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The LIFO/FIFO Choice: An Asymmetric Information Approach

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1. *Introduction*

There has been a vast empirical literature examining the reactions of investors to a firm's switch from the "first-in, first-out" (*FIFO*) to the "last-in, first-out" (*LIFO*) method of valuing inventory, beginning with Sunder [1973] and continuing through Dopuch and Pincus [1988]. This discretionary accounting change has captured the interests of researchers because of the direct effect on the firm's cash flows and presumably also on the firm's value.

This body of empirical results has raised several conundrums which question both the rationality of the market response and the economic motivation of managers. Lev and Ohlson [1982] review the empirical studies and conclude that the results subsequent to Sunder [1973] showing a negative market reaction are disturbing. The conundrums are first, that a large number of firms continue to use *FIFO*, foregoing billions of dollars in tax savings;[1] second, that firms which switch to *LIFO* appear to do so slowly;[2] and third, that *LIFO* adoptions may be accompanied by either a positive or a negative stock price change.[3]

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[1] "In 1979 the IRS estimated that if all firms which could have switched that year had done so, approximately $18 billion less in corporate income taxes would have been paid. Current estimates indicate potential savings of at least $6 billion annually" (Biddle and Martin [1985, p. 34]).

[2] Morse and Richardson [1983] find that for a sample of firms which switched to *LIFO* in 1939–78, positive mean tax benefits from *LIFO* existed for each of the five years prior to the switch.

[3] Positive price changes are reported by Sunder [1973] and Biddle and Lindahl [1982] and negative price changes by Brown [1980] and Ricks [1982].

Many papers have alluded to the potential for an accounting method choice to serve as a signal of inside information about investment and production activities (e.g., Gonedes and Dopuch [1974] and Dye [1985]). In this paper we attempt to explain the *LIFO/FIFO* puzzle through an information-signaling approach. First, we define the relevant costs and benefits of a *FIFO* choice and then derive the conditions under which a *FIFO* choice may serve as a credible signal of favorable private information by managers. Second, we analyze the conditions under which all firms select *LIFO* (*FIFO*) and no firm has an incentive to deviate to *FIFO* (*LIFO*). Finally, we study the market reaction to switches from *FIFO* to *LIFO*, and, in particular, we establish that there may be conditions under which a negative price reaction will be observed for the switching firms.

The conceptual basis of our model is that managers possess private information regarding the firm's future prospects. The manager must select an inventory cost-flow assumption while recognizing that his compensation, either explicitly or implicitly, depends on both current and future market prices. Investors attempt to learn the manager's private information by observing the *LIFO/FIFO* choice and price the firm's securities accordingly. Managers anticipate investor reactions to the *LIFO/FIFO* choice and include these in their decision problem. Rational expectations equilibria in which managers maximize their compensation and investors correctly price securities are obtained using the Nash concept that no agent has incentives to deviate from the equilibrium, taking the actions of other agents as given.

We show that there is an equilibrium in which managers truthfully signal their private information by not switching from *LIFO* to *FIFO* if and only if their information is favorable. Firms with favorable information remain at *FIFO*, thereby foregoing reduced taxes and the opportunity of reducing expected bankruptcy costs. The benefit of not switching is an immediate increase in the market value of the firm due to investors' belief that such behavior signals favorable information. Conversely, firms with unfavorable information choose to switch because the cost of being recognized as a low-quality firm does not exceed the current and future tax benefits and reduction in expected bankruptcy costs. Moreover, we show that, in some environments, the switching firms receive both the benefits of an increase in current market value and the tax benefits.

We view the *LIFO/FIFO* decision to be a tax-planning decision rather than a choice of an accounting method. If there are potential tax benefits associated with *LIFO*, these benefits cannot be realized without a switch to *LIFO* for financial reporting. The fact that *LIFO* was rarely used prior to its acceptance for tax accounting suggests that a switch to *LIFO* for financial reporting is merely a by-product of the decision to minimize current tax payments. Consequently, the effect of the inventory method choice on the financial statements is not relevant to our model.

Since the choice of *FIFO* in our model is in essence a decision to reduce cash flows, it can be considered as an example of a generic type of signals. We choose to focus on *FIFO* rather than some other cash-reducing signal because we observe that many firms continue to use *FIFO*,[4] and this continuing reluctance to switch to *LIFO* is generally regarded as an anomaly.

In section 2 we present the basic model and identify critical assumptions. The separating equilibrium in which firms with favorable information choose *FIFO* and those with unfavorable information choose *LIFO* is discussed in section 3. Section 4 deals with the conditions under which pooling equilibria at *FIFO* or *LIFO* will exist. In section 5 we derive the predicted price reactions to switches from *FIFO* to *LIFO*, and we show that, in spite of its simplicity, our model offers a potential justification for many of the unresolved puzzles. Section 6 summarizes specific empirical findings and relates them to our model. Finally, we conclude the paper with a summary of our main findings.

2. *The Model*

We develop a simple model to focus on the manager's choice of a method of accounting for inventory costs in a world of asymmetric information. In the model, the manager has private information about the firm's future cash flows and, under certain conditions, credibly communicates this information to investors through the choice of a *FIFO* or *LIFO* inventory method. Simplifying assumptions are employed in order to concentrate on the informative role of the *LIFO/FIFO* choice.

