A Note on Estimating the Economic Impact of the LIFO Method of Inventory Valuation

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During times of inflation, the use of the last-in, first-out (LIFO) method of inventory valuation has the effect of lowering the reported earnings by excluding inventory holding gains from this number. Current income tax payments due on the reduced earnings are also lower. Taxes payable on inventory holding gains, therefore, are postponed until some future period when the inventory is liquidated. Thus, the economic consequence of using LIFO in the presence of inflation, is to increase the current net cash flow of the firm. Since the value of a business entity can be represented as the discounted net present value of future cash flows, a change to LIFO also implies a change in the value of the firm, which is positive during inflation and negative during deflation. This paper presents a simple, easy-to-use model to estimate the economic effect of the adoption and use of LIFO on the value of a firm. This model can be used by the management of a firm considering an accounting change to or from LIFO to evaluate the economic impact of such a change. The model also can be used by investors and security analysts to evaluate the change in the economic value of the firms which make such accounting changes.

Briefly, the economic effect of LIFO depends on the size of inventory, expected rate of inflation, the firm's cost of capital or discount rate and the marginal tax rate. Development of the model is followed by a brief discussion of its implementation.

Model

Consider a steady state firm which expects to hold the same physical amount of inventory for the foreseeable future. The firm is considering a switch to LIFO for a part of its inventory which now is valued at X_0 under FIFO on a cost basis. The economic effect of such a change on the firm can be measured by the present value of the difference between net cash flows obtained under the LIFO and FIFO methods. The present value of differential cash flows (referred to as PV hereafter) depends on the number of years for which the accounting change remains in effect, the basic cost and changes in the replacement cost of the inventories involved over years and the marginal tax rate and the cost of capital of the firm. In the following paragraphs we develop an expression for PV in terms of these variables.

The firm anticipates that the replacement value of the inventory at the end of year t will be X_t. The rate of price change

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in the tth year will be I_t. Under the assumption that the physical quantity of inventory remains constant, X_t can be written in terms of the initial value X_0 and successive rates of price change:

$$X_t = X_0(1 + I_1)(1 + I_2) \cdots (1 + I_t). \quad (1)$$

X_t is also the value assigned to the inventory under FIFO. During year t, the FIFO value will increase by $(X_t - X_{t-1})$. On the other hand, under the LIFO method, the value assigned to the inventory will remain unchanged at X_0 in all years. Due to the difference in cost flow assumptions of the two methods of inventory valuation, the LIFO cost of sales in year t will exceed the FIFO cost of sales by the amount $(X_t - X_{t-1})$; the LIFO pretax income would be greater than the FIFO income by $(X_{t-1} - X_t)$. If G_t is the marginal tax rate for the firm in year t, the tax liability of the firm, and, therefore, the cash outflow in year t, would be lower under LIFO by an amount $G_t(X_t - X_{t-1})$.

Suppose the firm is interested in examining the economic consequences of switching to LIFO now and using it until year T when the firm reverts back to the FIFO method. We can compare the present value of the difference between the cash flows associated with (1) the continued use of FIFO and (2) the use of LIFO for the next T years, after which the firm returns to FIFO. The cash flow consequence of LIFO for each of the first $T-1$ years, $t = 1, 2, \cdots, T-1$ is given by $G_t(X_t - X_{t-1})$. For the Tth year, FIFO earnings will include the inventory holding gain $(X_T - X_{T-1})$ for that year. But under LIFO, the inventory holding gains for all T years, $(X_T - X_0)$ will be included in the earnings of the Tth year when the firm resumes the use of FIFO. Therefore, the LIFO income would exceed the FIFO income by $(X_{T-1} - X_0)$. The additional cash outflow under LIFO due to the tax liability on inventory holding gains would be $G_T(X_{T-1} - X_0)$.

If r_t is the cost of capital of the firm for year t, the discounted present value of the difference between cash flows under the LIFO and FIFO methods, PV, can be written as:

$$PV = \sum_{t=1}^{T-1} \frac{G_t(X_t - X_{t-1})}{\prod_{i=1}^{t}(1 + r_i)} - \frac{G_T(X_{T-1} - X_0)}{\prod_{i=1}^{T}(1 + r_i)}. \quad (2)$$

