ACCOUNTING TECHNIQUES AND FIRMS' EQUILIBRIUM VALUES: TAX METHODS AND THE LIFO/FIFO CHOICE

by

Nicholas J. Gonedes*

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RODNEY L. WHITE CENTER
FOR FINANCIAL RESEARCH

University of Pennsylvania

The Wharton School

Philadelphia PA 19104

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The contents of this paper are the sole responsibility of the author.

Comments Welcome

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ABSTRACT

The effect of firms' accounting techniques on firms' equilibrium values is the general topic considered here. The specific technique examined is the inventory-costing method--e.g., LIFO or FIFO--adopted for tax reporting. The connection between firms' selections of accounting techniques and the characteristics of firms' production-investment decisions is emphasized. Our framework provides a basis for getting theoretical insights into firms' selections of techniques, for explaining some available empirical results heretofore regarded as somewhat mysterious, and for improving the experimental designs used for work on accounting techniques' effects. Our results indicate that the optimality of an inventory method is inextricably bound to the characteristics of firms' production-investment decisions and that all value-maximizing firms pursuing the same type of decisions will opt for the same inventory method. Of course, the same method will be optimal for different types of decisions if the number of methods is less than the number of decision types. In spite of its alleged favorable tax effects under inflation, LIFO is not always the optimal method under inflationary conditions. Moreover, LIFO may be the optimal method even when the expected value of tax deductions under LIFO is less than the expected value of tax deductions under FIFO. Finally, the oft-inferred association between risk changes and changes in inventory methods is not due to a quirk of available sample evidence. It is precisely what one should expect.

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1. Introduction

The effects of firms' accounting techniques and of changes in accounting techniques on firms' equilibrium values have been examined in many papers on external reporting. One problem encountered in many of these papers turns on the connection between accounting techniques and the substantive attributes of firms' production-investment and financing decisions; see, e.g., Gonedes and Dopuch [1974], [September 1977], [1978] and Watts and Zimmerman [1978]. Expecting such a connection when the accounting techniques affect tax payments seems quite natural. But there may also be a connection when the techniques of interest are not used for tax reporting. This may be due to, for example, the variety of contractual agreements that are expressed in terms of accounting numbers used for financial (but not tax) reports--such as covenants of bond indentures or sharing-rules of management compensation plans.[1/] In addition, a connection between accounting techniques and the substantive attributes of firms' decisions may exist when these techniques are used for "signaling" purposes; see, e.g., Gonedes and Dopuch [April, 1978]. In any event, if such a connection exists, then what might seem to be "mere bookkeeping" differences or changes may actually correspond to substantive economic differences and, therefore, different equilibrium values of firms.

Such substantive economic differences may show up (in empirical work) as, for example, industry or risk differences among firms using different accounting techniques or firms making different changes in accounting techniques. This sort of phenomenon obviously complicates attempts to assess the effects of accounting techniques on firms' values--whether the effects turn on techniques' implications for accounting numbers' information content or on the information content of the techniques themselves. Moreover, it complicates attempts to "explain" firms' selections of accounting techniques: assertions about cosmetic "income smoothing" and "earnings management" designed to affect firms' values by, say, "fooling" investors will no longer suffice once one allows for a connection between accounting techniques and the substantive attributes of firms' decisions. There is nothing cosmetic about a change in techniques associated with a change in these substantive attributes.

As indicated, expecting such an association seems most natural when the techniques of interest are those used for tax reporting--because of the techniques' implications for distribution functions of firms' cash flows. Indeed, some explanations of firms' selections of tax reporting methods turn on this connection--as do some claims about "income management" for firms that forego seemingly beneficial tax reporting methods in order to avoid adverse effects on reported income numbers. This seems most vivid in the available papers on firms' decisions about using the Last-in-First-Out (LIFO) or the First-in-First-Out (FIFO) inventory costing method for tax reporting. See, for example, Sunder [1973], Eggleton, Penman, and Twombly [1976], and Abdel-khalik and McKeown [1978] for pertinent discussions and results on decisions to use LIFO. The tie-in to claims about "income management" is due, in part, to an expectation of conflicting effects of a switch to LIFO on cash flows numbers and reported income numbers, because of the legal requirement to use LIFO for external reporting when it is used for tax reporting. One of the major questions asked in the studies of switches to or from the LIFO method is: Do the ultimate effects on firms' equilibrium values turn on LIFO's effects on distribution functions of firms' cash flows or on its effects on distribution functions of firms' reported income numbers? The available studies shed considerable light on this question and, more generally, on the effects of alternative techniques on firms' values. But a variety of puzzles and questions linger on, as indicated by Abdel-khalik and McKeown [1978], among others.

There is still no adequate explanation for the apparent association between changes in firms' relative risks and changes in inventory accounting methods (see, e.g., Ball [1972] and Harrison [1977]). Nor is there one for the apparent association between industry classification and changes in inventory methods (see, e.g., Eggleton, Penman, and Twombly [1976])--or changes in other accounting techniques (see, e.g., Gosman [1973]). Presumably, these sorts of associations can be traced to connections between accounting techniques and the substantive attributes of firms' decisions. But, as yet, there is no theoretically grounded micro-model or framework that is rich enough to provide a basis for specifying the kinds of associations that we should expect--with respect to inventory costing methods or other accounting techniques--and, given these associations, the expected effects of accounting techniques on firms' values.

To be sure, there are several works on optimally selecting accounting techniques for tax reporting purposes--usually with respect to inventory costing and depreciation methods; see, e.g., Davidson and Drake [1961] and Sunder [1976]. But the conditions invoked in these studies seem quite restrictive and they provide no straightforward tie-in to issues of capital market equilibrium. Indeed, the available work on optimal micro-choices of accounting techniques and on capital market equilibrium seem to have developed almost independently of each other. Yet, insofar as general equilibrium analyses and empirical work on techniques' effects are concerned, some integration of these two lines of study seems fruitful.

The primary purpose of this paper is to take some beginning steps towards modeling issues pertaining to the selection and effects of accounting techniques that have substantive economic implications--such as the inventory costing techniques used for tax reporting. Throughout we shall, in fact, restrict attention to the LIFO/FIFO decision with respect to tax reporting. It should be clear, however, that the approach used applies to other tax reporting issues as well, such as firms' selections of depreciation methods used for tax reporting. Indeed, the only key features of the LIFO/FIFO decision exploited here are that firms have some latitude of choice in their selection of tax reporting methods and that the alternative methods have effects on the probability distributions of firms' net after-tax cash flows--and thus, in general, on firms' equilibrium values. Not unexpectedly, the approach developed here is based on substantial simplifications of the tax reporting problem facing any "real world" firm--as a quick reading of the pertinent tax regulations will indicate.[2/] Nevertheless, the approach developed does capture the seemingly major distinguishing features of the LIFO/FIFO problem. In the end, we provide a basis for identifying some of the key theoretical determinants of firms' optimal inventory-costing methods and some of the effects of firms' inventory method decisions on firms' equilibrium values--assuming only tax-reporting issues are considered.

For simplicity, we assume that FIFO is the only alternative to LIFO, unless otherwise indicated. This is solely a convenience. It has no essential effect on the crux of our discussion. But before getting to any of this, we set forth the basic model of the firm underlying our development.

2. The Firm's Decisions

2.1 Basic Assumptions and Relationships

In order to highlight only central issues, we consider a finite horizon setting and a decision to use either LIFO or FIFO for all periods within this time horizon. As will be indicated in Sec. 6, the basic aspects of the machinery developed here can be readily extended to more complicated settings--at least in principle. With no loss of generality, we assume that all firms are all-equity firms.

Several macro conditions are also assumed to hold. They are essentially those used in much of the literature on the Harberger Model and tax incidence; see McClure and Thirsk [1975]. Specifically, we assume that the taxing authorities pursue "balanced budget" policies and that government expenditures are distributionally neutral. The latter condition implies that when private demand declines on account of income losses due to taxation, public demand for all goods exactly replaces the losses of private demand. Similar offsets are implied for tax-induced increases in private demand. For a discussion of the restrictiveness of this neutrality assumption, see McClure and Thirsk [1975; fn. 12].

At the beginning of each period, our firm acquires the services of factors of production needed to implement its selected production-investment activities. This firm is permitted to hold goods in inventory as a part of these activities. The firm finances its activities by selling fractional interests ("shares") in the distribution function of its future values--the realizations of which are available at the end of each period. For the final period, T, of our finite horizon, the value of the firm is equal to that periods' net cash earnings plus the total value of whatever assets are still on hand.

The firm is assumed to follow the "market value rule" in selecting its optimal production-investment decisions. That is, at the time these decisions are made, optimal decisions are those consistent with maximizing the total value of the firm's outstanding securities. A variety of issues pertinent to enforcing this rule are discussed by Fama [1978].

It is convenient to initially focus on the firm's net cash inflow at the end of period T. Let $\tilde{S}_T$ and $\tilde{C}_T$ denote the firm's gross operating inflows and outflows, respectively, for the period ending at time T (or "at time T" for short). Tilde ($\sim$) denotes a random variable. Let $\tilde{Y}_T$ denote this period's before-tax net cash earnings. Assuming, for convenience, that no assets with nonzero salvage values are still on hand, the before-tax value of the firm at time T is:

$$(1) \qquad \tilde{Y}_T = \tilde{S}_T - \tilde{C}_T$$

The firm's after-tax net operating inflows will depend on the inventory costing method used for tax purposes. The method selected determines the tax deductible cost of goods sold. Only taxes levied against $\tilde{Y}_T$ are considered here. Moreover, for reasons given later, we shall ignore the lower-of-cost-or-market option available to a firm that chooses to use FIFO for tax reporting.[3/] And cost-of-goods-sold is the only tax deductible cost recognized here. This does not affect the crux of our analysis. (This is because our comparisons of LIFO and FIFO will presume that other things are held constant anyway.)

Let $\tilde{C}_t^L$ and $\tilde{C}_t^F$ denote the LIFO-determined and FIFO-determined cost of goods sold at time t, respectively. And let the constant rate of tax be denoted by τ. The firm's tax bill at time T is $\tau(\tilde{S}_T - \tilde{C}_T^L)$ if it opts to use LIFO and it is $\tau(\tilde{S}_T - \tilde{C}_T^F)$ if it opts to use the FIFO method. Net operating after-tax profits under LIFO and FIFO are, respectively,

$$
\begin{aligned}
(2) \qquad \tilde{\pi}_T^L &= (\tilde{S}_T - \tilde{C}_T) - \tau(\tilde{S}_T - \tilde{C}_T^L) \\
&= (\tilde{S}_T - \tilde{C}_T) - \tau(\tilde{S}_T - [\tilde{C}_T + \tilde{C}_T^L - \tilde{C}_T]) \\
&= (1 - \tau)\tilde{Y}_T + \tau(\tilde{C}_T^L - \tilde{C}_T)
\end{aligned}
$$

$$
(3) \qquad \tilde{\pi}_T^F = (1 - \tau)\tilde{Y}_T + \tau(\tilde{C}_T^F - \tilde{C}_T)
$$

Note that $\tilde{\pi}_T^L$ and $\tilde{\pi}_T^F$ are equivalent to dollar returns on portfolios defined by the portfolio proportions $(1 - \tau)$ and τ, which, of course, sum to unity. Under the LIFO method, the total portfolio return consists of the two flows $\tilde{Y}_T$ and $(\tilde{C}_T^L - \tilde{C}_T)$. Under the FIFO method, it consists of $\tilde{Y}_T$ and $(\tilde{C}_T^F - \tilde{C}_T)$. Thus, not unexpectedly, the equilibrium value of the firm at time T - 1 will equal the weighted sum of the explicit or implicit equilibrium values of the flows corresponding to the firm's tax reporting inventory method, where the weights for the flows are $(1 - \tau)$ and τ and where one of the flows, $\tilde{Y}_T$, is independent of that reporting method. In a complete perfectly competitive capital market, there would be explicit equilibrium values for these flows.

