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Inventory Method LIFO Changes: Impact on Firm Risk

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Abstract: The corporate decision to switch any part of a company's GAAP inventory valuation method from FIFO (First In, First Out) to LIFO (Last In, First Out) or from LIFO to FIFO may have an impact on firm value and on firm risk. Original research on this topic found significant positive abnormal returns from the adoption of LIFO, but the results were inconclusive for its impact on firm risk. The choice of using LIFO or not is back in the news today as the US considers adopting International Financial Reporting Standards (IFRS). Today's economic conditions are also much different than when the original studies were done during the high inflation rates in the 1970s. In the 21st Century inflation rates have been much lower. We investigate the impact of any inventory method change on firm value and on firm risk with data starting in 2000. In our sample, we find a significant positive impact on firm value from inventory accounting changes (which is surprising given the low inflation environment of this sample) and find significant changes in firm risk.

Key words: LIFO; accounting changes; volatility; CAR; event study
JEL codes: G10, F18

1. Introduction

In theory, accounting changes do not affect cash flows which are the basis of valuation in finance. Thus, the decision by management to change inventory accounting methods is often examined to see if managers are working to maximize shareholder wealth. This investigation can be done by measuring the change in a firm's risk-adjusted returns. Most investigations of accounting changes indicate no statistically significant change in firm value. However, several studies found that changes in inventory valuation methods from FIFO (First In, Last Out) method to LIFO (Last In, First Out) method had a significantly positive impact on firm value during the high inflationary period of the 1970s (Ball, 1972; Sunder, 1973; Sunder, 1975).

The main reason for this finding is that switching to LIFO in high inflation times leads to an immediate increase in the reported inventory expenses on the firm's Income Statement, with no change in actual cash outflows or change in the total market value of inventory. An increase in accounting expenses leads to lower earnings before taxes. This leads to lower taxes, which is a lower cash outflow. This results in higher after-tax

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cash flow today. Although the accounting changes washout over time, the impact on the time value of money from getting cash sooner rather than later is significantly positive. If there is no change in overall risk, this impact on cash flow should lead to increased firm value today. However, these early studies found conflicting results to changes in firm risk.

Today the interest in inventory systems and the LIFO method has been renewed due to the proposed adoption by US public companies of IFRS. IFRS does not recognize the LIFO method. Thus, there are many current reviews of the possible impact from switching from LIFO to FIFO or to another inventory method. The typical company that switches from LIFO would experience an increase in the valuation of its inventory on its Balance Sheet and an increase in its Earnings Before Taxes leading to higher taxes and higher Net Income. The change of inventory method needs more up-to-date studies of its effect on firm risk.

The history of the LIFO is interesting. Since 1939 the Internal Revenue Code has allowed taxpayers to use the LIFO method to calculate taxable income, with the requirement that the adopting taxpayer implement LIFO in reports to shareholders and other users (the so-called LIFO conformity rule). Taxpayers may adopt LIFO without requesting advance permission from the Internal Revenue Service (IRS), but once adopted, advance permission is required to discontinue LIFO. The company must file with the Security Exchange Commission (SEC) and it is this filing date that we use in this study for the firm's event date.

LIFO matches current costs of inventory against revenues generated from sales of that inventory. As a result, balance sheet inventory amounts generally are lower, especially during periods of rising prices for replacement goods. If business price cycles are fluctuating, LIFO will tend to smooth the impacts and decrease the likelihood that unrealized holding gains and losses in beginning of year inventory items will be recognized. An unavoidable consequence of adopting LIFO for tax advantages is that reported income will generally be lower than if FIFO had been used. International Financial Reporting Standards (IFRS) do not allow the use of LIFO.

LIFO provides benefits during periods of rising prices. Price levels of inventory components in the U.S. economy have not risen significantly in recent periods, suggesting that LIFO adoptions should be waning. However, as the data below indicate taxpayers are still adopting LIFO. This study does not attempt to identify the motivations for LIFO adoptions.

Over time, taxpayers that implement LIFO will report lower taxable income than if FIFO had been used, thus building a balance of deferred taxes (commonly called the LIFO reserve). Discontinuing LIFO (or liquidating the LIFO reserve through contraction of operations) will result in additional tax due as the reserve is decreased. Reduction in the reserve through normal operations is included in income currently, but for taxpayers who receive IRS permission to discontinue LIFO the tax due on the accumulated reserve is spread over four taxable years. There is current evidence that taxpayers are discontinuing LIFO for a variety of reasons.

