

Should You Be Leery of LIFO?

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EXECUTIVE SUMMARY

Based on 10 years of data, this study finds no reason to be leery of last-in, first-out, or LIFO. You should, however, be cautious. LIFO ratio analysis provides good signals for time series analysis and for most profitability ratios. When analyzing ratios between companies that may not be using LIFO, the data should be transformed using the LIFO reserve information.

ave you ever heard someone say, "I am leery of LIFO"? The inventory cost flow system last-in, first-out (LIFO) assumes the cost of the newest merchandise sells first, leaving the cost of the oldest merchandise remaining in ending inventory. In this manner, the income statement expenses the most recent costs, and the balance sheet warehouses the oldest costs. In times of rising prices, this minimizes the value of inventory on the balance sheet and maximizes the cost of goods sold (COGS), which, in turn, minimizes taxable income and the associated cash outflow for income taxes. Sometimes the inventory costs that remain on the balance sheet could be as much as 70 years old.¹ To be sure, that old inventory is no longer physically in inventory, yet its costs appear in part on the balance sheet. The result: underreporting the value of actual inventory held. For this very reason, LIFO is not even a permitted cost flow assumption under International Financial Reporting Standards (IFRS). But it is permitted under U.S. Generally Accepted Accounting Principles (GAAP).

There are three benefits to using LIFO—one is theoretical, another is practical, and the third is based on improving cash flow. The theoretical argument is that LIFO "expenses" the most recent costs on the income statement, providing the highest-quality income statement based on historical costs. Since the income statement is arguably the most important financial statement in the United States, LIFO is the theoretically preferred method on this basis. The practical argument is that companies that have historically used LIFO may wish to continue to do so based on comparability with prior periods. Finally, with respect to cash flow, LIFO's tax savings ability is another factor. Since the Internal Revenue Service (IRS) only permits companies that also use LIFO for financial reporting purposes to do so for tax purposes, this is another reason for a company to choose LIFO as its inventory cost flow assumption.

Because of this disparity as well as the differences between LIFO and its alternative—first-in, first out (FIFO)—the question arises whether it is possible to validly conduct financial statement analysis of LIFO companies without converting LIFO numbers to FIFO numbers given the potential bias produced. For this reason, this study examines:

- What types of companies still use LIFO,
- The extent to which its use distorts ratios in financial statement analysis on profitability, productivity, and financial leverage both over time and between companies,
- If the directional signals sent, regardless of distortions in magnitude, are true, and
- If LIFO earnings more closely correlate with cash from operations than do FIFO earnings to measure representational faithfulness.

This research is both quantitative and qualitative to both statistically measure the impact of LIFO on calculations and to visualize the practical impact.

DATA

This study collected annual financial statement data directly from XBRL (eXtensible Business Reporting Language) corporate annual reports on the EDGAR (Electronic Data Gathering, Analysis, and Retrieval) system of the U.S. Securities & Exchange Commission to calculate financial statement figures and financial ratios with and without LIFO numbers. Panel data for a 10-year period came from financial statements from 2018-2019 back to 2009-2010, or for as long as the corporation existed, for the 19 largest corporations currently using LIFO. All the data was collected in millions of dollars, regardless of how the actual financial statements presented them. Collecting data by hand allowed for checking and correcting errors, so the analyzed data should truly represent the underlying financials.

Initially, the data came from 10-K documents for all companies in the *Fortune* 100, including the company name, industry, and Standard Industrial Classification (SIC) code, and LIFO reserve for the current year and the year prior, if any, to find LIFO companies.

