

CURRENT COST ACCOUNTING: FALLACY OF THE LIGHT BULBS

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A significant amount of research is predicated on the assumption that current cost measurements of asset values are unbiased estimates of economic values. Current cost estimates, however, are determined by equivalencing current pretax cash flow whereas economic values are determined by discounting after-tax cash flows. This study explains that the traditional current cost model generates biased valuation estimates when discounted after-tax cash flows for new and used assets are disproportionate to current capacities. The traditional valuation model is extended to correct for the bias.

There are two generally accepted valuation procedures for estimating the value of capital stocks. The historical cost measurement (*HC*) is perhaps the most widely employed estimate of value since it is commonly used in preparation of business financial statements. *HC* is criticized, however, because it ignores the revaluation resulting from changing price levels. The current cost measurement (*CC*), on the other hand, is directly linked to the value of new capital goods, leading many researchers to presume that *CC* is an unbiased measure of economic value.¹ This presumption is explicated by Haw and Lustgarten (1988, p. 332):

If markets existed for all the firm's assets and the values of all assets were recorded, the value of the firm reported on the balance sheet under current cost accounting would equal the market value of the firm's securities, because both values would reflect the expected present value of the future cash flows to be generated by the firm's assets.

This study explains that the *CC* methodology is valid only when discounted after-tax cash flows from new and existing assets are equiproportional to current productive capacities. These conditions seldom exist, and *CC* measurements significantly diverge from economic values. The inaccuracy of the *CC* methodology is dramatically apparent in the

¹ The assertion that *CC* is an accurate measure of economic value also gives rise to the incorrect argument that Tobin's *Q*, the ratio of *CC* to market value, converges to unity. Studies showing that the steady state value for *Q* differs from unity include Summers (1981), Hayashi (1982), and Downs (1992).

valuation of light bulbs. A new light bulb and an old light bulb contribute identical amounts of *current* capital services; hence, according to the *CC* model, they have identical current costs. The economic values of the new and old light bulbs differ, though, because their *future* cash flow streams differ. In general, when the discounted value of future after-tax cash flows are disproportionate to current productive capacities, *CC* measurements are extremely biased.

This study shows that the valuation errors inherent with the current cost procedure can be corrected. An alternative model, referred to as the *FV* model, adjusts the valuation estimates to account for these biases.² The *FV* model is an extension of the *CC* model in the same way that *CC* is an extension of the *HC* model. In other words, just as *CC* reduces to *HC* (historical cost) when prices are constant, so does *FV* reduce to *CC* when discounted after-tax cash flows for new and used assets are equiproportional to current productive capacities.

The layout of the study is as follows. Section I specifies the valuation models and shows that the divergence between economic value and current cost occurs under the simplest conditions. Taxes are ignored initially because tax effects reinforce the divergence between economic value and current cost measurements.³ Section II examines comparative static relationships between current cost and economic value, explaining for example the impact on valuation measurements of a change in the real interest rate. Section III integrates tax effects into the model, and Section IV presents empirical evidence on the relation between financial market valuations and the estimates from the alternative valuation models. A brief summary closes the study.

I. The Association between Valuation Estimates and Economic Value

² Downs and Shriver (1992) introduce the *FV* model for specific assets (instead of net stocks). They compare the *FV* estimates for specific assets to used asset prices in the secondary capital goods markets and conclude that the *FV* model is more reliable than either the *HC* or *CC* model.

³ All the studies cited in footnote 1 find that due to differences in the tax treatment of income from new and existing assets, the current cost measurement diverges from economic value.

This section has three parts. In Part A the specification for the historical and current cost models are presented, followed by a conditional specification of economic value, denoted the *FV* estimate.⁴ Part B shows the relation between the valuation models, and Part C numerically illustrates valuation mechanics.

A. Specification of the Valuation Models

According to the historical cost model, an asset's value is equated to its acquisition cost less accumulated depreciation. This measurement, denoted HC_s , is computed for the accumulated net capital stock as

$$HC_s = \sum_{t=0}^{\infty} q_{s-t} I_{s-t} [1 - \sum_{j=0}^t d_j] . \quad (1)$$

The term $q_t I_t$ represents the gross historical capital expenditure in new capital assets made at time t . It is comprised of a price component, q_t , representing the acquisition cost of a unit of new asset and a real component, I_t , representing the number of units of productive capacity acquired. The d_j variable equals the proportional decline in capital's productive capacity occurring at the end of the j 'th year of use ($d_0 = 0$). Accumulated capacity depreciation for an asset concluding t 'th year of use equals $\sum_{j=0}^t d_j$. The series of weights d_j , for $j=0,1,\dots,L$ where L is the asset service life, is referred to as the capacity depreciation schedule.⁵

The historical cost measurement has been criticized because it ignores the revaluation resulting from changing price levels. An alternative measurement focuses on the cost of replacing existing assets with new ones of equivalent current productive capacity. This alternative is the current cost measurement, denoted CC_s . With the CC

⁴ The discussion on historical cost and current cost measurements has benefited due to the insights and assistance of Kenneth Rogers and Valerie Personick (formerly of the Bureau of Labor Statistics; Mr. Rogers is now at the Department of Commerce, Office of Business Economics), John Musgrave (Department of Commerce, Bureau of Economic Analysis), and Charles Hulten (University of Maryland, Economics Department).

