CHOICE OF INVENTORY ACCOUNTING METHODS:

A RICARDIAN APPROACH

By

Chi-wen Jevons Lee and David A. Hsieh

Working Paper No. 6-84

THE WHARTON SCHOOL

University of Pennsylvania

Philadelphia, Pa 19104

Preliminary Draft.
Please do not quote.
Comments are solicited.

Choice of Inventory Accounting Methods:

A Ricardian Approach

Chi-wen Jevons Lee and David A. Hsieh*

The Wharton School
University of Pennsylvania
Philadelphia, PA 19104

First Draft June 1983

Fourth Draft March 1984

*Respectively, Associate Professor of Accounting, University of Pennsylvania and Assistant Professor of Business Economics, University of Chicago. The helpful comments of Chris Petruzzi and Gary Biddle are gratefully acknowledged.

I. Introduction

In the past decade, the economy has experieced double-digit inflation. Although hundreds of firms have switched to the LIFO accounting method, thousands more continue to use the FIFO method. Biddle (1980) estimated that each of the 105 FIFO firms in his study paid an average of nearly $26 million each in additional federal income tax. What made these FIFO firms so reluctant to switch accounting methods?

A review of the literature provides three possible explanations for the pattern of inventory accounting choice: political cost theory, agency theory, and value-maximization theory. Because the underlying economic variables of these three theories are not observable, the empirical tests are based on examination of proxy variables. In general, there is no consistent evidence to support the agency theory. Many of the proxy variables of political cost theory and value-maximization theory are the same; hence it is difficult to discriminate one theory from another using univariate statistical methods. There is consistent evidence of a size effect on inventory accounting choice. The size effect can be associated with either political cost theory, value-maximization theory or both. Moreover, there is also strong evidence of the industry effect, but it has not been explained by any behavioral theory.

The major purpose of this paper is to test the above three theories simultaneously using multivariate probit and logit methods. Our multivariate statistical methods are useful to discriminate between the two behavioral theories with overlapping proxy variables. Following the basic premises of value-maximization theory, this paper develops a Ricardian Model of inventory accounting choice. Our model is "Ricardian" in two specific senses. First, we assume that all firms are endowed with a

different prodution-investment opportunity set. Second, we hypothesize that the difference in production-investment opportunity set provides firms with different comparative advantages in adopting the LIFO or FIFO method and that value-maximizing managers choose inventory accounting method according to the Ricardian principle of comparative advantage. Therefore, we explore only one important aspect of the value-maximization theory.[1] We call our model "Ricardian" to underline this limitation, namely, we study how the endowed difference in production-investment opportunity set would affect inventory accounting choice.

We have found that managers make their choice of inventory accounting method so that the value of the firm will be maximized. The size effect claimed by political cost theory is spurious because size is related to the production-investment opportunity set. We have also found a satisfactory explanation for the industry effect of inventory accounting choice.

The body of this paper is organized into seven sections. Section II briefly surveys the current literature. Section III elaborates a Ricardian model of inventory accounting choice. Section IV summarizes the proxy variables for the three theories of managerial behavior: agency theory, political cost theory and value-maximization theory. Many of the proxy variables of political cost theory and value-maximization theory overlap. That is why some researchers in the literature have thought that they have found empirical evidence for the political cost theory although the underlying economic force can be better explained by the value-maximizing theory. Section V describes the attributes of our data and elaborates a simple univariate analysis. Since a univariate analysis can only measure the gross effect of a proxy variable, it is difficult to use it to discriminate between political cost theory and value-maximization theory.

Therefore, Section VI develops two models of multivariate analysis, namely, the logit model and the probit model, to measure the marginal explanatory power of each proxy variable. The results of the multivariate analyses are discussed in Section VII. The last section concludes this paper by suggesting implications of the current literature on inventory accounting research.

II. Theories of Managers' Behavior

The literature provides three theories of managers' behavior: (1) agency theory, (2) political cost theory, and (3) value maximization theory. Much of the literature in accounting research on economic consequences has its origins in Jensen-Meckling's principal-agent framework.[2] Agency theory elaborates the conflict of interest between management and owner and between stockholders and bondholders. According to agency theory, since management compensation packages include profit sharing in excess of a target level, and since that target is typically stated in terms of accounting net income, managers would accordingly choose the accounting method that can increase current accounting net income. Agency theory also asserts that corporate lending agreements impose restrictions on the activities of borrowers, and that many of these restrictions are expressed in terms of accounting numbers. Accordingly, the restrictions in bond covenants lead managers to prefer the accounting method that gives rise to a higher accounting income.

Political cost theory is elaborated and advocated by Watts and Zimmerman (1978). Federal, state, and local governments and regulatory bodies base their economic policies, with respect to firms and industries, on accounting numbers. Moreover, a firm's accounting numbers can affect

its public image. The political visibility that derives from abnormally high accounting income often centers unfavorable public attention on the firm. According to political cost theory, managers prefer an accounting method that reduces accounting income.

Value maximization theory asserts that managers always try to maximize the present value of cash flows. As Fama (1980) points out, in a competitive managerial labor market ex post settling-up will lead managers to be loyal and faithful to owner. Moreover, internal competition and mutual monitoring among managers also forces them to act in the interest of the organization. Finally, being loyal and faithful to claimholders would benefit the managerial class as a whole. If a manager can be identified with a certain class, it is in his interest to maintain the integrity of this class.[3]

Before 1978, the literature on the choice of inventory accounting method provided little more than a rudimentary exploration of statistical association. For example, Copeland and Shank (1971) used a questionnaire survey to measure managers' perspective on inventory accounting methods. They found that the LIFO-adopting manager often perceives a significant tax benefit in the LIFO method while the non-LIFO-adopting manager often perceives no such tax benefit. However, they did not attempt any rational explanation. In this paper, we provide one.

Eggleton-Penman-Twombly (1976) showed a significant statistical association between changes in inventory accounting method and the change in management, industrial category and auditor. But they did not derive any consistent rational behavioral explanations for their findings. In this paper, we will discuss the industrial effect on the choice of inventory accounting methods. The <u>choice</u> of accounting methods should not be

affected by the change of management. Therefore, it is ignored in this paper.

In 1979, researchers started exploring the application of agency theory and political cost theory to understand the choice of inventory accounting method. Hagerman and Zmijewski (1979) asserted that the existence of a managerial profit sharing scheme would encourage the manager to adopt the FIFO method. They also argued, based on political cost theory, that higher industrial concentration, larger firm size and higher capital intensity lead to the adoption of the LIFO method. But none of the estimated coefficients of their probit analysis is statistically significant.[4]

Morse and Richardson (1983) found that only tax benefits and size were significant in explaining a firm's inventory decision if it deviated from the industrial norm. The tax effect can be clearly attributed to the value-maximizing theory. But the size effect can be attributed to both the value-maximizing theory and the political cost theory. They tried to use several other proxy variables to measure the effects arising from agency cost theory and political cost theory, but none showed any significance. Biddle (1980) matched a sample of 105 firms that adopted or extended the use of LIFO in 1972-1975 with FIFO firms that had at least the same two-digit SIC codes and were of similar size. He found that there were significant tax benefits to LIFO adoption and was puzzled by the inertia of the FIFO firms.

Abdel-Khalik (1983) found that executive compensation did not play a major role in decisions to change to the LIFO inventory valuation method. But he also concluded that political cost theory was the most likely motivation for managers to switch to LIFO. The statistically significant proxy variables were total assets and capital intensity. In this paper we

will demonstrate that these variables are proxies for production-investment opportunity sets.

III. A Ricardian Model of Value-Maximization Theory

In this section, we develop a Ricardian Model of inventory accounting choice. According to Gonedes (1979), the difference in inventory accounting methods can affect the net present value of a firm, if managers behave in conformity with the value-maximization theory, all firms with an identical production-investment opportunity set should choose the same inventory accounting method. For firms with heterogeneous production-investment opportunity sets, the value-maximizing manager would adopt an inventory accounting method according to a Ricardian principle of comparative advantage.

IIIA. IRS Tax Regulation and Ricardian Principle of Comparative Advantage

While a manager's choice of other accounting methods need only comply with FASB, which requires consistency but leaves managers free to choose among alternatives, the choice of inventory accounting method is under strict IRS regulation. There are four regulatory rules relevant to this decision:[5]

1. Only the cost method of valuation can be used in conjunction with the LIFO method. There cannot be any write-downs to market value.