The end-of-period values of the firm conditional on LIFO and FIFO are, respectively,

$$(4) \qquad \tilde{V}_T^L = \tilde{V}_T + \tau(\tilde{C}_T^L - \tilde{C}_T)$$

$$(5) \qquad \tilde{V}_T^F = \tilde{V}_T + \tau(\tilde{C}_T^F - \tilde{C}_T)$$

where $\tilde{V}_T \equiv (1 - \tau)\tilde{Y}_T$. Thus,

$$(6) \qquad \tilde{V}_T^L - \tilde{V}_T^F = (\tilde{C}_T^L - \tilde{C}_T^F).$$

Expression (6) represents the difference between the terminal values of a LIFO and a FIFO firm, assuming that the inventory costing method is the only factor distinguishing one firm from the other. I.e., the firms' production-investment decisions are identical; only their tax reporting methods differ. This expression is, of course, reminiscent of the Modigliani/Miller [1958], [1963] result for the effects of tax-deductible interest payments on firms' equilibrium values, given fixed and identical production-investment decisions. But instead of a payment to debtholders at time t, we have in (6) the difference between the tax deductible cost of goods sold under the LIFO and FIFO costing methods. Moreover, unlike the Modigliani/Miller result, the realized value of $\tilde{V}_T^L - \tilde{V}_T^F$ need not be nonnegative. The probability that it will not be depends on the joint distribution function of $\tilde{C}_T^L$ and $\tilde{C}_T^F$--or, more directly, on the distribution function of the difference $\tilde{C}_T^L - \tilde{C}_T^F$.

When expression (6) is applied to different firms--one on LIFO and one on FIFO--it must be the case that these firms differ only with respect to their inventory costing methods used for tax reporting. In particular, the use of expression (6) for describing the equilibrium value of a switch to or from LIFO presumes that the production-investment decisions of the different firms are identical. In short, expression (6) takes firms' production-investment decisions as fixed and identical just as does the Modigliani/Miller result on the effects of debt financing on firms' equilibrium values. In this regard, observe that a firm's production-investment decisions affect (for a given environment) the joint stochastic properties of $\tilde{C}_T^L$ and $\tilde{C}_T^F$. For given and identical decisions, all differences between the properties of $\tilde{C}_T^L$ and of $\tilde{C}_T^F$ turn on the fact that one variable is conditional on the LIFO method and the other is conditional on the FIFO method.

Expression (6) deals with the cash-flow effects of different tax reporting methods at time T--which is the end of our finite time horizon. But similar expressions can be obtained for all of the cash flow effects of the tax reporting methods.

2.2 Multiperiod Valuation Conditions

Let τW_{ts} denote the equilibrium value as of time t of the difference between the cash flows induced by LIFO and those induced by FIFO at time s for fixed production investment decisions. Clearly, $\tau\tilde{W}_{TT} = \tau(\tilde{C}_T^L - \tilde{C}_T^F)$ and

$$(7) \qquad V_{T-1}^L - V_{T-1}^F = \tau(C_{T-1}^L - C_{T-1}^F) + \tau W_{T-1,\, T}.$$

As of time T-2,

$$(8) \qquad V^L_{T-2} - V^F_{T-2} = \tau(C^L_{T-2} - C^F_{T-2}) + \tau W_{T-2,\,T-1} + \tau W_{T-2,\,T}$$

And, in general,

$$(9) \qquad V^L_o - V^F_o = \tau(\sum_{i=1}^{T} W_{oi})$$

where it is assumed that the inventory method is selected at time t=0 and that it has its inital effects at time t=1.

Consider a FIFO firm that opts for a switch to LIFO at time t=0. (Arguments analogous to the following apply to a LIFO firm that opts for a switch to FIFO.) Assume that this firm changes nothing else. In making this switch, it adds the stockastic scalar $\tau(\tilde{C}^L_t - \tilde{C}^F_t)$ to its net operating cash inflows at time t, t=1, 2, ..., T. The equilibrium value of this sequence of additions, as of time t=0, is equal to the difference between the time t=0 equilibrium values of otherwise identical firms using the different inventory methods. In particular, these firms' production-investment decisions are identical. The equilibrium value of this sequence is also equal to the change in one firm's equilibrium value induced by a change, at t=0, in inventory methods used for tax reporting. Given adherence to the "market value rule," this equilibrium value is necessarily nonnegative for a firm that actually switches. Quite trivially, no firm adhering to that rule would opt for LIFO over FIFO if doint so implies a decrease in the firm's equilibrium value.

In the next section, we discuss some means for enforcing the conditions given by (6) and (9). In Sec. 2.4, we briefly consider some forces that might lead to departures from these conditions. Such forces are given more attention in Sec. 6.

2.3 More on the Equilibrium Conditions

If firms' production-investment decisions, the number of firms, and firms' tax reporting methods are all held fixed at time t=0, and if there are both LIFO and FIFO firms making identical production-investment decisions, then expression (9) implies that a necessary condition for capital market equilibrium at time t=0 is:

$$(10) \qquad V_o^L = V_o^F + \tau\sum_{i=1}^{T} W_{oi}$$

where V_o^L and V_o^F are the equilibrium values at t=0 of firms that differ only with respect to tax reporting methods--one using LIFO and one using FIFO, respectively, and where the value of $\tau\sum_{i=1}^{T} W_{oi}$ equals the equilibrium value, at t=0, of a 100% ownership interest in the joint distribution function of the sequence $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F);\ t-1,2,\ldots,T\}$ or some stochastically equivalent sequence.[4/] This presumes, of course, that perfect substitutes for the ownership interests in $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F);\ t-1,2,\ldots,T\}$ exist or can be created. As indicated below, this condition is satisfied in a perfect capital market. Under the indicated assumptions, therefore, an inequality in (10) with respect to a LIFO and a FIFO firm that are, in all other respects, identical would represent an opportunity to get "pure profits" via portfolio transactions on personal account. This is due to the possibility, in a perfect capital market, of creating an asset with the payoff sequence $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F)\}$ via transactions on personal account when there are perfect-substitute firms with respect to both production-investment decisions and tax reporting methods.

To see that condition (10) necessarily describes the equilibrium values of otherwise equivalent LIFO and FIFO firms, consider an investor who establishes a long position in the LIFO firm and a simultaneous short position in the FIFO firm. The long position entitles this investor to receive, at time t=1, his fractional interest, equal to, say, α, of the realized value of $\tilde{V}_1^L = \tilde{V}_1 + \tau\sum_{t=2}^{T}\tilde{W}_{1t}^* + \tau(\tilde{C}_1^L - \tilde{C}_1)$, where $\tilde{W}_{st}^*$ is the value at time s of the cash flow $(\tilde{C}_t^L - \tilde{C}_t)$, and where this expression for $\tilde{V}_1^L$ results from recursive application of condition (4). The short position equal to $-\alpha$ in the FIFO firm obligates him to pay back an amount equal to α times the realized value of $\tilde{V}_1^F = \tilde{V}_1 + \tau\sum_{t=2}^{T}\tilde{W}_{1t}^{**} + \tau(\tilde{C}_1^F - \tilde{C}_1)$, where $\tilde{W}_{st}^{**}$ is the value at time s of the cash flow $(\tilde{C}_t^F - \tilde{C}_t)$ and where this expression for $\tilde{V}_1^F$ results from recursive application of expression (5). The net value at t=1 of this portfolio is, therefore, the realized value of $\alpha(\tilde{V}_1^L - \tilde{V}_1^F) = \alpha[\tau(\tilde{C}_1^L - \tilde{C}_1^F) + \tau\sum_{t=2}^{T}\tilde{W}_{1t}]$, since $\tilde{W}_{1t}^* - \tilde{W}_{1t}^{**}$ equals $\tilde{W}_{1t}$, for all t, in a perfect capital market. By combining this long/short position with a long position of α in an equivalent FIFO firm, the investor can get a terminal value equal to $\alpha[\tilde{V}_1^F + \tau\sum_{t=2}^{T}\tilde{W}_{1t} + \tau(\tilde{C}_1^L - \tilde{C}_1^F)]$.

But, from (9) applied to time t=1, this is precisely equal to the terminal value of a direct long position of α in an equivalent LIFO firm, the cost of which is αV_0^L at t = 0. In order to preclude arbitrage opportunities, this must be equal to the cost of the long position in the FIFO firm, αV_0^F plus the cost of the indicated long/short position, $\alpha[\tau\sum_{t=1}^{T} W_{ot}]$, because the value at t=1 of this manufactured asset is identical to the value at t=1 of the direct long position in the LIFO firm. Since this argument also applies to one who takes a long position in the FIFO firm and a short position in the LIFO firm, the equality in (10) must hold in equlibrium.

Condition (10) is a "short run" condition, in the sense that the numbers of firms using different methods and firms' production-investment decisions are held fixed. When these things are not held fixed, then one would never actually observe different tax reporting methods being used by firms pursuing identical production investment decisions, given adherence to the market value rule. Entry and exit by firms and entry and exit by management teams will ensure that, in equilibrium, the inventory method consistent with value maximization for given production-investment decisions will be the only method used for that set of decisions. Suppose, for example, that a FIFO firm with current value equal to V_o^F plans to pursue production-investment decisions requiring outlays with current value equal to I_o, where $V_o^F \geq I_o$. And suppose that $V_o^L > V_o^F$, conditional on the same decisions. Even without LIFO, new firms will enter until $V_o^F = I_o$ for a new entrant. Moreover, with the availability of LIFO, new firms will enter until $V_o^L = I_o$, given adherence to the market value rule. And every new entrant will opt for LIFO. Since $V_o^L > V_o^F$, then firms' values and the prices of factors of production will adjust so that $V_o^F < I_o$ in equilibrium. In short, for the given set of production-investment decisions, equilibrium prices of securities and factors of production will be such that use of the FIFO method is inconsistent with general equilibrium.

Entry and exit of firms are not the only forces leading to this result. Pursuit of the market value rule by existing firms that plan to make identical production-investment decisions implies the same result. That is, if $V_o^L > V_o^F$ for a given set of decisions and prevailing equilibrium prices, then adherence to the market value rule implies that all firms pursuing this set of decisions will opt for LIFO. As a result, there will be no FIFO firms engaged in these decisions.

Switching from one inventory method to another at time t=0 involves changing a stochastic component of the switching firm's net cash flow at time t, t=1, 2, ..., T. In the cash of a switch from FIFO to LIFO, for example, the net cash flow component $\tau(\tilde{C}_t^F - \tilde{C}_t)$ is replaced by the component $\tau(\tilde{C}_t^L - \tilde{C}_t)$, for each t. In general, this alters the entire distribution function of the switching firm's period t net cash flow. Thus, it can alter the risk characteristics of the firm's periodic net cash flows. If it alters the type of risk for which investors demand compensation, then the altered risk properties will be one of the determinants of the difference between the equilibrium values V_o^L and V_o^F. In short, a switch from one inventory costing method to another (for tax reporting) involves both return and risk issues--of the sort that usually enter into the selection of optimal production-investment decisions via the market value rule. In equilibrium, further changes in either production-investment decisions or inventory costing methods should permit no increases in any firm's value at time t=0.

This is, of course, why all firms selecting the same production-investment decisions will end up selecting the same inventory methods. If a given firm's decisions were such that, say, $V_o^L > V_o^F$ and if the firm were now on FIFO, then a mere shift of its inventory costing methods would have the same effect as adoption of an investment proposal with positive gross equilibrium value and with a required investment outlay equal to zero. I.e., it would be equivalent to a "pure profit" opportunity--the existence of which is inconsistent with equilibrium.

Next, suppose that all inventory-method switches consistent with value maximization are effected by existing firms. In order for the prevailing conditions to be consistent with general equilibrium, there must be no motivation for firms making different types of production-investment decisions to reallocate their resources, via revisions of their decisions, and there must be no motivation for entry into any activity by new firms (or new managerial teams--via, e.g., takeovers). This will be the case when stochastically equivalent cash flow sequences induced by the same outlays have the same current equilibrium values. Consider, for example, a LIFO firm making production investment decisions of, say, type j and a FIFO firm making production-investment decisions of type i. Denote the prevailing values of these firms, at t=0, by V^L_{jo} and V^F_{io}, respectively, and assume that the time t=0 outlays required by these firms' decisions are equal to the same amount, I_o. From our earlier remarks, we know that $i \neq j$. If $i = j$, then either both firms would opt for LIFO or both would opt for FIFO.