⁵ The depreciation and capital stock definitions employed herein follow the standard notation as most recently stated by Kim and Moore (1988, p. 111): "We should distinguish between economic (physical) depreciation and economic (value) depreciation. The first refers to the loss in productive capacity of a physical asset, while the second refers to the asset's loss in monetary value." Herein, we follow the terminology of the Bureau of Labor Statistics (1979) and Bureau of Economic Analysis (1987) and refer to the first type as "capacity depreciation".

procedure, the time s - t capital expenditure is partitioned into its two components. The real component, $I_{s,t}$, is depreciated according to the exogenous capacity depreciation schedule. The historical cost component, $q_{s,t}$, is dropped and instead the remaining productive capacity is valued by reflating with the current price level of capital goods, q_s . More precisely,

$$\begin{aligned} CC_s &= q_s \{ \sum_{t=0}^{\infty} I_{s,t} [1 - \sum_{j=0}^t d_j] \}, \\ &= q_s K_s. \end{aligned} \quad (2)$$

K , the term in curly brackets, represents the quantity of real capital and constitutes the constant cost estimate for the net stock. Equation 2 implies that a particular net asset stock has the same current cost as any other net asset stock as long as the two have the same current productive capacities; i.e., future cash flows are irrelevant.

Economic value equals the discounted value of expected cash flows. Presenting a specification for economic value requires a complete modeling of the cash flow stream expected from the net capital stock. A general specification undoubtedly depends on expectations regarding capacity utilization, future product demand, relative price changes, technological change, etc. The generation of these expectations, as well as their assimilation into the implied asset valuations, perhaps proceeds in a stochastic, nonstationary process that depends upon animal spirits as much as rational expectations. Instead of divining these intractable phenomena, the specification for economic value presented below imposes restrictive equilibrium assumptions on the valuation and expectations processes. Consequently, the specification for economic value is conditional on the maintained assumptions. As will be shown below, however, the economic justification for the CC framework depends implicitly on these same assumptions.

The key assumption in the conditional specification for economic value is that the current price for the marginal investment in the capital goods market equals the discounted value of the ^(asset) expected real capital service stream. This zero net present value investment equilibrium is given by

$$q_s = \sum_{t=0}^{\infty} (1+r-\pi)^{-(t+1)} c_s [1 - \sum_{j=0}^t d_j] . \quad (3)$$

c_s is the *user cost of capital* and represents the real cash flow accruing to the marginal investment at the end of its first period of use. r is the discount rate and π is the rate of expected inflation. Assuming a constant marginal physical product of capital beyond time s , then⁶

$$c_s = q_s(r-\pi)/(1-D_s) . \quad (4)$$

D is computed from the capacity depreciation schedule as

$$D_s = \sum_{t=1}^{\infty} (1+r-\pi)^{-t} d_t . \quad (5)$$

For assets that retain original capacity perpetually D is zero and it approaches unity as capacity depreciation accelerates. Notice that with geometric capacity depreciation over an *infinite* service life at the rate δ , the proportional decline in productive capacity, d_t , is given by $\delta(1-\delta)^{t-1}$, D is given by $\delta/(r+\delta-\pi)$, and c equals $q(r+\delta-\pi)$, the user cost formulation introduced by Jorgenson (1963).

The real cash flow accruing from the aggregate net stock at the end of period $s+t$ equals $c_s K_{s,t}$. The term $K_{s,t}$ denotes the capital services contributed at time $s+t$ by assets in-place at time s ,

$$K_{s,t} = \sum_{u=t}^{\infty} I_{s+t-u} [1 - \sum_{j=0}^t d_j] . \quad (6)$$

$K_{s,0}$ is equivalent to K_s .

The discounted value of cash flows expected throughout the future from the capital stock in-place at time s , denoted FV_s , is

$$FV_s = \sum_{t=1}^{\infty} (1+r-\pi)^{-t} c_s K_{s,t} . \quad (7)$$

Equation 7 specifies economic value for the net capital stock.

B. Relation between the Valuation Models

⁶ These assumptions, which also are implicit with the CC procedure, may be relaxed without altering the qualitative thrust of the argument presented herein: CC is a biased measure of economic value and the bias is measurable. For example, the FV model could incorporate a non-constant discount rate or a nonlinear homogeneous production function. Thomas (1969, pp. 41-47) presents a detailed discussion of the role of assumptions in valuation models.