2. LIFO may not be used if the taxpayer uses any other inventory method for credit purposes or for financial reports.

3. In general, once a taxpayer elects the LIFO method, a subsequent change is not available without approval from the IRS commissioner. Automatic approval is available if the taxpayer agrees to a 10-year spread of any positive adjustments.

4. The IRS has established a list of four situations that may warrant the termination of the LIFO election:

(1) violation of the reporting conformity requirements;
(2) failure to restate inventories for the preceding year to cost;
(3) failure to elect properly; and
(4) failure to maintain adequate records with respect to LIFO.

According to Rule 1, the LIFO method precludes write-downs to market value, hence firms with large inventory price fluctuations should have a comparative advantage in adopting the FIFO method and firms with steady price movements should have a comparative advantage in adopting LIFO. According to Rules 2 and 3, the LIFO method requires more sophisticated bookkeeping and is under closer scrutiny by IRS. Therefore the larger and technologically more advanced firms, who have the resources to invest in a sophisticated bookkeeping system, have a comparative advantage in adopting the LIFO method. However, the bookkeeping and tax-reporting costs, due to their relatively small magnitude, may play only a marginal role in a manager's decision.

The tax benefit of the LIFO method requires steadily increasing year-end inventories. Firms with large year-end inventory fluctuations have comparative advantages in adopting the FIFO method. Moreover, according to Rule 3, firms are free to switch from FIFO to LIFO but not vice versa. Hence the value of adopting the FIFO method includes the value of the option of switching to LIFO in the future. Since this option is freely disposable, its value is non-negative.[6] Finally this option is an American option with a "dividend," where the "dividend" is the tax-savings in the year of switching to the LIFO method. It has been established that an American option with a zero dividend is equivalent to a European option which is exercised at maturity.[7] Since the LIFO method is an innovation in accounting (especially for tax reporting), FIFO was the initial inventory accounting method for most of the firms.[8] Only those firms with a large "dividend" would switch to the LIFO method. According to Rule 4.(2)., this

large "dividend" requires a large positive inflation rate in the year preceding the accounting switch and again a high inflation rate in the year of switch.[9] Other firms would find a comparative advantage in maintaining the status quo.[10]

III.B The Production-Investment Opportunity Set and Proxy Variables

The foregoing discussion demonstrates that the comparative advantage in adopting an inventory accounting method depends on three major factors: (1) the stochastic process of inventory prices, (2) the stochastic process of inventory quantities, and (3) the bookkeeping and tax-reporting cost. In this paper, we hypothesize that the exogenously given production-investment opportunity set has dominant influence on these three factors. In this section, we have used price variability and inventory variability as proxy variables for the first two factors. We discuss six additional proxy variables for the characteristics of the production-investment opportunity set that are relevant to the choice of inventory accounting method. They are accounting income variability, absolute firm size, relative firm size, capital intensity, inventory intensity, and industry classification.

Accounting income variability is a proxy for a firm's operational volatility which depends on the nature of the output market, production technology, factoral intensity and general economic environment. When a firm operates smoothly, it is less costly to control inventory; hence the firm has a comparative advantage in adopting the LIFO method.

The LIFO-related bookkeeping and tax-reporting costs seem to be mostly independent of scale of operation. Consequently, larger firms may have a comparative advantage in adopting the LIFO method. However, the bookkeeping and tax-reporting costs do not seem to be very large and should not be

a primary concern in the manager's choice of inventory accounting method. A better explanation of size effect may be that absolute firm size is also a proxy variable for operational volatility and inventory controllability; because of economies of scale, larger firms tend to attain a smooth operation and better inventory control. Since the nature of the output market, production technology and factoral intensity varies from industry to industry, another measurement of economies of scale should be the relative firm size within each industry.

One important aspect of the production-investment opportunity set is the relative factoral intensity. In a capital-intensive firm, where a large portion of cost is fixed in nature, good financial and production planning is much more crucial to its prosperity and survival than in a labor-intensive firm. Since the LIFO method needs more control and planning than the FIFO method, the capital-intensive firm has a comparative advantage in adopting the LIFO method. When the nature of business activities requires a firm to make a relatively larger investment in inventories than other firms, the firm would devote more resources to inventory management, which in turn gives the firm a comparative advantage in adopting the LIFO method. Besides, the relatively large inventory investment implies a large tax benefit that could be accrued from the LIFO method.

Finally, production-investment opportunity sets vary from industry to industry. Hence, industry classification is a proxy variable for production-investment opportunity sets. However, this is a very robust proxy variable that could be consistent with many competing theories.

IIIC. Measurement of Variables

We do not have data on bookkeeping and tax-reporting costs. The measurements of the other eight variables are discussed in this subsection.

1. Inventory Variability

Inventory variability can be measured by the variance/mean ratio of year-end inventories.[11] However, if inventory variability were so measured, our results would be subject to the simultaneous equation bias because inventory variability is an endogenous variable which depends on the choice of accounting methods.

To elaborate this issue, we define ex ante inventory variability as the optimal inventory variability in the manager's value maximization plan with a zero tax rate, and ex post inventory variability as the observed variability. The difference between ex ante and ex post inventory variability is attributable to random errors in measurement and in operation and to the systematic tax effect factor. When the tax rate is actually zero, the conditional expected value of ex post inventory variability is equal its ex ante value. For illustration, the 45° line in Figure 1 shows the relationship between the conditional expectation of ex post and ex ante inventory variability. In this case, the inventory variability measured by the variance/mean ratio of year-end inventories should be an unbiased estimate of a firm's inventory controllability; the inventory control decision is independent of accounting choice.

Insert Figure 1 Here

When inventory prices are increasing and the tax rate is positive, the tax expenditure depends on inventory control activities and the accounting method. Managers can trade off the tax benefit of the LIFO method with the marginal cost of additional inventory control. The marginal firm, with ex ante inventory variability oa, needs to incur so much cost to reduce the

expected ex post inventory variability by cb that the net benefit of adopting the LIFO method is zero. For those firms with ex ante inventory variability larger than oa, the net benefit of adopting the LIFO method is negative. Therefore, with respect to a given positive tax rate the relationship between expected ex post and ex ante inventory variability is illustrated as obcd in Figure 1.[12] Those firms with ex ante inventory variability smaller than oa are ex ante LIFO firms and those with inventory variability larger than oa are ex ante FIFO firms.

Ex ante inventory variability is not observable; when we use ex post inventory variability as a proxy, we will generate bias in the measurement of the unobservable ex ante variability.[13] To solve this problem of measurement bias, we transform the ex post inventory variability into a rank-order variable and use it as a proxy variable for the unobservable ex ante inventory variability. As demonstrated in Figure 1, the rank-order relationship between expected ex post and ex ante inventory variability is independent of inventory accounting methods.

2. Accounting Income Variability

Accounting income variability, like inventory variability, is an endogenous variable. The above argument applies here too. We will use the rank-order of variance/mean ratios of before-tax accounting income to measure the accounting income variability.

3. Price Variability

The data on inventory prices are not available in the Compustat tape. The price data are collected from the DRI (Data Resources Institute) tape. Although we have tried to match closely, down to the SIC four-digit level, the descriptions of price indices in the DRI tape and the SIC code used in the Compustat tape, the problem of measurement errors may not have

been totally resolved. To avoid the measurement error problem, we chose a simple but robust measurement -- the relative frequency of positive inflation.[14] For each SIC four-digit industry, we have calculated the relative frequency of positive price changes for the period of 1960-1980. When the relative frequency of positive inflation is large, it implies that the mean inflation rate is high, the variance of inflation rate is small, or both.[15] Consequently, a higher frequency of positive inflation leads to comparative advantage in adopting the LIFO method.

4. Absolute Firm Size

Absolute firm size is measured by assets and net sales of the firm.

5. Relative Firm Size

Relative firm size is the ratio of a firm's assets to the total assets of the SIC four-digit industry. Relative firm size is also measured in terms of net sales.

6. Capital Intensity

Gross capital intensity is the ratio of gross fixed assets to net sales. Net capital intensity is the ratio of net fixed assets to net sales. We have tried both variables in our probit and logit analysis and found that gross capital intensity generated a slightly more significant result. We will only report the results for gross capital intensity in Section VII.