From (1), X_t can be substituted by

$$X_0 \prod_{i=1}^{t}(1 + I_i)$$

$$PV = X_0\left[\sum_{t=1}^{T-1} \frac{I_t G_t \prod_{i=1}^{t-1}(1 + I_i)}{\prod_{i=1}^{t}(1 + r_i)} - \frac{G_T}{(1 + r_T)} \prod_{i=1}^{T-1}\left(\frac{1 + I_i}{1 + r_i}\right) + \frac{G_T}{\prod_{i=1}^{T}(1 + r_i)}\right]. \quad (3)$$

Expression (3) can be simplified considerably if we assume that the anticipated rate of price changes, marginal tax rate and the cost of capital remain constant for all years, that is, $I_t = I$, $G_t = G$ and $r_t = r$ for all t. Then,

$$PV = X_0 \cdot G\left[I \sum_{t=1}^{T-1} \frac{(1 + I)^{t-1}}{(1 + r)^t} - \frac{(1 + I)^{T-1}}{(1 + r)^T} + \frac{1}{(1 + r)^T}\right]$$
$$= X_0 \cdot G \left\{\frac{I}{r - I}\left(1 - \left(\frac{1 + I}{1 + r}\right)^{T-1}\right) \quad (4)$$

$$- \frac{(1+I)^{T-1}}{(1+r)^T} + \frac{1}{(1+r)^T}\Bigg\}.$$

The expression for PV can be further simplified if T, the year in which the firm switches back to FIFO, is allowed to become very large or, in other words, if the switch to LIFO is made permanent. When the anticipated rate of price change, I, is less than the discount rate, r, the last three terms in expression (4) approach zero as T tends to infinity. Then the limiting value of PV is

$$PV = \frac{X_0 \cdot G}{\dfrac{r}{I} - 1} \qquad \text{for } r > I. \tag{5}$$

In other words, under the assumption of constant physical quantity of inventory, marginal tax rate, rate of price change and cost of capital, the present value of the difference between cash flows under LIFO and FIFO systems of inventory valuation, PV, is directly proportional to the basic cost of inventory, X_0, and the marginal tax rate G. PV is inversely proportional to $(S-1)$, where S is the ratio of discount rate to the rate of price change. It is important to point out that expression (5) is valid only under the restriction that r, the discount rate, be greater than I, the rate of price change, i.e., the real rate of discount must be positive. If this restriction does not hold, the present value of tax savings from LIFO under inflation will increase without bounds as the value of T is increased to infinity. No such restriction is necessary in expressions (3) and (4) for the value of PV when the use of LIFO is limited to a finite number of years.

The dependence of the present value of cash flow differences on parameters, G, P, X_0, I and r can be examined by partially differentiating PV with respect to each:

$$\frac{\partial PV}{\partial X_0} = G \bigg/ \left(\frac{r}{I} - 1\right) \qquad \text{for } r > I. \tag{6}$$
$$\begin{cases} \geq 0 & \text{if } I \geq 0 \\ \leq 0 & \text{if } I \leq 0. \end{cases}$$

The effect of altering the quantity of inventory under LIFO depends on the anticipated rate of price change, since the partial derivative is positive under inflation and negative under deflation. Clearly, if a larger quantity of inventory were put under LIFO during times of deflation, larger cash outflows would occur. The effect of change in marginal tax rate, G,

$$\frac{\partial PV}{\partial G} = X_0 \bigg/ \left(\frac{r}{I} - 1\right) \qquad \text{for } r > I \tag{7}$$
$$\begin{cases} \geq 0 & \text{if } I \geq 0 \\ \leq 0 & \text{if } I \leq 0 \end{cases}$$

on PV is similar to the effect of changes in X_0.

$$\frac{\partial PV}{\partial I} = X_0 \cdot G \cdot r/(r-I)^2 \qquad \text{for } r > I \tag{8}$$
$$> 0 \qquad \textit{for positive } r.$$

The effect of an increase in the rate of price change is always to increase the relative advantage of LIFO over FIFO, except in the unlikely case when the discount rate r is negative. To examine the effect of a change in discount rate itself,

$$\frac{\partial PV}{\partial r} = -\frac{X_0 \cdot G \cdot I}{(r-I)^2} \qquad \text{for } r > I \tag{9}$$
$$\begin{cases} \geq 0 & \text{for } I \leq 0 \\ \leq 0 & \text{for } I \geq 0. \end{cases}$$

When prices are increasing, the effect of an increase in the discount rate is to reduce the relative advantage of LIFO over FIFO. At first glance, this result appears to some as being counterintuitive.[1] Since the tax advantages of LIFO under inflation are only temporary in the sense that tax payments only are postponed and not

[1] I am grateful to George Sorter for a very useful discussion I had with him on this point.

