

# The Energy Intensity of the Dow Jones Industrial Average

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## **ABSTRACT**

When the Dow Jones Industrial Average (DJIA) began in 1896, it largely involved companies that processed cotton oil, sugar, tobacco, leather, rubber and other materials. Now, accounting for about a quarter of the total market value of all U.S. stocks, the components range from Coca-Cola to Wal-Mart. Changes in the Dow Jones Industrial Average have included changes in the composition of the 30 stocks included, differences in the manufacturing proportion, and changes in the industries represented.

This paper develops a simple energy intensity indicator of the manufacturing industries represented in the DJIA. In 1974, the price-weighted average of the energy intensities of the manufacturing industries represented in the DJIA was 32.4 thousand British Thermal Units (BTUs) per dollar of output, and in 1998 it was 19.6, a total change of 12.9 BTUs per dollar. This change was disaggregated into that portion, 7 or about fifty-five percent, largely due to improvements in energy efficiency, and the remaining portion, 5.8, mainly a function of the compositional changes.

## **Introduction**

While energy intensity changes within the manufacturing and industrial sectors have been examined extensively, the specific energy intensity changes of the firms represented in the DJIA have not. Do the closely-watched movements of the DJIA tell us anything about changes in the energy intensity of the U.S. economy? Are these firms usually more energy-intensive than the manufacturing average? How much of the DJIA energy intensity changes are a function of changes in the composition of the DJIA, as opposed to true efficiency changes?

After some discussion of the background of the DJIA, this analysis will first examine the changing proportion of manufacturing in the DJIA over time. The next step will be to construct an indicator to examine the energy intensities of the manufacturing industries in the DJIA in 1974 and 1998, decomposing the difference in the indicator from 1974 to 1998 into the portion largely attributable to changes in composition of the DJIA and the portion mainly attributable to improved energy efficiency. Finally, the 1974 to 1998 changes in the DJIA-related energy intensity indicator will be compared to changes in the overall intensity of U.S. manufacturing.

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<sup>1</sup> The views expressed here are not necessarily those of the U.S. Department of Energy.

## Background

The Dow Jones Industrial Average (DJIA) is the world's most quoted stock average (Siegel 2002). Computed continuously in real time throughout trading days, it is maintained by the editors of the Wall Street Journal.

### Who Are Dow and Jones?

In 1882, three New York newspapermen, Charles Dow, Edward D. Jones, and silent financial partner Charles Bergstresser founded Dow Jones and Company. From a basement next to the New York Stock Exchange, they began publishing the *Customer's Afternoon Letter*, a handwritten newsletter delivered to subscribers by messengers. By 1889 Dow Jones and Company had turned their newsletter into a 4-page, 2-cent newspaper, naming it the *Wall Street Journal* (Trumbore 2000). Until that time, consolidated stock tables published every day did not exist (Berfumo and Schay 2003).

The first stock indicator published by Dow Jones and Company was an 11-stock mostly railroad index in 1884, as they were trying to help Wall Street investors determine whether stock prices were generally rising, falling, or standing still. By May 26, 1896, the company had released its first 12-stock industrial stock average, and by 1916 there were 20 stocks in the DJIA. In 1928 the DJIA had reached its current level of 30 stocks (Dow Jones and Company 2003b).

### Is It Industrial?

It's sometimes difficult now to think of it as an "industrial" index, perhaps because the editors of the Wall Street Journal who now select the stocks for inclusion in the DJIA take a much broader view of the term "industrial" than does the bulk of the population. Probably because there are Dow Jones Averages for utilities and transportation, any company that does not fall into one of those two categories may find itself in the DJIA.

The original 12 stocks in the DJIA were concentrated in commodities and materials processing.

**Table 1. Original 12 Stocks in Dow Jones Industrial Average**

American Cotton Oil	Distilling & Cattle Feeding	North American Utility
American Sugar	General Electric	Tennessee Coal & Iron
American Tobacco	Laclede Gas	U.S. Leather Pfd.
Chicago Gas	National Lead	U.S. Rubber

Source: Dow Jones and Company 2003b

Eight of the original DJIA firms have changed their names and/or been acquired by other firms (e.g., Chicago Gas eventually became People's Energy Corp.), and some have also changed their industries (e.g., American Sugar became Amstar and now manufactures portable electric power tools). Two were broken up by antitrust action, and one, U.S. Leather, which was the seventh-largest corporation in the United States in 1909 (Siegel 2002), liquidated as its president fled to Brazil after looting assets. General Electric remained in the DJIA until 1898, returned in 1899, was replaced in 1901, and returned again in 1907. It is the only firm in the original DJIA to be in the current mix.