Corporations that use LIFO must disclose the amount of the excess of the replacement cost or current cost over the LIFO value if this amount is material. This requirement results in the LIFO reserve. Hence, the study considered LIFO companies as those with nonzero LIFO reserves in the most recent fiscal year ended prior to August 2019. This nonzero LIFO reserve rule is consistent with prior literature.²

The data from the 19 companies showed each used LIFO. Table 1 lists alphabetically by SIC code LIFO companies that come from a variety of industries ranging from petroleum refining, other heavy manufacturing, wholesale, and retail to miscellaneous other industries. Data from LIFO companies come from the financial statements: one year of data from the income statement and statement of cash flows and two years of data from the balance sheet. This study's data include the following: year-end date, sales, cost of sales, earnings before interest and tax (EBIT), income tax expense, net income, accounts receivable, LIFO inventory, total assets, accounts payable, total equity, net cash inflows from operating activities, and LIFO reserve.3 This study assumes the statutory tax rate to be 21% because it was the statutory tax rate in 2019. Using the same rate throughout the study avoided inserting unnecessary variability into the data.

The LIFO reserve permits the calculation of non-LIFO figures and ratios from the given LIFO figures.⁴

- LIFO inventory + LIFO reserve = FIFO inventory
- 2. LIFO total assets + LIFO reserve = FIFO total assets
- LIFO total liabilities + (LIFO reserve x tax rate) = FIFO total liabilities
- LIFO total equities + (LIFO reserve x (1 tax rate)) = FIFO total equities

Table 1: LIFO Companies and Industries Included in Study

Archer Daniels Midland	<u>SIC: 2070 - FATS & OILS</u>		
DuPont de Nemours	SIC: 2821 - PLASTICS, MATERIALS, SYNTH RESINS & NONVULCAN ELASTOMERS		
Merck	SIC: 2834 - PHARMACEUTICAL PREPARATIONS		
Chevron	SIC: 2911 - PETROLEUM REFINING		
ConocoPhillips	SIC: 2911 - PETROLEUM REFINING		
Marathon Petroleum	SIC: 2911 - PETROLEUM REFINING		
Phillips 66	SIC: 2911 - PETROLEUM REFINING		
Valero Energy	SIC: 2911 - PETROLEUM REFINING		
Deere	SIC: 3523 - FARM MACHINERY & EQUIPMENT		
Caterpillar	SIC: 3531 - CONSTRUCTION MACHINERY & EQUIP		
Honeywell International	SIC: 3724 - AIRCRAFT ENGINES & ENGINE PARTS		
Berkshire Hathaway	SIC: 4900 - ELECTRIC, GAS & SANITARY SERVICES		
AmerisourceBergen	SIC: 5122 - WHOLESALE-DRUGS PROPRIETARIES & DRUGGISTS' SUNDRIES		
Cardinal Health	SIC: 5122 - WHOLESALE-DRUGS PROPRIETARIES & DRUGGISTS' SUNDRIES		
CHS	SIC: 5150 - WHOLESALE-FARM PRODUCT RAW MATERIALS		
Costco Wholesale	SIC: 5331 - RETAIL-VARIETY STORES		
Kroger	SIC: 5411 - RETAIL-GROCERY STORES		
Publix Super Markets	SIC: 5411 - RETAIL-GROCERY STORES		
Walgreens Boots Alliance	SIC: 5912 - RETAIL-DRUG STORES AND PROPRIETARY STORES		

- 5. LIFO COGS increase in LIFO reserve = FIFO COGS
- 6. LIFO EBIT + increase in LIFO reserve = FIFO EBIT

ANALYSIS AND RESULTS

Comparing LIFO to FIFO figures and ratios permits the measurement of the distortions from the choice of the inventory cost flow assumption. Statistical analysis that uses a two-sample t-test of the differences in inventory figures and inventory-related ratios indicates indeed a statistically significant difference when calculating these ratios using LIFO vs. FIFO (see Table 2). With this sample of *Fortune* 100 LIFO companies, the average difference:

- In LIFO ending inventory vs. FIFO ending inventory was \$1.6 billion, with a p-value of less than 0.01,
- In COGS was \$86 million (LIFO COGS is less than FIFO COGS), with a p-value of 0.20 showing

no statistically significant difference,

- In the two gross profit calculations was \$86 million, with a p-value of 0.20 showing no statistically significant difference,
- In the two EBIT calculations was \$78 million, with a p-value of 0.21 showing no statistically significant difference,⁵
- In the days sales in inventory ratios was -9.4 days, with a p-value of less than 0.01 where days sales in inventory ratio is calculated as 365 × average inventory/COGS,
- In the cash operating cycle was -9.7 days because the inventory system affects both days sales in inventory and the days in payables calculation, with a p-value of less than 0.01 where the cash operating cycle is calculated as days sales in inventory plus days sales in receivables less days purchases in payables,
- In the total asset turnover was 0.07 times, with a p-value of less than 0.01 where total asset turnover