Of the three models presented in Part A, the *HC* model is the most primitive. The information reflected in *HC* estimates is a subset of information reflected in *CC* estimates; the *CC* model additionally incorporates information about changing price levels. With constant prices, of course, the *HC* and *CC* models are equivalent. The association between *CC* and *FV* is seen through further analysis of equation 7. Let $h_{s,t}$ denote the proportional decline at the end of period $s+t$ for real capital in-place at time s ($h_{s,0}=0$),

$$h_{s,t} = [K_{s,t-1} - K_{s,t}] / K_s. \quad (8)$$

The $h_{s,j}$ series defines the mortality distribution of the time s net capital stock. The series is determined exclusively by the interaction between the capital accumulation pattern and the capacity depreciation schedule. Substitution of equations 4, 6, and 8 into 7 yields, after simplification,

$$\begin{aligned} FV_s &= q_s K_s (1-H_s)/(1-D_s), \\ &= CC_s (1-H_s)/(1-D_s), \end{aligned} \quad (9)$$

H_s is constructed by depreciating the time s real capital stock into the future and discounting with the real rate the proportional decline in productive capacity occurring each period:

$$H_s = \sum_{t=0}^{\infty} (1+r-\pi)^{-t} h_{s,t}. \quad (10)$$

To the extent that *FV* constitutes a conditional specification for economic value, the ratio of economic value to current cost, FV/CC , is found by rearranging equation 9:

$$FV_s/CC_s = (1-H_s)/(1-D_s). \quad (11)$$

D depends solely on the capacity depreciation schedule of new assets and H depends on the mortality distribution of the aggregate net capital stock. The current cost measurement diverges from economic value when marginal investments and the aggregate net asset stock depreciate along different paths.

CC is a valid measure of economic value under only special conditions; those conditions include the assumptions used in deriving equation 11 (e.g., constant returns to scale) and also the assumption that capacity depreciation occurs along an infinite geometric

pattern.⁷ The *CC* measurement diverges from economic value as these special conditions cease to apply. Nonetheless, economic value still can be estimated within the *FV* specification. In other words, just as *CC* reduces to *HC* (historical cost) when prices are constant, so does *FV* reduce to *CC* when future productive capacities for new and used assets are equiproportional to current productive capacities. The *HC*, *CC*, and *FV* models are extensions from the same root; each is an extension of the former that incorporates into the valuation process a larger and more diverse information set.

The absence of a stable relationship between economic value and current cost is revealed dramatically for the case of one-hoss shay type assets such as light bulbs. The productive capacities of a new light bulb and an old one are identical. They each currently produce the same *quantity* of lumens, and their production of lumens is not altered by age until, of course, they burn out. They each contribute the identical *quantity* of capital services to production; they represent the same amount of *K*. Current cost is the cost of replacing existing assets with new ones while leaving productive capacity unchanged. Consequently, the current costs of new and old light bulbs are identical.⁸

The current cost measurement obviously overstates the old light bulb's economic value. The association between current cost and economic value developed in the preceding equations can be used to compute the magnitude of the overstatement for a capital stock comprised of light bulbs. For the light bulb's one-hoss shay capacity depreciation pattern, $d_j = 0$ for every j except $j = L$, in which case $d_L = 1$. Thus, D equals $(1 + r - \pi)^{-L}$. The determination of H depends on the capital accumulation history of the aggregate light bulb capital stock; H equals $(1 + r - \pi)^{-(L-a)}$ where a is the average age of existing light bulbs. As the average age of light bulbs in the aggregate stock approaches zero, i.e., they are all new, then H converges to $(1 + r - \pi)^{-L}$ and the ratio FV/CC is unity.

⁷ With infinite geometric capacity depreciation $d_t = \delta(1 - \delta)^{t-1}$, $H = D = \delta/(r + \delta - \pi)$, and $FV = CC$. Hulten and Wyckoff (1981) also point out that infinite geometric capacity depreciation is required to justify *CC* estimates as valid measures of economic values.

⁸ For one-hoss-shay assets the gross stock and net stock would be equal. Generally, however, the two measures differ. The *HC*, *CC*, and *FV* specifications developed herein pertain to net stocks.

Current cost exactly measures economic value when all light bulbs in the capital stock are new. Conversely, as the average age of existing light bulbs approaches L , i.e., they are almost ready to expire, then H converges to unity and FV/CC goes to zero. The percentage overstatement of economic value by current cost grows infinitely large when the stock is comprised exclusively of almost-expired light bulbs. The FV/CC ratio might equal any positive number. The relation between current cost and economic value is spurious.

C. An Illustration of the Valuation Mechanics

Insight about the valuation mechanics specified above is gleaned through a simplistic illustration. The illustration is summarized in Table 1. Suppose that real investments I_s , I_{s-1} , I_{s-2} , and I_{s-3} equal 100, 90, 80, and 70 units, respectively. Furthermore, say that the service life is 4 years and capacity depreciation proceeds along a straight-line pattern. The straight-line pattern is used by the Bureau of Economic Analysis (BEA 1987) in the construction of their capital stock estimates, and also by most corporations in the preparation of their financial statements. The capacity depreciation schedule is given by $d_t = 0.25$ for $t=1, \dots, 4$, and $d_t = 0$ otherwise. The only additional information needed for computing FV_s/CC_s for this hypothetical capital stock is the real rate of interest at time s , $r-\pi$. Suppose it is 4 percent.