Component changes are not common, with 20 such changes occurring since the DJIA list was expanded to 30 stocks in 1928. Changes in the mix are usually triggered when an existing company experiences a major change, such as bankruptcy or acquisition by another company. When one stock is changed, the others are reviewed to see if the editors of the Wall Street Journal think that the remaining stocks are still substantial and successful growth companies, interesting to a wide range of investors (Dow Jones and Company 2003b).

The most recent changes in the components of the DJIA were effective with trading on Monday, November 1, 1999. For the first time, NASDAQ-traded stocks were added to those listed on the NYSE.

**Table 2. Latest Changes to the Dow Jones Industrial Average**

Companies Added	Companies Deleted	In DJIA Since:
Home Depot Inc.	Union Carbide Corp.	1928
Intel Corp.	Goodyear Tire and Rubber	1930
Microsoft Corp.	Sears, Roebuck & Co.	1924
SBC Communications	Chevron	1984

Source: Dow Jones and Company 2003a

Table 3 below shows the range of businesses currently represented.

**Table 3. Firms Currently Included in the Dow Jones Industrial Average**

3M Company	Exxon Mobil Corp.	Johnson & Johnson
Alcoa Inc.	General Electric Co.	McDonald's Corp.
American Express Co.	General Motors Corp.	Merck & Co., Inc.
AT&T Corp.	Hewlett-Packard Co.	Microsoft Corp.
Boeing Co.	Home Depot Inc.	Philip Morris Co.
Caterpillar Inc.	Honeywell International Inc.	Altria Group, Inc.
Citigroup Inc.	Intel Corp.	SBC Communications Inc.
Coca-Cola Co.	International Business Machines Corp.	United Technologies Corp.
E.I. DuPont de Nemours & Co.	International Paper Co.	Wal-Mart Stores Inc.
Eastman Kodak Co.	J.P. Morgan Chase & Co.	Walt Disney Co.

Source: Dow Jones and Company 2003b

The changes in composition show a movement from a more agrarian economy. Automobile firms have been included since the DJIA expanded to 30 stocks in 1928, aircraft and technology entered in 1979, and entertainment in 1991 (Equity Analytics 2003).

### Is It An Average?

In 1896 Charles Dow put pencil to paper, summed the prices of 12 industrial stocks, and divided the sum by 12. The DJIA was truly an average. By 1928, however, it was no longer a simple average. At that time it became, and still remains, a price-weighted index. Since it is weighted by price and not by market capitalization, it does not account for the number of shares outstanding.

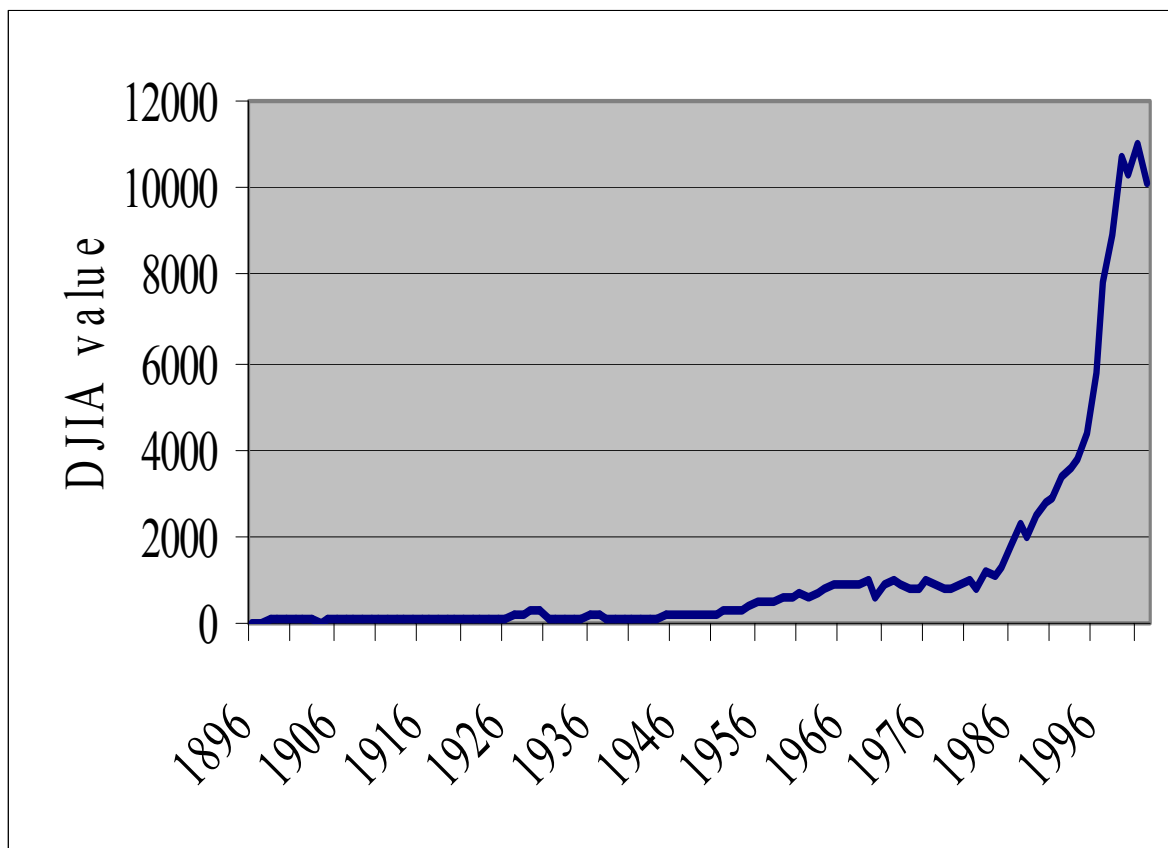
From 1928 until now, it has been calculated using the "Dow divisor" which changes to reflect splits in constituent shares, spin-offs, stock dividends and other corporate actions. As