Consider an economy in which there are two dates, the current date t_0 and a future date t_1, and two types of firms which differ only in the expected after-tax cash flow at t_1.[5] Firms with the higher expected cash flow μ_G will be referred to as "good" firms and those with the lower expected cash flow μ_B as "bad" firms, where μ_G and μ_B are the expected after-tax cash flows under *FIFO*. Under certain conditions[6] which are assumed to exist, the use of *LIFO* provides tax savings which increase the after-tax cash flows at t_1 by the discounted present value of tax savings until the firm or its inventory is liquidated. We will let T_G and T_B represent the tax savings for good and bad firms respectively. In general we would expect T_G to exceed T_B since the effective tax rate for bad firms might be less than that for good firms due to the greater likelihood of experiencing nonpositive cash flows and paying no taxes. Therefore, the use of *LIFO* shifts the distribution of after-tax cash flows

[4] As reported by *Accounting Trends and Techniques* in a survey of the accounting practices of 600 firms in 1986, 393 used *LIFO* to any extent, and only 229 of these 393 firms used *LIFO* for more than 50% of their inventory.

[5] That is, the cash flows for both types of firm have the same type of distribution and variance.

[6] Tax benefits with *LIFO* exist under inflation, positive marginal tax rates, and no decline in inventory.

to the right such that the new distribution has an expected value of $\mu_i + T_i$ (for $i = G, B$) and the same variance. The asymmetry of information is about both μ_i and T_i.

We assume that if the realized cash flow at t_1 falls below the level P, the firm is bankrupt and bears a fixed bankruptcy cost F. Since we assume that P and F are the same for all firms, we are in effect assuming that all firms have the same amounts of debt payments due at t, and all firms face identical bankruptcy costs.[7] The role of the promised debt payment P as a signal of expected cash flows has been explored by Ross [1977]. We are prohibiting the manager from communicating inside information via other signals such as debt level or dividend policy because the purpose of this analysis is to determine whether *FIFO* choice can serve as a signal. We are not addressing the question of which signaling mechanism is the least costly.[8]

The expected bankruptcy costs are then:

$$F_i = F \int_{-\infty}^{P} g(x;\ \mu_i)\ dx, \tag{1}$$

where x is the random after-tax cash flow at t_1, and $g(x; \mu_i)$ is the density function of x for type i. Figure 1 illustrates the distribution shift caused by a switch to *LIFO* and the resulting reduction in expected bankruptcy costs.

The expected payoff for a firm of type i under *FIFO* is $\mu_i - F_i$,[9] and the expected payoff under *LIFO* is $\mu_i + T_i - F_{iT}$. The incremental payoff of a switch to *LIFO* is given by:

$$T_i + (F_i - F_{iT}). \tag{2}$$

The shift of the density function to the right has two positive effects on cash flows: it increases the expected cash flows by T_i, and it reduces the bankruptcy costs by $F_i - F_{iT}$ through reducing the probability of bankruptcy.[10] The relative magnitudes of these benefits for different firm

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[7] This assumption is not crucial. Debt levels and the magnitude of bankruptcy costs could differ across firms as long as they were not informative about firm type. The notation in the analysis is simplified considerably by this assumption.

[8] When we hold debt levels constant across firms, we are also not addressing how the capital structure decision and the accounting choice decision may be interdependent. For example, an increase in debt increases the probability of bankruptcy through increasing P. Consequently, the switch to *LIFO* may be more attractive to firms with higher debt levels, ceteris paribus. We also assume that there are no adverse incentive effects created by debt because investment decisions and the resulting distribution of cash flows are taken here as exogenously determined. As described later in the paper, the manager is assumed to maximize the total value of the firm so that agency costs are minimized.

[9] Since μ_i represents the expected after-tax cash flows to be distributed to all claim holders of the firm, bankruptcy costs reduce cash flows available for distribution to bondholders, shareholders, and the manager.

[10] The probability of bankruptcy must also be less than 50%.

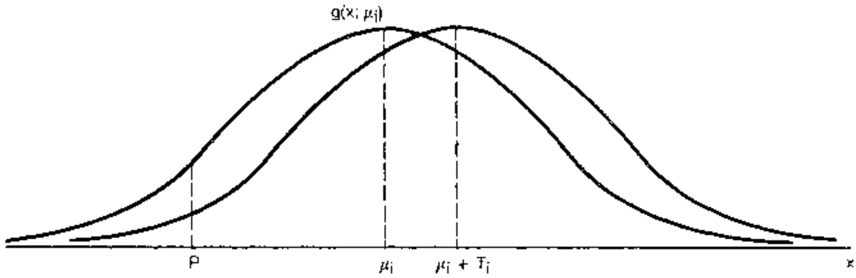

FIG. 1.—The effect of the *LIFO* switch on the distribution of after-tax cash flows of firm i ($i = G, B$). x = the future after-tax cash flow, $g(x; \mu_i)$ = the density function of x for type i, μ_i = the expected after-tax cash flow for type i under *FIFO*, T_i = the net present value of *LIFO* tax savings for type i, and P = the bankruptcy level of x.

types will be a critical element in the existence of the separating equilibrium to be derived in the next section.

