CHOICE OF INVENTORY METHOD
AND THE SELF-SELECTION BIAS

Pervaiz Alam and Eng Seng Loh

ABSTRACT

We examine the sample self-selection and the use of LIFO or FIFO inventory method. For this purpose, we apply the Heckman-Lee’s two-stage regression to the 1973–1981 data, a period of relatively high inflation, during which the incentive to adopt the LIFO inventory valuation method was most pronounced. The predicted coefficients based on the reduced-form probit (inventory choice model) and the tax functions are used to derive predicted tax savings in the structured probit. Specifically, the predicted tax savings are computed by comparing the actual LIFO (FIFO) taxes vs. predicted FIFO (LIFO) taxes. Thereafter, we estimate the dollar amount of tax savings under different regimes. The two-stage approach enables us to address not only the managerial choice of the inventory method but also the tax effect of this decision. Previous studies do not jointly consider the inventory choice decision and the tax effect of that decision. Hence, the approach we use is a contribution to the literature. Our results show that self-selection bias is present in our sample of LIFO and FIFO firms and correcting for the self-selection bias shows that the LIFO firms, on average, had $282 million of tax savings, which explains why a large number of firms adopted the LIFO inventory method during the seventies.
INTRODUCTION

Management accounting provides critical accounting information for day-to-day managerial decision-making. The choice of the inventory method influences managerial behavior for purchasing, cash flow management, and tax management. For instance, based on managerial accounting information regarding expected cash flows on various products and services, managers may decide that it is optimal to forego LIFO (last-in, first-out) tax savings. Thus, managers need to have a good understanding of the expected cash inflows and outflows from various segments of the business. They should also have information on available tax saving vehicles, including depreciation, interest, tax losses and the affect of these variables on taxable earnings. Not only could management accounting provide information on the initial selection of inventory method but it could also assist in deciding to continue with the inventory accounting method currently in use. One important role of managerial accounting in this area is in monitoring inventory-levels to prevent LIFO layer liquidation in the event LIFO is used.

Over the past twenty years, researchers in accounting have examined various issues arising from a firm’s choice of accounting methods. Much of this literature has been on the choice of the inventory costing method. Early research on inventory selection method estimated the tax effects of the LIFO vs. FIFO (first-in, first-out) method under the assumption that operating, financing, and investing activities remain unaffected as a result of a change in inventory method. Researchers have previously recognized that this ceteris paribus assumption ignores endogeneity and self-selection of LIFO and FIFO samples (see Ball, 1972; Hand, 1993; Jennings et al., 1992; Maddala, 1991; Sunder, 1973). The endogeneity problem in the choice of LIFO vs. FIFO method is particularly important because the tax effects of the inventory method may affect firm valuation (see Biddle & Ricks, 1988; Hand, 1995; Jennings et al., 1992; Pincus & Wasley, 1996; Sunder, 1973). However, it is not possible to observe what the managerial decision would have been had they used an inventory method different from the method currently in use. Hence, a number of studies have developed “as-if” calculations to estimate the tax effects of LIFO vs. FIFO (see Biddle, 1980; Dopuch & Pincus, 1988; Morse & Richardson, 1983). These studies estimate a LIFO firm’s taxes as if it was a FIFO firm and LIFO taxes for a FIFO firm. The “as-if” approach assumes that a firm’s managerial decisions would have remained unchanged with the use of an alternative method.

The purpose of this study is to re-examine the choice of LIFO vs. FIFO by using Heckman (1976, 1979) and Lee’s (1978) two-stage method that incorporates...
self-selection and endogeneity. The Heckman-Lee approach is used to incorporate the endogenous choice of inventory method in the tax estimation equation. The explicit inclusion of the inter-dependence of the choice of the inventory method and the tax effects of the choice distinguishes this paper from those extant in the literature. We use Lee and Hsieh’s (1985) probit model for the first-stage inventory choice model and develop a tax estimation function using prior literature for the second-stage analysis. Finally, we compare Heckman-Lee based measure of tax savings to those developed using ordinary least squares (OLS).

Our analysis leads to the following results. First, following Lee and Hsieh (1985), we derive the reduced-form probit estimates for the inventory choice method. The significance and sign of the coefficients of our probit estimates are generally similar to those of Lee and Hsieh. Second, the self-selection bias is a significant factor in analyzing whether firms choose to use LIFO or FIFO. Firms, on average, choose the inventory method that gives them the largest tax benefit. Third, the results of structured-probit show (not reported) that the predicted tax savings has a significant positive coefficient suggesting that firms are likely to select LIFO when predicted FIFO taxes are more than actual LIFO taxes. Fourth, correcting for self-selection bias enables us to infer that, on the average, LIFO firms would pay more taxes if they were using FIFO, and FIFO firms would pay lower taxes if they were using LIFO.

Our results for selectivity-adjusted approach show $282.2 million of mean (median $297.4 million) tax savings for LIFO firms and $12.3 million (median $1.2 million) of tax savings foregone for FIFO firms. Results based on ordinary least squares (OLS) estimate indicate that both LIFO (means $40.6 million, median $2.6 million) and FIFO firms (mean $11.3 million, median $5.0 million) had foregone tax savings by choosing the method they were using. In other words, these firms would have had tax savings had they used the alternative method.

We have greater confidence in the results of the selectivity approach because these results are econometrically derived and are based on variables, which are largely accepted in the LIFO and tax literature. The larger tax savings of LIFO results under the selectivity-based approach explains why a large number of firms had adopted LIFO inventory valuation method during the seventies. We also recognize that FIFO firms could have obtained sizable tax savings had they switched to LIFO. However, firms do operate under various restrictive conditions, which suggest that tax minimization is not the only objective function a firm’s management desires to achieve (Scholes & Wolfson, 1992). Hence, it appears that a firm’s choice of the inventory method is a rational economic decision even when an alternative method could have produced larger tax savings.
PRIOR RESEARCH

A number of studies have attempted to explain why firms do not use the LIFO method in periods of rising prices and thus forego the opportunity of potential tax savings (see Adel-Khalik, 1985; Hunt, 1985; Lee & Hsieh, 1985). One explanation advanced is that FIFO firms are concerned about the drop in stock prices upon the adoption of LIFO. Still another explanation is that the cost of LIFO conversion may be more than the tax benefits of adoption. For instance, using 1974–1976 LIFO data, Hand (1993) estimated that the cost of LIFO adoption for his sample of firms was as high as 6% of firm value, a sizable cost for most firms.

Empirical studies on whether LIFO tax saving is valued by investors has been extensively studied. Many of these studies suffer from the problems of event date specification, contaminating events, firm size, etc. (Lindahl et al., 1988). Kang’s (1993) model predicts that positive price reaction to LIFO adoption occurs only when the expected LIFO adoption costs are less than expected LIFO tax savings. He argues that the positive stock price reaction will occur because the switch to LIFO will recoup previously lost LIFO tax savings. Some studies demonstrate positive stock price reaction surrounding LIFO adoption (Ball, 1972; Biddle & Lindahl, 1992; Hand, 1995; Jennings et al., 1992; Sunder, 1973) while other studies have reported negative market reaction to LIFO adoption (see Biddle & Ricks, 1988; Ricks, 1982). Pincus and Wasley (1996) results show some degree of market segmentation. They found positive market reaction to OTC firms and negative market returns for NYSE/ASE firms. Finally, Hand’s (1993) results indicate that the LIFO adoption or non-adoption decision resolves uncertainty regarding LIFO tax savings.