	Mean LIFO	Mean FIFO	Mean	One-tailed
			Difference	p-value
Ending inventory*	\$6,308,000,000	\$7,928,000,000	-\$1,600,000,000	8.203 E-29
Cost of goods sold	\$63,427,000,000	\$63,514,000,000	-\$86,000,000	0.200665
Gross profit calculation	\$17,722,000,000	\$17,636,000,000	\$86,000,000	0.200665
Earnings before interest and taxes	\$6,329,000,000	\$6,251,000,000	\$78,000,000	0.208153
Days sales in inventory*	46.1	55.6	-9.4 days	1.685 E-33
Cash operating cycle*	25.7	35.4	-9.7 days	0.00018
Total asset turnover*	1.97	1.84	0.07 times	3.236 E-37
Gross profit margin ratio*	23.8%	23.7%	0.1%	5.898 E-35
EBIT return on sales*	7.6%	7.7%	-0.1%	3.198 E-18
EBIT return on assets*	8.4%	8.2%	0.2%	1.080 E-39
Financial leverage ratio*	3.76	3.31	0.44	2.640 E-44
EBIT return on equity*	31.6%	27.1%	4.5%	4.994 E-17

Table 2: Testing the Statistical Differences, LIFO vs. FIFO

* significant differences at $\alpha = 0.01$ level

is calculated as sales/average total assets,

- In the gross profit margin ratio was -0.001 (0.1 percentage point), with a p-value of less than 0.01 where gross profit margin is calculated as sales – COGS/sales,
- In the return on sales was 0.001 (0.1 percentage point), with a p-value of less than 0.01 where return on sales is calculated as EBIT/sales,
- In the return on assets was -0.002 (0.2 percentage points), with a p-value of less than 0.01 where return on assets is calculated as EBIT/total assets,
- In the financial leverage ratio was 0.44, with a p-value of less than 0.01 where financial leverage is calculated as total assets/total equity, and
- In the return on equity ratio was 0.045 (4.5 percentage points different), with a p-value of less than 0.01 where return on equity is calculated as EBIT/total equity.

Note that while a statistically significant difference exists between inventory figures under LIFO vs. FIFO, no such statistically significant difference exists with COGS, gross profit, or EBIT. This is because the fluctuations in the increase in LIFO reserves over time hover around zero. Figure 1 shows the LIFO reserve for one year and the prior year over time, as well as the change between the two. The data appear over time in this figure, as well as all the figures in this article, by companies listed by size, with the largest *Fortune* 100 firms appearing first.

Those engaged in financial statement analysis expect to find statistically significant differences in the ratio calculations. The mere detection of statistical differences, however, provides little evidence of the practical significance of these differences. To inform analysts and others of the practical importance (or not) of going through the trouble to adjust the reported numbers to value the impact of the inventory cost flow assumptions in assessing profitability, productivity, and financial leverage, one must conduct further analysis.

Of great interest is the representational faithfulness of the inventory figures and the impact on ratios and other calculations. In "Comparing LIFO and FIFO: An Empirical Test of Representational Faithfulness," Brock Murdoch and Paul Krause state Sir Richard John Hicks gives us the most well-established definition of representational faithfulness.⁶ Hicks asserts that income is the maximum amount a company can distribute to owners to still leave the company as well off as it was at



Figure 1: LIFO Reserve and Change in LIFO Reserve

the beginning of the period. Thus, the measure of income that best correlates with cash from operations is the most representationally faithful. Murdock and Krause studied data from 1985 through 2004 to compare companies that used LIFO with companies that used FIFO and found that LIFO is more representationally faithful than FIFO. In contrast, this present study looks exclusively at LIFO companies using both LIFO and

Table 3: Correlation Matrix

	Cash provided by operations	LIFO earnings before tax	FIFO earnings before tax
Cash provided by operations	1.00000		
LIFO earnings before tax	0.84600	1.00000	
FIFO earnings before tax	0.84861	0.89963	1.00000

FIFO numbers and finds a slightly different result.