The distribution functions of our illustrative firms' cash flow sequences are defined by the 2-tuples (j, LIFO) and (i, FIFO)--not just the different types of production investment decisions, i and j. This follows from the fact that the inventory costing method used for tax reporting affects the distribution function of firms' cash flow sequences in a manner that is, in general, dependent upon firms' production-investment decisions. For the example at hand, we are assuming that the distribution function induced by (j, LIFO) is equivalent to the distribution function induced by (i, FIFO)--at least with respect to whatever factors are relevant in the determination of firms' equilibrium values. We are also assuming that both firms' current outlays are equal to the same amount, I_o.

In view of the above, we can state that equilibrium implies

$$(11) \qquad V_{jo}^{L} = V_{io}^{F}$$

This condition implies, in turn, that firms' selected inventory reporting methods can be used to sort firms into mutually exclusive sets of <u>types</u> of production-investment decisions. In any event, if condition (11) is violated for $i \neq j$, then there will be profitable entry/exit opportunities and profitable arbitrage opportunities--all of which are inconsistent with equilibrium in both the capital market and the markets for goods and services (outputs and inputs).

2.4 Potential Complications: Frictions and Restrictions on Firms' Selections of Methods

In general, the equilibrium conditions discussed above need not hold if there are restrictions on entry and exit by firms regarding production-investment decisions or on firms' selections of tax reporting methods. One obvious restriction of this sort is a tax code regulation that precludes (or at least hinders) freely switching from, say LIFO to FIFO by existing firms--in spite of changes in economic conditions or modifications in some aspect(s) of the firms' operating decisions. But, taken by itself, the existence of this sort of restriction need not be sufficient to invalidate the equilibrium conditions described above. If existing firms (or collections of real resources) can be converted into new organizational forms--via, e.g., reorganizations, corporate takeovers, mergers, etc.--and if the resulting new organizational forms can be paired with either the FIFO or the LIFO method for tax reporting, then the restrictions on existing firms' selections of tax reporting methods are, other things equal, of no consequence insofar as satisfying the equilibrium conditions discussed above.

Of course, conversion costs induced by effecting such new organizational forms may introduce frictions into the system. In addition, differences between the costs of implementing a LIFO system and the costs of implementing a FIFO system may be large enough to preclude full satisfaction of the conditions described above. In general, these types of costs can be recognized via adjustments to the cash flow sequence $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F);\ t=1, 2, \ldots, T\}$. After they are recognized the relevant equilibrium condition is still condition (10), applied to the adjusted cash-flow numbers, for a given set of production-investment decisions. As before, if $V_o^L > V_o^F$, no firm pursuing this set of decisions will opt for the use of FIFO.

2.5 Remarks on Empirical Work: First Pass

The framework developed above provides a basis for understanding why firms pursuing different production-investment decisions select different inventory costing methods for tax reporting. As indicated, the stochastic attributes of the cash flow sequence $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F)\}$ are dependent on the substantive characteristics of these decisions, such as firms' inventory-management systems (which affect the quantities underlying the cost numbers used for tax reporting) and the stochastic properties of relative prices faced by firms in the markets for factors of production (such as raw materials and labor services). For some types of decisions, the equilibrium value of the LIFO sequence, $\{\tau\tilde{C}_t^L\}$, will be less than that of the FIFO sequence, $\{\tau\tilde{C}_t^F\}$--in which case $(\sum_{i=1}^{T} W_{oi}) < 0$ in expression (10).

This mundane observation points to an approach for empirically "explaining" firms' LIFO/FIFO choices.

Suppose that these choices are made in a manner consistent with the above framework, that we have a model for specifying the time t=0 equilibrium value of any cash flow sequence, and that this model is expressed in terms of estimable parameters (so that empirical application is feasible). Under these conditions, the estimated values of those parameters can be used to make inferences about firms' perceptions of the equilibrium value of the sequence $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F)\}$, conditional on the firms' production-investment decisions. For firms pursuing different production-investment decisions, these inferred values should be consistent (across firms) with firms' actual LIFO/FIFO decisions, conditional on the framework developed above. Thus, as far as empirical work is concerned, an important next step is to specify a model for establishing the equilibrium value of the sequence of $\{\tau(\tilde{C}_t^L - \tilde{C}_t^F)\}$ and to identify the testable implications of this model. More on this later. We first consider an additional aspect of the LIFO/FIFO decision: the Lower-of-Cost-or-Market option. Specifically, we indicate why it seems justifiable to ignore this option.

3. The Lower-of-Cost-or-Market (LCOM) Rule and LIFO/FIFO Deductions

The variables $\tilde{C}_t^F$ and $\tilde{C}_t^L$ denote the tax deductible cost-of-goods sold numbers for period t. Under the LIFO method, the value of this number is determined by the use of "historical cost" valuation procedures. Thus, in general, there are no "unrealized" amounts in the value of $\tilde{C}_t^L$. Under FIFO, however, the value of the tax deductible cost-of-goods sold number may be based upon "historical cost" valuation methods or methods based upon market values, possibly incorporating "unrealized" amounts. The following excerpt from Sec. 1.471 of the U.S. Internal Revenue Code (IRC) regulations is pertinent here:

> The bases of valuation most commonly used by business concerns and which meet the requirements of [this section] are (1) cost and (2) cost or market, whichever is lower . . . . Any goods in an inventory which are unsalable at normal prices or unusable in the normal way because of damage, imperfections, shop wear, changes of style, odd or broken lots, or other similar causes, including second hand goods taken in exchange, should be valued at bona fide selling prices less direct cost of disposition . . . or if such goods consist of raw materials or partly finished goods held for use or consumption, they shall be valued upon a reasonable basis, taking into consideration the usability and the condition of the goods, but in no case shall such value be less than the scrap value. Bona fide selling price means actual offering of goods during a period ending not later than 30 days after inventory date.

In later stipulations, the regulations elaborate on the notion of "market" to be used in implementing the LCOM rule. These stipulations cover both purchased and manufactured items. In addition, it indicates that under the LIFO costing method, "the inventory shall be taken at cost regardless of market value." That is, no LCOM option is granted to a LIFO firm. Moreover, it indicates that once a taxpayer chooses between the cost and LCOM bases of valuation, his chosen method should be consistently used. In particular, once a taxpayer chooses to use the cost (LCOM) basis of valuation, permission from the Commissioner of IRS must be secured to switch to the LCOM (cost) basis.

For precision, we should, therefore, distinguish between two general FIFO methods: the one based on "historical cost" valuation methods and the one based on LCOM methods.5/ After this is done, all of our remarks and results apply to whatever FIFO method is selected for examination. But, given our objectives, there is really no need to distinguish between these two general FIFO methods. And we shall not do so. The reader can treat all results as applying to one or the other of these methods.

Some additional remarks on LIFO and LCOM are in order. As indicated above, the LCOM rule is not available to those who opt to use LIFO for tax reporting. At first galnce, this might seem to provide a basic valuation method to FIFO firms but not to LIFO firms. And, when "market" is below LIFO "cost", it seems to deny a tax deduction of the sort that can be obtained by a FIFO firm when FIFO cost exceeds "market." There are, however, devices for undoing this seemingly discriminatory regulation. For example, a LIFO firm can effectively obtain the results of the LCOM rule by actually liquidating the inventoried items whose "costs" exceed their "market" values--and then by repurchasing them if it is optimal to do so.6/ This route often seems to escape the attention of works on inventory methods. But recognition of it is not novel. It was recognized many years ago by, for example, Butters and Niland [1949] in some remarks on the implications of LCOM rules for LIFO firms. They noted the following (on pp. 118-119):

> Most Lifo inventories are carried at prices well below current levels. If these inventories are reduced, as of the end of any taxable year for any category of goods, the difference between Lifo costs and current costs will be brought into income. With the pronounced price rises of recent years, the effects on income will be large; hence the tax incentive not to liquidate Lifo inventories and incur increased tax liabilities.
>
> Tax incentives also tend to discourage physical increments to Lifo inventories when prices are high. Since such increments must be carried permanently at their acquisition costs, regardless of

> future price declines, it is obviously desirable to build up physical inventories at as low prices as possible.
>
> A Lifo company may, however, get out from under inventory increments acquired at high prices by liquidating them in later years; in this event, the liquidated goods will be charged against income at their high book valuations. Thus, the tax incentives to hold inventories down to beginning-year quantities are not so strong as those to build inventories up to this level. If Lifo inventories are expanded in periods of high costs, the inability to reduce income by writing down the high-cost increments during a period of future price decline can be overcome at the taxpayers option by the actual liquidation of these increments as of the end of any year. If, however, Lifo inventories are partly liquidated when inventory costs are high, the income resulting from charging low-cost Lifo inventories against current sales must be taken into income immediately and taxes be paid on it with no opportunity for later offsetting adjustments. The special dispensation given to involuntary wartime liquidations constitutes the only exception to this last statement.

If a LIFO firm incorporates these (or similar) loss-recognition opportunities into its tax-reporting decision rules, then the definition of $\tilde{C}_t^L$ must recognize the effects of exploiting these opportunities. In the end, this simply leads to distinctions among methods of implementing LIFO. Our results must be understood to pertain to one such implementation strategy. As will be indicated, there is a variety of other reasons for treating the inventory-method choice problem as one involving a multidimensional decision variable. (See Sec. 6.) There is more involved here than just choosing LIFO over FIFO, because there are many acceptable ways of implementing these basic inventory valuation methods. More on this later.

4. Explicit Equilibrium Valuation of Alternative Inventory Methods.

4.1 Preliminaries

The value of W_{oi} , i = 1, 2, . . . , T, and thus the equilibrium value of $V_o^L - V_o^F$, can be expressed via whatever model characterizes the setting of cash-flow sequences' equilibrium values. We shall assume that a multiperiod extension of the Sharpe/Lintner two-parameter asset pricing model provides a descriptively adequate characterization. As will be seen, this assumption places some important restrictions on the sources of uncertainty that are permitted to exist, an issue explored in detail by Fama [1977]. And some additional restrictions not required by the Sharpe/Lintner framework will be invoked for the sake of tractibility. In return, we shall attain a framework that provides insights on the LIFO/FIFO choice problem and that leads to testable propositions on the extent to which firms' choices are consistent with value maximization.

We begin by establishing the equilibrium value of one of the cash-flow differences associated with switching from one inventory method to another--say from FIFO to LIFO. Consider the value of the difference $(\tilde{C}_T^L - \tilde{C}_T^F)$ as of time T - 1, i.e., the value of $W_{T-1,T}$. Conditional on the Sharpe/Lintner version of the two-parameter asset pricing model, one gets

$$(12) \quad W_{T-1,T} = (1+R_{fT})^{-1}\left[E_{T-1}(\tilde{C}_T^L-\tilde{C}_T^F)-\lambda_T\frac{Cov_{T-1}(\tilde{C}_T^L-\tilde{C}_T^F,\tilde{V}_{mT})}{\sigma_{T-1}(\tilde{V}_{mT})}\right]$$

where $E_{T-1}(\,.\,)$, $\sigma_{T-1}(\,.\,)$ and $Cov_{T-1}(\,.\,,\,.\,)$ denote, respectively, expectations, variances, and covariances assessed at time T-1; $\tilde{V}_{mT}$ is the value of the "market portfolio" (or aggregate wealth) at time T; R_{fT} is the value of the equilibrium zero variance ("risk free") rate of return for the period T-1 to T; $(1+R_{fT})^{-1}$ is the time T-1 equilibrium price per unit of expected dollar return (where the return will be observed at time T); and $(1+R_{fT})^{-1}\ \lambda_T$ is the time T-1 equilibrium price per unit of risk (applied to the risk of a payoff to be observed at time T).[7] With risk averse investors, $\lambda_T>0$. See Sharpe [1964] or Lintner [1965]. Throughout, we shall assume that the assessed variance of $\tilde{V}_{mt}$, for each t, is constant.