Annual deferred federal income tax revenue from the use of LIFO is approximately $5 billion. Should LIFO be repealed, as was proposed in the President's budget submission for FY 2017 (Department of the Treasury, 2016), estimates are that federal income tax revenues would increase by more than $81 billion over the ten-year budget projection period (Joint Committee on Taxation, 2015). Politically there is an incentive for government repeal of LIFO, as an alternative to taxpayer initiated changes to conform with IFRS (if and when convergence occurs), because repeal can accelerate the timing of cash flows from tax payments while convergence would result in the 4-year spread in most instances.

2. Literature Review

In the first comprehensive study of accounting changes, Ball (1972) examined stock price reactions to over 20 types of accounting changes. Included were LIFO adoptions. Ball concluded from an examination of cumulative excess monthly returns that "changes in accounting techniques do not appear to be associated with market adjustments in a consistent direction for the average firm" (1972, p. 23). However, the results indicate that firms adopting LIFO exhibited cumulative excess returns of +7.0 percent over the 12 months preceding the change. Ball concluded from his results that investors can anticipate most accounting changes. Sunder's (1973) study was the first to focus exclusively on stock price reactions to LIFO changes. His primary samples were composed of 119 firms which adopted LIFO. Sunder viewed these results as consistent with the hypothesis that on average the stock prices of firms that adopt LIFO increase because of the accompanying tax advantages.

Biddle and Lindahl (1982) found, after controlling for abnormal earnings performance, that larger LIFO tax savings were found to be (cross-sectionally) associated with larger cumulative excess returns over the year to which a LIFO adoption (extension) first applied. Ricks (1986) redid the Biddle and Lindahl study with a larger sample and found similar results. Stevenson (1987) studied an even larger sample (366 firms) during 1974 and 1975, a period of very high inflation, and found a positive stock reaction from switches to LIFO. Some studies found that firm risk increased, others found that firm risk decreased, and some found no significant change, as noted in Table 1.

Table 1 Previous Studies of Risk Changes Associated with Accounting Changes

Author	Dates	Sample #	Change in Risk -> yes/no; higher, lower
Ray Ball (1972)	1972	197	yes/higher
Shyam Sunder (1973)	1973	155	yes/higher
Shyam Sunder (1975)	1975	All - 118 LIFO only - 21	yes/higher 5.4%, yes/lower 5.3%
William Ricks (1982)	1982	(change) - 354 (no change) - 693	
Gary C. Biddle and Frederick W. Lindhal (1982)	1982	311	Upward shifts in systematic risk (p. 583)
William Ricks (1986)	1986	311	Adoption year tax savings
Francis Stevenson (1987)	1987	351	Increase in share values (p. 306)
Gary C. Biddle and William E. Ricks (1988)	1988	607	
Herbert Hunt (1985)	1985	462	Higher current ratio, higher income to interest expense, lower levels of management ownership
Rory F. Knight and John F. Affleck-Graves (1988)	1988	300, 21, 20	CAR decreases w/ adoption (p. 181)
Woon-oh Jung (1989)	1989		Tax benefit, firm value decreases

Traditional work on the impact of firm value from managerial decisions to change GAAP methods postulates that accounting changes do not change firms' cash flow, thus should have no impact on firm value. We posit the question: What impact does the change of inventory methods have on the value of the firm during low inflation periods?

3. Data

The list of companies that adopted LIFO is collected by a massive search of the LexisNexus Academic,

Google and EBSCO databases. Culled from tens of thousands of observations identifying companies that switch to LIFO or from LIFO starting in 2000 and going through 2014, 133 companies have announcement dates (filing dates) for their change in inventory method, as noted in Table 2 which lists their pre-change method and their method of adoption.