7. Inventory Intensity

Inventory intensity is measured by the inventory/net sales ratio and the inventory/total assets ratio. Since the amount of inventories is endogenously determined, we have transformed the inventory intensity ratios into a rank-order variable to avoid measurement bias.

8. Industry Dummies

To keep the number of industry dummy variables small and manageable, we have assigned a dummy variable to each of the two-digit SIC industries. We have 20 industry dummy variables as a result.

IV. Hypotheses and Proxy Variables

Generally a proxy variable can stand for many competing theories. Variables such as size and industry are consistent with almost any theory. In this section, we will demonstrate that some proxy variables that have been studied under the political cost theory overlap with the proxy variables in our Ricardian model of accounting choice.

Insert Table 1 Here

Table 1 summarizes all proxy variables that have been studied in the literature of inventory accounting choice. Most of the sixteen variables are not statistically significant in explaining a manager's behavior. The five variables that have shown statistical significance are (1) absolute firm size, (2) potential tax savings of LIFO over FIFO, (3) industry, (4) auditor, and (5) total debts/total assets. Among these five variables, absolute firm size and industry are also proxy variables in the Ricardian model. Since the Ricardian model elaborates the economic conditions for the potential tax savings of the inventory accounting method, all the variables discussed in Section III are proxies for the potential tax savings.

Because the big-eight firms have developed their own comparative advantages in certain industries, the identity of the auditor in

Eggleton-Penman-Twombly's univariate test can be only a proxy for industry. Besides, there is no theory to relate a specific auditor to a manager's behavior. We will not discuss this variable in our paper. The total debts/total assets ratio is associated with the agency theory and will be examined in our empirical work.

According to the Ricardian model, when bookkeeping and tax-reporting costs of the LIFO method are small, the fundamental proxy variables that determine the choice of inventory accounting method are (1) variability of price, (2) variability of inventories, and (3) inventory intensity. The other proxy variables discussed in Section III are merely associated with these three variables. If the Ricardian model is descriptively valid, the inclusion of these three fundamental proxy variables in a multivariate analysis should prove the explanatory power of other proxy variables insignificant. However, if the bookkeeping and tax-reporting costs were fixed and large, the absolute firm size would become a fundamental proxy variable for the economies of scale in administering the LIFO method. Therefore, it should be significant in spite of the other three fundamental proxy variables.

V. Data and Univariate Analysis

The data were collected from the Compustat File. All firms in the sample had adopted either the LIFO method or the FIFO method for at least seven uninterrupted years.[16] For those firms which had adopted the same inventory accounting method for longer than seven years, we collected data for the entire period. The data collection period of each firm varies from seven years to twenty years. Over all, 799 firms were chosen, of which 127 firms had adopted LIFO and 672 firms had adopted FIFO. Table 2 lists the

distribution of data in terms of the SIC two-digit code and the inventory accounting method. Except in the steel industry, the FIFO method is the method adopted by the majority of firms.

Insert Table 2 Here

The attributes of the LIFO firms and the FIFO firms are summarized in Table 3. The first eleven variables will be examined extensively throughout the remainder of this paper. The variables V_{12} to V_{19} are briefly discussed in this section. Most of the attribute difference between column (1) and column (2) of Table 3 can be traced to some sort of managerial behavior. Column (3) lists the possible theories of managerial behavior discussed in the literature. The univariate test of the hypothesis concerning managerial behavior is accomplished by calculating the statistic t_i.[17] The hypothetical sign of t_i is given in columnn (4) and the calculated t-statistic is given in column (5).

Insert Table 3 Here

The results in column (5) of Table 3 seem to support the value-maximization theory and the political cost theory and to reject the agency theory. Putting Tables 1 and 3 together, we can see that there is no evidence in the literature on inventory accounting choice that is consistent with the agency theory. Although there is evidence that is consistent with the value-maximization theory and the political cost theory, it is difficult to differentiate between these two theories because they employ an overlapping set of proxy variables.

Except for the long-term debt/equity ratio (V_5), the first eleven variables in Table 3 are all significant with the correct hypothetical sign. As discussed in Sections III and IV, variability of inventories (V_3), variability of before-tax income (V_4), inventories/net sales (V_6), inventories/total assets (V_7), and relative frequency of price increases (V_{11}) are fundamental proxy variables that are directly associated with the choice of inventory accounting method under the value-maximization theory. Net sales (V_1), total assets (V_2), relative size in net sales (V_8) and in total assets (V_9), and gross capital intensity (V_{10}) are the attributes that are related to V_3, V_4, V_6 and V_7; hence, they are <u>indirectly</u> associated with the choice of inventory accounting method under the value-maximization theory. In a univariate analysis, all these proxy variables have gross explanatory power. Since the indirect proxy variables for the value-maximization theory overlap with the proxy variables for the political cost theory, it is impossible to differentiate between these two theories in a univariate analysis. However, in a multivariate analysis where the marginal explanatory power of each proxy variable can be measured, we would expect that if the value-maximization theory is descriptively valid, then the indirect proxy variables, V_1, V_2, V_8, V_9, and V_{10}, should have little marginal explanatory power. On the other hand, if the political cost theory is descriptively valid, then V_3, V_4, V_6, V_7 and V_{11} should show little marginal explanatory power and V_1, V_2, V_8, V_9, and V_{10} should be the fundamental attributes that determine the manager's choice of inventory accounting methods. In the next section, we will develop two methods of multivariate analysis to measure the marginal explanatory power of each proxy variable.

Before leaving this section, we will briefly discuss V_{12} to V_{19}. Both debt/equity ratio (V_{12}) and long-term debt/equity ratio (V_5) measure the stringency of the bond-covenant; they are neither statistically significant nor have the hypothetical sign. In Section VII, we will only report the results on V_5. We will also calculate the marginal effect of V_{12} and get the same results. The variability of earnings per share (V_{14}), which is somewhat related to variability of before-tax income (V_4), is only an indirect proxy for value-maximization theory; it is not statistically significant in multivariate analysis or in univariate analysis. Both variability of inflation rates (V_{19}) and relative frequency of price increases (V_{11}) measure the price movement of inventories, but V_{19} is not statistically significant in either univariate or multivariate analysis. The net capital intensity (V_{18}) considers the depreciation in calculating the capital intensity. The multivariate and univariate analysis results from gross capital intensity (V_{10}) are more significant than from V_{18}. Using either variable would not change our conclusion.

Hagerman and Zmijewski (1979) presumed that the LIFO method has a tax-benefit over the FIFO method, hence, the larger the effective tax rate, the more desirable the LIFO method would be. However, the LIFO method does not necessarily result in tax savings for all firms. A good counter-example is that in an industry with a declining price level, the FIFO method should have a tax-benefit over the LIFO method. Hence the effective tax rate (V_{13}) cannot represent the relative attractiveness of the LIFO method. We do not have any hypothesis about the statistic t_{13}. The relative frequency of profitable fiscal year (V_{17}) is just another way of measuring V_{13}. Table 3 shows that there is no significant difference in effective tax rate between LIFO firms and FIFO firms. The inventory growth rates (V_{15}) and

relative frequency of year-end inventory increases (V_{16}) show that the inventories of FIFO firms grow faster and more frequently than those of LIFO firms. These results are inconsistent with Biddle's (1980) hypothesis that firms with higher growth of inventories would switch to LIFO. A possible explanation for this inconsistency is that these results are spurious, i.e., the inventory variability are important to inventory accounting choice and inventory variability and inventory growth are positively correlated.

VI. Methodology of Multivariate Analysis

VIA. Logit and Probit Binary Choice Models

In this section, we discuss two multivariate methods to measure the marginal explanatory power of each proxy variable. We deal with the binary choice facing a firm - whether to use LIFO or FIFO as its inventory accounting method. For simplicity, we shall refer to the choice variable as i, where $i = 1$ for FIFO and $i = 2$ for LIFO. We postulate that the decision i is a function of characteristics of the production-investment opportunity set, factors of political cost and factors of agency cost. Since these variables are not directly observable, we use a set of proxy variables to measure these economic variables. The specification of the vector of proxy variables Z was provided in Section IV. The relations between i and Z are summarized by the model $P_{iz}(\theta)$, which is the probability of observing choice i given the set of proxy variables Z, and a vector of unknown parameters θ to be estimated from the data.