Equation 11 shows that FV_s/CC_s may be deduced by computing D and H . D is computed by discounting with the real rate the capacity depreciation schedule as specified in equation 5; D equals 0.9075. H is computed by discounting the mortality distribution of the real capital stock. The time s real capital stock, K_s as specified in equation 2, equals 225 units of capital and the proportional decline in the real capital stock at the end of the first year of use, denoted $h_{s,1}$ in equation 8, is 38 percent.⁹ The proportional declines in real capital at the ends of the second, third, and fourth periods of use ($h_{s,2}$, $h_{s,3}$, and $h_{s,4}$),

⁹ $K_s = 100 + 0.75 \times 90 + 0.50 \times 80 + 0.25 \times 70$. During the subsequent year fewer capital services are available and $K_{s,1}$, as specified in equation 6, equals 140 units (i.e., $K_{s,1} = 0.75 \times 100 + 0.50 \times 90 + 0.25 \times 80$), etc.

equal 30 percent, 21 percent, and 11 percent, respectively. Discounting the $h_{s,t}$ series with the real rate, as specified in equation 10, yields an H equal to 0.9233.

The ratio of economic value to current cost, $(1-H)/(1-D)$, equals 0.8293 for this illustration; the current cost measurement exceeds economic value by about 17 percent. The overstatement in the current cost methodology occurs because the unit price of a new asset is the value assigned to a bundle of existing assets with equivalent *current* productive capacity, but *future* capacities are disproportionate to current capacities. The differences are evident in a comparison of the d_t and $h_{s,t}$ series ($t=1, \dots, 4$). The marginal investment loses 25 percent of original productive capacity each year, whereas the aggregate capital stock loses 38 percent the first year, 30 percent the second, 21 percent the third, and 11 percent in the fourth. For this hypothetical stock, new capital is more durable than the aggregate stock. The current unit price of capital goods capitalizes the new asset's larger real service stream, and using that price to value a bundle of existing assets, as in the current cost measurement, results in an overstatement of economic value.

The CC_s and FV_s measurements can be computed directly with one additional bit of information, namely the unit supply price of new capital goods, q_s . Suppose q_s is \$1 in which case, according to equation 2, CC_s is \$225. The preceding paragraphs ascertained that FV_s/CC_s is 0.8293, implying that FV_s equals \$186.59.

Additional insight about the interaction of the different variables in the model is gleaned through a more detailed analysis of the FV computation. The user cost is constructed according to equation 4 and equals \$0.4323. This represents the cash flow accruing to a unit of capital during its first period of use. Notice that the marginal investment satisfies the zero net present value equilibrium condition: the first period's real cash flow is \$0.4323, the second period's is \$0.3242 (i.e., 0.75×0.4323), the third and fourth period's are \$0.2162 and \$0.1081, respectively, and the present value of the real cash flow stream is \$1. For the aggregate net stock, the 225 units of K that exist at time s promise cash flow in the first period of \$97.27 (i.e., 225×0.4323). During the second period of use,

the 140 units (K_{s+2}) promise *real* cash flow of \$60.52, and during the third and fourth periods of use expected real cash flow equals \$31.34 and \$10.81. The present value of the real cash flow stream is \$186.59. This measurement of FV_s represents the *economic value* of the capital stock.

II. Comparative Statics on the FV/CC Ratio

This section obtains comparative statics for the FV/CC ratio. In lieu of algebraic formulations, however, numerical computations of the wedge between current cost and economic value are obtained for different situations. Table 2 shows the FV/CC ratio for simulated cases in which the real rate is 4 percent, the service life of capital is 16 years, capacity depreciation follows a finite geometric pattern, and real investment steadily increases along a 4 percent growth path. This is the case assumed by Fraumeni and Jorgenson (1980), except that taxes are absent. As row 1 of Table 2 shows, the FV/CC ratio for this case is 0.8850, implying current cost overstates economic value by 11.5 percent. This estimate is referred to below as the "base case".

The remaining rows in the table keep all but one setting the same as in the base case. In row 2 the sensitivity of the FV/CC ratio to the real rate is demonstrated. When the real rate is increased by one hundred basis points the FV/CC ratio rises by 56 basis points. The overstatement bias in CC measurements is related inversely to the real rate of interest.

Row 3 demonstrates that the overstatement bias is less for assets with a long service life. By itself, this implies that the FV/CC ratio is closer to unity for structures than for equipment. At the same point in time, therefore, the overstatement bias inherent with current cost estimates is not the same for different asset types.

Rows 4 and 5 illustrate the effect on FV/CC of a change in the underlying capacity depreciation schedule. The overstatement of economic value by CC increases when capacity depreciation is decelerated. It often is assumed (e.g., Bureau of Labor Statistics

1979) that structures depreciate along a less decelerated path than equipment. This is further evidence that the bias inherent with *CC* estimates is not constant across asset types.

Finally, rows 6 and 7 show the effects on the net stock estimates from changing the pattern of capital accumulation. When the investment history is shaped so as to represent a growth industry (i.e., real investment (I_t) is increasing at an increasing rate) the overstatement of *FV* by *CC* is diminished. On the other hand, for a declining industry (real investment is increasing at a decreasing rate) the overstatement is larger.