By imposing some additional restrictions, this expression and those to follow can be made substantially more tractable. The following restrictions are added:

(R.1) For every t, the quantity of output sold at time t, q^*_t, is less than or equal to the quantity produced during the period t-1 to t.

(R.2) For every t, the quantity of output sold at time t exceeds or equals the quantity, q^B_t, in the beginning inventory of the period t-1 to t. Thus, q^B_t equals the quantity of output available at time t-1 and sold at time t. This restriction is equivalent to the assumption that inventory "turnover" (in terms of quantities) exceeds or equals unity.

Restriction (R.1) implies that there will never be any "lifo liquidations" for the LIFO firm. Cost-of-goods-sold for the LIFO firm will, therefore, be determined entirely by current period costs of acquisition and production. Restriction (R.2) implies that the FIFO firm will never have to consider more than two "cost layers": the current period's production and acquisition costs and the previous period's costs.

By definition, for each t, the quantity sold is

(13) $q^*_t \equiv q^B_t + (q^*_t - q^B_t)$

where, from (R.2), $q_t^* \geq q_t^B$. At the end of each period t, conditional on information available at t-1, the LIFO and FIFO costs of goods sold are, respectively,

$$(14)\quad \tilde{C}_t^L = \tilde{p}_t\tilde{q}_t^* \qquad \text{[from (R.1)]}$$

$$= \tilde{p}_t q_t^B + \tilde{p}_t(\tilde{q}_t^* - q_t^B) \qquad \text{[from (13)]}$$

$$(15)\quad \tilde{C}_t^F = \tilde{p}_t(\tilde{q}_t^* - q_t^B) + p_{t-1}\ q_t^B\ ) \qquad \text{[from (13) and (R.2)]}$$

where, for each t, $\tilde{p}_t$ is the per unit cost of production (or acquisition) incurred for a unit produced (or acquired) during the period from t-1 to t. This is an "historical cost" number--except when the LCOM basis of valuation is adopted. When the LCOM basis is adopted and "market" is less than "cost," the total inventory write-down at time t is assumed to be allocated to units sold at time t--on a constant per unit basis. Thus, in the latter case, the per unit "historical costs" that would otherwise be used to determine costs of goods sold are reduced by an amount equal to the total write-down divided by q_t^*.

Using (18) and (19), one gets, for each t,

$$(20)\quad \tilde{C}_t^L - \tilde{C}_t^F = \tilde{p}_t q_t^B - p_{t-1} q_t^B$$

$$= (\tilde{p}_t - p_{t-1}) q_t^B$$

$$= \Delta\tilde{p}_t q_t^B$$

where $\Delta\tilde{p}_t \equiv (\tilde{p}_t - p_{t-1})$. By using (20) in (12) one gets:

$$(21)\quad W_{T-1,T} = (1+R_{fT})^{-1}\left[E_{T-1}(\Delta\tilde{p}_t q_T^B) - \lambda_T \frac{\mathrm{Cov}_{T-1}(\Delta\tilde{p}_T q_T^B, \tilde{V}_{mT})}{\sigma(\tilde{V}_{mT})}\right]$$

$$= E_{T-1}(\Delta\tilde{p}_T q_T^B)\left[\frac{1-\lambda_T^*\ \mathrm{Cov}_{T-1}(\Delta\tilde{p}_T q_T^B\ ,\ \tilde{R}_{mT})/E_{T-1}(\Delta\tilde{p}_T q_T^B\ )}{1+R_{fT}}\right]$$

since $\tilde{V}_{mT} = (1+\tilde{R}_{mT})V_{mT-1}$, where $\tilde{R}_{mT}$ is the rate of return on the market portfolio from time T-1 to T, and where $\lambda^*_T \equiv \lambda_T/\sigma(\tilde{R}_{mT})$.

Note that $\tilde{W}_{TT} = \Delta\tilde{p}_T q^B_T$. Also, by definition,

$$(22)\quad E_{T-1}(\tilde{W}_{TT}) = (1+E_{T-1}(\tilde{R}_{TT}))W_{T-1,T}$$

where, in general, $\tilde{R}_{st}$ is the rate of return from time s-1 to s on an asset whose sole cash payoff is $\tilde{C}^L_t - \tilde{C}^F_t$. Thus, using (21) and (22), one has:

$$(23)\quad [1+E_{T-1}(\tilde{R}_{TT})]^{-1} = \left[\frac{1-\lambda^*_T \, \mathrm{Cov}_{T-1}(\Delta\tilde{p}_T q^B_T \,,\, \tilde{R}_{mT})/E_{T-1}(\Delta\tilde{p}_T q^B_T)}{1+R_{fT}}\right]$$

Observe that the only cash-flow specific quantity on the right hand side of (23) is

$$(24)\quad \frac{\mathrm{Cov}_{T-1}(\Delta\tilde{p}_T q^B_T \,, \tilde{R}_{mT})}{E_{T-1}(\Delta\tilde{p}_T q^B_T)} = \mathrm{Cov}_{T-1}\left(\frac{\Delta\tilde{p}_T q^B_T}{E_{T-1}(\Delta\tilde{p}_T q^B_T)} \,,\, \tilde{R}_{mT}\right)$$
$$= \mathrm{Cov}_{T-1}\left(\frac{\tilde{E}_T(\Delta\tilde{p}_T q^B_T)}{E_{T-1}(\Delta\tilde{p}_T q_T)} \,,\, R_{mT}\right)$$

where $\tilde{E}_T(\Delta\tilde{p}_T q^B_T) = \Delta\tilde{p}_T q^B_T$, from the calculus of probability. Thus, at time T-1, the only source of variation in the equilibrium expected rates of return on different assets is the extent to which the percentage changes in the <u>expected</u> payoffs on the assets covary with the percentage changes in aggregate wealth. The values of λ^*_T and R_{fT} also affect the investment opportunity set facing investors at time T-1. But these values do not vary across assets.

The previous expressions result from applying the Sharpe/Lintner model to a single period setting--with the period extending from time T-1 to time T. In order to apply this single-period model to a multiperiod pricing problem--and thus to obtain values of W_{sT} for all s<T--we must impose restrictions on the intertemporal behavior of the opportunity sets

facing investors at different times. As indicated in Fama [1977], a sufficient condition for the applicability of the single-period Sharpe/Lintner model to a multiperiod world is that the opportunity set facing investors at a given future point in time be known at all preceding points within the multiperiod horizon. Thus, since equilibrium expected rates of return from t-1 to t, for any t, are components of the opportunity set at time t-1, this implies that these expected values must be known at all times $s \leq t-1$. For the case at hand, the value of $E_{T-1}(\tilde{R}_{TT})$ in (23) must be known at all times $s \leq T-1$. From the right-hand side of (23), one can see that this implies, in general that the values of λ^*_T, R_{fT}, and $\mathrm{Cov}_{T-1}(\Delta\tilde{p}_T q^B_T, \tilde{R}_{mT})/E_{T-1}(\Delta\tilde{p}_T q^B_T)$ are nonstochastic.

This has an immediate important implication for establishing the equilibrium value of $\tilde{W}_{T-1,T}$ at time T-2--which is also the equilibrium value of $\tilde{C}^L_T - \tilde{C}^F_T$ at time T-2. Using (23) and (21), one sees that the only admissible source of uncertainty about the value of $\tilde{W}_{T-1,T}$ is uncertainty about the value of $\tilde{E}_{T-1}(\Delta\tilde{p}_T q^B_T)$ --which is an expectation whose value will be set at time T-1 on the basis of information available at that time. I.e., the value of this expectation at time $s < T-1$ is, in general, a random variable. In addition, the calculus of probability implies that this expectation must evolve over time according to a martingale model; see Doob [1953; pp. 91-94]. I.e., the stochastic process $\tilde{E}_s(\tilde{C}^L_T - \tilde{C}^F_T)$, for $s \leq T-1$, is a martingale process.

One model consistent with martingale behavior and convenient for our purposes is:

$$(25) \quad \tilde{E}_s(\tilde{C}^L_T - \tilde{C}^F_T) = E_{s-1}(\tilde{C}^L_T - \tilde{C}^F_T)(1+\tilde{\eta}_{sT})$$

where $E_{s-1}(\tilde{\eta}_{sT})=0.0$. By definitiion, $\tilde{\eta}_{sT}$ is the percentage change from time s-1 to s in the <u>expected</u> <u>value</u> of $(\tilde{C}_T^L - \tilde{C}_T^F)$.

As of time T-2, the next-period payoff induced by 100% ownership rights in the terminal payoff $(\tilde{C}_T^L - \tilde{C}_T^F)$ is given by

$$(26)\quad \tilde{W}_{T-1,T} = \tilde{E}_{t-1}(\tilde{C}_T^L - \tilde{C}_T^F)\ [1+E_{T-1}(\tilde{R}_{TT})]^{-1},$$

which follows from (21) and (23). Incorporating (25) into (26) gives, for time T-2,

$$(27)\quad \tilde{W}_{T-1,T}=[E_{T-2}(\tilde{C}_T^L - \tilde{C}_T^F)(1+\tilde{\eta}_{T-1,T})]\ [1+E_{T-1}(\tilde{R}_{TT})]^{-1}$$

And upon applying the Sharpe/Lintner model to get the equilibrium value of $\tilde{W}_{T-1,T}$ as of time T-2, one gets:

$$(28)\quad W_{T-2,T} = (1+R_{f,T-1})^{-1}\ [E_{T-2}(\tilde{W}_{T-1,T}) - \lambda^*_{T-1}\ \mathrm{Cov}_{T-2}(\tilde{W}_{T-1,T}, \tilde{R}_{mT-1})]$$

$$= E_{T-2}(\tilde{W}_{T-1,T}) \left[\frac{1-\lambda^*_{T-1}\ \mathrm{Cov}_{T-2}(\tilde{W}_{T-1,T}, \tilde{R}_{mT-1})/E_{T-2}(\tilde{W}_{T-1,T})}{1+R_{f,T-1}}\right]$$

where, from (27),

$$(29)\quad E_{T-2}(\tilde{W}_{T-1,T})=E_{T-2}(\tilde{C}_T^L - \tilde{C}_T^F)[1+E_{T-1}(\tilde{R}_{TT})]^{-1}$$

$$(30)\quad \mathrm{Cov}_{T-2}(\tilde{W}_{T-1,T}, \tilde{R}_{mT-1})=E_{T-2}(\tilde{C}_T^L - \tilde{C}_T^F)[1+E_{T-1}(\tilde{R}_{TT})]^{-1}\mathrm{Cov}_{T-2}(\tilde{\eta}_{T-1,T}, \tilde{R}_{mT-1})$$

and, using (29) and (30),

$$(31)\quad \frac{\mathrm{Cov}_{T-2}(\tilde{W}_{T-1,T}, \tilde{R}_{mT-1})}{E_{T-2}(\tilde{W}_{T-1,T})} = \mathrm{Cov}_{T-2}(\tilde{\eta}_{T-1,T}, \tilde{R}_{mT-1}).$$

But from (25) applied to s=T-1,

$$(32)\quad \mathrm{Cov}_{T-2}(\tilde{\eta}_{T-1,T}, \tilde{R}_{mT-1})=\mathrm{Cov}_{T-2}\left(\frac{\tilde{E}_{T-1}(\tilde{C}_T^L - \tilde{C}_T^F)}{E_{T-2}(\tilde{C}_T^L - \tilde{C}_T^F)}, \tilde{R}_{mT-1}\right)$$

In short, the admissible risk affecting the equilibrium value of $W_{T-2,T}$ pertains to the covariation of percentage changes in aggregate wealth at time T-1, $\tilde{R}_{mT-1}$, and percentage changes in <u>expected</u> <u>values</u> (or forecasts) of the terminal cash flow from time T-2 to T-1, $\tilde{E}_{T-1}(\tilde{C}^L_T-\tilde{C}^F_T)/E_{T-2}(\tilde{C}^L_T - \tilde{C}^F_T)$.