stocks split, the divisor becomes smaller. As higher-priced stocks substitute for lower-priced stocks, the divisor becomes larger. The DJIA, equaling the sum of all 30 stock prices divided by the “Dow divisor”, is proportional to the arithmetic average (Dow Jones and Company 2003a).

### Historical Activity

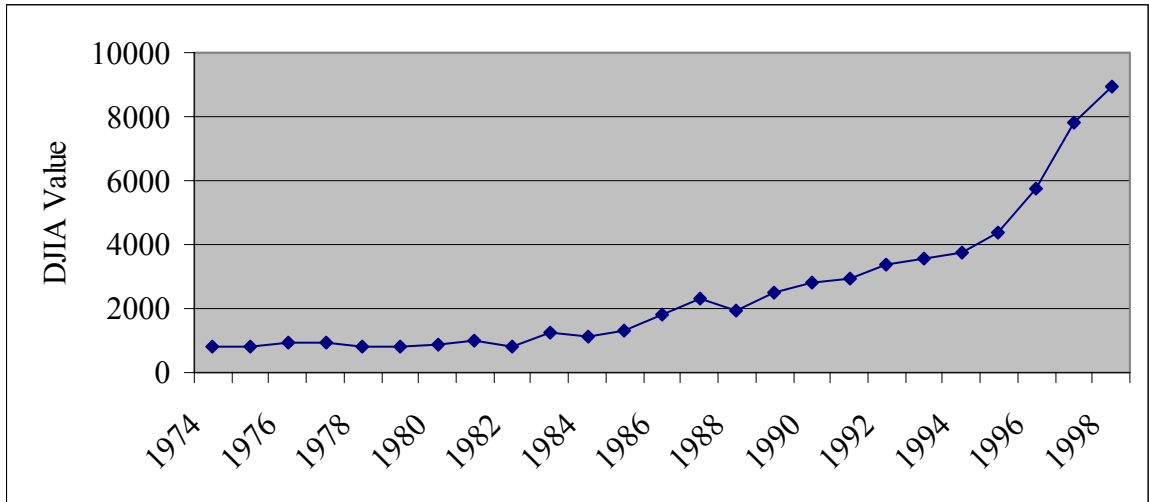
Since 1896 the DJIA attempt to produce a daily measure of stock market performance has enabled us to follow the market’s progress. As shown in annual mid-May values in Figure 1, the action was slow from 1896 to the year before this analysis period, 1973, with growth at a 4 percent annual rate. After this slow start, Figure 2 shows that the average annual rate of increase for the period for this analysis, 1974 to 1998, was more than twice as high, over 10 percent per year.