There are two popular methods of modeling $P_{iz}(\theta)$: the logit and probit models. The difference between them lies in the distribution function. In the logit model, $P_{iz}(\theta)$ is the logistic function. In the probit model, $P_{iz}(\theta)$ is the cumulative normal distribution. Since we have no prior

reason for choosing one over the other, we report our results in both models. The logit model assumes that the logarithm of P_{iz} is linear in Z:

(1) $$P_{iz} = e^{Z'\Gamma_i} \quad , i = 1,2 .$$

Since $P_{1z} + P_{2z} = 1$, we must normalize the probabilities:

(2) $$P_{1z} = e^{Z'\Gamma_1} / (e^{Z'\Gamma_1} + e^{Z'\Gamma_2}) \quad , \text{and}$$

(3) $$P_{2z} = e^{Z'\Gamma_2} / (e^{Z'\Gamma_1} + e^{Z'\Gamma_2}) .$$

In other words, we have

(4) $$P_{1z} = \frac{e^{Z'(\Gamma_1 - \Gamma_2)}}{1 + e^{Z'(\Gamma_1 - \Gamma_2)}} \quad ;$$

$$P_{2z} = \frac{1}{1 + e^{Z'(\Gamma_1 - \Gamma_2)}} \quad .$$

Reparametrizing the model in terms of $\theta = \Gamma_1 - \Gamma_2$, we have

(5) $$P_{1z}(\theta) = \frac{e^{Z'\theta}}{1 + e^{Z'\theta}} \quad ;$$

$$P_{2z}(\theta) = \frac{1}{1 + e^{Z'\theta}} \quad .$$

The logit model is consistent with a "random utility" model (see McFadden [1982]). It has wide appeal for models of consumer choice theory but does not have much theoretical grounding in the context of a profit maximizing firm.

The second method we use is the probit model. It assumes that the discrete choice decision is based on an unobserved continuous variable:

(6) $$y = Z'\beta + \varepsilon ,$$

where ε is normally distributed with mean 0 and variance σ_ε^2 and ε is independent of Z.

The variable y can be interpreted as the comparative advantage in adopting the FIFO method versus the LIFO method. The firm chooses FIFO (i=1) if y is below the threshold level L (such as oa in Figure 1), and chooses LIFO (i=2) if y exceeds L, i.e.,

$$(7) \qquad i = \begin{cases} 1, \text{ if } y \leq L \\ 2, \text{ if } y > L \, . \end{cases}$$

Therefore the probability of observing i = 1, given Z, is:

$$(8) \qquad \begin{aligned} P(i=1 \mid Z) &= P(y < L \mid Z) \\ &= P(Z'\beta + \varepsilon < L \mid Z) \\ &= P(\varepsilon < L - Z'\beta \mid Z) \\ &= \Phi\left(\frac{L - Z'\beta}{\sigma_\varepsilon}\right) ; \end{aligned}$$

where Φ is the cumulative normal distribution. Also

$$(9) \qquad P(i=2) \mid Z) = 1 - \Phi\left(\frac{L - Z'\beta}{\sigma_\varepsilon}\right) .$$

Obviously, the data can only allow us to estimate $\frac{L}{\sigma_\varepsilon}$ and $\frac{\beta}{\sigma_\varepsilon}$. By setting $\theta = \left(\frac{L}{\sigma_\varepsilon}, \frac{\beta}{\sigma_\varepsilon}\right)$ we have:

$$(10) \qquad P_{1z}(\theta) = \Phi\left(\frac{L - Z'\beta}{\sigma_\varepsilon}\right) ;$$

$$P_{2z}(\theta) = 1 - \Phi\left(\frac{L - Z'\beta}{\sigma_\varepsilon}\right) .$$

VIB. Estimation and Inferences

Our purpose is to find an estimate of the parameter θ, for either the logit or the probit model. The statistical significance of the estimated parameter indicates the marginal explanatory power of the proxy variable in Z. For simplicity of notation, let us denote:

(11) $$P_{1z} = F(\theta, Z) \ ;$$

$$P_{2z} = 1 - F(\theta, Z) \ .$$

Suppose we have a random sample of size T from the population. Let (i_n, Z_n) denote the choice and the conditioning variables observed for the n-th observation in the sample and define:

(12) $$d_n = \begin{cases} 0 \text{ if } i_n = 1 \ ; \\ 1 \text{ if } i_n = 2 \ . \end{cases}$$

A standard method to estimate θ is to maximize in θ the log-likelihood function of the sample, conditioned on the observed Z's:

$$\underset{\theta}{\text{Max}} \ L(\theta) = \sum_{n=1}^{T} [\log F(\theta, Z)]^{d_n} [\log \{1 - F(\theta, Z)\}]^{1-d_n} \ ,$$

where n is the observation index and T is the sample size. We must restrict θ to a compact set H in R^k. The θ at which $L(\theta)$ is maximized is called the maximum likelihood estimator and is denoted by θ_{MLE}. In the case of logit and probit, θ_{MLE} is consistent, asymptotically normal and asymptotically efficient. (See Theil [1971], pp. 384-397). Furthermore, the $L(\theta)$ is globally concave in θ, and so a unique maximum exists.

A numerical method, which is programmed by the junior author, for finding the θ_{MLE} is briefly described as follows.[18] Pick any $\theta_0 \varepsilon \ H$ as a starting value, then search along the Newton-Ralphson direction for the highest value of $L(\theta)$. Call this new point θ_1, i.e.,

(13) $$\theta_1 = \theta_0 + \lambda \ [-L_{\theta\theta} \ (\theta_0)]^{-1} \ [L_\theta \ (\theta_0)] \ ,$$

where the subscripts in $L_{\theta\theta}$ and L_θ denote partial derivatives and $\lambda > 0$. If $[-L_{\theta\theta} \ (\theta_0)]$ is positive definite, then there always exists a $\lambda > 0$ for which the $L(\theta)$ will increase. We iterate this step until certain convergence criteria are met, namely,

(1) the increment in $L(\theta)$ is sufficiently small, and

(2) $L'_\theta \ [-L_{\theta\theta}]^{-1} \ L_\theta$ is sufficiently small.

In our experience, convergence is usually achieved in less than ten iterations, starting at any arbitrary point. At convergence, the value of θ in the last iteration is θ_{MLE}.

We calculate the covariance of θ_{MLE} by taking a Taylor series expansion around the true parameter θ^*.

$$(14) \qquad 0 = L_\theta(\theta_{MLE}) = L_\theta(\theta^*) + L_{\theta\theta}\ (\bar{\theta})\ (\theta_{MLE} - \theta^*)$$

where $\bar{\theta}$ is between θ_{MLE} and θ^*. Rewriting, we have

$$(15) \qquad T\ (\theta_{MLE} - \theta^*) = [-L_{\theta\theta}\ (\bar{\theta})]^{-1}\ [T\ L_\theta(\theta^*)]\ .$$

The random variable $T(\theta_{MLE} - \theta^*)$ is asymptotically normal with mean zero and covariance V_{MLE}, where

$$(16) \qquad V_{MLE} = [-\ L_{\theta\theta}\ (\theta^*)]^{-1}\ .$$

We can consistently estimate V_{MLE} by

$$(17) \qquad \hat{V}_{MLE} = [-L_{\theta\theta}\ (\theta_{MLE})]^{-1}\ .$$

To test the restriction $\theta^* \epsilon \Omega$, where Ω is a proper compact subset of parameter space H, we can employ the likelihood ratio test. First, maximizing $L(\theta)$ with respect to $\theta \epsilon H$, we can get the unrestricted maximum likelihood estimator θ^1_{MLE}. Second, maximizing $L(\theta)$ with respect to $\theta \epsilon \Omega$, we can get the restricted maximum likelihood estimator θ^R_{MLE}. Under the null hypothesis that

$$(18) \qquad H\ :\ \theta^* \epsilon \Omega\ ,$$

the log-likelihood ratio as defined in eq.(19):

$$(19) \qquad LR = -2 \log \left[\frac{L(\theta^{1}_{MLE})}{L(\theta^{R}_{MLE})}\right] ,$$

and has an asymptotic chi-square distributiion with q degrees of freedom, where

$$(20) \qquad q = \text{Dim} (H) - \text{Dim} (\Omega) .$$

The LR statistic defined in eq.(19) measures the marginal explanatory power of a set of explanatory variables.