Contracting cost theory also provides reasons why firms may not adopt the LIFO inventory method. LIFO adoption decreases asset values and net income, potentially causing some firms to be in violation of debt covenants. Furthermore, managers on bonus contracts may not want lower LIFO earnings because the use of LIFO may reduce their total compensation. Adel-Khalik (1985), Hunt (1985), and Lee and Hsieh (1985) provide some evidence that debt covenants help to explain the choice of inventory method but compensation plans do not. Another reason why firms decide to use a particular method is that firms differ systematically in the nature of the production-investment opportunity set available to them. Therefore, the LIFO method is an optimal tax reporting choice for some firms and not for others. A common empirical approach to estimate the amount of tax savings firms could have obtained from an alternate method, other than their observed choice of inventory accounting method, is the as-if method (see Biddle, 1980; Biddle & Lindahl, 1982; Dopuch & Pincus, 1988; Morse & Richardson,
We implement an alternative approach, which relies on the work of Heckman (1976, 1979) and Lee (1978).

**CONCEPTUAL FRAMEWORK**

This section presents the conceptual basis for the empirical analysis that follows. Assume firms have only two inventory valuation methods available: LIFO or FIFO. A typical firm’s decision to adopt LIFO depends on its own assessment of the benefits to be gained and the costs that must be incurred. As previously stated, LIFO costs are associated, among others, with implementation, negative market reaction, and contracting costs. In addition, there may be LIFO layer liquidation costs resulting from price decline (e.g. electronics industry). As a result, a firm would rationally choose to use LIFO only if the expected benefits outweigh the expected costs. Otherwise, it would remain as a FIFO firm. With the LIFO or FIFO status thus determined, the firm’s LIFO benefits depend on their operating and financial characteristics, the nature of the industry, and the provisions of the tax code.

Let the benefit of adopting the LIFO method be measured by the tax savings received by the firm. We assume that tax savings is a benefit to the firm because the increased cash flow widens the set of feasible production-investment opportunities and, thus, improves the firm’s long-term prospects. However, foregoing tax benefits may be an optimal strategy for a firm in a framework of Scholes and Wolfson (1992) or when the inventory valuation method is used to signal firm value.

Let the total taxes $T$ paid by each type of firm be written as:

$$T_L = aX_L + e_L$$  \hspace{1cm} (1)

$$T_F = bX_F + e_F$$  \hspace{1cm} (2)

where the subscripts $L$ and $F$ denote the LIFO and FIFO firms, $X$ is a vector of explanatory variables common to both groups of firms, $a$ and $b$ are vectors of coefficients, and $e$ is the random error term. Firms choose the type of inventory valuation method that will maximize their overall tax benefits given other constraining factors. Thus, they choose the LIFO method if

$$TS = (T_F - T_L) > C$$  \hspace{1cm} (3)

where TS is the positive dollar tax savings (assuming $T_F > T_L$), and $C$ is the associated dollar cost, of choosing LIFO. There is unlikely to be a single observed number in the firm-level data set to represent the cost of choosing LIFO, although, in practice, many reasons can be found to justify the assumption that choosing LIFO is not cost-free. Prior literature suggests that the dollar cost of LIFO adoption may
reduce management compensation (Hunt, 1985), lead to possible violation of debt covenants (Hunt, 1985; Morse & Richardson, 1983), and increased fixed costs of computing ending inventory value (Hand, 1993; Morse & Richardson, 1983). Using these arguments, we assume that there is a systematic relationship between LIFO costs \( C \) and these factors; that is,

\[ C = cY + n \quad (4) \]

where \( Y \) is a vector of regressors, \( c \) is a vector of coefficients, and \( n \) is the error term. Substituting Eq. (4) in Eq. (3), we get

\[ T_F - T_L > cY + n \quad (5) \]

This expression may be written as a probit equation:

\[ I = \text{LIFO} \quad \text{if} \quad I^* > 0 \]
\[ I = \text{FIFO} \quad \text{if} \quad I^* \leq 0 \]

where

\[ I^* = \gamma_0 + \gamma_1 T_F - \gamma_2 T_L + \gamma_3 Y - (\mu - e) \quad (6) \]

where \( \mu \) is the error term of the probit function. In practice, we observe the tax payments of either the LIFO or FIFO firm, but never both simultaneously, implying that the probit Eq. (6) cannot be estimated directly. One way to proceed is to estimate the tax Eqs (1) and (2), via ordinary least squares (OLS) and use the predicted values in Eq. (6). However, because of the self-selected nature of the LIFO and FIFO firms, the expected mean of the error terms in the tax equations are non-zero, i.e. \( E(e_L|I = \text{LIFO}) \neq 0 \) and \( E(e_F|I = \text{FIFO}) \neq 0 \). Thus, the OLS estimation of the tax equations leads to inconsistent results. There is no guarantee that the estimated coefficients will converge to the true population values even in large samples. To avoid this bias, we proceed via the two-stage method suggested by Heckman (1976, 1979) and Lee (1978). We begin by estimating the reduced form probit equation found by substituting Eqs (1) and (2) into Eq. (6).

\[ I = \text{LIFO} \quad \text{if} \quad I^* > 0 \]
\[ I = \text{FIFO} \quad \text{if} \quad I^* \leq 0 \]

where

\[ I^* = \gamma_0 + \gamma_1 X + \gamma_2 Y - (\mu - e) \quad (7) \]
Equation (7) is the form of the estimation equation commonly found in the LIFO determinants literature. After estimating (7), we derive the inverse Mills’ ratios,

$$
\lambda_L = \left[ \frac{-\varphi(u)}{\Phi(u)} \right],
$$

(8)

$$
\lambda_F = \left[ \frac{\varphi(u)}{1 - \Phi(u)} \right]
$$

(9)

where \( u \) is the predicted value of the error term from the reduced form probit, \( \varphi \) is the standard normal probability density function (pdf) for \( u \), and \( \Phi \) its cumulative density function (cdf). In the second stage, the coefficient of the lambda terms in the tax functions serve as sample covariances between the tax function and the criterion \( I^* \) (i.e. \( a_2 = \sigma_{L\mu} \) and \( b_2 = \sigma_{F\mu} \)). Hence, the following the tax functions are obtained:

$$
T_L = a_1X_L + a_2\lambda_L + \varepsilon_L
$$

(10)

$$
T_F = b_1X_F + b_2\lambda_F + \varepsilon_F
$$

(11)

Equations (10) and (11) are then estimated using the self-selectivity and the OLS approaches to construct predicted FIFO tax payments for observed LIFO firms and predicted LIFO taxes for observed FIFO firms. In essence, the Heckman-Lee two-stage procedure treats the self-selection bias as arising from a specification error: a relevant variable \( \lambda \) is omitted from each of the tax equations. Statistical significance on \( a_2 \) and \( b_2 \) shows that these covariances are important and that management selection of the LIFO or the FIFO inventory valuation method is not random. In short, self-selection is present. Interpretation of the firms’ behavior depends on the signs of \( \sigma_{L\mu} \) and \( \sigma_{F\mu} \), which may be either positive or negative. For instance, if \( \sigma_{L\mu} < 0 \) then firms whose expected LIFO taxes are lower than average, should have a lower chance of being a FIFO firm. Similarly, if \( \sigma_{F\mu} < 0 \) then firms whose expected FIFO taxes are lower than average should have a lower chance of being LIFO firms. Although these covariances can bear any sign, model consistency requires that \( \sigma_{L\mu} > \sigma_{F\mu} \) (see Trost, 1981). This condition of the covariance term (\( \sigma_{L\mu} > \sigma_{F\mu} \)) ensures that the expected FIFO taxes of FIFO firms will be less than their expected taxes if they switched to LIFO status. Similarly, the expected tax payments of LIFO firms will remain less than their expected tax payments if they switched to FIFO.