Both LIFO and FIFO numbers strongly correlate with cash provided by operations at 85% correlation (see Table 3). Thus, both LIFO and FIFO produce equally representationally faithful results. As Table 3 shows, a slight difference exists in correlations when you get to the thousandths place favoring FIFO. That miniscule difference, however, makes the correlations distinguishable. Since this finding contradicts Murdock and Krause's results that found LIFO to be more representationally faithful, the field needs more research. Arguably, the present study uses a stronger research design that pulls data from the same set of companies under two separate sets of calculations.

On the other hand, Murdock and Krause's results could differ due to inflation from 1985 through 2004 vs. the period in this study of 2008 through 2019. Inflation rates clearly impact the LIFO vs. FIFO results. During the period between 1985 and 2004, inflation ranged from a low of 1.6% per year to a high of 5.4% per year, with an overall average of 3.0%. During 2008 through 2019, inflation ranged from a low of -0.4% to a high of 3.8%, with an average of 1.8%. Another possible explanation of the difference is that Murdock and Krause's sample included



Figure 2: Ending Inventory, LIFO vs. FIFO

more companies and smaller ones. Importantly, though, both results indicate operations provided a strong relationship between LIFO earnings and cash flows.

Now that the statistical analysis is complete, consider

the graphical findings to better understand the practical differences. Figure 2 shows that LIFO endinginventory figures are clearly different from FIFO ending-inventory figures. For some years and some



Figure 3: Cost of Goods Sold, LIFO vs. FIFO



Figure 4: Gross Profit, LIFO vs. FIFO

Figure 5: Earnings Before Interest and Taxes, LIFO vs. FIFO





Figure 6: Days Sales in Inventory, LIFO vs. FIFO

companies, that difference is large; and for some years and some companies, the difference is small. This implies that LIFO ending inventory is not a good surrogate for FIFO ending inventory.

Figures 3, 4, and 5 show what Table 2 identified— COGS LIFO vs. FIFO, gross profit LIFO vs. FIFO, and EBIT LIFO vs. FIFO are virtually the same and nearly indistinguishable from each other. Notice that Figure 5 shows additional data (the first "mountain" of data points is added) from Figure 4. This is because Berkshire Hathaway does not report COGS in the face of its income statements.

Figure 6 shows that LIFO days sales in inventory are clearly different from FIFO days sales in inventory at a variety of magnitudes. The LIFO measures are almost uniformly lower than the FIFO figures, with at least two small exceptions. Recall that the ratios were statistically different. Thus, the financial analyst would want to convert a LIFO days sales in inventory ratio to the FIFO measure before comparing FIFO and LIFO values of the number of days it takes on average to sell inventory to avoid bias.

A measure of the cash flow cycle efficiency, the cash

operating cycle is days sales in inventory plus days sales in receivables less days purchases in payables. Figure 7 shows that the LIFO cash operating cycle is typically lower than the FIFO cash operating cycle, with only a short series of exceptions. This is another example of an instance when the analyst would want to convert the LIFO values to FIFO values before relying on this statistical signal. This is because the data are both statistically and practically different from each other.

Thus far, a similarity appears in each LIFO vs. FIFO graph. This is no surprise because the LIFO and FIFO data are paired data from the same companies during the same period, with the only difference being the inventory cost flow calculation. The similarity continues in many of the subsequent graphs to the point that the LIFO line graph is almost indistinguishable from the FIFO line graph. Remember that in all subsequent cases, these line graphs differ statistically in a significant way, despite the similarity. The question you need to answer is whether the differences are unique on a practical level.