The manager must decide whether to use *FIFO* or *LIFO* at t_0, aware that he alone knows his firm type and investors will rationally infer the type from his choice of the accounting method. As in Ross [1977], Miller and Rock [1985], and Harris and Raviv [1985], we assume that the manager's compensation depends on firm values at both t_0 and t_1 in order to guarantee that the manager wants to maximize market prices at each point in time. Managers then choose an accounting method so as to maximize $a_0 V_0 + a_1 V_1$, or:

$$\text{Max } V_0 + \alpha V_1 \tag{3}$$

where a_0, a_1 represent the manager's share in the market value of the firm at t_0 and t_1, $\alpha = a_1/a_0$, V_0 is the value of the firm which investors infer at t_0 after observing the accounting choice, and V_1 is the true expected value of the firm at t_1, known only by the manager at t_0.

V_0 will be the actual market value of the firm (i.e., debt plus equity) at t_0 after investors observe the *LIFO/FIFO* choice. It is in the shareholders' interests that the manager maximizes the value of debt as well as equity so that agency costs are minimized. The future point in time t_1 can be viewed as a telescoping of all future periods into one point in time, or that time at which the firm realizes its final cash flow immediately prior to the debt principal repayment. Therefore, at t_1 the value of the firm will be its actual cash flow, and the manager's share in that cash flow will be a_1. At t_0, the manager, knowing that the final cash flow x will be drawn from the true distribution, maximizes over V_1 which is determined by the true expected value of x.[11]

[11] The true expected value of the firm's cash flows is never observed by investors. We are implicitly assuming that investors learn nothing about the firm in the time period between t_0 and t_1 which would be useful in contingent contracting.

We recognize that the tax saving resulting from *LIFO* represents an interest-free loan from the government and that the *LIFO* choice problem is essentially a multiperiod problem because the size of the tax savings depends on exogenous factors such as the rate of inflation and the tax rate and endogenous factors such as inventory management over time until the inventory is finally liquidated and the loan falls due. Therefore, in order to simplify the analysis to what appears as a one-period problem, we assume that T_i represents the discounted present value of the expected tax effects of *LIFO*, including the repayment of the interest-free loan at some future time. Sunder [1976] shows that the discounted present value of tax savings may be substantial. We attempt to capture the multiperiod nature of the problem by letting t_1 be some future period at which firm value is a realized cash flow. We are in essence eliminating the points in time between t_0 and t_1 during which investors learn nothing, or collapsing them into t_0 and t_1. Therefore, when the firm is liquidated at t_1, the realized cash flow is shared by bondholders, shareholders, the government, and the manager.

We also assume that the manager and investors are risk neutral in order to abstract the analysis from risk-sharing considerations which are not important in this model where tax benefits are nonrandom. The manager's objective function is thus simplified to maximizing at t_0 the weighted sum of the expected after-tax cash flows as perceived by investors at t_0 and those at t_1 as known by the manager, with α being the relative weight on the t_1 value. We do not restrict the size of α and recognize that α may exceed one if many periods are collapsed into t_1. The assumption implicit in expression (3) that the risk-free rate of interest is zero is innocuous.

3. *Separating Equilibrium*

In this section we determine the conditions under which a separating Nash equilibrium will obtain in which good firms choose *FIFO*, bad firms choose *LIFO*, no manager has an incentive to change from his choice of an accounting method, and investors rationally interpret the actions of the manager and correctly price the firm's securities.

In a world of perfect information and with tax savings attributable to *LIFO*, all firms would use *LIFO* if managers were maximizing the market value of the firm. In a world of asymmetric information as described in section 2, good firms can signal their quality by selecting *FIFO* rather than *LIFO*, and investors will infer that a firm selecting *FIFO* is a good firm if the costs and/or benefits are such that bad firms are worse off by selecting *FIFO* rather than *LIFO*.

If investors infer that good firms select *FIFO* and bad firms select *LIFO*, the payoff to the manager of the good firm will be:

$$W_{GF} = (\mu_G - F_G) + \alpha(\mu_G - F_G); \tag{4}$$

and the payoff to the manager of the bad firm will be:

$$W_{BL} = (\mu_B + T_B - F_{BT}) + \alpha(\mu_B + T_B - F_{BT}). \qquad (5)$$

Note that in each case, the market value at t_0 and the expected value at t_1 are identical since both good and bad firms are truthfully revealing their types.

We will now consider the incentives for any manager to misrepresent his firm's type. If a good firm selects *LIFO*, it will be perceived by investors to be a bad firm at t_0 but will obtain the tax benefits at both t_0 and t_1. The payoff to the manager of the good firm is:

$$W_{GL} = (\mu_B + T_B - F_{BT}) + \alpha(\mu_G + T_G - F_{GT}). \qquad (6)$$

If a bad firm selects *FIFO*, it loses tax benefits but is perceived by investors to be a good firm at t_0. Its manager then receives:

$$W_{BF} = (\mu_G - F_G) + \alpha(\mu_B - F_B). \qquad (7)$$

Note that in each case, the t_0 value is based on investors' inferences, and the t_1 value is based on the true distribution of cash flows which is altered only through the choice of *LIFO*.

We are now able to prove that a separating equilibrium exists under certain conditions.