An important assumption of the Heckman-Lee model is that the error terms in the structural equations (\( \varepsilon_L \), \( \varepsilon_F \), and \( \mu \)) are joint-normally distributed. Inconsistent estimates result if the underlying population distribution is non-normal (although, strictly speaking, this problem exists with any parametric model). Given the perceived rigidity of the joint-normality assumption, researchers have suggested
alternative approaches based on nonparametric and semi-parametric estimators (see, for example, Duncan, 1986; Heckman, 1976, 1979; Manski, 1989, 1990; Ming & Vella, 1994). Unfortunately, these approaches are often limited in their applicability. For instance, the nonparametric bounds model in Manski (1990) is defined for only two regressors. Thus, one might gain robustness in estimates but may not be able to exploit the breadth of data available. This issue remains unsettled at the present time, leaving the Heckman-Lee model as the accepted dominant vehicle for the empirical analysis of selection bias. In this study, we use Pagan and Vella (1989) for the joint normality test. The results of this test are reported in Note 23.

In order to assess tax savings under different regimes we use three different approaches: (1) the estimated tax savings is calculated as the difference between predicted taxes less actual taxes and is used as an independent variable in a structured probit; (2) the coefficients from selectivity-adjusted tax equations are used to calculate alternative dollar FIFO tax savings for observed LIFO firms, and vice versa; and (3) the coefficients from OLS tax equations are used to compute LIFO (FIFO) dollar tax savings for FIFO (LIFO) firms.  

MODEL SPECIFICATION AND DATA SELECTION

Determinants of Inventory Method Selection

We use Lee and Hsieh’s (1985) model for purposes of estimating the reduced-form probit model described in Eq. (7). We select their model because of the comprehensiveness of the variables examined and the theoretical justification for the selection of those variables. They test the joint effect of political cost, agency theory, and Ricardian theory on the LIFO-FIFO decision, by using eight proxy variables and an industry dummy to capture the features of the production-investment opportunity set that are pertinent to the choice of the inventory accounting method. The variables they use are: firm size, inventory variability, leverage, relative firm size, capital intensity, inventory intensity, price variability, income variability, and industry classification.  

Thus in this study, the inventory choice model is expressed as follows:

\[
I = \gamma_0 + \gamma_1 \text{LGTASST}_it + \gamma_2 \text{INVVAR}_it + \gamma_3 \text{LEV}_it + \gamma_4 \text{RELASST}_it + \gamma_5 \text{CI}_it \\
+ \gamma_6 \text{INVM}_it + \gamma_7 \text{CPRICE}_it + \gamma_8 \text{INCVAR}_it + \gamma_9 \text{IDNUM}_it \epsilon_i \tag{12}
\]
where:

\( I \) = 1 for LIFO firms and 0 for FIFO firms;

LGTASST = firm size computed as the log value of total assets;

INVVAR = inventory variability computed as the coefficient of variation (variance/mean) for year-end inventories;

LEV = agency variable derived as the ratio of long-term debt less capitalized lease obligations to net tangible assets;

Cl = capital intensity variable computed as the ratio of net fixed assets to net sales;

RELASST = relative firm size derived as the ratio of a firm’s assets to the total industry assets;

INVM = inventory intensity computed as the ratio of inventory to total assets;

CPRICE = price variability derived as the relative frequency of positive price change for each four-digit SIC industry code;

INCVAR = accounting income variability as the coefficient of variation (variance/mean) of before tax accounting income; and

IDNUM = captures the industry effect by assigning a dummy variable to each of the 19 two-digit industries. Thus, IDNUM is a vector of 19 two digit SIC codes.

Table 1 provides further description of the variables used in Eq. (12). The table lists the variables used, their description, and the Compustat data items used to derive the variables.

A brief description of the reasons for the selection of the regressors used in the probit function (Eq. (12)) follows. 10 Ceteris paribus, larger firms (proxied by LGTASST) are likely to adopt LIFO because of their comparative advantage in absorbing costs of LIFO conversion and related bookkeeping and tax-reporting costs. The high inventory variability (INVVAR) suggests that the cost of inventory control may be higher because of the possibility of liquidation of LIFO layers or possible excess inventories. On the other hand, it is likely that adopting LIFO may lead to lower inventory variability in order to maintain LIFO layers. Hence, it is difficult to predict the association of the INVVAR variable to LIFO use. The leverage variable (LEV) serves as an agency proxy. Firms with higher leverage are more likely to default on debt covenant restrictions (Smith & Warner, 1979), driving them to choose income-increasing accounting methods. Hence, the leverage variable is likely to be negatively related with the use of LIFO method. The relative firm size (RELASST) is a measure of size with respect to industry. It is expected that relatively larger firms in an industry will have a comparative advantage in using LIFO.

Firms with high values of capital intensity (Cl) generally possess necessary resources to engage in extensive financial and production planning needed to
Table 1. Operationalization of Variables Used for Probit and Tax Functions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Dependent variable used in probit estimation where I = 1 if the firm uses LIFO and 0 if the firm uses FIFO (59).</td>
</tr>
<tr>
<td>LNTXPAY</td>
<td>Dependent variable used in tax functions. Defined as the natural logarithm of total income tax expenses (16).</td>
</tr>
<tr>
<td>LGTASST</td>
<td>Firm size measured as log of total assets (6).</td>
</tr>
<tr>
<td>INVR</td>
<td>Coefficient of variation (variance/mean ratio) for year-end inventories.</td>
</tr>
<tr>
<td>LEV</td>
<td>Leverage ratio computed by dividing long-term debt less capitalized lease obligations to net tangible assets ((9-84)/(6-33)).</td>
</tr>
<tr>
<td>RELASST</td>
<td>Ratio of a firm’s assets to the total of industry assets based on the SIC four-digit industry codes.</td>
</tr>
<tr>
<td>CI</td>
<td>Capital intensity measured as net property, plant, and equipment divided by net sales ((8/12)).</td>
</tr>
<tr>
<td>INVM</td>
<td>Inventory materiality computed as a ratio of inventory to total assets ((3/6)).</td>
</tr>
<tr>
<td>CPRICE</td>
<td>Relative frequency of positive price changes for each SIC four-digit industry code over the sample period. Producer Price Index was obtained from the publications of the U.S. Department of Commerce.</td>
</tr>
<tr>
<td>INCVAR</td>
<td>Coefficient of variation (variance/mean ratio) of before tax accounting income.</td>
</tr>
<tr>
<td>FIXED</td>
<td>Property, plant, and equipment, net ((8)) divided by the market value of equity at the fiscal year-end ((24 \times 199)).</td>
</tr>
<tr>
<td>NDTTS</td>
<td>Non-debt tax shield computed as the ratio of the sum of depreciation and investment tax credits ((103 + 51)) to earning before interest, taxes, and depreciation ((172 + 15 + 16 + 103)).</td>
</tr>
<tr>
<td>LATS</td>
<td>Available tax savings measured as natural logarithm of tax loss carryforwards ((52)) multiplied by cost of goods sold ((41)).</td>
</tr>
<tr>
<td>INVTS</td>
<td>Inventory to sales measured as inventories ((3)) to net sales ((12)).</td>
</tr>
<tr>
<td>TLCF</td>
<td>Net operating tax loss carryforward measured as a ratio of net operating tax carryforward to net income before interest, taxes, and depreciation expenses ((52/(172 + 15 + 16 + 103))).</td>
</tr>
</tbody>
</table>

Note: Compustat data item numbers in parentheses.