Table 2 Firms Switching from FIFO to LIFO, or from LIFO to Another Inventory System from the Beginning of 2000 through 2015

Previous Method	ADOPTION	Identification	Total
FIFO	LIFO	1	14
LIFO	FIFO	2	95
LIFO	Weighted Average	3	15
Multiple LIFO pools	Single LIFO pool	4	2
LIFO pools & double extension	LIFO pools reduction & "Link Chain"	4	1
LIFO "Specific Goods"	LIFO "Link Chain"	5	1
LIFO	Specific Identification	6	1
LIFO retail	LIFO Average	7	1
LIFO external indices	LIFO internal index	8	1
LIFO year to date average cost	LIFO latest acquisition cost	9	1
LIFO retail, FIFO, LIFO	LIFO cost, weighted average	10	1
			133

There are 108 companies with publicly traded data on the CRSP database for 551 trading days; each company needs 275 trading days before the firm's filing date and 275 trading days after their filing date. The filing date and stock returns are needed to test the impact of LIFO changes on firm value. To run Park, Lee and Song (2014) use 250 trading days in their estimation period (Day -275 to Day -26 inclusive) to calculate the event study parameters (see Appendix A). The event period starts on Day -25 and goes to Day +25 for 51 trading days. Then the next 250 trading days are used to estimate the of event study risk parameters (each firm's pre- and post-event beta, variance and residual standard deviation of daily returns on the CRSP daily return file). Our final sample of firms consists of the 108 public corporations that have all the required returns necessary for running the event study and the pre- and post-event risk comparisons.

The difference in the Consumer Price Index (CPI) as a measure of inflation from the 1970s to the 2000s is shown in Figure 1. Most of the studies in the Literature Review section used primarily the 1973 and 1974 years in their samples to test for the impact of inventory valuation changes. The average increase in CPI for these two years is over 10% per year. The average annual increase in the CPI for the years 1970 to 1980 inclusive (11 years) is 7.9%. We compare the 1970-1980 CPI annual average to the average change of the CPI in the 2000s (2000 to 2015 inclusive, 16 years) that averages close to 2.2%. As the reason for switching to LIFO by the researchers in the Literature Review is mainly attributed to tax savings during high inflation periods. Thus, this investigation during such a low inflation period is biased against finding significant positive abnormal returns for firms adopting LIFO if the benefits from switching to LIFO occur primarily from the tax benefits that accrue from switching to LIFO. On the other hand, finding significantly positive abnormal returns would indicate that firms switch their inventory valuation methods to benefit shareholders. Thus, an empirical study is conducted to examine the impact on firm value to firm's switching to and from LIFO valuation accounting methods during the 2000s.