PROPOSITION 1. A separating Nash equilibrium in which good firms choose *FIFO* and bad firms choose *LIFO* exists only if:

$$T_B + (F_B - F_{BT}) > T_G + (F_G - F_{GT}), \qquad (8)$$

and:

$$\mu_G - F_G > \mu_B + T_B - F_{BT}. \qquad (9)$$

Proof. For a separating equilibrium to exist it is necessary that good firms prefer *FIFO* and bad firms prefer *LIFO*. Good firms will prefer *FIFO* if $W_{GF} > W_{GL}$. After substituting from (4) and (6) and simplifying, good firms prefer *FIFO* if:

$$\frac{(\mu_G - F_G) - (\mu_B + T_B - F_{BT})}{\alpha} > T_G + F_G - F_{GT}. \qquad (10)$$

Similarly, bad firms will prefer *LIFO* if $W_{BL} > W_{BF}$. After substituting from (5) and (7) and simplifying, this expression reduces to:

$$\frac{(\mu_G - F_G) - (\mu_B + T_B - F_{BT})}{\alpha} < T_B + F_B - F_{BT}. \qquad (11)$$

In order for expressions (10) and (11) to hold simultaneously, it is clearly necessary that (8) and (9) are satisfied. *Q.E.D.*

As indicated in expression (2), both sides of inequality (8) represent the marginal benefits of a switch to *LIFO* for bad and good firms. Therefore, the same expression represents the marginal costs of remaining at *FIFO* or the costs of signaling with *FIFO*. Condition (8) requires that the marginal cost of signaling be higher for bad firms than for good firms. Therefore, the requirement that marginal signaling costs be negatively correlated with quality (see Spence [1973]) also is required here for separation.

Expression (8) can be rewritten as:

$$(F_B - F_{BT}) - (F_G - F_{GT}) > T_G - T_B, \tag{12}$$

where the right-hand side is the difference between tax savings for both types. The difference between expected bankruptcy costs for bad and good firms must exceed the difference in tax savings.[12] Figure 2 illustrates this relation by displacing the four distributions $g(x;\ \mu_G)$, $g(x;\ \mu_{GT})$, $g(x;\ \mu_B)$, and $g(x;\ \mu_{BT})$, so that they all have the same mean. The reduction in the probability of bankruptcy for bad firms is the area of the curve between P_{BT} and P_B, and that for the good firms is between P_{GT} and P_G. Inequality (9) specifies that, in separation, the true value of a good firm signaling at *FIFO* must exceed the true value of a bad firm at *LIFO*.

Under the conditions of Proposition 1, for given values for all other parameters, there will always be a range of values of α for which (10) and (11) will be simultaneously satisfied. The value of α represents the relative importance which the manager assigns to current versus future values in his objective function.[13] Since signaling affects only the current market value of the firm, there is little benefit to be derived from signaling when α is high and future value dominates current value to the manager. Since all managers would choose to signal at very low values of α when current market values dominate, the signal cannot be credible within such a region. Consequently, there is an intermediate range of α which satisfies (10) and (11) for given parameters.[14]

As in all static signaling models, the manager of the good firm who chooses *FIFO* implicitly precommits to continue using *FIFO* until t_1. He cannot choose *FIFO* at t_0 and take the market's high valuation and subsequently switch to *LIFO* and take the tax benefits. If reneging on contracts were permitted in an asymmetric information scenario, signaling would not be credible and therefore would not occur.

It is obvious that a separating equilibrium is not feasible if there are more than two firm types. We have extended the analysis to three types and determined the conditions under which a partition equilibrium exists. There are two equilibria: one in which the high-quality firm selects *FIFO* and the remaining two types pool at *LIFO*, and one in which the two

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[12] Condition (12) always holds if it is the case that $TG \leq T_B$.

[13] We are implicitly assuming that all managers have the same α.

[14] While we have shown that there exists a range of α for which a separating equilibrium exists for fixed values of all other parameters in (10) and (11), it is also possible to show that a separating equilibrium exists for a fixed α for a range of some other parameters.

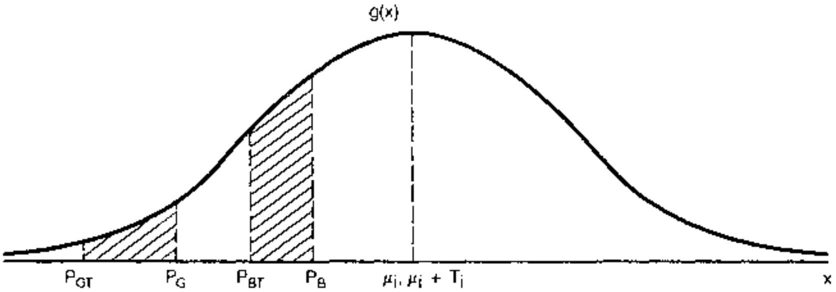

FIG. 2.—The effect of the *LIFO* switch on the probability of bankruptcy. x = the future after-tax cash flow, $g(x)$ = the density function of x, μ_i = the expected after-tax cash flow for type i ($i = G, B$) under *FIFO*, T_i = the present value of *LIFO* tax savings for type i, P = the bankruptcy level of x, and the shaded area between P_{iT} and P_i is the reduction in the probability of bankruptcy for type i.

higher-quality firms pool at *FIFO* and the lowest-quality firm selects *LIFO*. Which of the two equilibria obtains depends on the relative costs of signaling with *FIFO* and investors' prior beliefs about firm type. We omit the analysis from the paper because it adds little intuition to the separating equilibrium with two types.

4. *Pooling Equilibria*

Crucial elements in a signaling model are the specification of investors' beliefs. We assume that p is the proportion of good firms in the population under consideration and $(1 - p)$ is the proportion of bad firms, where p is known by all investors. In addition, when investors observe both *FIFO* and *LIFO* choices, they believe that the good firms are at *FIFO* and the bad firms at *LIFO*.