The overstatement of economic value by current cost is influenced by a variety of factors. Analyses of current cost net stock estimates for different industries, for different time periods, or for different assets, may draw inferences unjustified by the economic values of the underlying real assets. Current cost estimates are spuriously related to economic value.

III. Integration of Tax Effects into the Valuation Process

The effects of taxes on the valuation ^{price less} estimates is shown in this section. The historical cost and current cost valuation models are unaffected by taxes; the specifications in equations 1 and 2 for estimating *HC* and *CC* for the net asset stock remain valid. The *FV* specification for measuring discounted after-tax cash flows must be modified, however. ✓

The zero net present value investment equilibrium (equation 3 in the absence of taxes) is modified to reflect corporate taxes and tax depreciation deductions. The user cost is extracted from the equilibrium condition as

$$c_s = q_s(r-\pi)(1-v-\tau Z)/((1-D_s)(1-\tau)) , \quad (4)$$

where Z denotes the present value of the marginal investment's tax depreciation deductions, v is the rate of the investment tax credit, and τ is the corporate tax rate. The effect on expected after-tax cash flows of the tax policies is incorporated into the *FV* model (equation 7), thereby showing

$$\begin{aligned}
FV_s &= p_s K_s \{ (1-\nu-\tau Z_s)(1-H_s)/(1-D_s) + \tau Y_s \} , \\
&= CC_s \{ (1-\nu-\tau Z_s)(1-H_s)/(1-D_s) + \tau Y_s \} .
\end{aligned} \tag{4}$$

CC_s is the current cost for total owned used assets at time s and equals $p_s K_s$. K_s is the quantity of potential productive capacity embodied in total owned used assets; i.e., K_s is the real capital stock. The variables H_s and D_s are measures of discounted capacity depreciation for the total owned used assets and for new assets, respectively. Y_s and Z_s are the discounted tax depreciation deductions per dollar of total owned used assets and per dollar of new assets, respectively. Explicit specifications for all variables are presented in the Appendix.

The general relation between tax-adjusted fundamental value and current cost is depicted in equation 4. Under some conditions the term in curly brackets is unity, implying FV and CC are conceptually equivalent. Differences between FV and CC , however, arise from both discounting effects and tax effects. These two effects are multiplicatively related and, consequently, examining one effect requires holding constant the other.

In order to focus on the relation between FV , CC and the discounting effect, suppose there are no taxes (ν and τ equal zero). The specification for tax-adjusted fundamental value reduces to

$$FV_s = CC_s (1-H_s)/(1-D_s). \tag{5}$$

H and D are related to the discounted real service stream embodied in the total owned used assets and in new assets, respectively. If the real capital service streams beyond time s for new and owned used assets are identical, then H and D are identical and FV equals CC . If, on the other hand, the total owned used assets depreciate along a different pattern than the one characterizing new assets, then FV and CC diverge because the specific price of new assets capitalizes the real service stream of the assets. The specific price is then utilized in the current cost methodology as a benchmark for valuing owned used assets and adjustments are made for differences in current productive capacities. When the future productive capacity relative to current capacity differs depending on whether assets are

new or used, however, the current specific price does not accurately reflect the discounted pretax cash flow stream embodied within owned used assets.

The *HC* and *CC* models are insensitive to the shape of the expected pretax cash flow streams. Both models implicitly assume that the decline over time in productive capacity is equiproportional to the decline in future discounted cash flows. Seldom, however, will such equiproportionate declines occur. For example, assume that the productive capacity for an asset declines along a straight-line pattern over a 10-year service life. When the asset concludes its fifth year of service the *CC* model sets the asset's value at 50 percent of the current specific price for a new asset. Consequently, two such five-year old assets would have a *CC* identical to one new asset. The two owned used assets, however, promise a five-year cash flow stream whereas the new asset promises a ten-year stream. *FV* for the two owned used assets is substantially less than for the new asset, even though their *CC*'s (and current productive capacities) are identical.¹⁰

In the absence of taxes a capacity depreciation schedule for which *FV* necessarily equals *CC* is geometric depreciation over an infinite service life. Jorgenson [1967] assumes geometric capacity depreciation in the neoclassical model (albeit over a finite service life) and Hulten and Wykoff [1981] provide evidence supporting this pattern.¹¹ The geometric

¹⁰ The ratio of *FV* to *CC* is $(1-H)/(1-D)$, as specified in equation 5. With the 10-year straight-line capacity depreciation schedule, $d_j = 1/10$ for $j = 1, \dots, 10$. Discounting the capacity depreciation schedule (as specified in the Appendix) with, say, a real interest rate of 3 percent shows $D = .8530$. For the owned used asset with five years of service remaining, $H = .9159$ (i.e., H equals $1/5$ discounted at 3 percent for 5 years). The ratio of *FV* to *CC* for the used asset therefore equals .57.