Ultimately one finds that, as of T-2,

$$(33)\quad W_{T-2,T}=E_{T-2}(\tilde{C}^L_T - \tilde{C}^F_T)\ [1+E_{T-2}(\tilde{R}_{T-1,T})]^{-1}\ [1+E_{T-1}(\tilde{R}_{TT})]^{-1}$$

and as of t=0,

$$(34)\quad W_{o,T}=E_o(\tilde{C}^L_T - \tilde{C}^F_T)\prod_{i=o}^{T-1}[1+E_i(\tilde{R}_{i+1,T})]^{-1}\quad .$$

Thus, whether or not $W_{o,T}>0$--and thus whether or not LIFO should be preferred to FIFO for given production-investment decisions--depends on the sign of $E_o(\tilde{C}^L_T - \tilde{C}^F_T)$ and the signs of the equilibrium expected values of the one-period rates of return, $\tilde{R}_{i+1,T}$, i=0, 1, . . . , T-1. Whether or not the latter are or are not positive depends, in part, on the values of $Cov_i(\tilde{W}_{i+1,T},\tilde{R}_{m,i+1})/E_i(\tilde{W}_{i+1,T})$, for i=0,1, . . . , T-1.

Applying the mechanics underlying (32) to each value of i, one sees that the values of the latter covariances ultimately depend on the joint stochastic properties of $\tilde{E}_{i+1}(\tilde{C}^L_T - \tilde{C}^F_T)/E_i(\tilde{C}^L_T - \tilde{C}^F_T)$ and $\tilde{R}_{m,i+1}$. Since $(\tilde{C}^L_T - \tilde{C}^F_T)= \Delta\tilde{p}_T\tilde{q}^B_T$, we can get some insights on the determinants of these values by considering the stochastic properties of $\Delta\tilde{p}_T\tilde{q}^B_T$, as seen at any time i<T. Since, in general, $\tilde{E}_{i+1}(\tilde{C}^L_T - \tilde{C}^F_T)=\tilde{E}_{i+1}(\Delta\tilde{p}_T\tilde{q}^B_T)$ $=\tilde{E}_{i+1}(\Delta\tilde{p}_T)\tilde{E}_{i+1}(\tilde{q}^B_T) + \tilde{Cov}_{i+1}(\Delta\tilde{p}_T,\tilde{q}^B_T)$, for i<T, attention must be given to both the expected values of $\Delta\tilde{p}_T$ and $\tilde{q}^B_T$ and the covariance of $\Delta\tilde{p}_T$ and $\tilde{q}^B_T$.

4.2 Remarks on Determinants of Equilibrium Values

First note that $\Delta\tilde{p}_T$ need not be uncorrelated with $\Delta\tilde{q}_T^B$. Indeed, it is unlikely to be uncorrelated. Thus, one should probably not expect $\widetilde{\text{Cov}}_{i+1}(\Delta\tilde{p}_T, \tilde{q}_T^B)=0$ for any i. One reason for expecting (or at least not precluding) an association between $\Delta\tilde{p}_T$ and $\tilde{q}_T^B$ is that the latter variable is a result of a firm's production (or acquisition) and inventory management strategies. And it seems likely that the decisions made at any point in time--such as decisions about ending inventory levels--would be based upon anticipated production costs relative to the current period's production costs. I.e., it seems likely that the value of $\tilde{q}_T^B$ will be based upon predictions of $\Delta\tilde{p}_T$. If the forecasting method used by a firm exploits some of the systematic features of the process generating values of $\Delta\tilde{p}_T$, then the forecasted values of $\Delta\tilde{p}_T$ will be correlated with $\Delta\tilde{p}_T$. And if $\tilde{q}_T^B$ is monotonically related to the forecasted value of $\Delta\tilde{p}_T$, then one can expect an induced correlation between $\tilde{q}_T^B$ and $\Delta\tilde{p}_T$ in this case.

It seems worth noting that various "market structure" factors may influence the strength of the connection between $\tilde{q}_T^B$ and $\Delta\tilde{p}_T$. Presumably, the inaccuracy of a firm's cost-change forecasts (as measured by, e.g., mean squared errors) will vary directly with the number and importance of exogenous sources of uncertainty (i.e., those beyond the firm's control)--for a given level of total variability of $\Delta\tilde{p}_T$. In other words, inaccuracy should vary inversely with the extent to which a given firm influences $\Delta\tilde{p}_T$. Thus, for given total variability of $\Delta\tilde{p}_T$, one should expect a lower absolute value of $\mathrm{Cov}_{i+1}(\Delta\tilde{p}_T, \tilde{q}_T^B)$, for any i, in a perfectly competitive market than in an imperfectly competitive one, such as a perfect monopsony.[8/]

The extent to which per unit costs reflect intertemporal cost allocations--which may be to a large extent in capital intensive industries --will also contribute to a relationship between $\Delta\tilde{p}_T$ and $\tilde{q}_T^B$ if these allocations are of amounts fixed in total but variable per unit, such as periodic depreciation charges on manufacturing equipment. In this case, if the observed level of $\tilde{q}_T^B$ is correlated with total output for period T or period T-1, then this level will be inversely correlated with $\tilde{P}_T$ or $\tilde{P}_{T-1}$. This may induce a relationship between $\tilde{q}_T^B$ and $\Delta\tilde{p}_T = \tilde{p}_T - \tilde{p}_{T-1}$, depending on the joint stochastic properties of output in period T-1 and output of period T. In the extreme case where per unit production costs reflect nothing but intertemporally allocated costs, there will be no exogenous sources of uncertainty affecting $\Delta\tilde{p}_T$ except for those affecting the levels of expenditures on "fixed factors" and those that directly affect utilization of these factors--such as uncertainties regarding demanded quantities, bottlenecks, strikes, and breakdowns. In line with our previous remarks, one should expect a strong association between $\Delta\tilde{p}_T$ and $\tilde{q}_T^B$ in this case, for a given total variability of $\Delta\tilde{p}_T$.

The above remarks provide some insights on the types of factors that will affect the periodic assessed values of $\tilde{\mathrm{Cov}}_{i+1}(\Delta\tilde{p}_T, \tilde{q}_T^B)$ and thus the values of $\tilde{E}_{i+1}(\tilde{C}_T^L - \tilde{C}_T^F)$. Consequently, they provide insights on some of the determinants of the equilibrium value of $W_{o,T}$, as expressed in (34). Additional and more precise insights can be obtained by imposing seemingly reasonable restrictions on the joint distribution function of $\tilde{E}_{i+1}(\Delta\tilde{p}_T)$, $\tilde{E}_{i+1}(\tilde{q}_T)$, and $\tilde{R}_{mi+1}$, for each i<T. This is done in the next section, which imposes the condition of joint symmetry.

4.3 Determinants of Equilibrium Values Under Joint Symmetry.

Applying the mechanics behind (32) to any i, i=0, 1, 2, . . . , T-1, one gets, as of time i,

$$(35)\quad \mathrm{Cov}_i\left(\frac{\tilde{E}_{i+1}(\tilde{C}^L_T - \tilde{C}^F_T)}{E_i(\tilde{C}^L_T - \tilde{C}^F_T)}, \tilde{R}_{m,i+1}\right)$$

$$= [E_i(\Delta\tilde{p}_T\tilde{q}^B_T)]^{-1} \; \mathrm{Cov}_i(\tilde{E}_{i+1}(\Delta\tilde{p}_T q^B_T), \tilde{R}_{mi+1})$$

and from the discussion below (34),

$$(36)\quad \mathrm{Cov}_i(\tilde{E}_{i+1}(\Delta\tilde{p}_T\tilde{q}^B_T), \tilde{R}_{mi+1})$$

$$= \mathrm{Cov}_i(\tilde{E}_{i+1}(\Delta\tilde{p}_T)\tilde{E}_{i+1}(\tilde{q}^B_T), \tilde{R}_{mi+1})$$

$$+ \mathrm{Cov}_i(\tilde{\mathrm{Cov}}_{i+1}(\Delta\tilde{p}_T, q^B_T), \tilde{R}_{mi+1}).$$

We add the following restrictions:

(R.3) For each i, $\tilde{\mathrm{Cov}}_{i+1}(\Delta\tilde{p}_T, \tilde{q}^B_T)$ is uncorrelated with $\tilde{R}_{mi+1}$.

(R.4) For each i, $\mathrm{Cov}_o(\tilde{n}_{1T}, \tilde{R}_{m1}) = \mathrm{Cov}_i(\tilde{n}_{i+1,T}, \tilde{R}_{mi+1})$

(R.5) For each i, the random variables $\tilde{E}_i(\Delta\tilde{p}_T)$, $\tilde{E}_i(\tilde{q}^B_T)$, and $\tilde{R}_{mi}$ are jointly symmetric.[9/]

Restriction (R.4) implies that, as of time t=0,

$$(37)\quad \mathrm{Cov}_o\left(\frac{\tilde{E}_1(\tilde{C}^L_T - \tilde{C}^F_T)}{E_o(\tilde{C}^L_T - \tilde{C}^F_T)}, \tilde{R}_{m1}\right) = \mathrm{Cov}_1\left(\frac{\tilde{E}_2(\tilde{C}^L_T - \tilde{C}^F_T)}{\tilde{E}_1(\tilde{C}^L_T - \tilde{C}^F_T)}, \tilde{R}_{m2}\right)$$

$$= \ldots = \mathrm{Cov}_{T-1}\left(\frac{\tilde{C}^L_T - \tilde{C}^F_T}{\tilde{E}_{T-1}(\tilde{C}^L_T - \tilde{C}^F_T)}, \tilde{R}_{mT}\right)$$

$$= [E_o(\tilde{C}^L_T - \tilde{C}^F_T)]^{-1} \; \mathrm{Cov}_o(\tilde{E}_1(\tilde{C}^L_T - \tilde{C}^F_T), \tilde{R}_{m1})$$

This restriction implies, therefore, that all temporal variation in the equilibrium expected one-period returns, $E_i(\tilde{R}_{i+1,T})$, i=0, 1, . . . , T-1, is due to temporal variation in the equilibrium prices of dollar return, $(1+R_{fi})^{-1}$, i=1, 2, . . . , T, or in the equilibrium prices of risk $(1+R_{fi})^{-1}\lambda_i^*$, i=1,2, . . . , T.

Restriction (R.3) implies that the value of the last covariance term in expression (36) is equal to zero. Thus, a joint implication of restrictions (R.3) - (R.5) is:

$$(38) \quad \mathrm{Cov}_i(\tilde{\eta}_{i+1,T}, \tilde{R}_{mi+1}) = [E_o(\tilde{C}_T^L - \tilde{C}_T^F)]^{-1} \mathrm{Cov}_o(\tilde{E}_1(\Delta\tilde{p}_T)\tilde{E}_1(\tilde{q}_T^B), \tilde{R}_{m1}),$$

for each i, where 10/

$$(39) \quad E_o(\tilde{C}_T^L - \tilde{C}_T^F) = E_o(\Delta\tilde{p}_T\tilde{q}_T^B)$$
$$= E_o(\Delta\tilde{p}_T)E_o(\tilde{q}_T^B) + \mathrm{Cov}_o(\Delta\tilde{p}_T, \tilde{q}_T^B)$$

$$(40) \quad \mathrm{Cov}_o(\tilde{E}_1(\Delta p_T)\tilde{E}_1(q_T^B), \tilde{R}_{m1}) = E_o[\tilde{E}_1(\Delta\tilde{p}_T)]\mathrm{Cov}_o(\tilde{E}_1(\tilde{q}_T^B), \tilde{R}_{m1})$$
$$+ E_o[\tilde{E}_1(\tilde{q}_T^B)]\mathrm{Cov}_o(\tilde{E}_1(\Delta\tilde{p}_T), \tilde{R}_{m1})$$

Since $E_o[\tilde{E}_1(\Delta\tilde{p}_T)] = E_o(\Delta\tilde{p}_T)$ and $E_o[\tilde{E}_1(\tilde{q}_T^B)] = E_o(\tilde{q}_T^B)$, (40) can be rewritten as:

$$(41) \quad \mathrm{Cov}_o(\tilde{E}_1(\Delta\tilde{p}_T)\tilde{E}_1(\tilde{q}_T^B), \tilde{R}_{m1}) = E_o(\Delta\tilde{p}_T)\mathrm{Cov}_o(\tilde{E}_1(\tilde{q}_T^B), \tilde{R}_{m1})$$
$$+ E_o(\tilde{q}_T^B)\mathrm{Cov}_o(\tilde{E}_1(\Delta\tilde{p}_T), \tilde{R}_{m1})$$

Under restrictions (R.1) - (R.5), expressions (39) and (41) give the only firm-specific parameters relevant to the choice of either LIFO or FIFO, at least insofar as one of the cash flow differences, $\tau(\tilde{C}_T^L - \tilde{C}_T^F)$, induced by this choice is concerned. All other parameters that are determinants of the value of W_{oT}, in (34), are common to all firms. The next section provides some remarks on the firm specific parameters.