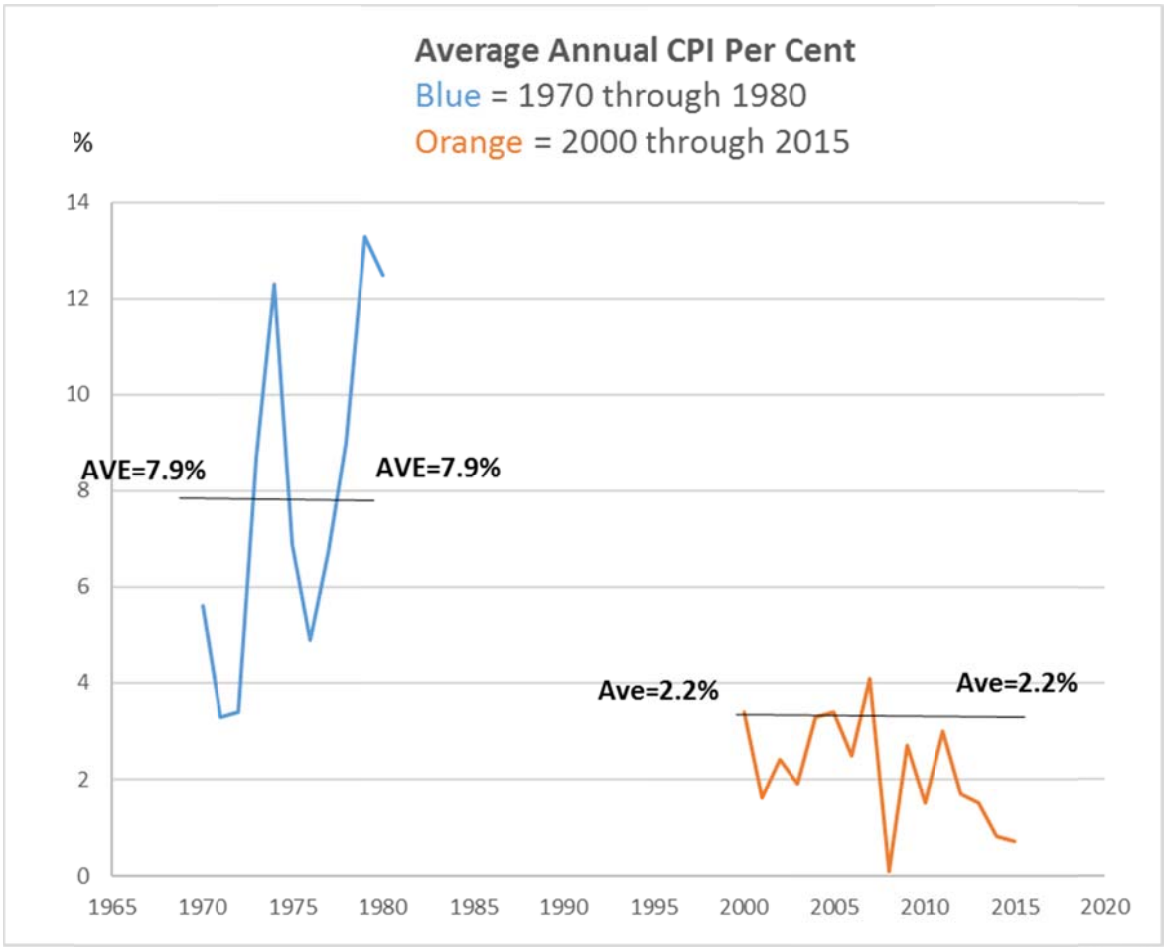

Figure 1 Inflation as Measured by the Consumer Price Index (CPI) from the Bureau of Labor Statistics 1970-2015 with the Average for 1970 through 1980 and the Average for 2000 through 2015

Researchers suggest that a change in inventory valuation can have an impact on a firm's risk. Some say there is an impact on the firm's systematic risk (beta) due to changing their inventory valuation method, while others suggest it affects firm specific risk (variance and residual standard deviation). We look to measure these risk measures before and after the filing date of an inventory valuation change and to test whether there is a statistically significant change.

4. Methods

Standard event study methods are used to calculate abnormal returns and cumulative abnormal returns over various event periods. Statistical tests determine the level of significance of the results and to measure the magnitude of the impact on firm value of the firm's stock certificate becoming dematerialized. Campbell et al. (1997) discuss the historical development of event study research and summarize commonly used event study methodologies. Event studies measure the value effect of an event under the assumption of market rationality, allowing us to assume that investor assessment of firm value is accurate and reflected in the firm's stock prices. Consequently, any abnormal returns experienced in the event window can be interpreted as a measure of the impact of the event — the firm's filing for a change in its inventory account ting method involving LIFO — on

the value of the firm.

Therefore, we test the following hypothesis:

$H1_0$: The change of inventory methods has no impact on firm value and results in statistically insignificant abnormal returns.

$H1_A$: Firms change inventory methods to increased present value of cash flows for the firm without any increase in risk resulting in significant positive abnormal returns.

To study whether the adoption of LIFO event has any impact on the market, we measure event-day cumulative abnormal returns (CARs) and test their statistical significance. We focus primarily on whether or not there was a market price effect of the firm's adoption of a new inventory method within a reasonable time period, called the event window. The event window is the amount of time, usually measured in the number of trading days, taken by investors to absorb the impact of a new event. According to the efficient market hypothesis, new information is incorporated very quickly into the stock price. Consequently, a short event window is likely to be a more reliably test of the market effect on the value of the firm from the event.

Single factor market model parameters are calculated using the estimation period of trading days before the event date to approximate one year of stock returns. The Park, Lee and Song (2014) estimation period begins 275 trading days before the event and ends 26 days before it. Thus, there 250 trading days in the estimation period before the event, which represents about one year before the event. The event period starts 25 days before the event and goes 25 days after the event, thus there are 51 trading days in the event period. Each firm in our sample must have 250 trading days after the event period.

For this study, the market model event study method uses a linear regression to predict stock returns; then it compares the predicted value to its actual return. To test whether the cumulative abnormal return is significantly different from zero, we use the standardized cross-sectional method. We use the equally-weighted CRSP (Center for Research in Security Prices) index for the model's market returns. We also employ a generalized sign test, which differs from the simple sign test in that the fractions of positive and negative returns under the null hypothesis are determined by the fractions observed in the estimation period, rather than fixed at 0.5. Betas in the market model are estimated using the method of Scholes and Williams (1977).