¹¹ Two models which assume depreciation is endogenous and depends upon utilization rates and maintenance expenditures as choice variables are Epstein and Denny [1980] and Kim and Moore [1988].

assumption has been challenged, however, by Eisner [1972] and Feldstein and Rothschild [1974]. Even with an infinite geometric capacity depreciation schedule, though, FV and CC valuation estimates may diverge due to the existence of differential tax effects.

Consider the case with taxes in which capacity depreciation occurs at the geometric rate δ over an infinite service life; i.e., $d_t = \delta(1-\delta)^{t-1}$. Simplification of equation 4 (the specifications for H and D from the Appendix show that for this case $H=D$, implying the discounting effect is suppressed) results in

$$FV_s = CC_s \{ 1 - v - \tau(Z_s - Y_s) \}. \quad (6)$$

FV equals CC when taxes are absent or when new and owned used assets face the same tax treatment. FV and CC diverge, however, when new assets receive an investment tax credit (v or ITC), or when depreciation tax savings (per unit of productive capacity) for new assets (τZ) differs from owned used assets (τY). Two asset bundles may be productively equivalent, they may yield identical pretax cash flows and, therefore, they may possess identical current costs. If they are subject to differential tax treatment, however, they will deliver different after-tax cash flows and their economic values will differ.¹²

Tax effects cause a divergence between FV and CC (and HC) because the specific price of new assets capitalizes the tax benefits received by new assets. This specific price is used in the current cost methodology as a benchmark for valuing owned used assets and adjustments are made for differences in current productive capacities. When the discounted tax benefits relative to current capacity are different for new assets than for

¹² A tax policy under which Y equals Z is when (1) the depreciable basis is indexed to inflation, and (2) tax depreciation and capacity depreciation each proceed along identical infinite geometric patterns at the rate δ . The U.S. Treasury Tax Reform Proposal of November 1984 suggested such a tax depreciation schedule but it was not enacted. Under these conditions $c = p(r + (1-\tau)\delta - \pi)/(1-\tau)$ and FV equals CC .

owned used assets, however, the current specific price does not accurately reflect discounted after-tax cash flows for owned used assets.

In summary, the *FV* specification reduces to the *CC* model when, for assets of varying ages, effective tax rates are identical and discounted pretax cash flows are a constant proportion of current productive capacities. The specifications further reduce to the *HC* model when specific prices are constant. The primary difference among the three models arises from the information incorporated in the estimate of economic value. For all three, the capacity depreciation schedule is always exogenous. For *HC* and *CC*, however, this schedule is the only source of decline in an asset's economic value throughout its service life. For the *FV* model, on the other hand, the change through time in an asset's economic value is determined by the interaction between differential tax effects and capacity depreciation. Estimating the economic value of owned used assets with the *HC* or the *CC* model is tantamount to using the *FV* model with implicit acceptance of the assumptions required for reducing the model – incremental information about differential tax effects (and specific price changes) is ignored.

is computed from the capacity depreciation schedule as

$$D_s = \sum_{t=1}^{\infty} (1+r-\pi)^{-t} d_t . \quad (5)$$

IV. Industry Estimates

This section examines the extent of variation in the *FV/CC* ratio across industries and time by constructing estimates encompassing four benchmark years, 1970, 1975, 1980, and 1985, for the total nonfinancial corporate sector ("NFC") and ten unique manufacturing industries. The ratio of economic value (*FV*) to current cost (*CC*) equals (1-

IV. Summary

The preference for current cost (*CC*) measurements is manifested repeatedly in business and economic research, as exemplified in the following two examples. Example one: The Financial Accounting Standards Board mandated (Financial Accounting Standard No. 33, 1979) that large corporations *must* supplement financial statements prepared by the traditional historical cost procedure with ones prepared by the current cost procedure. A growing body of literature is examining the incremental information content of current cost disclosures.¹³ Example two: Robert Eisner (1989) presents a comprehensive proposal for revising the National Income and Products Accounts so that they more accurately measure wealth accumulation and the economic value of goods and services. *CC* measurements are used for estimating capital stock values and imputing economic income.

This study shows that the *CC* measurement is a biased estimate of economic value and, perhaps more importantly, the bias is measurable. The bias occurs because the current price of new capital goods capitalizes the real service stream from new investments, and the *CC* procedure applies that price to value a bundle of existing assets with equivalent current productive capacity. When the *future* productive capacities of new and existing assets are disproportionate to their *current* capacities, valuation errors occur.

A true measure of economic value cannot be constructed without taking account of *future* productive capacities and cash flows. *CC* is an invalid measure of economic value except under very special conditions; the *FV* estimate also is valid under these conditions. The *FV* estimate, however, applies for a wider variety of situations. In other words, just as the *CC* model reduces to the *HC* (historical cost) framework when specific prices are constant, the *FV* model reduces to *CC* when current and future productive capacities for new and used assets are equiproportional.

¹³ Mandatory disclosure was revoked with FAS No. 89 in 1986, but voluntary disclosure still is urged. Debate is on-going about whether current cost disclosures again should be mandatory. The research on this accounting issue is discussed by DeBerg and Shriver (1987) and Lobo and Song (1989).