4.4 Remarks on Equilibrium Values Under Joint Symmetry

From (34), (39), and (41), it is seen that the equilibrium value, τW_{oT}, of the LIFO-induced flow, $\tau\tilde{C}_T^L$, over the FIFO-induced flow, $\tau\tilde{C}_T^F$, for period T depends on the forecast of time T-1 ending inventory $\tilde{q}_T^B$, the forecast of the change in per unit production (or acquisition) costs, $\Delta\tilde{p}_T$, from time T-1 to time T, the covariation of future forecasts with percentage changes in aggregate wealth, $Cov_o(\tilde{E}_1(\Delta\tilde{p}_T),\tilde{R}_{m1})$ and $Cov_o(\tilde{E}_1(\tilde{q}_T^B),\tilde{R}_{m1})$, and the covariation, $Cov_o(\Delta\tilde{p}_T,\tilde{q}_T^B)$, of the time T-1 ending inventory and the per unit cost change, $\Delta\tilde{p}_T$, from time T-1 to time T. All of these forecasts and values of covariances are as of time t=0, when the LIFO and FIFO methods are being compared.

Presumably, for a given level of output (and thus a given level of intertemporally allocated costs per unit of sales) the covariance between $\tilde{E}_1(\Delta\tilde{p}_T)$ and $\tilde{R}_{m1}$ will vary directly with the extent to which events at time t=1 alter time t=1 forecasts of prices for factors of production (e.g., raw materials) and the extent to which the input-price changes from T-1 to T are expected to affect the per unit change in costs from T-1 to T. Evidently, this covariance's absolute value will be lower the greater the extent to which per unit production costs consist of intertemporally allocated amounts (e.g., depreciation) and thus amounts that are less responsive to period-by-period variations in the economy, as reflected by the percentage changes in aggregate wealth.

Of course, the value of $Cov_o(\tilde{E}_1(\Delta\tilde{p}_T),\tilde{R}_{m1})$--and that of $E_o(\Delta\tilde{p}_T)$ and of $Cov_o(\Delta\tilde{p}_T,\tilde{q}_T^B)$--will, in general, depend upon a firm's cost accounting system (e.g., standard cost system vs. actual cost system). This covariance's absolute value will be larger the greater the extent to which a firm's system allows the economic events of period T to be reflected in the per unit costs for period T and the greater the extent to which the value of $\tilde{R}_{m1}$ has implications for the cost-affecting events of period T.

Moreover, the value of $Cov_o(\tilde{E}_1(\Delta\tilde{p}_T),\tilde{R}_{m1})$--and of $E_o(\Delta\tilde{p}_T)$ and $Cov_o(\Delta\tilde{p}_T,\tilde{q}_T^B)$--will depend upon technological features of the firm's production process--such as changes in optimal factor proportions along the firm's expansion path and changes in optimal factor proportions along an isoquant (in response to changes in relative input-prices).[11/] It seems reasonable to expect $\tilde{E}_1(\Delta\tilde{p}_T)$ to be more sensitive to "current" (time t=1) economic developments if these developments have implications for the events of time T and if the firm's production process implies an important role for productive factors that will be purchased on a period-by-period basis at prevailing market prices. This is the type of setting in which the value of $\Delta\tilde{p}_T$ will be significantly affected by contemporaneous changes in input prices, which are likely to be correlated with changes in the state of the economy (as reflected by variation in the market portfolio's returns). Of course, if firms within an industry (or some other specified grouping) are homogeneous regarding these attributes of their production processes, then one should expect to see industry concentrations of LIFO and FIFO use.

The elasticity of a firm's supply function is also likely to affect the firm's evaluation of alternative inventory methods. Presumably, at any point in time, a firm's quantity expectations--such as $E_o(\tilde{q}_T^B)$--will be consistent with the characteristics of its supply function. It seems, for example, unlikely that a firm's expected level of output and expected inventory balance will be substantially altered by current economic developments--as captured by $\tilde{R}_{ms}$, s=1,2, ,. . . , T--if the firm knows that it will face an inelastic supply function at time T. There is, however, more to this story.

As indicated at several points, the expectations being considered here are as of each point in time s < T and they are for random variables whose values will be observed at time T. Thus, the implications of $\tilde{R}_{ms}$ for <u>subsequent</u> events are relevant in evaluating the covariance terms involving $\tilde{R}_{ms}$ in (41). If such events are not among the arguments of the optimal decision rules that ultimately define output quantities, costs per unit of sales, and inventory levels, then there should be no correlation between $\tilde{R}_{ms}$ and the period s expectation of $\tilde{q}_T^B$ or of $\tilde{p}_T$. Moreover, there should be "internal consistency" regarding the assessed correlation between $\tilde{R}_{ms}$ and $\tilde{E}_s(\Delta\tilde{p}_T)$ and between $\tilde{R}_{ms}$ and $\tilde{E}_s(\tilde{q}_T^B)$, because, in general, $\tilde{q}_T^B$ and $\Delta\tilde{p}_T$ are not independently distributed random variables.

Of course, if the <u>expected</u> value of $(\tilde{C}_T^L - \tilde{C}_T^F)$, assessed as of time s<T, is uncorrelated with $\tilde{R}_{ms}$, then the single-period discount rates that determine the value of W_{oT} in (34) are the single-period zero-variance (or "risk free") rates corresponding to the time periods i=1,2, . . . , T, because (from (38) and (40)) the risk associated with $(\tilde{C}_T^L - \tilde{C}_T^F)$ would be zero for each i, i=1, 2, . . . , T. In this case, the only cash-flow specific determinant of W_{oT} is $E_o(\tilde{C}_T^L - \tilde{C}_T^F) = E_o(\Delta\tilde{p}_T)E(\tilde{q}_T^B) + \mathrm{Cov}_o(\Delta\tilde{p}_T, \tilde{q}_T^B)$.

In general, the value of W_{oT} increases with the extent to which the period T cost per unit, $\tilde{p}_T$, is expected to be greater than the period T-1 cost per unit, $\tilde{p}_{T-1}$. If $E_o(\Delta\tilde{p}_T)$ is greater (less) than zero, then W_{oT} increases (decreases) with the importance of the firm's expected inventory position, as reflected in $E_o(\tilde{q}_T^B)$. Moreover, the value of W_{oT} varies directly with the extent to which the change in per unit costs and the importance of inventory position vary together, as reflected in the value of $Cov_o(\Delta\tilde{p}_T, \tilde{q}_T^B)$. The value of this covariance will depend on the types of uncertainty that a firm faces and the nature of competition. If, for example, a firm in a perfect output market faces long-run supply function uncertainty but no demand function uncertainty, then output levels and production costs per unit should be uncorrelated. That is, all pairs of per unit costs and output levels should lie along a fixed demand function--which is horizonal for a given firm in a perfectly competitive market. In any event, it is clear that the production technology and the production uncertainty facing a firm are among the determinants of a firm's optimal choice of tax reporting methods.

4.5 <u>The Equilibrium Value of All Cash Flow Effects Induced by Alternative Reporting Methods</u>.

Expression (34) provides the equilibrium value of the cash-flow difference $(\tilde{C}_T^L - \tilde{C}_T^F)$ for the last period of a multiperiod horizon, conditional on the Sharpe/Lintner version of the two-parameter asset pricing model. The mechanics leading to this result can also be used for the cash-flow difference induced at each point in time s, s=1,2, . . . , T-1. This provides an expression for the overall equilibrium value of LIFO over FIFO as of time t=0, $V_o^L - V_o^F$, as given in (9). Specifically,

$$(42)\quad V_o^L - V_o^F = \tau\sum_{i=1}^{T} W_{oi}$$
$$= \tau\sum_{i=1}^{T}\left\{E_o(\tilde{C}_i^L - \tilde{C}_i^F)\prod_{s=0}^{i-1}[1+E_s(\tilde{R}_{s+1,i})]^{-1}\right\}$$

Note that the "discount factors" applied to a given expected cash flow difference-- $\tau E_o(\tilde{C}_i^L - \tilde{C}_i^F)$ for a fixed i--can vary over time. And the sequence of discount factors used for a given period's expected cash flow difference may differ, in whole or in part, from the sequence used for a different period's expected cash flow difference. From our previous analysis of W_{oT}--now applied to W_{oi} for each i-- one can see that the temporal differences for a given period's expected cash-flow difference will depend on the temporal variation in the risk of <u>that period's</u> cash flow difference. Also, quite naturally, the differences across different periods' cash-flow differences will depend upon the risk variations across these cash-flow differences, which may be induced by temporal changes in the sorts of economic determinants discussed in Secs. 4.2 - 4.5. Of course, for the cash flow difference, $(\tilde{C}_i^L - \tilde{C}_i^F)$, of each period i, i=1, 2, . . . , T, the relevant measure of risk at each time $s < i$, is $Cov_s(\tilde{\eta}_{s+1,i}, \tilde{R}_{ms+1})$, where $\tilde{\eta}_{s+1,i}$ denotes the percentage change from s to s+1 in the expected value of $(\tilde{C}_i^L - \tilde{C}_i^F)$. If the forecasted values of all cash-flow differences induced by switching from one inventory method to another are completely unaffected by contemporaneous events (as summarized in the value of $\tilde{R}_{ms}$, for each s) then all of these cash-flow differences are "riskless" payoffs, conditional on the Sharpe/Lintner model.

But this "riskless" case is a special case. And nothing unique to inventory reporting methods implies that a firm should expect to be faced by that case. In general, therefore, a firm may rationally select FIFO even though the expected cost-of-goods sold deduction for taxes under LIFO (i.e., $E_o(\tilde{C}_t^L)$) exceeds the expected value of this deduction under FIFO (i.e., $E_o(\tilde{C}_t^F)$) for each period t, t=1,2, . . . , T. The relevant issue is whether each period's expected "tax savings" under LIFO is sufficient to compensate for the additional risk induced by a switch from FIFO to LIFO. As indicated earlier, selecting the optimal tax reporting method is analogous to making optimal production-investment decisions in the sense that a balancing of "risk" and "return" is required. A firm that opts to use FIFO is not necessarily "sacrificing" a LIFO-induced "tax subsidy," as is often implied by discussions of LIFO's effects on cash flows and its effects on reported income numbers. In this regard, the following argument from Wallich and Wallich [1974; p. 128] is typical:

> In a period of inflation, FIFO has two great shortcomings. First, it overstates profits by including in them a sizable quantity of what are in essence capital gains on inventory. Second, by enlarging profits it also enlarges tax liabilities. This happens because the government insists that identical methods of inventory accounting be used in reporting to stockholders and to the Internal Revenue Service. A corporation, to be sure, can put one part of its inventories on LIFO and another part on FIFO or some other accounting basis. But the same accounting method or methods must still be used for both stockholders and tax collectors. So when roughly three out of four companies vote against LIFO, they are in effect choosing to pay additional taxes.