VII. Multivariate Analyses

It has been well documented that there is a size effect and an industrial effect on the choice of inventory accounting methods (for example, Eggleton-Penman-Twombly [1976], and Morse and Richardson [1983]). It is generally agreed that the size effect and industrial effect are just proxies for more fundamental economic variables whose nature and characteristics are yet to be determined. In this section, we shall identify some of these underlying fundamental economic variables determined from our logit and probit multivariate analysis.

We start the multivariate analysis by measuring the industrial effect. We designate twenty dummy variables to represent the twenty SIC two-digit industries defined in Table 2. Then we estimate the logit and probit models and report the results as Analysis 1 in Table 4. Each entry in Table 4 is the t-statistic of the marginal effect of a given proxy variable on the inventory accounting choice. If the t-statistic is larger than two, then the given proxy variable is deemed to have significant marginal explanatory power. The marginal explanatory power of all industrial

dummies is measured by the likelihood ratio test statistic:

(21) $LR = -2\,[-349.900 - (-293.030)] = 113.740$.

With degrees of freedom of (10.798), LR is significant at the 0.01% level. From Analysis 1 we can see that the industrial effect does significantly "explain" the manager's choice of inventory accounting method. With knowledge of the SIC two-digit code to which the firm belongs, we can correctly predict the firm's inventory accounting method 85.98% of the time. This prediction power is much better than Hagerman-Zmijewski's agency and political cost model which has only a 58.00% correction rate.

One possible explanation of this industrial effect is the industrial price movement. Only when the price of inventories goes up would a firm benefit from adopting the LIFO method. For example, the economic life of books is usually very short; if a new edition cannot be sold out in the first year, it would usually be moved to the bargain section in the following year. Writing down year-end inventories is a common practice in the publishing industry. This alone would explain why all firms in the SIC 2700 industry (publishing) adopt the FIFO method.

To examine whether industrial price movements actually explain the industry effect, we include industry dummies and V_{11} (relative frequency of price increases) in our estimations of the logit and probit models. The result is reported as Analysis 2 in Table 4. If the industry dummies are nothing but proxies for the inventory price movement, then including V_{11} in the estimation of logit and probit models should greatly reduce the significance of the t-statistics of the dummy variables. The evidence from Analysis 2 suggests that the industry dummies are not proxies for inventory price movements. In fact, the industry dummies and V_{11} jointly and complementarily determine the inventory accounting choice. When V_{11} is

included in the estimation, the values of the t-statistic of many industry dummies increase.

Another possible explanation of the industry effect is that firms in different industries have different production-investment opportunity sets. Except for the long-term debt/equity ratio (V_5), the ten variables, V_1-V_{10}, listed in Table 5 are proxy variables for production-investment opportunity sets. The four variables, variability of inventory (V_3), variability of income (V_4), inventory/sales (V_6) and inventory/assets (V_7), can only be related to the Ricardian model of value-maximization theory. The other five variables, net sales (V_1), total assets (V_2), relative size in sales (V_8) and in assets (V_9) and capital intensity (V_{10}), have been interpreted as proxies for political cost in the literature as well. Before exploring the relationship between industry effect and production-investment opportunity sets, we should first examine the descriptive validity of the value-maximization theory versus the political cost theory.

V_1 and V_2 are size variables which can be incorporated into a large number of competing theories of the firm. V_8 and V_9, which can be interpreted as the market share of a firm, are alternative ways of measuring firm size. If the value-maximization theory is descriptively valid, then the size effect is spurious. The univariate association between size and inventory accounting choice documented in Table 3 is due to the association between size, V_3, V_4, V_6 and V_7. By including all these variables in a multivariate analysis, the size effect should disappear. On the other hand, if the political cost theory were descriptively valid and the size variables are close proxies for political cost, then the size effect should be significant in both the univariate and the multivariate analysis.

The results of Analysis 3 strongly support the value-maximization theory; not only do all the estimated coefficients show the correct sign, they are also highly significant. Moreover, the significance of the size effect disappears. The results of Analysis 4 are very similar to those of Analysis 3 except that total assets seem to be a less important component in the measurement of factoral intensity than net sales. The estimated R^2, the percentage correctly predicted and the absolute value of the log-likelihood function are all measurements of goodness of fit. The fit is better when the value of the first two measurements are higher and the absolute value of the last measurement is lower. The goodness of fit in Analysis 4 is somewhat less than that in Analysis 3. The estimated coefficient of V_7 (inventory intensity) has an incorrect sign.

To explain the industrial effect in terms of the production-investment opportunity set suggested by the Ricardian Model of inventory accounting choice, we include V_1-V_{11} and D_1-D_{20} in estimations in the logit and probit models. The results are reported as Analysis 5 and Analysis 6 in Tables 4 and 5. When the economic variables, V_3, V_4, V_6, V_7 and V_{11}, that are directly associated with the Ricardian Model of inventory accounting choice are included in estimations, the significance of the industrial effect disappears. Hence the industrial effect documented in Analyses 1 and 2 is attributable to the cross-industrial differences in production-investment opportunity sets.

Overall, our study provides evidence for several interesting issues. First, the agency theory does not describe the manager's choice of inventory accounting method. Second, the size effect which is so prominent in the univariate analysis disappears in the multivariate analysis. The size effect on inventory accounting choice is probably due to its close

association with the economies of scale in inventory control. Third, the industrial effect can also be explained by the cross-industrial differences in the production-investment opportunity set. Finally, our evidence strongly supports the value-maximization theory that the manager makes the inventory accounting choice according to the Ricardian principles of comparative advantage.[19]

VIII. Concluding Remarks

In this paper, our empirical evidence strongly suggests that firms with different production-investment opportunity sets would adopt different inventory accounting methods according to the Richardian principle of comparative advantage. This finding sheds an interesting light on the current literature of accounting choice.

If managers faithfully follow the rule of value-maximization, then all of the firms which could have extracted economic rent from adopting the LIFO method would have done so. The incipient firm which is about to adopt the LIFO method is the marginal firm to which the cost of adopting LIFO is just equal to the benefit. Hence the value of the incipient LIFO-adopting firm is independent of the change of inventory accounting method. A rational capital market would not react to the change of inventory accounting method per se.

However, since a change of inventory accounting method reflects a change of the production-investment opportunity set, a rational capital market would react to this change in underlying real economic factors. For example, LIFO firms have lower variability in inventories and accounting incomes than FIFO firms. The literature suggests that the variability of accounting income is positively associated with the market risk of

securities (see Beaver-Kettler-Scholes [1970]). Consequently, our study implies that when a firm switches to the LIFO method, the market risk of its securities should decline. This prediction is consistent with the empirical evidence in Biddle and Lindahl (1982).

Since LIFO firms tend to be larger, more capital intensive, and have better inventory control than FIFO firms, a switch of accounting method from LIFO to FIFO signals manager's intention to change business policy in production and investment. The capital market ought to react to this important signal. However, the current literature (for example, Biddle [1980]) assumes a stationary production-investment opportunity set and calculates the potential tax-saving accordingly.[20] This calculation often leaves a puzzling question: why don't all firms take advantage of the tax benefit? This study demonstrates some explanations for why not all firms can find tax advantages in the LIFO method.

In order to achieve the conditions of "ceteris paribus", many studies (for example, Ricks [1982] and Brown [1980]) try to match LIFO firms and FIFO firms according to size and industrial code. Our study implies that LIFO firms and FIFO firms are fundamentally different in production-investment opportunity sets; the matching of LIFO firms and FIFO firms will not generate a well-controlled sample. If a LIFO firm and a FIFO firm in the same industry are about the same size, they would be different in other important aspects such as capital intensity and inventory controllability.

If LIFO firms and FIFO firms were identical except for inventory accounting method, then an unexpected inflation would benefit the LIFO firms relative to the FIFO firms because of the unexpected tax savings. The capital market would react favorably to the LIFO firms relative to the FIFO firms in a period of unexpected inflation. However, for a FIFO firm

having such a production-investment opportunity set that it cannot extract any tax-benefit by switching to the LIFO method, unexpected inflation would not generate any unexpected opportunity cost of adopting the FIFO method; consequently, unexpected inflation would not inversely affect the market's assessment of such a FIFO firm. Our study indicates that FIFO firms have less potential for saving tax through the LIFO method than LIFO firms; hence, the effect of unexpected inflation on the relative price movements of LIFO securities over FIFO securities is smaller than it would be if both LIFO firms and FIFO firms had homogeneous production-investment opportunity sets. This implication is consistent with the empirical evidence provided by Lee (1983).