The abnormal return (ABR_{jt}) is the difference between the actual return (R_{jt}) on a specific date and the expected return ($E(R_{jt})$) calculated for the firm on that specific date and over the specific intervals. To statistically test the data, the null hypothesis that the introduction of the event has no effect on the returns of the underlying security will be rejected if the Z-statistic is significant at the 0.10 level or lower with a one-sided test.

To examine the change in risk from switching to or from the LIFO inventory method, we test the following hypothesis:

$H2_0$: The change of inventory methods has no impact on firm risk and results in an insignificant statistical difference between risk measures (beta and residual standard deviation of returns) before and after the event.

$H2_A$: The change of inventory methods increases firm risk and results in a significant statistical difference between risk measures (beta and residual standard deviation of returns) before and after the event.

The significance of the difference in means of the Post-event minus the Pre-event risk measures of the firms' betas, total mean of the total return variances and the residual standard deviations are examined using the one-tail t test.

5. Results

We use a different data set than any other previous research to test for both a statistically significant abnormal return around an inventory change involving the LIFO method and a change in firm risk. The measures of firm risk are its Beta, total variance and residual standard deviation of returns.

5.1 The Event Study Results

The results in Table 3 show that there is a statistically significant abnormal return on the event date (Day 0). The Day 0 abnormal average return ($CAAR_0$) is 0.93%. This abnormal return is statistically significant using both the Patell Z statistic (Z = 2.60, significant at the .01 level) and the cross-sectional t test (t = 2.617, significant at the .05 level). This result indicates that firms switching their inventory valuation methods to and from LIFO during the 21st Century experience positive impacts to their firm value. This method uses improvements in the event study methods as detailed in the Appendix. In this study, the actual filing date for changing the inventory accounting technique is used which is much better for measuring the impact on firm value than previous studies using the next accounting earnings period. The statistically significant positive abnormal returns in Table 3 are similar to the findings of Ray Ball (1972), Shyam Sunder (1973, 1975), and Stevenson (1987). These results are different from those of Knight and Affleck-Graves (1988) and Woon-oh Jung (1989).

Table 3 The Event Study Results using the Market Model with the CRSP Equally-Weighted Index

Days	N	CAAR	Positive: negative	Patell Z	Cross sectional t statistic	Generalized sign Z
(-10,-1)	108	1.63%	59:49)	1.583$	1.415$	1.395$
(-5,-1)	108	1.36%	62:46>	1.375$	1.535$	1.973*
(-1,0)	108	1.40%	61:47>	1.962*	1.694*	1.780*
(0,0)	108	0.93%	58:50	2.600**	2.617*	1.202
(0,+1)	108	1.02%	59:49)	1.849*	1.574$	1.395$
(-1,+1)	108	1.50%	55:53	1.609$	1.239	0.624
(+1,+5)	108	1.25%	62:46>	1.132	1.346$	1.973*
(+1,+10)	108	0.60%	56:52	1.144	0.609	0.817
(-5,+5)	108	3.54%	64:44>>	2.418**	2.164*	2.358**
(-10,+10)	108	3.16%	66:42>>	2.383**	1.923*	2.743**
(-15,+15)	108	3.42%	68:40>>>	2.135*	1.697*	3.128***
(-20,+20)	108	3.16%	58:50	1.772*	1.339$	1.202

Note: The symbols $, *, **, and *** denote statistical significance at the 0.10, 0.05, 0.01 and 0.001 levels, respectively, using a generic one-tail test. The symbols (,< or), > etc. correspond to $,* and show the direction and significance of the generalized sign test.

Previous research reported that the event period before the inventory valuation change experiences positive Cumulated Average Abnormal Returns (CAAR). The event period of 2 weeks of trading days before the filing date of a switch to or from LIFO (Days -10,-1) has a $CAAR_{-10,-1}$ of 1.63%. This abnormal return is statistically significant using both the Patell Z statistic (Z = 1.583, significant at the .10 level), the cross-sectional t test (t = 1.415, significant at the .10 level), and the Generalized Sign test (Z = 1.395, significant at the .10 level). This result indicates that firms switching their inventory valuation methods to or from LIFO during the 21st Century experience positive impacts to their firm value during the period before their filing date of their change of accounting methods to or from LIFO.