use LIFO. Hagerman and Zmijewski (1979), Lee and Hsieh (1985), and Dopuch and Pincus (1988) suggest that large capital-intensive firms have a comparative advantage in adopting LIFO. The inventory to total assets ratio (INVM) serves as a proxy for measuring how efficiently the inventory has been managed. Following Lee and Hsieh (1985), INVM is expected to be negatively associated with the use of the LIFO method. The price variability (CPRICE) variable is a proxy for inflation. The higher the inflation rate, the higher the likelihood that firms would adopt LIFO. Lee and Hsieh (1985) argue that production-investment opportunity sets will vary from industry to industry. Therefore, a dummy variable is assigned to each of the two-digit SIC industries.
The regressors for the tax functions were identified based on the review of the relevant tax literature (see Biddle & Martin, 1985; Bowen et al., 1995; Dhaliwal et al., 1992; Trezevant, 1992, 1996). The tax functions are listed below:

\[ T_L = \delta_0 + \delta_1 \text{FIXED}_L + \delta_2 \text{NDTS}_L + \delta_3 \text{LATS}_L + \delta_4 \text{INVTS}_L + \delta_5 \text{TLCF}_L + \varepsilon_L \]  

\[ T_F = \delta_0 + \delta_1 \text{FIXED}_F + \delta_2 \text{NDTS}_F + \delta_3 \text{LATS}_F + \delta_4 \text{INVTS}_F + \delta_5 \text{TLCF}_F + \varepsilon_F \]  

where:

- \( T_L \) or \( T_F \) = the logarithmic value of total taxes for LIFO or FIFO firms, respectively;
- FIXED = net property, plant, and equipment divided by the market value of equity;\(^{11}\)
- NDTS = non-debt tax shield derived as the sum of depreciation and investment tax credits divided by earnings before interest, taxes, and depreciation;
- LATS = available tax savings measured as the logarithmic value of tax loss carryforwards times cost of goods sold;
- INVTS = inventory turnover measured as inventories to net sales; and
- TLCF = net operating loss carryforward to net income before interest, taxes, and depreciation.

The variables used in tax functions (13a) and (13b) are based on the assumption that a firm’s taxes depend upon net fixed assets, non-debt tax shield, tax savings available from adopting LIFO, efficiency of inventory management, and the amount of the tax loss carryforward. It is important to note that firms do trade-off or substitute various tax shields to minimize the marginal tax rate. The model used in this study examines not only the effect of the individual coefficients in the tax function but also the joint effects of these coefficients. Thus, when high tax shields increase the possibility of tax exhaustion, the firm is likely to have a lower marginal tax rate which may decrease the likelihood of LIFO use.

Ceteris paribus, we expect that firms with relatively high values of net property, plant, and equipment scaled by the market value of equity (FIXED) are likely to pay lower taxes. FIXED is a measure of debt securability (Dhaliwal et al., 1992; Trezevant, 1992). Firms with a larger proportion of their assets represented by fixed assets are likely to raise larger amounts of debt or lower the cost of financing (Titman & Wessels, 1988). Therefore, the variable FIXED provides a tax shield by
enhancing the possibility of increased debt financing, which increases the level of interest deductibility, and consequently the FIXED variable indirectly lowers taxes.

Assuming no available substitution of tax shields, the higher proportion of non-debt tax shield (NDTS) would lower the marginal tax rate, and therefore lower will be the taxes. The variable LATS is a proxy measure for tax savings. It is computed by multiplying the cost of goods sold with tax loss carryforwards. This measure is based on the argument that firms with relatively higher cost of goods sold and tax loss carryforwards are likely to pay lower taxes (see Bowen et al., 1995). Therefore, the expected sign of the coefficient for the LATS variable is negative.

The variable INVTS represents efficiency in inventory management (Lee & Hsieh, 1985). The INVTS coefficient is expected to be negatively associated with taxes. This relationship could be best explained by using the following illustration. Suppose, net sales increases from $150,000 to $175,000, and cost of goods sold and ending inventory remain unchanged at $80,000 and $20,000, respectively. This would cause inventory to sales ratio (INVTS) to decrease from 13.3% to 11.4%, increasing gross margin from $70,000 to $95,000 thereby increasing taxes assuming that the marginal tax rate is the same as in the previous year.

Finally, the variable TLCF is expected to be negatively associated with taxes for LIFO firms. In other words, firms are less likely to use LIFO if they have tax loss carryforwards, which could be used to shield taxes. Auerbach and Porterba (1987) indicate that firms expecting persistent loss carryforwards are likely to experience lower marginal tax rates. On the other hand, firms are more likely to use FIFO or other income-increasing methods even if they have tax loss carryforwards in the event the alternative available tax shields are tax exhaustive. Thus, the expected sign of the TLCF coefficient cannot be predicted.

Table 1 gives further description of the variables used in the tax functions. It also gives the data item numbers used for extracting financial statement values from Compustat tapes.

Sample and Data Collection

The data for the variables used in this study were obtained from the back data Compustat files. The sample firms were obtained from 1973 to 1981 years, a period of historically high inflation rates in the United States during which firms adopting LIFO could obtain substantial tax savings. This yielded an initial sample of 10,777 observations for firms using either the LIFO or FIFO inventory method. Since firms use a combination of inventory methods for financial reporting, LIFO firms are those who use LIFO for most of their inventory accounting and FIFO

Panel A: Sample selection

| Number of observations on the back data compustat files for which the inventory method is either LIFO or FIFO from 1973 to 1981 | 10,777 |
| Number of missing observations | 4,687 |
| Number of observations where the primary inventory method is either LIFO or FIFO | 6,090 |
| Number of LIFO observations (number of firms = 247) | 1,050 |
| Number of FIFO observations (number of firms = 1006) | 5,040 |

Panel B: Sample Distribution by Industries

<table>
<thead>
<tr>
<th>Industry</th>
<th>LIFO</th>
<th>FIFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>01–19 (Agricultural products)</td>
<td>17</td>
<td>204</td>
</tr>
<tr>
<td>20–39 (Manufacturing)</td>
<td>872</td>
<td>3,255</td>
</tr>
<tr>
<td>40–49 (Transportation &amp; utilities)</td>
<td>–</td>
<td>127</td>
</tr>
<tr>
<td>50–59 (Wholesale &amp; retail products)</td>
<td>225</td>
<td>699</td>
</tr>
<tr>
<td>60–69 (Finance, insurance &amp; real estate)</td>
<td>16</td>
<td>110</td>
</tr>
<tr>
<td>70–89 (Services)</td>
<td>20</td>
<td>563</td>
</tr>
<tr>
<td>90–99 (Public administration)</td>
<td>–</td>
<td>82</td>
</tr>
<tr>
<td>Total number of sample observations</td>
<td>1,050</td>
<td>5,040</td>
</tr>
</tbody>
</table>

firms are those who use FIFO as their predominant inventory valuation method. After eliminating missing observations, the total sample is made of 6,090 observations. Of this number 1,050 (247 firms) represents LIFO observations and 5,040 observations (1006 firms) are of FIFO firms. Table 2, Panel A lists the sample selection procedure.15

Table 2, Panel B shows the two-digit SIC code industry composition of the LIFO and FIFO samples. The LIFO group consists of 1,050 observations distributed over 5 different two-digit industries with the manufacturing industry being the largest followed by the wholesale and retail industries. The FIFO observations are distributed over seven different two-digit industries where the largest concentration is also in the manufacturing industries followed by the wholesales and retail industries. Overall, the sample distribution for the two groups of firms appears to be concentrated in the manufacturing, wholesale, and retail industries.