Figure 8 shows that the LIFO total asset turnover line graph has higher peaks than the FIFO total asset



Figure 7: Cash Operating Cycle, LIFO vs. FIFO

Figure 8: Total Asset Turnover, LIFO vs. FIFO





Figure 9: Gross Profit Margin Ratio, LIFO vs. FIFO

turnover line graph, but the lines converge throughout most of the graph otherwise. Also notice that in all cases, the "signal" sent by both ratios is similar. This is because the distortion in earnings from LIFO vs. FIFO is partially offset by the distortion in total assets. The similarities in the two lines of this graph demonstrate that despite statistical significance, there is no practical difference between the two lines. Granted, differences appear during the early half of this graph, but the lines are otherwise so close together that no white space can be seen between the two lines. Thus, both LIFO and FIFO send for the most part equally useful signals. It appears there is no need to recast the total asset turnover ratio from its original LIFO basis to a FIFO basis since the bias in inventory is very small when compared to the bias in total assets.

Figure 9 shows that the LIFO gross profit margin line graph highly converges with the FIFO line graph. To be sure, the differences are small and idiosyncratic, with no clear visual pattern to the distortion. As reported earlier, the average difference is just 0.1%, one tenth of one percentage point. Since the impact on COGS relative to sales is small, the impact from the LIFO vs. FIFO calculation is very slight. Again, there appears to be no benefit in transforming the LIFO measure of COGS to a FIFO basis.

Figure 10 tells a similar story in that the EBIT earnings relative to sales LIFO line graph converges with the FIFO line graph, with only a few idiosyncratic observations. The average difference is, again, less than one tenth of a percentage point. So, on a practical level, the very slight difference means recasting LIFO calculations of EBIT return on sales to a FIFO basis provides no particular benefit.

Figure 11 tells a similar, yet slightly different story. The LIFO EBIT return on assets line graph converges with the corresponding FIFO ratio in some of the companies but is visually separate from it in other companies. Even in the cases when the line graphs diverge, the directional signal sent for financial statement analysis is generally representative. Specifically, when LIFO return on assets increases, the corresponding FIFO ratio typically increases as well. And when the LIFO ratio decreases, the corresponding FIFO ratio typically does as well. For this reason, the LIFO ratio of return on assets is fine for use in an overtime basis but not as



Figure 10: EBIT Return on Sales, LIFO vs. FIFO

Figure 11: EBIT Return on Assets, LIFO vs. FIFO



MANAGEMENT ACCOUNTING QUARTERLY 21 FALL 2020, VOL. 22, NO. 1



Figure 12: Financial Leverage, LIFO vs. FIFO

Figure 13: EBIT Return on Equity, LIFO vs. FIFO



MANAGEMENT ACCOUNTING QUARTERLY 22 FALL 2020, VOL. 22, NO. 1

good in a between-companies basis.

Financial leverage is calculated as total assets divided by total equity to measure the impact of the ownership structure on return on equity relative to return on assets. Figure 12 shows that the LIFO financial leverage graph line mostly converges with the corresponding FIFO ratio. The divergences are typically small, except for the single tall spike that results from an exceptionally large change in total equity. Hence, under normal circumstances, only a small difference appears between LIFO and FIFO financial leverage.

Figure 13, however, tells a different story with return on equity. Both the statistical difference and the practical difference make it worthwhile to recast LIFO numbers into ones comparable to FIFO before relying on them for comparative purposes. That is, the impact on both the numerator and the denominator make it impractical to compare LIFO results to FIFO results. The comparative line graphs on return on equity, EBIT earnings relative to stockholders' equity, show two distinctly separate lines that rarely converge, with an average difference of 4.5 percentage points. Notice also that the signals sent by both line graphs, in terms of the directions of the line slopes, are very similar, with the big exception being the tall spike previously noted in reference to Figure 12 wherein the company purchased a large amount of treasury stock. The smaller the denominator, the greater the magnitude of change that results from a change in the numerator.