Although the 2-week period after the LIFO adoption event is positive ($CAAR_{1,10}$ = 0.60% for Days +1,+10),

it is not statistically significantly different than zero. However, the 21-trading days before, after and including the event date of filing for a change in their LIFO method demonstrates highly positive and statistically significant CAARs ($CAAR_{-10,+10}$ = 3.16%). This event period (Days -10,+10) is statistically significant using both the Patell Z statistic (Z = 2.383, significant at the .01 level), the cross sectional t test (t = 1.923, significant at the .05 level), and the Generalized Sign test (Z = 2.743, significant at the .01 level). The magnitude of this result is very high. It agrees with several earlier findings on inventory accounting method changes.

5.2 The Risk Change Results

Additional research investigates the risk changes that may have occurred after the change in inventory accounting methods involving LIFO, both total firm risk as measured by the standard deviation of firm returns before and after the event, as well as the systematic risk changes as measured by the firm's beta. The statistical technique is the paired t test. For each of the 108 companies in our sample, we calculate the returns per trading day from 275 days before the event to 26 days before the event for a total of 250 returns. We next calculate the returns per trading day from 26 days after the event until 275 days after the event for a total of 250 returns. Then we calculate the Beta for the pre-event period and the post-event period using the CRSP equally-weighted index daily returns to proxy the market portfolio. As can be seen in Table 4, the difference calculated from subtracting the pre-event Betas from the firm's post-event Beta is very small (0.002857), positive and not statistically significant by any conventional standard. The finding here is that on average firm Beta increases after the change in inventory accounting techniques involving LIFO. This finding is similar (positive) to Biddle and Lindhal (1982), who found an increase in Beta risk after the event, but here it is not significantly different from zero, thus it equates to no change.

We calculate the total return variance of each firm's daily returns for the pre-event period and the post-event period for each company. As can be seen in Table 4, the difference calculated from subtracting the pre-event total return variance from the firm's post-event total return variance is very small (0.000510), positive and statistically significant at the .05 level. The finding is that, on average, firm total return variance increases after the change in inventory accounting techniques involving LIFO. This finding is different than Sunder (1975) for the LIFO sample, but is similar to Sunder (1975) total sample. We calculate the residual standard deviation of returns for the pre-event period and the post-event period for each company. As can be seen in Table 4, the difference calculated from subtracting the pre-event residual standard deviation of returns from the firm's post-event residual standard deviation of returns is small (0.002452), positive and statistically significant at the .06 level. The finding is that, on average, firm residual standard deviation of returns increases after the change in inventory accounting techniques involving LIFO. This finding is different than Sunder (1975) for the LIFO sample and is similar to Sunder (1975) total sample.

Table 4 Results of the Pre- and Post-Inventory Method Change on Firm Risk Using the CRSP Equally-Weighted Index

Period	Beta	Total Return Variance	Residual St. Dev.
Post-Event	1.277411	0.001765	0.028644
Pre-Event	1.274554	0.001255	0.026192
Difference (Post - Pre)	0.002857	0.000510	0.002452
(Probability p value)	(0.4757)	(0.0454)**	(0.0576)*

The symbols *, **, and *** denote statistical significance at the 0.05, 0.01 and 0.001 levels, respectively, using a generic one-tail test.

The main finding from this research is that firm specific risk changes after the filing of an inventory accounting change involving LIFO. However, there is no indication of an effect on the firm's systematic risk (as measured by Beta). In the future, additional studies on the factors affecting firm risk changes would be important.

6. Conclusions

In conclusion, comparing the results of this study to Sunder's (1973) findings, the findings on the event date are much stronger than the monthly results of Sunder's study. On the other hand, the $CAAR_{-20,+20}$ of 3.16%, basically one month before and one month after the adoption of LIFO, is similar to the findings of Sunder with a sample of companies approximately the same size as his study.

These results indicate no change in systematic risk (Beta) from changing inventory valuation methods, different from the Biddle and Lindhal result of an increase in beta after the change. We find a significant increase in firm-specific risk, as there are statistically significant increases in firm variance and residual standard deviation, similar the Sunder's 1973 findings, but contrary to his 1975 findings.

This study provides new findings as to the significantly positive impact on firm value from firms adopting LIFO. The time period is completely different. The inflation rates are vastly different. A much stronger methodology using daily event study is employed in this study instead of a monthly returns study. Surprisingly to us, even with all the differences, results find similar positive abnormal returns for firms adopting LIFO. This result should not happen as markets know the impact of switching to LIFO from publicly available information. Investors should already have the possibility of a switch to LIFO built into to their valuations of these firms.