Table 3 presents descriptive statistics for the variables used for multivariate analyses, classified by LIFO and FIFO groups. We corrected for price inflation whenever a variable entered as a dollar value, using 1982 as the base-year and
Table 3. Sample Descriptive Statistics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>LIFO</th>
<th>FIFO</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lntxpay</td>
<td>1.294</td>
<td>3.926</td>
<td>2.004</td>
</tr>
<tr>
<td>Lgtasst</td>
<td>4.837</td>
<td>1.954</td>
<td>4.550</td>
</tr>
<tr>
<td>Invvar</td>
<td>0.134</td>
<td>0.121</td>
<td>0.096</td>
</tr>
<tr>
<td>Lev</td>
<td>0.148</td>
<td>0.115</td>
<td>0.144</td>
</tr>
<tr>
<td>CI</td>
<td>0.243</td>
<td>0.185</td>
<td>0.195</td>
</tr>
<tr>
<td>Relasst</td>
<td>0.005</td>
<td>0.017</td>
<td>0.000</td>
</tr>
<tr>
<td>Invm</td>
<td>0.277</td>
<td>0.141</td>
<td>0.269</td>
</tr>
<tr>
<td>Cprice</td>
<td>6.828</td>
<td>4.194</td>
<td>6.300</td>
</tr>
<tr>
<td>Incvar</td>
<td>0.138</td>
<td>3.095</td>
<td>0.183</td>
</tr>
<tr>
<td>Fixed</td>
<td>0.883</td>
<td>3.143</td>
<td>0.140</td>
</tr>
<tr>
<td>Nds</td>
<td>0.292</td>
<td>1.918</td>
<td>0.186</td>
</tr>
<tr>
<td>Lats</td>
<td>2.408</td>
<td>3.408</td>
<td>1.954</td>
</tr>
<tr>
<td>Invts</td>
<td>0.166</td>
<td>0.086</td>
<td>0.155</td>
</tr>
<tr>
<td>Tclf</td>
<td>−0.012</td>
<td>0.722</td>
<td>0.000</td>
</tr>
<tr>
<td>Tasst</td>
<td>1177.25</td>
<td>4362.33</td>
<td>94.597</td>
</tr>
<tr>
<td>Sales</td>
<td>1509.14</td>
<td>6518.58</td>
<td>173.926</td>
</tr>
<tr>
<td>Invent</td>
<td>170.04</td>
<td>529.41</td>
<td>26.485</td>
</tr>
</tbody>
</table>

Note: Tasst, sales, and inventories represents total assets, sales, and inventories in millions of dollars. All other variables are defined in Table 1. The t-value tests differences in means between LIFO and FIFO samples. ***, ** significant at 0.01, and 0.05 levels, respectively. Dollar values adjusted for price inflation using 1982 as the base year.

CPI as the index. Table 3 shows the mean, median, and standard deviation values for each of the two groups. Also given is the t-value for testing significant differences in mean values for each of the variables. The t-test shows that with the exception of INVM, INCVAR, FIXED, and TLCF, the remaining variables used in the probit and tax functions are significantly different between LIFO and FIFO groups thereby suggesting that the two groups differ from each other on several dimensions. Table 3 also provides statistics on selected financial statement variables for each of the two groups of firms. The total assets (TASST) of LIFO firms (median value of $94.6 million) are about four times the value of total assets for FIFO firms (median value of $21.8 million). Similarly, the size of LIFO inventory (median value of $26.5 million) is nearly five times the size of inventory for FIFO firms (median value of $4.8 million). The results of the Kolmogrov-Smirnov and Shapiro-Wilks tests show that the observed distribution of individual variables is not significantly different from a normal distribution.
EMPIRICAL RESULTS

Estimates of Reduced-Form Probit Equations

Table 4 shows the estimated coefficients for the reduced-form probit Eq. (12) in which the dependent variable is a dichotomous dummy variable defined to be unity if the firm is LIFO and zero if FIFO. We present the results without the coefficient for the industry variable. Columns 1 and 2 provide estimated regression coefficients and t-values.

Table 4, Columns 1 and 2 shows that sample firms are more likely to be LIFO firms because of price-level increases. The inflation (CPRICE) variable is statistically significant at the 1% level. Columns 1 and 2 also shows that firms may not use the LIFO inventory method because of high variability of inventories (INVVAR), high leverage (LEV), high capital intensity (CI), and relatively high inventory as a component of total assets (INVM). The table shows that with the

Table 4. Estimated Coefficients for Reduced-Form Probit Equations.

\[ I = \gamma_0 + \gamma_1 \text{LGTASST}_i + \gamma_2 \text{INVVAR}_i + \gamma_3 \text{RELASST}_i + \gamma_4 \text{CI}_i + \gamma_5 \text{INVM}_i \]
+ \gamma_7 \text{CPRICE}_i + \gamma_8 \text{INCVAR}_i + \epsilon_i

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>0.001</td>
<td>0.008</td>
</tr>
<tr>
<td>LGTASST (+)</td>
<td>0.025</td>
<td>1.194</td>
</tr>
<tr>
<td>INVVAR (?)</td>
<td>-2.824</td>
<td>-11.446***</td>
</tr>
<tr>
<td>LEV (--)</td>
<td>-0.787</td>
<td>-4.795***</td>
</tr>
<tr>
<td>RELASST (+)</td>
<td>-0.663</td>
<td>-0.563</td>
</tr>
<tr>
<td>CI (++)</td>
<td>-0.198</td>
<td>-1.786*</td>
</tr>
<tr>
<td>INVM (--)</td>
<td>-1.113</td>
<td>-5.932**</td>
</tr>
<tr>
<td>CPRICE (+)</td>
<td>0.025</td>
<td>4.555***</td>
</tr>
<tr>
<td>INCVAR (--)</td>
<td>-0.008</td>
<td>-1.519</td>
</tr>
</tbody>
</table>

No. of observations 6090
Chi-square 906.4***
Log-likelihood -2346.3
Estimated $R^2$ 16.0%
Percent correct classification 83.0%

Note: Expected sign of the coefficients is in parentheses. CPRICE is the relative frequency of price increases in each industry during the 1973–1981 period. See Table 1 for definition of variables.

* Significant at 0.10 level.
** Significant at 0.05 level.
*** Significant at 0.01 level.
exception of the CI variable, which is significant at 10%, the coefficients for INVVAR, LEV, INVM variables are statistically significant at less than 5% and the sign is generally in the expected direction.\textsuperscript{17}

Estimates of Income Tax Equations

Table 5 presents the estimates of selectivity-adjusted income tax equations in Columns 1 and 2. The dependent variable in both equations is the natural logarithmic value of the total income taxes for the year.\textsuperscript{18} All regressors are as defined in

\begin{table}[h]
\centering
\begin{tabular}{lccc}
\hline
Variable & Selectivity-Adjusted & OLS & \\
& (Expected Sign) & LIFO & FIFO & LIFO & FIFO & \\
\hline
Intercept & & & & & \\
& & 6.666 & -2.152 & 3.205 & 0.761 & \\
& & (18.07)*** & (-12.65)*** & (11.13)*** & (6.04)*** & \\
FIXED (\textendash ) & & & & & \\
& & -0.145 & -0.103 & -0.071 & -0.130 & \\
& & (-4.04)*** & (-4.39)*** & (-1.32) & (-4.47)*** & \\
NDTS (\textendash ) & & & & & \\
& & -0.294 & 0.027 & -0.270 & 0.047 & \\
& & (-5.37)*** & (0.55) & (-2.64)** & (0.46) & \\
LATS (\textendash ) & & & & & \\
& & -0.518 & -0.233 & -0.513 & -0.196 & \\
& & (-6.55)*** & (-5.96)*** & (-3.29)*** & (-3.99)*** & \\
INVTS (\textendash ) & & & & & \\
& & (-3.67)*** & (-8.43)*** & (-5.49)*** & (-6.47)*** & \\
TLCF (?) & & & & & \\
& & 0.558 & 0.024 & 0.565 & 0.029 & \\
& & (3.44)*** & (1.27) & (2.47)** & \\
LAMBDA & & & & & \\
& & (-13.09)*** & (-29.43)*** & & & \\
Num. of obs. & 1050 & 5040 & 1050 & 5040 & \\
Adj. R\textsuperscript{-}square & 0.243 & 0.243 & 0.123 & 0.042 & \\
F-value & 57.17*** & 270.33*** & 27.72*** & 34.74*** & \\
\hline
\end{tabular}
\caption{Estimated Coefficients for Income Tax Equations.}
\end{table}