The payoffs $V_0 + \alpha V_1$ for all possible *LIFO/FIFO* choices under the above two assumptions about beliefs appear in figure 3. The payoffs in cell 4 exceed the payoffs in cell 1 for both good and bad firms. Therefore, a *LIFO* pooling equilibrium is clearly Pareto superior to a *FIFO* pooling equilibrium when positive tax benefits are associated with *LIFO*. In the absence of tax benefits and any other costs, we would expect that firms would be indifferent between *FIFO* and *LIFO*. However, actual observation does not indicate indifference since an extremely small number of firms used *LIFO* in the United States prior to 1939, the year in which *LIFO* became acceptable for taxes (i.e., when T became positive). In Canada *LIFO* is not acceptable for taxes, and consequently no firms use *LIFO* for financial reporting. This apparent reluctance to use *LIFO* in the absence of tax benefits is not addressed in this paper. The frequent assertion that the reluctance is due to the negative impact on reported earnings cannot be analyzed in our model in which there is no role for accounting. However, as discussed in the introduction, we view the *LIFO* choice as a tax-management choice in which the effect on accounting numbers is a by-product.

4.1 POOLING AT FIFO

The payoffs in figure 3 resemble those of the "prisoner's" dilemma in that, while a *LIFO* pool Pareto dominates a *FIFO* pool, there is no way to guarantee that all firms will move to *LIFO* from *FIFO* when the tax benefits associated with *LIFO* become available. The manager of a firm must consider the beliefs of investors about observed deviations from equilibrium. In order to examine the stability of a *FIFO* pool, we must specify the reaction of investors to an observed defection from equilibrium. We therefore assume that when all firms use *FIFO* and a deviation to *LIFO* is observed, investors believe that the deviant is a bad firm because it is that firm which most needs the tax savings.

The payoffs in a *FIFO* pool appear in cell 1 in figure 3. For good firms in a *FIFO* pool, the manager's payoff will be:

$$W_{GPF} = p(\mu_G - F_G) + (1 - p)(\mu_B - F_B) + \alpha(\mu_G - F_G). \tag{13}$$

For bad firms in a *FIFO* pool, the payoff will be:

$$W_{BPF} = p(\mu_G - F_G) + (1 - p)(\mu_B - F_B) + \alpha(\mu_B - F_B). \tag{14}$$

Note that the first two right-hand terms are identical when firms are in a pool, or making identical choices, because investors have no information which permits identifying firm types at t_0.

GOOD FIRMS, μ_G

BAD FIRMS, μ_B		*FIFO*	*LIFO*
	FIFO	1 $W_{GPF} = p(\mu_G - F_G) + (1-p)(\mu_B - F_B) + \alpha(\mu_G - F_G)$ $W_{BPF} = p(\mu_G - F_G) + (1-p)(\mu_B - F_B) + \alpha(\mu_B - F_B)$	2 $W_{GL} = (\mu_B + T_B - F_{BT}) + \alpha(\mu_G + T_G - F_{GT})$ $W_{BF} = (\mu_G - F_G) + \alpha(\mu_B - F_B)$
	LIFO	3 $W_{GF} = (\mu_G - F_G) + \alpha(\mu_G - F_G)$ $W_{BL} = (\mu_B + T_B - F_{BT}) + \alpha(\mu_B + T_B - F_{BT})$	4 $W_{GPL} = p(\mu_G + T_G - F_{GT}) + (1-p)(\mu_B + T_B - F_{BT}) + \alpha(\mu_G + T_G - F_{GT})$ $W_{BPL} = p(\mu_G + T_G - F_{GT}) + (1-p)(\mu_B + T_B - F_{BT}) + \alpha(\mu_B + T_B - F_{BT})$

FIG. 3.—Payoffs from the *LIFO/FIFO* choice.

We are now in a position to prove conditions under which a pooling equilibrium at *FIFO* will exist.

PROPOSITION 2. If investors believe that a deviation from a *FIFO* pool is a bad firm, then a pooling Nash equilibrium in which all firms choose *FIFO* exists if:

$$p > \frac{(1 + \alpha)(T_B + F_B - F_{BT})}{(\mu_G - F_G) - (\mu_B - F_B)} = p_1. \tag{15}$$

Proof. A pooling equilibrium at *FIFO* will exist if no individual firm has an incentive to deviate to *LIFO*. If investors believe that a deviant from the *FIFO* pool is a bad firm, a bad firm will prefer the *FIFO* pool if $W_{BPF} > W_{BL}$. Using (5) and (14), $W_{BPF} > W_{BL}$ if (15) is satisfied. Likewise, given the posited investors' beliefs, a good firm will prefer the *FIFO* pool if $W_{GPF} > W_{GL}$. Using (6) and (13), $W_{GPF} > W_{GL}$ if:

$$p > \frac{(T_B + F_B - F_{BT}) + \alpha(T_G + F_G - F_{GT})}{(\mu_G - F_G) - (\mu_B - F_B)} = p_1'. \tag{16}$$

It follows from (8) that $p_1 > p_1'$ and that whenever bad firms prefer to pool at *FIFO*, good firms also do. *Q.E.D.*

While every firm would be better off if all firms switched to *LIFO*, there is no incentive for one individual firm to switch if investors believe that the proportion of good firms in the economy is suitably high (i.e., $p > p_1$) *and* also believe that such a deviant is a bad firm. When considering a deviation from the *FIFO* pool, a firm faces the trade-offs of obtaining tax benefits and being valued as a bad firm under *LIFO* or foregoing tax benefits while being valued partially as a good firm in the *FIFO* pool. If investors believe that it is highly likely that a firm is a good type, then no firm will deviate from the *FIFO* pooling equilibrium.