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Appendix A Event Method

The expected return is calculated using the parameters of a single index regression model during the pre-event estimation period. The regression model parameters are determined by the following equation:

$$R_{jt} = a_j + b_j R_{mt} + e_{jt} \quad (1)$$

Where R_{jt} = the return on security j for period t, a_j = the intercept term,

b_j = the covariance of the returns on the jth security with those of the market portfolio's returns,

R_{mt} = the return on the CRSP equally-weighted market portfolio for period t, and

e_{jt} = the residual error term on security j for period t.

Betas (β_j) in the market model are estimated using the method of Scholes and Williams (1977). Ordinary Least Squares (OLS) was used to estimate the slope and intercept parameters for each security in the data set. The market model estimation is adjusted for any first order autocorrelation with a GARCH (1,1) approach. These estimates were then used to calculate the expected return for the event window, from which the abnormal returns (AR_{jt}) can be calculated as follows in equation below:

$$AR_{jt} = R_{jt} - a_j + b_j R_{mt} + e_{jt} \quad (2)$$

where R_{jt} is the observed return of security j on Day t and R_{mt} is the return of the CRSP equally-weighted market index on Day t. The estimates of alpha and beta are those calculated above from the estimation period. The average abnormal return (AAR_t) is calculated as the mean AR_{jt} for all N securities:

$$AAR_t = \frac{\Sigma_{j=1}^{N} AR_{jt}}{N} \quad (3)$$

where t is the trading day relative to the event. The cumulative average abnormal return (CAAR) from Day T_1 to Day T_2 (is calculated as follows:

$$CAAR_{T_1,T_2} = \sum_{t=T_1}^{T_2} AAR_t \quad (4)$$

Test statistics are calculated as in Patell (1976). Standardized abnormal returns (SAR_{jt}) are defined as follows:

$$SAR_{jt} = \frac{AR_{jt}}{S_{jt}} \quad (5)$$

S_{jt} is further defined as the square root of the security j estimated forecasted variance:

$$S_{jt}^2 = S_j^2 (1 + \frac{1}{D_j} + \frac{(R_{mt} - R_m)^2}{\Sigma_{k=1}^{D_j} (R_{mk} - R_m)^2} \quad (6)$$

where R_{mt} is the observed return on the market index on day t, R_m is the mean market return over the estimation period, and D_j is the number of trading day returns (251) used to estimate the parameters for firm j, and is calculated as follows:

$$S_j^2 = \frac{\Sigma_{k=1}^{D_j} AR_{jk}^2}{D_j - 2} \quad (7)$$

Finally, the test statistic for the null hypothesis that the equals zero is defined as:

$$Z_{T_1,T_2} = \frac{1}{\sqrt{N}} \sum_{j=1}^{N} Z_{T_1,T_2}^{j} \tag{8}$$

where

$$Z_{T_1,T_2}^{j} = \frac{1}{\sqrt{Q_{T_1,T_2}^{j}}} \sum_{t=T_1}^{T_2} SAR_{jt} \tag{9}$$

and

$$Q_{T_1,T_2}^{j} = (T_2 - T_1 + 1)\frac{D_j - 2}{D_j - 4} \tag{10}$$

To test the data, the null hypothesis that the firm's adoption of LIFO event has no effect on the returns of the underlying security will be rejected if the Z-statistic is significant at the 0.10 level or lower.

The generalized sign test is used as a nonparametric test of the impact of the announcements. For each trading day or month in the event periods the number of securities with positive and negative average abnormal returns (cumulative or compounded abnormal returns for intervals) is calculated. The generalized sign test statistic controls for the normal asymmetry of positive and negative abnormal returns in the estimation period. The significance levels for the generalized sign test are calculated. The null hypothesis for the generalized sign test is that the fraction of positive returns is the same as in the estimation period. For example, if 46% of market adjusted returns are positive in the estimation period, while 60% of firms have positive market adjusted returns on event day −1, then the test reports whether the difference between 60% and 46% is significant at the five percent, one percent, or one tenth of one percent level. The actual test uses the normal approximation to the binomial distribution. For examples of the generalized sign test in the literature, see Sanger and Peterson (1990), Singh, Cowan and Nayar (1991), and Chen, Hu and Shieh (1991). Chen, Hu and Shieh (1991) refer to the test as a binomial sign test. For a more detailed explanation of the generalized sign test, see Sprent (1989) and Cowan (1992). Cowan (1992) reports that the generalized sign test is well specified for an event date variance increase and more powerful than the cross-sectional test.