Note: See Table 1 for definition of variables. Lambda is the inverse Mills’ ratio derived as: $\lambda = [\psi(u)/\Phi(u)]$, where $u$ is the predicted value of the reduced form probit, $\psi$ is the standard normal probability density function for $u$, and $\Phi$ is its cumulative density function. *Figures in parentheses are t-values based on heteroskedasticity-consistent variance-covariance matrix derived in Heckman (1979), Columns 1 and 2, and White (1980), Columns 3 and 4. ** Significant at 0.05 level. *** Significant at 0.01 level.
Table 1. As stated in Section 3, the LAMBDA terms are the inverse Mills ratio. The statistical significance of the LAMBDA term in Columns 1 and 2 indicate a non-zero covariance between the error term in the inventory choice and the LIFO (FIFO) tax equations. In short, the self-selection of firms into the LIFO (FIFO) category is confirmed. The negative sign of LAMBDA terms show that firms, which expect to pay higher than average taxes in the LIFO (FIFO) category are less likely to be LIFO (FIFO) firms. Thus, the average firm’s choice of the LIFO or the FIFO method for inventory valuation in this sample is consistent with rational decision-making. The typical LIFO or FIFO firm in the sample would have been worse off had it chosen the alternate method. Note also that the sign pattern on the LAMBDA terms satisfy the condition for model consistency: $\lambda_{L} < \lambda_{F}$. The lambda coefficient for LIFO firm is $-3.612$ and for FIFO firms it is $-9.614$ and both these values are statistically significant.

Other results shown in Table 5, Column 1 are noteworthy. In Column 1, all of the remaining regressors are significant at the 1% level and the sign of the regression coefficients are generally in the expected direction for LIFO firms with the exception of TLCF. We find that LIFO firms’ taxes are inversely related to tax shield provided by fixed assets (FIXED), non-debt tax shield (NDTS), available tax savings (LATS), inventory turnover (INVTS) and positively related to tax loss carryforwards (TLCF). In Table 5, Column 2, the results for FIFO firms show that the sign of the coefficients are in the expected direction for each of the regressors, with the exception of TLCF. Similar to LIFO firms, the positive sign of the TLCF coefficients suggest that firms paying higher taxes also have higher values of TLCF on their books. Taken together, these reported sign patterns are largely consistent with the theoretical predictions listed in Section IV.

For comparison, Columns 3 and 4 in Table 5 show the corresponding estimates for the specifications without correcting for self-selection. The results are generally consistent with those of the selectively adjusted regressions reported in Columns 1 and 2. The extent of self-selection bias is assessed by comparing the corresponding coefficients in Columns 1 and 3 vs. Columns 2 and 4 of Table 5. The implied elasticity of the firms’ tax payments with respect to each of the independent variables (measured by multiplying the estimated coefficients by their respective means) is used to estimate the differences in the size of the coefficients between the selectivity-adjusted and OLS estimates. Our calculations reveal that for LIFO firms the implied elasticity for variables, FIXED and INVTS, is sizably different between selectivity-adjusted and OLS regressions. For instance, a 10% increase in inventory to sales (INVTS) is expected to decrease taxes by 7.64% ($-4.603 \times 0.166$) using selectivity approach and 15.36% ($-9.255 \times 0.166$) decrease using OLS. Large differences in implied elasticity between selectivity-adjusted and OLS regressions are also found for FIFO firms. A 10% increase in
available tax savings (LATS) will decrease taxes by 13.02% ($-0.233 \times 5.59$) under selectivity approach and by 10.96% ($-0.196 \times 5.59$) using the OLS approach. Also, about 24% difference in implied elasticity is found for the INVTS variable between the selectivity-adjusted and OLS categories. In addition, we also performed the Wald test for the overall differences in the selectivity-adjusted and OLS regressions in each of the LIFO and FIFO categories. Our results show significant differences ($p < 0.001$) across selectivity-adjusted and OLS estimates.23

Estimates of the Structural Probit and Sensitivity Tests

The estimates of structural-probit (not reported) model are based on the results of the reduced-form probit. Thus, using reduced-form probit, we derive the estimated value for predicted tax savings under LIFO and FIFO approaches. These econometrically computed predicted tax savings are introduced as an added variable in the structural probit equations. The results of the estimated structural probit equations based on Eq. (12) show that the sign and significance of the coefficients are largely similar to those for the reduced-form probit except the size variable (LGTASST), which is significant at the 1% level, and the inflation variable (CPRICE) which is negatively and significantly associated with LIFO use. As previously noted, for the reduced-form probit the LGTASST was not significant and the CPRICE variable was significantly positive.

The results of the structural probit (not reported) also show the coefficient for the predicted tax savings, PRTXSAV, calculated as the difference between predicted less actual taxes under the two inventory valuation methods for each firm in the sample. For LIFO firms, it is calculated as the difference between predicted FIFO taxes and actual LIFO taxes. For FIFO firms, it is the difference between predicted LIFO taxes and actual FIFO taxes. For identifiability reasons, the structured probit equations exclude the INCVAR variable. The estimation results (not reported) reveal that the predicted tax savings variable is the most significant and a positive coefficient in explaining the use of LIFO, indicating that increases in the tax benefit of adopting LIFO increase the likelihood that firms will choose the LIFO method.

Since the results of structural probit may depend on the choice of the variable excluded from the inventory choice equation, we conducted sensitivity tests by re-estimating the structured probit model with a different variable excluded in turn. The results of these tests are reported in Table 6. Each row in the Table represents a separate estimation of the structured model. The excluded variable in each case is listed in the first column. Clearly, all the predicted tax savings
Table 6. Sensitivity Test of the Structural Probit Equation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>PRTXSAV</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCVAR</td>
<td>0.296</td>
<td>35.764***</td>
</tr>
<tr>
<td>INVVAR</td>
<td>0.294</td>
<td>35.427***</td>
</tr>
<tr>
<td>RELASST</td>
<td>0.295</td>
<td>38.850***</td>
</tr>
<tr>
<td>INVM</td>
<td>0.296</td>
<td>35.885***</td>
</tr>
<tr>
<td>CI</td>
<td>0.294</td>
<td>35.917***</td>
</tr>
<tr>
<td>LGTASST</td>
<td>0.286</td>
<td>36.243***</td>
</tr>
<tr>
<td>LEV</td>
<td>0.292</td>
<td>36.363***</td>
</tr>
<tr>
<td>CPRICE</td>
<td>0.296</td>
<td>35.780***</td>
</tr>
</tbody>
</table>

Note: Dependent variable equals 1 if the firm is LIFO, 0 if FIFO. Each coefficient reported above represents predicted tax savings computed as the difference between predicted taxes less actual taxes in separate estimates of the probit equation. The variable removed from the structural probit equation is named in the first column. For example, the coefficient on predicted taxes in Table 6 is reported as the first entry labeled INCVAR when INCVAR is removed.

Table 6 is reported as the first entry labeled INCVAR when INCVAR is removed.

*** Significant at the 0.01 level.

in Table 6 are positive and significant at less than the 1% level and qualitatively similar in magnitudes in each case. Thus, the positive effect of the predicted tax savings variable appears to be robust with respect to differences in the specification of the structural probit equations.