It is clear in expression (15) that $p_1 > 1$ for "very high" values of α. If the current value of the firm is not important to a manager, then he will defect from the *FIFO* pool in order to obtain tax benefits regardless of the beliefs of investors about his type either before or after defection.

If investors believe that a defector from the *FIFO* pool is a good firm, then it is easy to show that all firms would switch to *LIFO*. Therefore, the existence of a *FIFO* pool depends crucially on investors' beliefs.

4.2 POOLING AT LIFO

If all firms are at *LIFO* and a deviation to *FIFO* is observed, we assume that investors believe that the deviant is a good firm. The wealth of the manager of a good firm in a *LIFO* pool is:

$$\begin{aligned} W_{GPL} = {} & p(\mu_G + T_G - F_{GT}) \\ & + (1 - p)(\mu_B + T_B - F_{BT}) + \alpha(\mu_G + T_G - F_{GT}). \end{aligned} \tag{17}$$

The wealth of the manager of a bad firm in a *LIFO* pool is:

$$W_{BPL} = p(\mu_G + T_G - F_{GT}) + (1 - p)(\mu_B + T_B - F_{BT}) + \alpha(\mu_B + T_B - F_{BT}). \tag{18}$$

PROPOSITION 3. If investors believe that a deviation from a *LIFO* pool is a good firm, then a pooling Nash equilibrium in which all firms choose *LIFO* exists if:

$$p > \frac{(\mu_G - F_G) - (\mu_B + T_B - F_{BT}) - \alpha(T_G + F_G - F_{GT})}{(\mu_G + T_G - F_{GT}) - (\mu_B + T_B - F_{BT})} = p_2. \tag{19}$$

Proof. A pooling equilibrium at *LIFO* will exist if no individual firm has an incentive to choose *FIFO*. If investors believe that only a good firm will switch to *FIFO*, a good firm will prefer the pool at *LIFO* rather than be identified as a good firm by switching to *FIFO* if $W_{GPL} > W_{GF}$. Using (4) and (17), $W_{GPL} > W_{GF}$ if (19) is satisfied. Likewise, given the posited investors' beliefs, a bad firm will prefer the pool at *LIFO* rather than be perceived as good if $W_{BPL} > W_{BF}$. Using (7) and (18), $W_{BPL} > W_{BF}$ if:

$$p > \frac{(\mu_G - F_G) - (\mu_B + T_B - F_{BT}) - \alpha(T_B + F_B - F_{BT})}{(\mu_G + T_G - F_{GT}) - (\mu_B + T_B - F_{BT})} = p_2'. \tag{20}$$

It follows from (8) that $p_2 > p_2'$ and that whenever good firms prefer to pool at *LIFO*, bad firms also prefer it.

It is straightforward to show that $p_2 < 1$ if tax savings are positive. *Q.E.D.*

When a proportion of good firms is very high, a good firm will prefer to pool at *LIFO* where it benefits from the resulting tax savings as well as the high weight on $\mu_G + T_G - F_{GT}$. As the proportion of good firms declines, greater tax benefits are necessary for a good firm to remain in the *LIFO* pool.

Propositions 2 and 3 show that there are multiple pooling equilibria. The analysis shows that every firm may remain at *FIFO* even though all managers would be better off if all firms switched to *LIFO*. If managers care about current market value and investors believe ex ante that it is highly likely that any specific firm is a good firm, then no individual manager will switch to *LIFO*.

5. *Price Reactions to LIFO Adoptions*

In the previous sections we have considered the possible equilibria resulting from the choice by managers of a cost-flow assumption for taxes when this choice signals firm type to investors. Consider the situation where all firms use *FIFO* just prior to t_0 because there are no tax benefits and then at t_0 tax benefits are created by a change either in the tax laws or in the rate of inflation. Our model provides a justification of why we may observe some firms switching to *LIFO*, all firms switching to *LIFO*, or all firms remaining at *FIFO*, depending on the magnitude of tax benefits and the proportions of good and bad firms. In this section we explore the implications of our model with respect to price reactions when firms switch from *FIFO* to *LIFO*.

The manager's decision problem is to maximize an objective function which includes the t_0 market value and the expected t_1 market value, whereas the price reaction at the time of *LIFO* adoption includes only the t_0 value. Therefore, the manager may conceivably undertake an action which maximizes $V_0 + \alpha V_1$ while it reduces the current market value of the firm.

When firms are pooled at *FIFO*, the market price of each firm is the pooled value given by:

$$V_{0F} = p(\mu_G - F_G) + (1 - p)(\mu_B - F_B). \tag{21}$$

If tax benefits change such that separation obtains, the market values of good and bad firms after the bad firms have adopted *LIFO* are:

$$V_{0GF} = \mu_G - F_G. \tag{22}$$

$$V_{0BL} = \mu_B + T_B - F_{BT}. \tag{23}$$

Since V_{0GF} clearly exceeds V_{0F}, the price reaction for good firms after bad firms adopt *LIFO* will always be positive. The price reaction for bad firms, however, will depend on the sign of $V_{0BL} - V_{0F}$. The price reaction for bad firms switching to *LIFO* will be negative if $V_{0BL} < V_{0F}$, or equivalently:

$$p > \frac{T_B + F_B - F_{BT}}{(\mu_G - F_G) - (\mu_B - F_B)} = p_3. \tag{24}$$

Since this price decline accompanies a switch to *LIFO* only in a separating equilibrium, it is necessary that p_3 be less than both p_1 and p_2. While we have been unable to identify the range of parameter values for which a price decline would occur, we have been able to provide an example where this occurs.[15] Similarly, the price reaction for bad firms switching to *LIFO* in a separating equilibrium will be positive if $p < p_3$. There is no price reaction if $p = p_3$.