TABLE 1

NET PRESENT VALUE OF CASH FLOW DIFFERENCES UNDER LIFO AND FIFO FOR $1 OF BASIC INVENTORY ($X_0 = 1$)

See Expression (5).

Ratio of Discount Rate to the Rate of Price Change r/I, $r>I$	*Marginal Tax Rate (Percent)*						
	0	*10*	*20*	*30*	*40*	*50*	*60*
1.1	0	1.00	2.00	3.00	4.00	5.00	6.00
1.2	0	0.50	1.00	1.50	2.00	2.50	3.00
1.3	0	0.33	0.67	1.00	1.33	1.67	2.00
1.4	0	0.25	0.50	0.75	1.00	1.25	1.50
1.5	0	0.20	0.40	0.60	0.80	1.00	1.20
1.8	0	0.125	0.25	0.375	0.50	0.625	0.75
2.0	0	0.10	0.20	0.30	0.60	0.50	0.60
2.5	0	0.067	0.13	0.20	0.27	0.33	0.40
3.0	0	0.05	0.10	0.15	0.20	0.25	0.30
3.5	0	0.04	0.08	0.12	0.16	0.20	0.24
4.0	0	0.033	0.067	0.10	0.13	0.17	0.20
4.5	0	0.03	0.06	0.09	0.11	0.14	0.17
5.0	0	0.025	0.05	0.075	0.10	0.125	0.15

eliminated, one might expect that the relative advantage of LIFO would only increase with an increase in r, the time value of money. Without presenting a detailed discussion of the issue here, we shall only state that the effect of changes in the discount rate on PV depends, among other things, on T, the number of years for which LIFO is used. For small values of T, the effect of changes in the discount rate on PV under inflation is, indeed, positive and not negative as shown in (9). As the value of T increases, the additional tax differences between LIFO and FIFO become increasingly distant, and the predominant effect of discounting on tax deferments far into the future is to reduce their importance. Thus, when T is increased towards infinity, the overall effect of an increase in the discount rate on the present value of the advantage of LIFO under inflation is negative. Symmetrically, the effect of an increase in r on the relative advantage of FIFO under deflation is also negative, as can be seen from (9). It might be pointed out that expressions (5) to (9) are applicable only when T tends towards infinity. For finite values of T, appropriate relationships can be obtained by differentiating partially expressions (3) and (4) with respect to various parameters of interest.

Since r and I appear in expression (5) in form r/I, the value of PV remains unchanged by proportionate changes in both r and I.

APPLICATION

Application of the simplified model (5) is quite straightforward after values of the three parameters have been estimated. The possible net present values of cash flow differences for $1 worth of basic inventory have been shown in Table 1 for various values of parameters G and r/I. If parameters G and r/I are not expected to remain unchanged in the future, the simplified model (5) would provide only an approximation. If more detailed estimates of r, I and G are available, equation (3) can be used to determine the economic impact of a prospective accounting change to LIFO. If it is not possible to obtain single-point estimates of r/I and G, a range of estimates can be used to obtain a "ball-park" figure for the effect of the accounting change.

It might be pointed out that the economic effect of LIFO on the value of the firm may, in certain cases, exceed the basic cost of the inventory involved. This will happen whenever the marginal tax rate, G, is greater than $(r/I-1)$.

Concluding Remarks

A model for estimating the change in the economic value of a firm due to the adoption and use of LIFO under conditions of certainty has been presented. The model requires single-point estimates of three parameters: the marginal tax rate, the cost of the basic inventory and the ratio of the cost of capital of the firm to the anticipated rate of inflation. In estimating the effect of LIFO on the economic value of the firm, the analysis has been limited to the net present value of future cash flows. Any additional risk that the firm may have to bear due to uncertainty in the future rates of inflation and, therefore, in the effect of LIFO on the firm has not been considered. Indeed, there is some empirical evidence available to indicate that the adoption of LIFO is accompanied not only by an increase in the market value of the firm, but also by an increase in the market risk of its ownership shares [Sunder, 1973 and 1975a]. Development of a model which incorporates the risk characteristics of the accounting change under discussion here would appear to be a fruitful channel for further investigation.

The critical assumptions of the model are that the physical quantity of inventory remains constant and the rates of price change, discount and taxation are known deterministically. Relaxation of these assumptions to obtain more realistic estimates of the economic effects of LIFO would be another direction for further research [Sunder, 1975b].

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