Estimates of FV/CC are constructed for two different capacity depreciation patterns: the finite geometric and the straight-line pattern.¹² The settings for the productive service life, L , are specific to each asset and industry, but are constant across time. This setting is based upon data from the Bureau of Labor Statistics (1979). For the NFC, L equals 30 years and 13 years for structures and equipment, respectively. For the manufacturing industries, L equals 28 years for all structures and it varies between 11 and 16 years for equipment.

Table 4 presents the industry estimates of FV/CC for the case in which capacity depreciation follows a finite geometric pattern. In 1970 the interindustry range of ratios is fairly small; CC overstates FV in each industry but the overstatement is always less than five percent. In 1985 the interindustry range is greater. The overstatement is 11 percent in Textile Products whereas in Electrical Machinery the FV/CC ratio is unity. There is little downward time-series drift in the FV/CC ratio; for the NFC the ratios in 1970 and 1985 are within one percentage point of each other.

Table 5 presents the industry estimates of FV/CC for the case in which capacity depreciation follows a straight-line pattern. The ratios are substantially smaller indicating that the overstatement biases in CC data are larger. For example, in Textile Products in 1985 the current cost measurement overstates economic value by 27 percent; for Primary Metals in 1970 the overstatement is 26 percent; for the NFC the overstatement exceeds 20 percent in two of the four benchmark estimates. The *BEA* capital stock estimates (1987) are predicated on the assumption that true capacity depreciation follows a straight-line pattern. If so, then a significant bias exists in their current cost measurements because the valuation procedure is inaccurate when future productive capacities are disproportionate to current capacities.

¹² The capacity depreciation schedule for the finite geometric pattern is given in footnote 10. For the straight-line pattern the half-life convention is used, so $d_t = 0.5/[L-0.5]$ for $t=1$; $d_t = 1/[L-0.5]$ for $t=2, \dots, L-1$; and $d_t = 0$ for $t \geq L$.

There is a fair amount of cross-sectional and time series variation in the empirical association between current cost measurements and economic values. For example, if capacity depreciation follows a straight-line pattern (as assumed by the *BEA*) then *CC* overstates the economic value of nonfinancial corporate plant and equipment by around 20 percent; the overstatement is near 5 percent if capacity depreciation follows a finite geometric pattern. The bias is affected to a lesser extent by factors such as the level of the real interest rate and the capital accumulation pattern of historical real investments.

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TABLE 1 - HYPOTHETICAL ILLUSTRATION OF VALUATION MECHANICS

for this year of use -1-	quantity of real capital remaining productive -2-	proportional decline in real capital at end of period -3-	real cash flow -4-	cumulative discounted value of cashflows -5-
<i>Conditions for the marginal investment costing \$1</i>				
1	1.00	.25	\$.4323	\$.4157
2	.75	.25	.3242	.7155
3	.50	.25	.2162	.9076
4	.25	.25	.1081	1.0000
<i>Conditions for the aggregate capital stock with current cost of \$225</i>				
1	225.00	.38	\$97.27	\$ 93.53
2	140.00	.30	60.52	149.49
3	72.50	.22	31.34	177.35
4	25.00	.11	10.81	186.59

Notes:

The user cost of capital equals \$0.4323 as described in the text.

In all cases the real cash flow equals the user cost of capital multiplied by the quantity of real capital remaining productive.

The real discount rate equals 4%.

The service life is 4 years, capacity depreciation follows the straight-line pattern, and the real investment history equals 100 units at the beginning of the year 1, and 90, 80, and 70 units before that.

The marginal investment has zero net present value.

The discounted value of the aggregate capital stock's expected cash flow stream is \$186.59, or 82.93% of its current cost.

The entries in column 3 are discounted to compute D for the marginal investment (equation 5) and H for the aggregate capital stock (equation 10). D and H equal 0.9075 and 0.9233, and $(1-H)/(1-D)$ is the ratio of economic value to current cost for the capital stock, 0.8293, as specified in equation 11.

TABLE 2 - VALUATION MECHANICS FOR A CASE BASED ON FRAUMENI & JORGENSEN (1980)