The intuition behind this result is straightforward. If $p > p_3$ where separation occurs, there is a high proportion of good firms and there consequently is a high weight on $\mu_G - F_G$ in the pooled value which is lost after *LIFO* adoption. The tax benefits at t_0 are less than the lost benefit of pooling (while the tax benefits for two periods are greater). If

[15] In an earlier version of this paper, we identified the conditions under which a price decline occurs for $T_B = T_G$.

$p < p_3$, there is a low weight on $\mu_G - F_G$ and the tax benefits at t_0 exceed the loss of being partially valued as a good firm.

If all firms switch to *LIFO* and a *LIFO* pooling equilibrium obtains, then the value of all firms at t_0 is given by:

$$V_{0L} = p(\mu_G + T_G - F_{GT}) + (1 - p)(\mu_B + T_B - F_{BT}). \qquad (25)$$

V_{0L} exceeds V_{0F} for all values of p and T. All firms benefit from the tax benefits of an increase in cash flows and a reduction in the probability of bankruptcy. Accordingly, a positive price reaction will be observed if all firms switch from *FIFO* to *LIFO*.

Since the above predicted price reactions are for the entire firm, we cannot predict the separate effects on the values of the claims of different security holders.

6. *Empirical Evidence*

In this section we will review some of the empirical results emerging from the *LIFO/FIFO* studies of the past 15 years and show that these results are generally consistent with the predictions of our signaling model. An important difference between these studies and our analysis is that the empirical results pertain to changes in common stock prices while our analysis considers changes in the total current market value of the firm. Analysis of the potential wealth transfers among the various claim holders of the firm (i.e., stockholders, bondholders, the manager, and the government) is beyond the scope of this paper.

In the model, the existence of a particular equilibrium is determined by the values of the parameters α, p, and T_i which were assumed to be constant. However, in relating empirical observations to the model's predictions, it is important to recognize that these parameters are likely to vary across firms in the real world. There are reasons to expect more homogeneity within an industry as to the values of α, p, and T_i. The value of α may be explicitly determined by a management compensation plan, and there is evidence (e.g., Ely [1988]) of interindustry heterogeneity of these plans. The magnitude of the tax benefits of *LIFO* depends on changes in the prices for raw materials and changes in demand, and these changes are likely to be similar for firms within an industry who are purchasing the same materials and selling the same products. Finally, the degree of information asymmetry and agreement about the relative numbers of good and bad firms may vary across industries because some industries are more established and less innovative than others.

The static signaling model assumes precommitment. Empirical observations occur in a dynamic world where a manager may switch from *FIFO* to *LIFO* and then revert to *FIFO*, albeit at a cost. In order to explain what appears to be the lack of precommitment, a dynamic model in which firm types may change over time and managers may receive new information would be required.

Sunder's [1973] study of 129 firms switching from *FIFO* to *LIFO* in the period 1946–66 finds an average abnormal return of 5.3% during the year of the switch to *LIFO*. Sunder's findings suggest an industry effect in both the choice to switch and the market response to the switch. To illustrate the industry choice effect, consider these findings (from Sunder [1973, p. 12, table 12*a*]): Steel: 23 of 24 firms switched to *LIFO*; Rubber & Plastics: 4 of 6 firms switched; Textiles: 3 of 10 firms switched. In the framework of our model, it appears that steel moved to a *LIFO* pool while rubber & plastics and textiles both moved to separation. Sunder's results on market reaction also have a strong industry effect: 18% of the sample is composed of steel firms which simultaneously adopted *LIFO*. When Sunder omits steel firms from the *LIFO* sample, the abnormal return decreases to 2.3%, and the return for the steel firms alone is 18.6%. If the sample under study is composed of all firms adopting *LIFO*, we will observe the combined market reaction to the separating and *LIFO* pooled equilibria if both exist. When Sunder removes steel firms from his sample, he is in effect removing a *LIFO* pool for which we would predict a positive price reaction, and it therefore is not surprising that the remaining average price increase is reduced.

Most subsequent studies have used a sample of *LIFO* adopters in the years 1974 and 1975 because of the large amount of switching observed in these years. We may expect different results in different time periods if tax benefits change over time for all firms as the tax rate or rate of inflation changes, or if tax benefits change within an industry as prices of new materials or demand conditions change. Brown [1980] studies a sample of about 160 firms, half of which switch to *LIFO* and half remain at *FIFO* in 1974. Again we see the following example of an industry factor in the number of firms adopting *LIFO* (from Brown [1980, p. 46, table 1]):

Industry	Number of Firms Adopting *LIFO*	Number of Firms Retaining *FIFO*
Consumer Goods—Health Care	0	4
Chemicals	6	5
Industrial Equipment	14	7
Metals—Nonferrous	2	0

We see that the health care consumer goods industry is in a *FIFO* pool, nonferrous metals in a *LIFO* pool, and chemicals and industrial equipment are in separation. Brown finds positive abnormal returns for firms remaining at *FIFO* and negative returns for firms adopting *LIFO* where week zero is the date of the preliminary earnings announcement in the *Wall Street Journal*. These results are consistent with our hypothesized price reaction when $p > p_3$ and separation obtains. However, since Brown's sample of *LIFO* adopters may also be an aggregation of a *LIFO* pooling and a separating equilibrium, we cannot claim that Brown's results support our theory.