> Last year's surge of inventory profits confronts management with a serious question. Is it justifiable to forgo a legitimate means of holding down tax liabilities--namely, LIFO--in order to show higher profits? To go one step further, is it justifiable to make this tax sacrifice in order to show low-grade profits that by their nature are transient and in some measure illusory? Inventory profits generate no direct cash flow for investment, dividends, or even taxes. They are already embodied in the costlier inventory that the company needs to stay in business. Inventory profits, in other words, do not contribute to what today is the foremost function of profits--to increase the supply of investable funds. On the contrary, they deplete that supply by requiring corporations to make unnecessarily large tax payments.
>
> . . . .
>
> Only one argument on the anti-LIFO side seems to have gained in strength as inflation has escalated. Corporate officers are well aware that in a time of rapid inflation a switch to LIFO will have a negative impact on reported profits. They may fear that this would drag down the price of the stock. Surely, they can argue, it is in the interest of stockholders to pay even a substantial tax premium in order to avoid a decline in the price of the stock.

That the generalizations in this excerpt are, as they stand, somewhat misguided should be clear from our analysis. Note, for example, that a firm may rationally opt to use LIFO even though its expected tax deductions under LIFO are less than its expected deductions under FIFO in each period, t, t=1, 2, . . . , T. If, to consider an extreme case, the risks of the cash flow differences, $\tau(\tilde{C}_t^L - \tilde{C}_t^F)$, t=1, 2, . . . , T, are such that

(43) $$\prod_{i=0}^{t-1} [1 + E_i(\tilde{R}_{i+1,t})]^{-1} < 0$$

for each t, then $V_o^L - V_o^F > 0$ in (42) when $E_o(\tilde{C}_t^L - \tilde{C}_t^F) < 0$ for each t. The situation is even more complicated when some of the cash-flow differences induced by a switch to LIFO have positive time t=0 equilibrium values and others have negative values. Whether LIFO is or is not optimal in this case depends, from (42), on the value of the sum $\tau\sum_{i=0}^{T} W_{oi}$, which may incorporate a variety of offsetting values. In any event, the framework developed here indicates that, in general, it is not necessary to assume--as was effectively done by Sunder [1973b] and Abdel-khalik and McKeown [1977], among others--that the expected tax deduction under LIFO exceeds the expected deduction under FIFO in order to infer the desirability of switching to LIFO.[12/]

Our framework also points to a variety of testable propositions pertaining to firms' selections of inventory costing methods. And it identifies a variety of "empirical problems" likely to be encountered in work on the effects of accounting techniques and changes in techniques on capital market equilibrium. These are among the issues considered in the next section.

5. Assessing the Effects of Accounting Techniques: Relative Risk Differences, Other Empirical Problems, and Some Testable Propositions

Several studies on accounting methods (or method changes) point to an empirical connection between relative risk (or risk changes) and accounting methods (or method changes). Evidence on this issue with respect to inventory method changes is provided by Sunder [1973b; Table 6] and Ball [1972; Table 4]. Both authors infer that, on average, firms switching to (or extending their use of) LIFO experience increases in relative risk. Various possible reasons for a relationship between changes in accounting methods and relative risk changes were offered, on grounds of plausibility. But they were, nevertheless, ad hoc, as in other studies of this type.[13] More specifically, it was not presumed at the outset that risk changes should be expected for firms that change the inventory methods used for tax reporting.

The framework developed in Secs. 2-4 clearly indicates, however, that, other things equal, a change in relative risk should be regarded as "the rule" rather than "the exception" when there is a change in inventory costing methods. This can be seen by using the rate-of-return version of the Sharpe/Lintner model. This model implies that the relative risk for a portfolio of assets is equal to the value-weighted average of the component assets' relative risks (defined in terms of rates of returns). The value-weight for any component asset equals the current equilibrium value of that asset divided by the current equilibrium value of the entire portfolio. If relative risks of dollar returns--rather than rates of return--are used, then the relative risk of the portfolio is simply the sum of the relative risks of the component assets.

From expression (10) in Sec. 2.3, it is seen that, for given production-investment decisions, the single-period dollar payoff conditional on LIFO, $\tilde{V}_1^L$, is equivalent to the combined payoffs $\tilde{V}_1^F$ and $\tau\tilde{W}_{1i}$, i=1,2,...,T. Thus, the relative risk of the dollar return conditional on LIFO, β_v^L, as of t=0, can be written as:

$$\beta_v^L = \beta_v^F + \tau\sum_{i=1}^{T} \beta_w^i$$

where β_v^F is the time t=0 relative risk conditional on FIFO and β_w^i is the time t=0 relative risk of the asset with time t=1 payoff $\tilde{W}_{1i}$, i=1,2,...,T. (As before, we assume that the tax rate, τ, is constant over time.) It would seem somewhat coincidental to have $\sum_{i=1}^{T} \beta_w^i = 0$. Thus, rather than designing empirical tests on the assumption of constant relative risks--and thus exposing oneself to one of the internal validity deficiencies noted by Demski [1973;p.49]--it appears that one should presume that relative risk changes are likely to be experienced by firms that change inventory costing methods for tax reporting. This, in effect, involves a change in one of the maintained hypotheses underlying empirical work regarding the effects of accounting changes on capital market equilibrium.

The situation is a little different for analyses of firms that change both their production investment decisions and their inventory reporting methods. It is also different for cross-sectional analyses wherein firms that may be pursuing different production-investment decisions end up being treated as homogeneous because they are pursuing the same inventory costing method.

As indicated in Sec. 2, a given set of production-investment decisions implies the optimality of either LIFO or FIFO. Thus, all firms pursuing that set will, in equilibrium, pursue one or the other reporting method. But then not all firms pursuing the same reporting method will be pursuing the same set of production investment decisions if more than two sets of decisions are on the efficient frontier of feasible production investment decisions. In this case, homogeneity with respect to inventory methods used for tax reporting necessarily implies, in general, heterogeneity with respect to substantive attributes of production-investment decisions--as does heterogeneity with respect to inventory methods. Unless one is willing to presume that differences among the risk attributes of $\{(\tilde{C}_t^L - \tilde{C}_t^F);\ t=1,2,\ldots,T\}$ for firms pursuing a given reporting method offset risk differences among their different production-investment decisions, one should presume, it seems, that firms pursuing a given inventory method have different relative risks. In different words, risk inequality rather than risk equality should be the "working hypothesis" guiding one's design of experiments.

The above remarks point to a specific aspect of a more general problem identified by our framework: holding "other things" constant when attempting to empirically assess the effects of alternative accounting methods. If, for example, a given firm is adhering to the market value rule and if it now changes its tax reporting methods, our framework implies that it did so because of substantive changes in its production-investment decisions. If the latter changes are not taken into account, attempts to assess the effects of accounting methods using both prechange and postchange data seem likely to produce misleading results, even though one is conducting the analysis on a firm by firm basis (which might otherwise make the "other things equal" presumption plausible). For the case at hand, there are solid theoretical reasons for assigning a low probability to the descriptive adequacy of the "other things equal" assumption.

Similar remarks apply to cross-sectional analyses based on different firms' data for a given time period. Attempts to assess the effects of accounting methods (using the observed different methods of the different firms) without explicitly recognizing the effects of substantive differences among the firms will probably not satisfy the condition of holding "other things" constant. The fact that the different firms opted for different accounting methods implies that their production-investment decisions are different. Moreover, as indicated above, there are grounds for expecting this to also be the case for the different firms that opted for the same accounting method.

These sorts of issues are often considered after a study is designed and perhaps initiated--typcially as a result of observing anomalies. The lack of a model or framework for characterizing firms' selections of accounting methods is probably one reason for this. The framework provided in Sections 2-4 provides some basic ingredients for filling this gap. As it stands, it only applies to the LIFO/FIFO decision. But it can obviously be extended to other accounting method choices, at least when they have direct (or contractually induced) effects on firms' future values.[14/]

In addition to identifying problems that are likely to be encountered in the design of experiments dealing with the effects of accounting techniques, the framework developed here points to some basic testable propositions on firms' selections of accounting methods. Suppose that managers' and investors' distributional assessments are dominated by the weight of available sample evidence and that these assessments are in agreement.[15/] Further suppose that sampling distributions conditional on available evidence adequately represent investors' and managers' predictive distributions. Under these assumptions, sample values of the parameters that appear in the valuation expressions for W_{ot}, $t=1,2,\ldots,T$, can be used to test for firms' adherence to the optimality conditions for alternative inventory methods. Pursuing this line of attack would not lead to unusual data problems if firms routinely disclosed values of accounting numbers based on their selected methods and alternative methods. But this is usually not done, at least on a regular basis. Thus, one might have to resort to the use of approximations to what firms would have disclosed. Such approximations for inventory and cost-of-goods-sold numbers can be secured via available conversion methods, most of which are based upon some variant of the Dollar-Value-Lifo method; see, e.g., Derstine and Huefner [1974].

Alternatively, one might use sample evidence on variables that are, on theoretical or empirical grounds, taken to be determinants of the parameter values that appear in the valuation expressions for W_{ot}, t=1,2,...,T. For example, if it is felt that demand function uncertainty directly affects the risk contribution of the cash-flow sequence $\{(\tilde{C}_t^L-\tilde{C}_t^F);\ t=1,2,\ldots,T\}$, then data on the determinants of demand for a firm's output (e.g., data on relative prices, new product introductions, competitors' advertising expenditures, etc.) could be used. Supply function uncertainty could be modeled in terms of data on net new entry into a firm's markets, technological changes (as measured by, e.g., patent applications), and the flexibility/adaptability of so-called "fixed factors" of production (which influences the extent to which resources can be shifted from one use to another, as indicated by, e.g., Stigler [1939]. In any event, a variety of indirect approaches can be used to conduct tests of the implications of firms' adherence to value maximization in their selection of inventory methods, perhaps with the aid of simplifying restrictions such as (R.1)-(R.5); see Sec. 4. Since the data needed for direct tests may not be available or adequate, these indirect tests may be more appealing than direct tests. At least they cannot, it appears, be declared to be dominated by the currently feasible direct tests.

The framework developed here is based upon a variety of simplifications that may adversely affect its descriptive adequacy. Some of these simplifications and their potential effects are briefly discussed in the next section.

6. Complications and Extensions

By design, the equilibrium conditions given here fail to explicitly recognize a variety of complicating factors, some of which are induced by the regulations of the U.S. Internal Revenue Code (IRC). Some of these complications and their potential influence are considered below. They point to possible extensions of our theoretical framework and to factors that will probably complicate empirical work based on this framework.

We assumed that any firm can freely switch from one inventory method to another at time t=0 and that new "managerial terms" can--after, for example, a takeover or a reorganizaiton--freely switch methods at time t=0. This assumption is important in our characterization of the mechanism which leads to enforcement of the market value rule. In reality, the "reporting history" of a firm and the perspective of the Internal Revenue Service (IRS) commissioner may contrain a firm's choices. Strictly speaking, switches of methods used for tax reporting must be approved by the IRS Commissioner. Various conditions (pertaining to, e.g., restated values of inventory numbers and their effects on values of income numbers) may be imposed on a firm as a condition of approval. Presumably, if the switch is to a method that IRS deems to be "correct," given the firm's production investment decisions, then the switch will be approved.[16/] The firm's "reporting history" may also play a role here: it appears that IRS gives nontrivial weight to "consistency." I infer this from Sec. 1.471-2(f) of the IRC regulations. It is there stated that:

> ...inventory rules cannot be uniform, but must give effect to trade customs which come within the scope of the best accounting practice in the particular trade or business. In order clearly to reflect income, the inventory practice of a taxpayer should be consistent from year to year, and greater weight is to be given to consistency than to any particular method of inventorying or basis of valuation....

In short, this (and other) IRC regulations on accounting changes may introduce frictions into the value maximization process underlying our framework. As a result, one might observe $V_o^L > V_o^F$ for a FIFO firm or $V_o^F > V_o^L$ for a LIFO firm. Yet, these firms might not switch to the value maximizing methods, because of the IRC regulations pertaining to switches. For the same reason, the value maximization conditions may not be enforceable via takeovers, reorganizations, or other devices for introducing new managerial teams.