for this year of use -1-	quantity of real capital remaining productive -2-	proportional decline in real capital at end of period -3-	real cash flow -4-	cumulative discounted value of cashflows -5-
<i>Conditions for the marginal investment costing \$1</i>				
1	1.0000	.1250	\$.1761	\$.1693
2	.8750	.1094	.1541	.3118
3	.7656	.0975	.1348	.4317
4	.6699	.0837	.1180	.5325
5	.5862	.0733	.1032	.6173
6	.5129	.0641	.0903	.6887
7	.4488	.0561	.0790	.7488
8	.3927	.0491	.0692	.7993
9	.3436	.0429	.0605	.8418
10	.3007	.0376	.0529	.8776
11	.2631	.0329	.0463	.9077
12	.2302	.0288	.0405	.9330
13	.2014	.0252	.0355	.9543
14	.1762	.0220	.0310	.9722
15	.1542	.0193	.0272	.9873
16	.1349	.1349	.0238	1.0000
<i>Conditions for the aggregate capital stock with current cost of \$590.57</i>				
1	590.57	.1361	\$104.00	\$100.00
2	510.19	.1195	89.85	183.07
3	439.60	.1050	77.41	251.89
4	377.56	.0924	66.49	308.73
5	322.99	.0813	56.88	355.48
6	274.95	.0717	48.42	393.74
7	232.60	.0633	40.96	424.87
8	195.23	.0559	34.38	449.99
9	162.20	.0495	28.56	470.06
10	132.95	.0439	23.41	485.88
11	107.00	.0391	18.84	498.12
12	83.92	.0348	14.78	507.35
13	63.34	.0312	11.15	514.05
14	44.93	.0280	7.91	518.62
15	28.40	.0252	5.00	521.39
16	13.49	.0228	2.38	522.66

Notes:

The user cost of capital equals $(r-\pi)/(1-D)$ and is \$0.1761, as described in the text.

The real rate is 4% and geometric capacity depreciation occurs at a rate of 12.5% over a 16 year service life.

The real investment equals 100 units at the beginning of the year 1 and it is 4 percent less each year before that.

The marginal investment has zero net present value.

The discounted value of the aggregate capital stock's expected cash flow stream is \$522.66, or 88.50% of its current cost.

The entries in column 3 are discounted to compute D for the marginal investment (equation 5) and H for the aggregate capital stock (equation 10). D and H equal 0.7729 and 0.7990, and $(1-H)/(1-D)$ is the ratio of economic value to current cost for the capital stock, 0.8850, as specified in equation 11.

TABLE 3 - RATIOS OF ECONOMIC VALUE (FV) TO CURRENT COST (CC) FOR SIMULATED CASES

For all simulated cases the settings are as follows except for the noted exceptions: real rate, 4 percent; service life, 16 years; capacity depreciation, finite geometric; real investment history, 4 percent real growth.

1.	simulated case with no exceptions	.8850
2.	as above except real rate is 5 percent	.8906
3.	as above except service life is 20 years	.8913
4.	as above except capacity depreciation is one-hoss shay	.6331
5.	as above except capacity depreciation is straight-line	.7697
6.	as above except capital accumulation history is for growth industry	.9379
7.	as above except capital accumulation history is for declining industry	.8813

Notes:

The ratios equal $(1-H)/(1-D)$, as specified in equation 11, and are constructed as described in the text.

TABLE 4 - RATIOS OF ECONOMIC VALUE (FV) TO CURRENT COST (CC)
FOR SELECTED INDUSTRIES AND YEARS GIVEN FINITE GEOMETRIC CAPACITY DEPRECIATION

Industry Group	1970	1975	1980	1985
Food Products, SIC 20	.9648	.9329	.9343	.9279
Textile Products, SIC 22	.9735	.9245	.9143	.8927
Paper Products, SIC 26	.9713	.9259	.9404	.9496
Chemical Products, SIC 28	.9817	.9457	.9447	.9488
Petroleum Products, SIC 29	.9584	.9009	.9220	.9240
Rubber & Plastics, SIC 30	.9901	.9548	.9414	.9605
Stone, Clay, & Glass, SIC 32	.9691	.9347	.9364	.9291
Primary Metals, SIC 33	.9628	.9042	.9178	.9146
Non-Electrical Machinery, SIC 35	.9815	.9484	.9724	.9790
Electrical Machinery, SIC 36	.9994	.9677	.9705	1.0007
Nonfinancial Corporate Sector	.9641	.9329	.9367	.9564

Notes:

The estimates are for equipment and structures and equal $(1-H)/(1-D)$, as specified in equation 11.

They are constructed with the data described in the text.

TABLE 5 - RATIOS OF ECONOMIC VALUE (FV) TO CURRENT COST (CC)
FOR SELECTED INDUSTRIES AND YEARS GIVEN STRAIGHT-LINE CAPACITY DEPRECIATION

Industry Group	1970	1975	1980	1985
Food Products, SIC 20	.8285	.7853	.7797	.7722
Textile Products, SIC 22	.8392	.7653	.7506	.7277
Paper Products, SIC 26	.8361	.7656	.7952	.7963
Chemical Products, SIC 28	.8529	.7944	.7954	.7944
Petroleum Products, SIC 29	.8206	.7487	.7797	.7715
Rubber & Plastics, SIC 30	.8611	.8012	.7852	.8137
Stone, Clay, & Glass, SIC 32	.8285	.7755	.7823	.7755
Primary Metals, SIC 33	.8192	.7373	.7663	.7498
Non-Electrical Machinery, SIC 35	.8456	.7978	.8342	.8362
Electrical Machinery, SIC 36	.8688	.8163	.8278	.8740
Nonfinancial Corporate Sector	.8242	.7854	.7926	.8191

Notes:

The estimates are for equipment and structures and equal $(1-H)/(1-D)$, as specified in equation 11.

They are constructed with the data described in the text.