Woodward, P.D. [1956], "Depreciation-the Development of an Accounting Concept", *The Accounting Review* 31, 71-76.

Wright, F.K. [1964], "Towards a General Theory of Depreciation", *Journal of Accounting Research* 2, 80-90.

Young, A.A. [1928], "Increasing Returns and Economic Progress", *The Economic Journal* 38, 527-542.

Young, H.P. (ed.), [1985], *Cost Allocation: Methods Principles, Applications*, Amsterdam: North-Holland.

Young, H.P. [1994], "Cost Allocation", pp. 1193-1235 in *Handbook of Game Theory*, Volume 2, R.J. Aumann and S. Hart (eds.), Amsterdam: Elsevier.