Predicted Tax Savings Under Different Regimes

The implications of self-selection in an inventory method selection study cannot be easily dismissed. The presence of a significant lambda term in the selectivity-adjusted model suggests that the tax savings or tax savings foregone could be potentially large. Thus, the model could then be used to estimate what the tax savings or tax savings foregone would have been had a firm chosen the alternate method. As an illustration, we calculate the differences between the actual tax payments for each LIFO (FIFO) firm and what they would have paid had they been in the other category, with and without adjustment for self-selection. For consistency, we define the tax saving as actual LIFO (FIFO) taxes less predicted FIFO (LIFO) taxes. The calculated differences so obtained are reported in Table 7. The table provides the answer to the question: how much more or less taxes would LIFO (FIFO) firms had paid had it been in the other category?

The predicted tax savings or tax savings foregone for LIFO and FIFO firms under the selectivity-adjusted and the OLS methods are presented in Table 7. Columns 1
Table 7. Predicted Dollar Tax Savings Under Different Regimes for LIFO and FIFO Firms.

<table>
<thead>
<tr>
<th></th>
<th>Selectivity-Adjusted</th>
<th>OLS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LIFO</td>
<td>FIFO</td>
</tr>
<tr>
<td>Mean</td>
<td>−282.20</td>
<td>12.300</td>
</tr>
<tr>
<td>Median</td>
<td>−297.44</td>
<td>1.242</td>
</tr>
<tr>
<td>Std Dev</td>
<td>190.35</td>
<td>43.000</td>
</tr>
<tr>
<td>Maximum</td>
<td>709.31</td>
<td>449.45</td>
</tr>
<tr>
<td>Minimum</td>
<td>−723.67</td>
<td>−0.315</td>
</tr>
<tr>
<td>InterQuartile range</td>
<td>188.59</td>
<td>5.975</td>
</tr>
<tr>
<td>No. of obs.</td>
<td>1032</td>
<td>5031</td>
</tr>
</tbody>
</table>

Note: Tax savings for the LIFO (FIFO) firms is the difference between the actual LIFO (FIFO) taxes and predicted FIFO (LIFO) taxes. The negative sign indicates tax savings and positive sign indicates tax savings foregone. Selectivity-adjusted values are based on Heckman-Lee (1979, 1978) procedure. OLS estimates are ordinary least squares regression-based estimates. To eliminate the effect of extreme values 18 observations were dropped from LIFO sample and 9 observations from the FIFO sample. Our results remain qualitatively the same with or without these outliers.

and 2 shows selectivity-adjusted tax savings/tax savings foregone while Columns 3 and 4 show the corresponding tax savings/tax savings foregone when OLS estimate is used. Selectivity-adjusted values (Columns 1 and 2) show that for LIFO firms the mean tax savings are $282.2 million (median $297.4 million) and mean tax savings for FIFO firms is $12.3 million (median $1.2 million). These results suggest that FIFO firms would have had sizable tax savings had they been LIFO firms.

Had the non-random nature of the sample been ignored, the corresponding OLS estimated mean tax savings foregone would have been $40.6 million (median $2.3 million) for LIFO firms and $11.3 million (median $5.0 million) for FIFO firms (Columns 3 and 4). Compared to selectivity approach, the OLS results are consistent for FIFO firms but not so for LIFO firms.

Compared to the OLS approach, we have greater confidence in the results of the selectivity-based approach because it is econometrically derived and it utilizes a set of explanatory variables in the regression models, which are well defined in the accounting and tax literature. We believe that large selectivity-based tax savings provide a partial explanation of why a number of firms adopted LIFO during the mid-1970s. Finally, the results in Table 7 for FIFO firms are fairly uniform. In each case, the selectivity adjusted or the OLS approach, the FIFO firms would have had tax savings had they used the LIFO inventory method.
SUMMARY AND CONCLUSIONS

Managerial decision to use an inventory accounting method is based on a number of variables. Some of these variables may be linked to the tax strategy, compensation policy, debt covenants, stock prices, and working capital. Which ever inventory method is used (e.g. LIFO, FIFO), the firm needs to design its managerial accounting system to optimize its choice of the accounting method. For instance, the decision to adopt LIFO or FIFO suggests that a firm has the ability to forecast cash flows under either of these choices. In addition, a firm planning to use LIFO expects to remain profitable and that the investment in inventories is likely to increase due to expected inflation. Thus, management accounting needs to do careful profit planning for business units and segments and be able to examine the implications of the inventory method on firm taxes, managerial compensation, debt covenants, and inventory management. This discussion demonstrates that the choice of the inventory method affects a firm’s management accounting system in a wide variety of ways.

Prior research examining a firm’s choice of either LIFO or FIFO as an inventory valuation method has concentrated on two major areas. One line of inquiry has measured the effects of this choice while the other has examined the determinants of the choice. This study extends LIFO-FIFO research by developing a model in which the choice of an inventory valuation method and the effects of this choice are jointly determined. Approaching the subject area in this way makes the self-selection bias arising from firms’ choice of LIFO and FIFO the central issue of our analysis. Self-selection occurs when the observed assignment of firms into these two accounting categories is due to a priori, unobserved decision processes. Ignoring the self-selection of firms and treating the LIFO-FIFO status as exogenous introduces bias into the empirical estimates. In dealing with this issue, we applied the two-stage regression procedure developed by Heckman (1976, 1979) and Lee (1978) to 1973–1981 data, a period during which the incentive to adopt LIFO was most pronounced. We estimated tax equations for LIFO and FIFO firms separately, simultaneously correcting for self-selection bias. The unbiased parameters from the tax functions are then used to create a measure of the tax benefits from adopting LIFO.

Self-selection bias arises because sample items have been pre-selected. The researcher, as a result, has no opportunity to select the sample items randomly. In case of the selection of LIFO and FIFO firms, we could not select the sample firms randomly. We used the firms in our sample where the managers had already selected either LIFO or FIFO as the predominant inventory choice method. Hence, the researcher ends up using a non-random sample. The self-selection approach used here attempts to measure whether there is self-selection bias when
using pre-selected LIFO and FIFO firms. Knowing the self-selection bias, we are able to estimate the tax savings, which would have been had the firms not been pre-selected and the sample was randomly derived. The estimated Mills ratio (lambda term) based on the two-stage method identifies the extent of self-selection bias and then explicitly computes the best measure of the predicted tax savings in a structured probit estimate.

Our analysis yields the following results. First, we find strong evidence that self-selection is present in our sample of LIFO and FIFO firms, consistent with the hypothesis that the managerial decision to choose the observed inventory accounting method is based on a rational cost-benefit calculation. Second, correcting for self-selection leads to the inference that LIFO firms would, on average, pay more taxes as FIFO firms, and FIFO firms could have had tax savings had they been LIFO firms. Our selectivity-adjusted calculation shows that the mean tax savings is $282.2 million for LIFO firms and that FIFO firms would, on the average, pay $12.3 million less in taxes if they were LIFO firms. Without correction for selectivity bias, the mean tax benefit foregone is $40.6 million for LIFO firms and $11.3 million for FIFO firms. Overall, the results suggest that the difference between the LIFO/FIFO tax savings could partly be the function of firm size. LIFO firms in our sample are on the average larger than the FIFO firms. In addition, the difference in tax savings may be related to specific industries. Finally, we believe that the inventory method (LIFO or FIFO) is reflective of the various economic constraints confronting the firm. Hence, the inventory method used by a firm is a rational economic decision.

Two weaknesses may be related to our work. Despite controlling for firm size in the accounting choice function, one may argue that our results are affected by the size difference between the LIFO and FIFO firms. The LIFO firms in our sample are on the average larger than the FIFO firms. In addition, the difference in tax savings may also be specific to selected industries. We do not compute tax savings on industry-level because of insufficient data. Future studies could explore this issue further. Future work may also investigate the presence of self-selection bias on other management accounting issues. For instance, the effect of the selection of the depreciation method on managerial performance could be studied. An additional area of work could focus on the effect of the selection of the pooling vs. purchase method of accounting on the post-merger performance of merged firms.