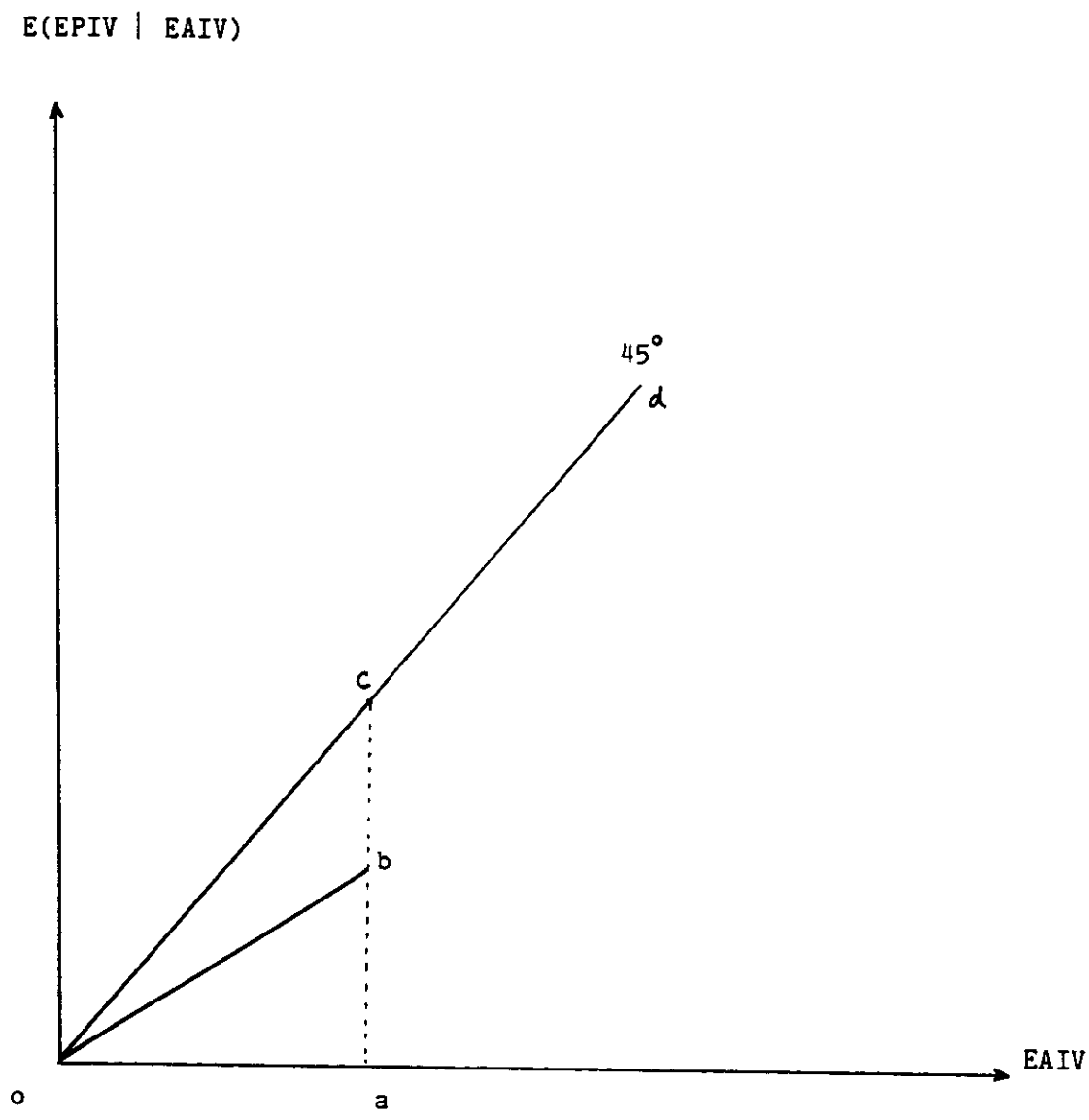

Figure 1 Ex Post Versus Ex Ante Inventory Variability

Note: EAIV: ex ante inventory variability
EPIV: ex post inventory variability

Table 1 Proxy Variables in the Literature on Choice of Inventory Accounting Methods

Proxy Variables	Authors	Theories	Significance at 5% level
1. absolute firm size	Hagerman and Zmijewski (79)[a]	political cost	no
	Morse and Richardson (83)	political cost or value maximization	yes
	Abdel-Kalik (83)	political cost	yes
2. growth of accounting income	Morse and Richardson	political cost	no
3. dividend/unrestricted R.E.	Morse and Richardson	agency	no
4. income/interest expense	Morse and Richardson	agency	no
5. net tangible assets / long-term debts	Morse and Richardson	agency	no
6. As-if cost of goods (potential tax savings of LIFO over FIFO)	Biddle (80)	value-maximization	yes
	Morse and Richardson	value-maximization	yes
7. concentration ratio	Hagerman and Zmijewski	political cost	no
8. capital intensity	Hagerman and Zmijewski	political cost	no
	Abdel-Kalik	political cost	yes
9. risk (beta)	Hagerman and Zmijewski	political cost	no
10. effective tax rate	Hagerman and Zmijewski	agency and political cost	no
11. change of corporate personnel	Eggleton-Penman-Twombly (76)	N/A[c]	no
12. industry	Eggleton-Penman-Twombly	N/A	yes
13. Auditor	Eggleton-Penman-Twombly	N/A	yes
14. Management Profit sharing dummy	Hagerman and Zmijewski	agency	no
15. CEO compensation	Abdel-Kalik	agency	no
16. Total debt/Total Assets	Zmijewski-Hagerman (81)	agency	yes[b]

Note: a. The number in bracket indicates the publication year
b. It is significant only in the sample of small firms.
c. Eggleton-Penman-Twombly did not elaborate any theory of management motivation.

Table 2 Distribution of Sample Data

SIC Code	Description	Number of LIFO firms	Number of FIFO firms	subtotal
2000	foods and beverages	7	24	31
2200	textile products	7	13	20
2300	textile-apparel mfrs.	3	59	62
2400	forest products	2	16	18
2500	home furnishings	1	14	15
2600	paper products	5	6	11
2700	publishing	0	12	12
2800	chemicals	5	53	58
2900	petroleum products	5	13	18
3000	rubber and plastic	3	17	20
3300	steel products	30	15	45
3400	metal products	12	50	62
3500	machinery	15	124	139
3600	appliances	8	123	131
3700	motor vehicle and aircraft	5	32	37
3800	instruments	4	39	43
3900	leisure goods	2	21	23
5100	drug stores	1	14	15
5300	department stores	6	6	12
5400	grocery stores	6	21	27
	Total	127	672	799

Table 3 Univariate Analysis of Inventory Accounting Choice

	Attributes	(1) LIFO firms	(2) FIFO firms	(3) Behavioral Theory[c]	(4) Hypothesis	(5) t-statistic[d]
V_1	net sales	445M[a]	152M[a]	P.C., V.M.	$t_1 > 0$	6.35
V_2	total assets	349M[a]	110M[a]	P.C., V.M.	$t_2 > 0$	5.04
V_3	variability of inventories	194[b]	439[b]	V.M.	$t_3 < 0$	-11.9
V_4	variability of before-tax income	287[b]	421[b]	V.M.	$t_4 < 0$	- 6.13
V_5	longterm debt/equity ratio	0.63	0.55	A.	$t_5 < 0$	1.14
V_6	inventories/net sales	413[b]	330[b]	V.M.	$t_6 > 0$	3.75
V_7	inventories/total assets	317[b]	278[b]	V.M.	$t_7 > 0$	3.83
V_8	relative size in net sales	1.32	0.87	P.C., V.M.	$t_8 > 0$	3.44
V_9	relative size in total assets	1.28	0.87	P.C., V.M.	$t_9 > 0$	3.05
V_{10}	gross capital intensity	0.55	0.34	P.C., V.M.	$t_{10} > 0$	7.38
V_{11}	relative frequency of price increases	0.74	0.62	V.M.	$t_{11} > 0$	4.76
V_{12}	debt/equity ratio	1.43	1.34	A.	$t_{12} < 0$	0.64
V_{13}	effective tax rate	0.42	0.45	N.A.	-------	- 1.40
V_{14}	variability of EPS	0.69	0.75	V.M.	$t_{14} < 0$	- 0.16
V_{15}	inventory growth rates	0.09	0.22	V.M.[e]	$t_{15} > 0$	- 6.86
V_{16}	relative frequency of year-end inventory increases	0.59	0.69	V.M.[e]	$t_{16} > 0$	- 6.87
V_{17}	relative frequency of profitable fiscal years	0.94	0.90	N.A.	-------	3.15
V_{18}	net capital intensity	0.29	0.20	P.C., V.M.	$t_{18} > 0$	4.28
V_{19}	variability of inflation rates	0.07	0.06	V.M.	$t_{19} < 0$	1.55

Notes:
a. M represents million dollars.
b. Average rank where rank order varies from 1 to 799.
c. P.C. stands for political cost theory; V.M. for value maximization theory; A. for agency theory; and N.A. for no particular theory applied.
d. With degree of freedom of 797, the t-statistics are normally distributed.
e. Biddle (1980), based on value-maximization theory, hypothesized that t_{15} and t_{16} be positive. We did not derive any hypothesis for these two variables.