Ricks [1982] also studies *LIFO* adoptions in 1974 and 1975 for 400 firms matched on unexpected earnings and industry using weekly returns and finds an adverse market reaction across all industries. The Sunder and Ricks studies have opposite results, a puzzle which may be explained by considering that both are aggregations of different equilibria at different points of time. Since tax benefits may change over time, Sunder's sample may contain a higher proportion of *LIFO* pools than Ricks' sample.

Biddle and Ricks [1988] reexamine Ricks' [1982] results and discover that the negative market reaction for firms adopting *LIFO* was specific to 1974. They find that in that year of extreme inflation, analysts had systematically overestimated earnings and that the negative investor reaction was due to the disclosure of earnings that were lower than anticipated. Their reported industry statistics show that the percentage of each industry adopting *LIFO* in 1974 varied from 16 to 64 and the mean two-day excess returns around the time of the earnings announcement were positive for some industries and negative for others.

Morse and Richardson [1983] look at factors influencing the decision to adopt *LIFO* and find that firms which switch appear to forego small tax benefits for some years and then switch in the year of maximum tax benefits. They conclude that firms appear to delay the adoption due to some perceived cost of change. They also find industry effects consistent with our model: close to 100% of oil firms switched to *LIFO* when the tax laws were changed and tax benefits became positive, while about 90% of drug firms were still using *FIFO* in the late 1970s. The steel industry moved to a *LIFO* pool in the 1960s and chemicals in 1974.

More recently, Dopuch and Pincus [1988] present evidence that casts doubts on this existing body of empirical evidence. They investigate the underlying earnings processes of *FIFO* and *LIFO* firms and conclude that the processes differ even after removing the earnings effect of different inventory methods. More important, the process appears to change prior to the time of change in accounting methods, suggesting that investors can anticipate the switch to *LIFO* and that market studies using announcement dates will therefore miss the true market reaction. In the light of this finding, we might question the validity of the market studies using dates such as the date of the earnings announcement.

A second finding of Dopuch and Pincus is that tax savings actually foregone by *FIFO* firms may be small. In their sample of 122 firms using *FIFO* for the years 1963–81, the median difference in *FIFO* cost of sales was only $350,000. Our signaling model requires only that tax savings exist. While the model does not permit the manager to choose from a number of costly signals, it is likely that the *FIFO* choice as a signal of value would be dominated by other less costly signals if tax savings were very large.

Notwithstanding the Dopuch and Pincus results, the empirical evidence in the above selected studies is representative of the general empirical evidence that we observe: (1) both positive and negative market reactions to *LIFO* switches, (2) delays in *LIFO* adoption, (3) many firms continuing to use *FIFO*, and (4) an industry factor influencing the decision to switch. While we believe that this evidence is consistent with our simple signaling model, we recognize that it is not a test of our model. Our model makes predictions dependent upon the values of the various parameters, and any test of our model would have to attempt to partition the sample so as to identify those firms in a *FIFO* or *LIFO* pool and those firms in separation. The predictions of the model also depend on the beliefs of investors which are unobservable. The model does provide the following predictions about the market value of the firm's securities: (1) if all firms in an industry switch to *LIFO*, the market values of all securities will increase; and (2) a negative security price reaction to *LIFO* adoption can occur only if some firms in an industry switch to *LIFO*. Since the model predicts a decrease in actual and perceived default risk when all firms switch to *LIFO*, an additional prediction is that bond ratings should improve for those firms which switch to a *LIFO* pool. The effect on bond ratings for *LIFO* firms in a separating equilibrium is not unambiguous because the direction of the change in perceived default risk depends on the ex ante beliefs of investors.

7. *Summary and Conclusions*

The model developed in this paper offers a potential explanation to many of the *FIFO/LIFO* puzzles encountered in the empirical accounting literature. The model is able to explain the following observations: (1) in some industries, no firms have switched from *FIFO* to *LIFO*; (2) in other industries, only some of the firms have switched to *LIFO*; (3) in some industries, all firms have switched to *LIFO*; and (4) the price reaction to the *LIFO* switch has been both positive and negative. The basis of the model is the information asymmetry between managers and investors. Managers know more about their firm's future prospects and they credibly signal their private information through the *LIFO/FIFO* choice.

In order to develop a tractable model from which economically interesting results could be derived, we have made simplifying assumptions. Two of these assumptions are particularly critical: the two-period nature of the model and the managers' objective function.

While recognizing that the very essence of the tax saving resulting from the use of *LIFO* occurs in a multiperiod setting, we choose to collapse the future into one random cash flow. This assumption considerably simplifies the valuation problem in a world of asymmetric information. The assumption that a manager maximizes a weighted sum of current and future stock prices is consistent with a situation where his compensation depends on current and future stock prices.

We believe, however, that in spite of the above critical simplifying assumptions, the model we have developed captures a relevant aspect of the *LIFO/FIFO* choice. While the existing empirical evidence does not seem to be inconsistent with the model, new empirical tests would be necessary to test the specific predictions of the model.

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