CONTRIBUTIONS OF THIS RESEARCH

This study's findings contribute to the discussion of whether the Financial Accounting Standards Board (FASB) should retain LIFO as a valid inventory cost flow assumption. Currently, the U.S. is the sole holdout country to permit its companies to use LIFO, and, in fact, 19% of the *Fortune* 100 choose to do so. The data tell us that both LIFO and FIFO EBIT are equally correlated with cash provided by operations, so both LIFO and FIFO numbers are equally representationally faithful. Before this study, accountants relied on the conceptual analysis that LIFO is a better predictor of cash flows. With this study, along with the results of Murdock and Krause, companies will be able to rely on data, not just a conceptual argument, to determine the benefits and pitfalls of LIFO.7

Specifically, this research supports the validity of LIFO to redirect cash flows and perform some ratio analysis. On a statistical level, measurable differences show up between LIFO vs. FIFO ratio calculations. And while on a practical level, LIFO does distort most activity and most liquidity ratios, it has typically indiscernible effects on most profitability ratios including gross profit margin ratio, return on sales, and return on assets. Because the cost flow assumption affects the financial leverage ratio, the return on equity ratio is affected as well. Despite the sometimes distorted across-companies results, on an over-time basis, the directional signals show remarkably similar patterns. Hence, this research supports the continuation of LIFO as a valid inventory cost flow assumption given the footnote LIFO reserve disclosure.

With respect to financial statement analysis over time, LIFO calculations generally send similar signals, such that there appears to be little benefit to transform the data to a FIFO basis. Yet, when conducting financial statement analysis between companies, when one or more of the companies uses a non-LIFO inventory cost flow assumption, best practices would require the company to transform the data to a FIFO basis for comparative purposes. Otherwise, it introduces inherent bias into activity and leverage ratios.

This research also offers the ability to illustrate which major companies still use LIFO, as well as gives accounting instructors and financial statement analysts the opportunity to illustrate the impact LIFO has on financial ratios to interested students, investors, and others.

The 10-year period for this study poses limitations because this was a time when crude oil prices were generally trending lower over time. While the sample was not made up completely of oil-related companies, the oil trend may have biased some of the results. To alleviate this potential problem, a longer data window was considered; the practical issue, however, is the XBRL data that facilitated the data-collection process was not available for the earlier period.

So, to answer the question "Should you be leery of LIFO?" The answer is no; being leery of LIFO is not well-founded. LIFO provides good signals for financial

statement analysis over time. Caution, however, to those who want to conduct a careful analysis between companies such that an inventory adjustment is warranted, especially since the adjustments necessary are straightforward.

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ENDNOTES

- 1 Paul B.W. Miller and Paul Bahnson report that the IRS began permitting LIFO for tax purposes in 1939. "The Spirit Of Accounting: Fortress LIFO is crumbling: It's about time," *Accounting Today*, January 2008, pp. 13-14, www.accounting today.com/news/the-spirit-of-accounting-fortress-lifo-iscrumbling-its-about-time.
- 2 Frances Ayres, Christine Bauman, Mark Bauman, and Yun Fan, "Inventory Accounting After LIFO," *Commercial Lending Review*, September-October 2008, pp. 17-24.
- 3 EBIT is the best measure of earnings because it ignores interest, income taxes, discontinued operations, and previously recorded extraordinary items.
- 4 Peter Easton, Robert Halsey, Mary Lea McAnally, Al Hartgraves, and Wayne Morse, *Financial & Managerial Accounting for MBAs*, Cambridge Publishing House, Belmont, Ill., 2018.
- 5 Berkshire Hathaway did not disclose COGS on the face of its income statement. Therefore, more data were available to calculate the EBIT than the gross profit and COGS. Hence, this explains the difference in results from COGS and gross profit vs. EBIT.
- 6 Brock Murdoch and Paul Krause, "Comparing LIFO and FIFO: An Empirical Test of Representational Faithfulness," *Conflict Resolution & Negotiation Journal*, March 2013, pp. 104-110; Sir Richard John Hicks, *Value and Capital*, University Press, Oxford, U.K., 1939.
- 7 Murdock and Krause, 2013.