Table 4
Multivariate Analysis of Inventory Accounting Choice:
Industrial Effect

Determinant Variable	Analysis 1		Analysis 2		Analysis 5		Analysis 6	
	Logit	Probit	Logit	Probit	Logit	Probit	Logit	Probit
D_1 (2000)	-2.869	-3.012	-3.876	-4.050	-0.226	-0.359	+0.269	+0.032
D_2 (2200)	-1.319	-1.341	-2.851	-2.786	+0.516	+0.398	+0.553	+0.337
D_3 (2300)	-5.007	-6.071	-5.362	-6.081	-1.746	-1.596	-1.675	-1.655
D_4 (2400)	-2.773	-3.121	-3.815	-4.114	-0.334	-0.360	-0.138	-0.209
D_5 (2500)	-2.550	-3.012	-3.642	-4.044	-1.616	-1.792	-1.519	-1.792
D_6 (2600)	-0.301	-0.301	-2.191	-2.010	-0.333	-0.377	-0.075	-0.186
L_7 (2700)	-44.720	-67.589	-16.324	-12.478	-9.843	-7.258	-10.520	-7.641
D_8 (2800)	-5.047	-5.821	-5.412	-6.039	-1.226	-1.344	-1.166	-1.401
D_9 (2900)	-1.816	-1.872	-3.171	-3.173	-1.258	-1.366	-0.885	-1.056
D_{10} (3000)	-2.770	-3.027	-3.786	-3.993	-0.055	-0.380	+0.203	-0.212
D_{11} (3300)	+2.193	+2.228	+1.574	+1.303	+1.440	+1.364	+1.483	+1.361
D_{12} (3400)	-4.440	-4.731	-4.117	-4.481	-0.720	-0.858	-0.639	-0.890
D_{13} (3500)	-7.759	-8.765	-4.613	-5.349	-0.218	-0.398	-0.384	-0.683
D_{14} (3600)	-7.517	-8.954	-7.858	-9.570	-0.753	-0.893	-0.847	-1.109
D_{15} (3700)	-3.860	-4.262	-4.357	-4.731	-1.086	-1.082	-0.985	-1.067
D_{16} (3800)	-4.283	-4.894	-4.569	-5.022	-1.047	-1.229	-1.148	-1.442
D_{17} (3900)	-3.178	-3.662	-4.123	-4.521	-1.753	-0.953	-o.760	-1.048
D_{18} (5100)	-2.550	-3.012	-3.493	-3.928	-1.850	-2.150	-0.859	-1.189
D_{19} (5300)	0.000	0.000	-1.997	-1.785	+0.0001	-0.038	+0.292	+0.165
D_{20} (5400)	-2.706	-2.845	-3.776	-3.932	-1.333	-1.539	-0.228	-0.485
V_{11} Price movements	-	-	+2.655	+2.714	+2.336	+2.249	+2.372	+2.303
Estimated R^2	0. 471	0.471	0.481	0.481	0.594	0.591	0.586	0.582
% correctly predicated	85.98	85.98	85.98	85.98	88.24	87.86	87.98	87.98
Value of log likelihood function	-293.030	-293.030	-287.439	-287.525	-224.991	-226.565	-229.312	-231.323

NOTE:

1. D_i, i=1, . . ., 20, are dummy variables for SIC two-digit industries as indicated in bracket. The description of SIC codes is given in Table 2.
2. V_{11} is the relative frequency of price increases during 1960-1979.
3. The value of log-likelihood function when all coefficients are restricted to be zero is -349.900 (same for both logit and probit).
4. The entry is Table 4 is the t-statistic of the estimated coefficient of each proxy variable. Because the degree of freedom is very large, each t-statistic is deemed normally distributed.

Table 5

Multivariate Analysis of Inventory Accounting Choice:
Economic Determinants

Determinant Variables		Behavioral Theory	Hypothetical sign	Analysis 3		Analysis 4		Analysis 5		Analysis 6	
				logit	probit	logit	problt	logit	probit	logit	probit
V_1	net sales	P.C., V.M.	+	0.386	0.350	---	---	0.365	0.548	---	---
V_2	total assets	P.C., V.M	+	---	---	0.080	0.154	---	---	0.221	0.377
V_3	var. of inventory	V.M.	-	-8.075	-8.078	-7.951	-7.879	-6.874	-6.594	-6.729	-6.232
V_4	var. of inc.	V.M.	-	-3.383	-3.592	-3.556	-3.773	-2.785	-2.953	-2.822	-2.943
V_5	long term D/E	A.	-	0.506	0.576	0.471	0.528	-0.141	-0.012	-0.359	-0.251
V_6	inv./sales	V.M.	+	2.881	3.053	---	---	3.411	3.515	---	---
V_7	inv./ assets	V.M.	+	___	___	-2.001	-1.792	---	---	-2.391	-2.182
V_8	rel.size, sales	P.C., V.M.	+	0.790	0.847	---	---	1.288	1.112	---	---
V_9	rel.size, assets	P.C., V.M.	+	---	---	0.681	0.647	---	---	1.447	1.171
V_{10}	capital capacity	P.C., V.M.	+	4.099	4.017	2.601	2.577	1.409	1.501	0.420	0.521
	Estimated R^2			0.540	0.540	0.532	0.531	0.594	0.591	0.586	0.582
	% Correctly Predicted			86.48	86.23	86.23	86.36	88.24	87.86	87.98	87.98
	Value of log-likelihood function			-254.682	-254.884	-259.119	-259.938	-224.991	-226.565	-229.312	-231.323

Note:

1. Each entry is the t-statistic of estimated coefficient.
2. The value of log-likelihood function when all coefficients are restricted to be zero is -349.900 (same for both logit and probit).
3. P.C. is political cost theory, V.M. is value-maximization theory, and A. is agency theory.
4. In Analyses 3 and 5, the size is measured in terms of sales, and in Analyses 4 and 6, the size is measured in terms of assets.

FOOTNOTES

1. As Biddle (1980) pointed out, the potential tax savings from the LIFO method depend on the underlying production-investment opportunity set and managers may alter production-investment opportunity sets in order to accommodate the chosen inventory accounting method. However, Biddle's (1980) univariate non-parametric analysis was not well-equipped to answer this complicated question. We limit our study by taking a Ricardian approach, namely, we examine whether the exogenously given inter-firm differences in production-investment opportunity sets are significant enough to explain the pattern of inventory accounting choice. Consequently, our paper examines only a subset of possible explanations that are based on the value-maximization theory.

2. For a detailed survey of the literature on the economic consequences of accounting choice, please see Holthausen and Leftwich (1982).

3. Akerlof (1983) provides an interesting theory stating that well-trained, well-meaning bureaucrats (such as managers in large corporations) act selflessly according to their best conscience, yet nevertheless manage to earn more than the competitive wage. Parents often teach their children to be honest, even to the children's own detriment.

4. There was a peculiarity in Hagerman-Zmijewski's sample. Their "random sample" of firms consisted of 151 FIFO firms and 149 LIFO firms. A careful study of the Compustat file reveals that the population ratio of LIFO firms/FIFO firms is less than one to six. Many firms cannot be classified into either category.

5. For a more detailed discussion, please see McCarthy, Crumbley and Davis (1983, Ch. 15).

6. Lee and Petruzzi (1983) developed a stochastic model of inventory accounting choice. They first model stochastic processes of the movements of inventory prices and quantities. Then they derive a modified Black-Scholes formula to valuate the adoption of an inventory accounting method.