NOTES

1. The LIFO reserve reported by LIFO firms since 1975 is also an as-if number (see Jennings et al., 1996).
2. Martin (1992) argues that FIFO method may be a logical tax minimizing strategy for some firms in the event sales and production grow faster than the inflation rate when idle capacity exists, and fixed manufacturing costs is relatively large.

3. Sunder (1976a, b) develops models to estimate the differences between the net present value of tax payments under LIFO vs. FIFO inventory valuation methods. He shows that the expected value of net cash flows depend on the future marginal tax rates, anticipated change in the price of inventories, cost of capital of the firm, pattern of changes in the year-end inventories, and the number of years for which the accounting change will remain effective. Caster and Simon (1985) and Cushing and LeClere (1992) found that tax loss carryforward and taxes are significant factors in the decision to use the LIFO method, respectively.

4. The accounting literature has yet to develop a unified theory explaining managers' choice of an accounting method. However, an emerging body of accounting literature has advocated the concept of rational choice as a basis of managerial decision-making (see Watts & Zimmerman, 1986, 1990).

5. We recognize that a principal-agent problem can arise when self-interest of managers do not coincide with the interest of firms' shareholders (Jensen & Meckling, 1976). We do not incorporate the agency issue into the theoretical framework for two reasons: (1) it is another source of self-selection in the data in addition to the self-selection caused by maximizing shareholders' wealth; and (2) some empirical studies have found that managerial compensation and managerial ownership variables are not significant regressors in explaining inventory valuation choice (Adel-Khalik, 1985; Hunt, 1985).

6. The Heckman-Lee method has also been used in previous accounting studies. For instance: Adel-Khalik (1990a, b) applied the Heckman-Lee model to firms acquiring management advisory services from incumbent auditors vs. other sources, and to the endogenous partitioning of samples into good news and bad news portfolios of quarterly earnings announcements. Shehata (1991) uses the Heckman-Lee model to examine the effect of the Statement of Financial Accounting Standard No. 2 on R&D expenditures, and Hogan (1997) shows that the use of Big 6 vs. non-Big 6 auditor in an initial public offering depends upon a strategy which minimizes the total cost of under-pricing and auditor compensation.

7. The error terms in Eqs (10) and (11) are heteroskedastic and a correction must be made in calculating the correct standard errors of the estimates. In this study, this correction is achieved by using LIMDEP software in implementing the Heckman-Lee model. See Greene (1990) for a description of the correction process.

8. Following Dopuch and Pincus (1988), we also estimate using the “as-if” approach but we do not report the results in this paper.

9. Lindahl et al. (1988) characterize Lee and Hsieh’s (1985) probit model to be comprehensive which includes many of the variables used in previous studies.

10. The rationale for the use of the regressors in the probit function is covered extensively in Lee and Hsieh (1985).

11. Dhaibliwal et al. (1992) compute the FIXED variable by including long-term debt in addition to the market value of equity in the denominator.

12. DeAngelo and Masulis (1980) demonstrated that a firm’s effective marginal tax rate on interest deductions is a function of the firm’s non-debt tax shields (e.g. tax loss carryforwards, investment tax credits).

13. Trezevant (1996) investigates the association of debt tax shield to changes in a non-investment tax shield (cost of good sold) in the post LIFO adoption period.
14. A similar argument is made by Mackie-Mason (1990) when considering tax carryforward and debt financing. He argues that tax carryforward have a large effect on the expected marginal tax rate on interest expenses since each dollar of tax carryforward is likely to reduce a dollar of interest deduction.

15. We included firms with as few as one LIFO (FIFO) year, as long as it has not been a FIFO (LIFO) firm in any other years in this period. There are several reasons for our choice: (1) specifying a minimum number of years for inclusion in the sample is arbitrary and introduces potential bias in estimates; (2) the time element is unimportant in the pooled cross-sectional analysis as each year of the data is treated as an independent observation; and (3) since firms obtain the benefits from choosing LIFO (FIFO) in the year of adoption, firms using LIFO (FIFO) for only one year will still provide us with as much relevant information on the inventory method choice as those using LIFO or FIFO for more than one year.

16. Aside from differences in inventory methods and substantial economic differences, the differences in t-values between the two groups may also be a function of possible violation of the assumptions of the t-test.

17. Probit results with industry dummies included are similar to the results reported in Table 4. In addition, the results indicate that the regression coefficients are positive and significant for the textile, chemicals, petroleum and coal, rubber, leather, primary metal and wholesale industries and are negative and significant for electronic and business services industries.

18. We also used the logarithmic value of income taxes paid (income taxes-total [Compustat item 16] minus deferred income taxes [Compustat item 126] as the dependent variable). The results are essentially similar to those reported in Table 5. In addition, we examined the possibility of using effective corporate tax rate as the dependent variable but decided against its use for lack of consistency in the definition of the effective tax rate measure in the literature (Omer et al., 1990).

19. The lambda term is based on the predicted value of the error term derived from the reduced form probit. Hence, the selectivity adjustment reported in Table 5 is based on the probit reported in Table 4.

20. The t-statistics shown in Table 5 are based on the correct asymptotic variance-covariance matrix derived in Heckman (1979). Also, the OLS regression reveals that there is no multi-collinearity among regressors (VIF values are no more than 2.0).

21. The results obtained using a different set of regressors for the tax function, are qualitatively similar. For instance, we developed a model containing the following variables: NDT, TLC, FIXED, INV, VAR, RELASST, and INCVAR. The corresponding coefficients of the lambda terms are $-1.815 (t = -5.292)$ for LIFO firms and $-7.071 (t = -22.462)$ for FIFO firms. The sign and significance of other regressors in the tax equations are generally in the expected direction. Similar results are also found when we drop the INCVAR variable from the above tax function.

22. Differentiating the dependent variable with respect to the variable, FIXED, for example, yields $(\frac{\delta T/F}{T/F})$ where $T$ is dollars of tax payments and $F$ represents the FIXED variable. Multiplying by the mean value for FIXED gives us $(F \delta T/F)$, the elasticity of taxes associated with fixed assets. Note that for the LATS regressor, both the dependent and independent variables are already in natural logarithmic value. Thus, the estimated coefficient is itself the elasticity figure.

23. We tested the normality assumption for each of the variables prior to adjusting for selectivity by either using the Kolmogrov-Smirnov or the Shapiro-Wilks statistic. The
results show that the observed distribution is not significantly different from the normal distribution. In addition, following Pagan and Vella (1989), we perform a moment-based test for normality in selectivity models. In this test, the predictions from the probit model are squared and cubed, weighted by the Mills ratio. Using the two-stage least squares results, the null hypothesis that squared and cubed terms are zero cannot be rejected.

24. The difference between actual LIFO (FIFO) taxes and predicted FIFO (LIFO) taxes for LIFO (FIFO) firms is either tax savings or tax savings foregone. The negative difference suggests tax savings and the positive sign difference indicates tax savings foregone.

25. We also computed tax savings/tax forgone using the “as-if” method described in Lindahl (1982), Morse and Richardson (1983), Dopuch and Pincus (1988), and Pincus and Wasley (1996). Our results (not reported) show that the average “as-if” tax savings for LIFO firms is $10.9 million. The FIFO firms’ average tax savings foregone under the “as-if” approach is $60.0 million. Overall, our results show that the selectivity-adjusted approach has the highest tax savings for LIFO firms. The selectivity approach takes into consideration the joint decision of the inventory method choice and the tax effect of the decision.

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