Another potentially restrictive condition is our assuming that inventory method choices are irrevocably made at time t=0. I.e., after t=0, there are no provisions for additional switches during the horizon ending at time T. On the one hand, this restriction is made palatable by IRS's apparent emphasis on "consistency." On the other hand, the degree of inflexibility implied by this restriction seems somewhat extreme. It precludes not only switches after time t=0, but also "extensions" of methods first selected at time t=0--no matter how production-investment decisions change after time t=0.

Perhaps of greater importance is our treating the inventory method choice problem as one that involves a dichotomous choice: LIFO or FIFO (or, more precisely, LIFO and non-LIFO). A firm may, in actuality, be using both methods concurrently. Moreover, for each method, a variety of other decisions must be made. In general, a firm must select the types of inventories to which each method will be applied (e.g., raw materials, work-in-process, finished goods, and various subclasses of the latter) and it must select the specific methods to be used in computing "cost" (e.g., actual acquisition costs, dollar-value lifo, average acqusition costs computed over a specified time period, among others). These sorts of details increase the dimensionality of the decision variable associated with optimal selections of inventory methods. They do not, however, alter the basic aspects of our framework; they just add to the variety of ingredients defining an "optimal method." For example, these additional details do not alter our conclusions about the correspondence between optimal methods and the characteristics of firms' production-investment decisions. Nor do they eliminate the connection between firms' relative risks and their selected methods.

Finally, although our framework recognizes the dependence of optimal inventory methods on production-investment decisions, it does not deal explicitly with a potential dependence between optimal inventory methods and other accounting methods used for tax reporting. An obvious example of a potential connection of this sort is that between inventory methods and depreciation methods used for manufacturing equipment. Since the resulting values of depreciation charges affect the costs allocated to inventoriable goods, the depreciation methods can affect the stochastic characteristics of cost-of-goods-sold numbers and, therefore, the stochastic characteristics of the tax deductions attainable under alternative inventory methods. In short, developing a more descriptively adequate framework may involve using an explicitly joint optimization approach with respect to several accounting methods used for tax reporting.

7. Summary

This paper deals with the general topic of the effects of firms' accounting techniques and changes in techniques on firms' equilibrium values. The specific technique considered is the inventory costing method adopted for tax reporting. But the general issues pertinent to this inventory-method choice problem are also pertinent to firms' selections of other techniques that have (direct or indirect) effects on the distribution functions of firms' future values. A general issue of particular interest here is the connection between the effects of accounting techniques on firms' equilibrium values and the substantive attributes of firms' production-investment decisions. A framework dealing with this issue provides a basis for getting theoretical insights into firm's selections of accounting techniques, for explaining some available empirical results that have heretofore been regarded as somewhat mysterious, and for improving the experimental designs used in empirical work on the effects of accounting techniques.

Our results indicate that a value maximizing firm's optimal inventory method is inextricably bound to the characteristics of a firm's production-investment decisions and that the method selected affects the characteristics of the distribution function of a firm's future value as of the end of any period--and thus, in general, it affects the firm's current equilibrium value. Moreover, in equilibrium, all firms pursuing production-investment decisions of the same type will also pursue the same inventory costing method. But the same method will, in general, be optimal for firms pursuing different types of production-investment decisions, so long as the number of production-investment decisions exceeds the number of different inventory methods. Loosely speaking, the value maximizing mapping from types of decisions to optimal inventory methods is a many-to-one mapping.

Our results have a variety of implications for available empirical work on the effects of accounting techniques. For example, they imply that, in general, one should expect to observe changes in the relative risks of firms that change inventory methods--assuming that multiperiod two-parameter asset pricing adequately describes the setting of assets' equilibrium values. This connection between relative risks and changes in inventory methods is not an anomaly, a reflection of some systematic sample selection bias, or a quirk of available sample evidence--which seems to be the way it is usually treated in available empirical studies; see, e.g., Ball [1972] and Sunder [1973]. Nor is it something to be ignored in the design of one's experiment. Indeed, one should presume from the outset that relative risks change and, therefore, that it is not appropriate to use estimation methods that do not allow for such changes at the time inventory methods are changed.

Moreover, our results imply that if matching control ("nontreatment") firms are used in an attempt to "hold other things constant" when assessing the information content of inventory method changes, then matching firms on the basis of prechange values of their relative risks will not suffice to hold the effects of risk differences constant or to abstract from the effects of risk changes. Unless the group of firms making inventory method changes is so well diversified that their risk changes (induced by contemporaneous inventory method changes) are offsetting, the risk of the portfolio of firms in this group will change. In addition, if the risk of the portfolio of control group firms is stationary, then the risks of the two groups will differ after the inventory method changes are made. These things may have affected the empirical results of, for example, Abdel-khalik and McKeown [1978], who used the control group approach to abstract from differential risks and risk changes in their examination of the effects of switches to the LIFO method.

In addition to identifying these sorts of "empirical problems," the framework developed here points to some basic, testable propositions on firms' selections of accounting methods. In this regard, testing the implications of firms' adherence to the value maximization rule is of particular interest. For example, one might test for the joint optimality of different accounting methods used for tax reporting when the different methods interact with each other. Depreciation methods used for manufacturing equipment and inventory costing methods are among these methods--because they jointly determine the values of cost-of-goods-sold numbers.

It is not unusual to observe a firm's simultaneously using several inventory methods for tax reporting--with each method used for a different component of the tax-deductible cost of goods sold number (e.g., the costs of different products). The framework developed here implies that components for which different methods are used should have different stochastic properties. One can conduct tests using firms that adopt different methods for different divisions or subsidiaries--in order to assess the consistency of these differences with the joint optimality of the firms' accounting method choices. Finally, one might conduct tests on firms that report to several tax authorities in order to determine whether differences among the methods used to report to different authorities are consistent with the joint optimality of firms' reporting methods. Multinational firms operating in several substantially different tax regimes might be suitable for this sort of test.

Of course, any test for consistency with value maximization will involve getting results that deal directly or indirectly with both the expected returns and risks induced by alternative inventory methods. Results (or a priori statements) about just the expected returns--which is what one usually finds in treatments of the inventory method choice problem--will not suffice.

Not unexpectedly, our framework does not explicitly recognize a variety of complicating factors, some of which are induced by the regulations of the Internal Revenue Code. These complications and their potential influence point to possible extensions of our framework and to additional "empirical problems."

FOOTNOTES

1/ See Fogelson [1975] for a discussion of techniques and restrictive covenants in credit agreements and indentures.

2/ See Sec. 1.471 of the U.S. Internal Revenue Code for Regulations pertaining to inventory accounting. Unless otherwise indicated, the compendium used for this paper is Prentice-Hall [1963].

3/ Alternatively, one can assume that the cost-of-goods sold numbers recorded for tax purposes already incorporate the effects of this option, conditional on optimal use of the option at each point in time.

4/ The random variable $\tilde{x}$ is said to be "stochastically equivalent," or just "equivalent," to the random variable y if $Pr(\tilde{x} \neq \tilde{y}) = 0$, where Pr(.) denotes probability.

5/ It is worth noting that write-downs under LCOM (or equivalent loss recognitions secured via sales/repurchases) alter the timing of loss realizations for tax purposes. If, at time t, the market value of inventory is less than the inventory's "historical cost" by an amount equal to, say, X_t, then the use of LCOM induces a tax "saving" equal to τX_t at time t and an ending inventory valuation equal to an amount that is less than it would otherwise be by an amount equal to X_t. If inventory turnover exceeds unity, then the FIFO period t+1 cost of goods sold (taxable income) will be less (greater) than it would otherwise be by an amount equal to X_t. Thus, taxes payable will be greater than they would otherwise be by an amount equal to τX_t. If there is no write down at time t, then cost of goods sold (taxable income) at time t+1 will be higher (lower) than it would otherwise be by an amount equal to X_t--resulting in taxes payable equal to an amount less than they would otherwise be by an amount equal to τX_t at time t+1. In the end, the writedown at time t allows the firm to increase its wealth by an amount equal to whatever profits are expected on the additional investment of τX_t for the period from t to t+1. Similar remarks apply to available writedowns at each point in time in a multiperiod setting. Of course, under the existing tax system, no firm will survive if sales of inventoried items constitute its sole source of profits and if it systematically acquires (produces) goods that are sold at less than acquisition (production) cost.

[6] There is no "wash sale" rule that precludes this. Of course, "arms length" transactions must be used for both the sales and the repurchases.

[7] In general, the distribution function of $\tilde{V}_{mt}$, for any t, depends on the private sector's choices of tax reporting methods. But we are looking at things from the perspective of one firm in a perfect market setting--a setting in which each firm behaves as if it does not affect the distribution function of $\tilde{V}_{mt}$, for any t.

[8] Monopsony rather than monopoly is relevant here because $\Delta \tilde{p}_T$ is the change in the per unit cost of production, not the per unit price to purchasers of the produced output.

[9] The implication of joint symmetry used below is as follows. Let $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$ be jointly symmetric. Then

$$E[(\tilde{x}-\mu_x)(\tilde{y}-\mu_y)(\tilde{z}-\mu_z)] = 0.0$$

where μ_x, μ_y, and μ_z denote the expected values of $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$, respectively.

[10] The general result underlying expression (40) is as follows. In general, for any random variables $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$,

$$\mathrm{Cov}(\tilde{x}\tilde{y},\tilde{z}) = E(\tilde{x})\mathrm{Cov}\ (\tilde{y},\tilde{z}) + E(\tilde{y})\ \mathrm{Cov}(\tilde{x},\tilde{z}) + E[(\tilde{x}-\mu_x)(\tilde{y}-\mu_y)(\tilde{z}-\mu_z)].$$

where μ_x, μ_y, and μ_z denote the expected values of $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$, respectively. If the joint distribution function of $\tilde{x}$, $\tilde{y}$, and $\tilde{z}$ is symmetric, then the last term in the above sum has a value equal to zero. A derivation of this result on covariances of products of random variables is given by Bohrnstedt and Goldberger [1969].

[11] The latter changes in factor proportions could be summarized via elasticities of substitution, given perfectly competitive input markets.

[12] This assumption can be inferred from the discussion on pp. 854-855 of the Abdel-khalik/McKeown paper. In Sunder's paper, it is implied by his assumption of an "inflationary" environment and nondecreasing inventory levels; see pp. 8 and 9 of his paper or pp. 27 and 28 of Sunder [1973a]

13/ Note that Sunder's attempted explanation of risk changes (see Sunder [1973a; Sec. 5]) is conditional on his assumption that changes in accounting methods are independent of changes in the characteristics of production-investment decisions (see Sunder [1973a; p. 27]). The framework developed here makes it clear that changes in accounting methods and changes in the characteristics of production investment decisions necessarily go together--given adherence to the market value rule. Also, contrary to Sunder's statements, neither the wage-lag hypothesis nor the debtor-creditor hypothesis plays any special role in linking the characteristics of production-investment decisions to accounting methods.

14/ Debt-agreement covenants expressed in terms of accounting numbers may lead to contractually induced effects; see, e.g., Fogelson [1978]. Incentive-compensation plan terms expressed in terms of accounting numbers may have the same effect. When these sorts of contractually induced effects are recognized, there may be substantive economic reasons for the types of economic behavior often referred to (somewhat pejoratively) as "income smoothing" or "earnings management." In short, seemingly "cosmetic" changes in reported earnings numbers may be motivated by substantive economic reasons. The mere fact that an accounting-technique change does not have direct effects on cash flows--because, e.g., it does not affect tax reporting--is not a sufficient basis for claiming that the change has no substantive economic implications or that it is motivated only by managements' attempts to make their past performance "look better" by "managing" reported values of accounting numbers.

15/ Under a variety of conditions, this would be the case after repeated updating of prior distribution functions for the random variables that are determinants of firms' terminal values, conditional on firms' production-investment decisions and inventory methods.

16/ Helpful remarks on the technicalities of switching inventory methods are given in Coopers & Lybrand [1974; pp. 23 and 46-47] and in Ernst & Ernst [1977].

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