7. Merton (1973) and Black and Scholes (1973) discuss in detail the conditions of rational option pricing.

8. LIFO was deemed acceptable for tax purposes in 1939, and it has been used in the steel and petroleum industries since the late 1940s. A large number of firms switched to LIFO in 1974 and 1975.

9. According to Rule 4.(2)., a LIFO-switching firm needs to restate inventories for the preceding year to cost. Hence a positive inflation rate in the year preceding the accounting switch implies that the LIFO-switching firm valuates inventories at cost and no restatement is necessary. If the inflation rate of the preceding year were negative, then the "dividend" would be reduced by the restatement to cost.

10. In this paper, we examine firms which have strictly adopted the LIFO or the FIFO method for at least seven years. Hence we are not concerned with the switch of accounting methods. Lee and Petruzzi (1984) calculated the "dividend" and study the optimal timing of the accounting switch.

11. This ratio is called coefficient of variance which is unit-neutral and is generally independent of firm size.

12. Here, I implicitly assume that FIFO firms cannot subtract tax benefits from additional inventory control. Lee and Petruzzi (1983) show that when a FIFO firm anticipates switching to the LIFO method, it is profitable to increase inventory variability.

13. The issue of simultaneous equation bias can be viewed as a special case of errors-in-variables problem. For reference, see Griliches (1974). However, our results are not changed by this consideration.

14. We also measured the price variability in terms of the coefficient of variance of inflation rates. Under this measurement, our estimation of the effect of price variability on choice of accounting method is not statistically significant.

15. Since the mean inflation rate is positive, when the variance of the inflation rate is approaching zero, the relative frequency of positive inflation will be approaching one.

16. Beginning in 1972, if more than one inventory accounting method is used to value inventory, then all applicable codes of method will be noted in the Compustat. We eliminate all the firms with more than one code of inventory accounting method. Hence our data is less pure before 1972 than after 1972. However, the inventory accounting method that is identified for each sampled firm is at least the primary method used.

17. $$t_i = \frac{\sum_{l=1}^{127} \frac{V_{if}}{127} - \sum_{f=1}^{672} \frac{V_{if}}{672}}{\frac{(127 - 1)\, S_{il}^2 + (672 - 1)\, S_{if}^2}{127 + 672 - 2}} \quad ;$$

where i = attribute index;

l = index of LIFO firms, $l = 1, \ldots, 127$;

f = index of FIFO firms $f = 1, \ldots, 672$;

V_{il}, V_{if} = value of variable V_i of firm l and f respectively;

S_{il}^2, S_{if}^2 = sample variance of variable V_i of all LIFO firms and FIFO firms respectively.

18. The junior author is responsible for the programming and computation, and the senior author is responsible for all the remaining errors.

19. There are many ways to manipulate accounting numbers; for example, Hagermann and Zmijewski (1979) suggested four accounting methods that can be adopted for this purpose. In contrast to other methods, manipulating accounting numbers through inventory accounting incurs a large opportunity cost - the potential tax savings. Consequently, inventory accounting is not an efficient instrument for number-manipulation. Moreover, the effect of inventory accounting on financial reports depends on the movements of inventory prices and quantities. Unless inventory prices and quantities are under managerial control, tampering with inventory accounting does not necessarily yield the "desired" financial report. Hence, inventory accounting is an ineffective instrument for number-manipulation. Finally, the manager does not have complete freedom in the choice of inventory accounting method which, in some cases, may need the approval of the tax authority. Therefore, inventory accounting is an inefficient, ineffective, and sometimes unfeasible instrument for number-manipulation. Even if political cost theory and agency theory did actually motivate managers' behavior, one should not find empirical evidence from the study of inventory accounting choice.

20. To calculate the potential tax-savings, one needs to assume that the firm will change accounting method but keep everything else constant. Since other things will be different after a firm changes accounting methods, the calculated potential tax savings is a biased estimate of the benefit of accounting switch. This is the so called "simultaneous equation bias" in Econometrics. This paper provides some explanations for the possible bias in Biddle's (1980) study. However, his work still gives a fundamental contribution toward the understanding of accounting choice.

References

Abdel-Kalik, A.R. "The Decision To Change To LIFO: The Role of Executive Compensation and the Political Cost Hypothesis." Working paper, University of Illinois at Urbana-Champaign, 1983.

Akerlof, G.A., "Loyalty Filters," American Economic Review, March 1983, pp. 54-63.

Beaver, W.H., P. Kettler, and M. Scholes, "The Association Between Market Determined and Accounting Determined Risk Measures," Accounting Review, October 1980, pp. 654-682.

Biddle, G., "Accounting Methods and Management Decisions: The Case of Inventory Costing and Inventory Policy." Supplement of Journal of Accounting Research, 1980, pp. 235-280.

Biddle, G.C. and F.W. Lindahl, "Stock Price Reactions to LIFO Adoptions: The Association Between Excess Returns and LIFO Tax Savings," Journal of Accounting Research, Autumn 1982, Pt. II, pp. 551-588.

Black, F. and M. Scholes, "The Pricing of Options and Corporate Liabilities," Journal of Political Economy, Vol. 81, 1973, pp. 637-654.

Brown, R.M., "Short-Range Market Reaction to Changes to LIFO Accounting Using Preliminary Earnings Announcements Dates," Journal of Accounting Research, 18, Spring 1980, pp. 38-63.

Copeland, R.M. and J.K. Shank, "LIFO and Diffusion of Innovation," Supplement of Journal of Accounting Research, 1971, pp. 196-224.

Eggleton, I.R., S.C. Penman, and J.R. Twombly, "Accounting Changes and Stock Prices: An Examination of Selected Uncontrolled Variables," Journal of Accounting Research, Spring 1976, pp. 66-88.

Fama, E.F., "Agency Problems and the Theory of the Firm," Journal of Political Economy, March 1980, pp. 288-307.

Gonedes, N.J., "Accounting Techniques and Firms' Equilibrium Values: Tax Methods and the LIFO/FIFO Choice," Report 7911, Center for Mathematical Studies in Business and Economics, University of Chicago, 1979.

Griliches, Z. "Errors in Variables and Other Unobservables," Econometrica, Vol. 42, 1974, pp. 971-998.

Hagerman, R. and M. Zmijewski, "Some Economic Determinants of Accounting Policy Choice, Journal of Accounting and Economics, August 1979, pp. 141-161.

Holthausen, R.W. and R.W. Leftwich, "The Economic Consequences of Accounting Choice: Implications of Costly Contracting and Monitoring," CRSP WP. No. 87. Center for Research in Security Prices, Graduate School of Business, University of Chicago, October 1982.

Jensen, M.C. and W. Meckling, "Theory of Firm: Managerial Behavior, Agency Costs and Ownership Structure," Journal of Financial Economics, September 1976, pp. 305-360.

Lee. C.J., "Inflation, Inventory Accounting Methods and Stock Returns," Working Paper, Center of Research in Securities Prices, University of Chicago, 1983.

Lee, C.J. and C.R. Petruzzi, "A Stochastic Model of Inventory Accounting Choice," Work in progress, University of Pennsylvania, 1983.

McCarthy, C.F., D.L. Crumbley, and P.M. Davis, The Federal Income Tax, Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983.

McFadden, D. "Econometric Models of Probabilistic Choice," in C. Manski and D. McFadden (eds) Structural Analysis of Discrete Data: With Econometric Applications, Cambridge, MA: M.I.T. Press, 1982.

Merton, R.C., "Theory of Rational Option Pricing," Bell Journal of Economics and Management, Vol. 4, 1973, pp. 141-183.

Morse, D. and G. Richardson, "The LIFO/FIFO Decision," Journal of Accounting Research, forthcoming, 1983.

Reder, M.W., "Chicago Economics: Permanence and Change," Journal of Economic Literature, March 1982, pp. 1-39.

Ricks, W., "The Market's Response to the 1974 LIFO Adoptions," Journal of Accounting Research, Autumn 1982, Pt. I, pp. 367-387.

Theil, H. Principles of Econometrics, New York: John Wiley, 1971.

Zmijewski, M.E. and R.L. Hagerman, "An Income Strategy Approach to The Positive Theory of Accounting Standard Setting/Choice," Journal of Accounting and Economics, Vol. 3, 1983, pp. 129-149.