**Figure 1. Historical Activity of the Dow Jones Industrial Average, 1896-2002**



Source: Dow Jones Indexes 2003

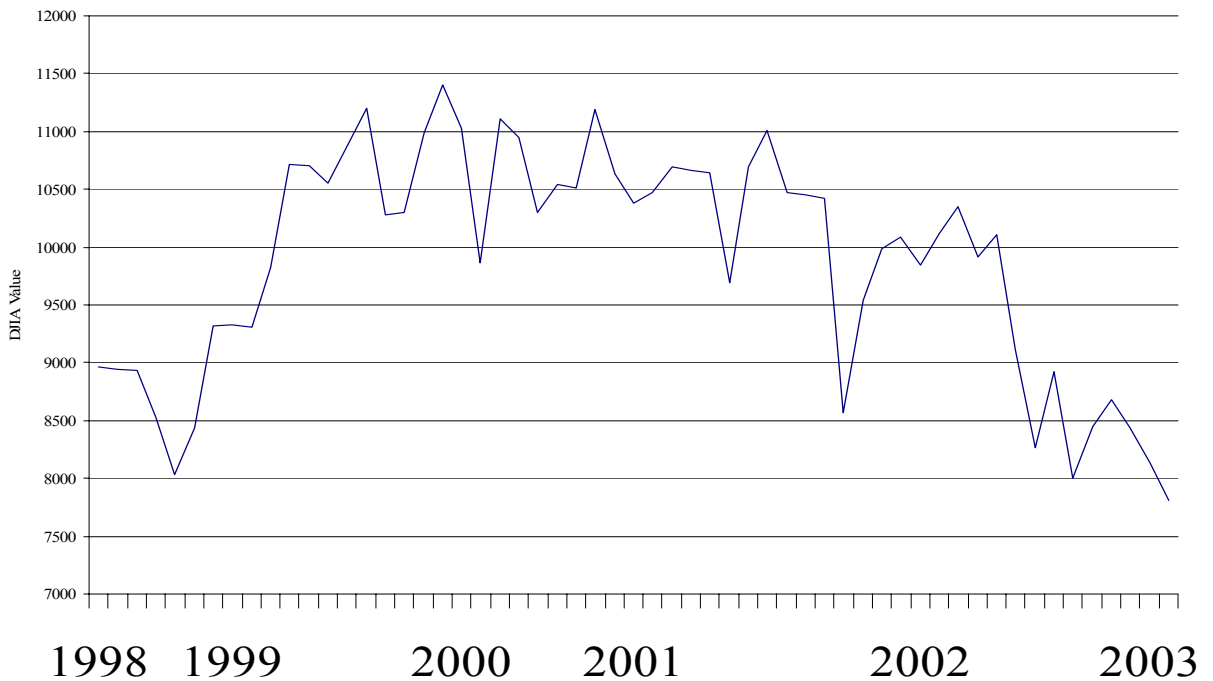
**Figure 2. Activity of the Dow Jones Industrial Average, 1974 to 1998**



Source: Dow Jones Indexes 2003

The post-analysis period, mid-1998 to the present, has presented a more volatile picture, as shown in the monthly values in Figure 3. From mid-1998 to the time of the final edit of this paper in May of 2003, the daily values for the DJIA have ranged from a high of 11723 in January of 2000 to a low of 7286 in October of 2002. Yes, for so many of us, it has been a sometimes wild but always compelling ride.

**Figure 3. Activity of the Dow Jones Industrial Average, 1998 to 2003**



Source: Dow Jones Indexes 2003

## **Construction of the Energy Indicator**

First, the data. Always. The time frame for this analysis, 1974 to 1998, was chosen on the basis of manufacturing energy data availability. The Energy Information Administration (EIA) has published derived estimates of manufacturing energy consumption back to 1974 (Energy Information Administration 1992), and their latest Manufacturing Energy Consumption Survey results are for energy consumption in 1998 (Energy Information Administration 2003). While the industrial sector also includes agriculture, forestry and fisheries, mining, and construction in addition to manufacturing, this paper will concentrate on manufacturing because of data availability.

The industry-specific manufacturing energy use was divided by industry value-added data from the Annual Survey of Manufactures (United States Department of Commerce 1976 and 2000) to create an energy intensity measure. These industry intensity measures were then weighted by the DJIA price weights for firms in those industries to produce a price-weighted average energy intensity indicator. The days of the year chosen for the analysis were the trading days closest to the anniversary of the DJIA, May 24, 1974 and May 26, 1998.

### **Limitations of the Indicator**

There are several limitations to this methodology, primarily based on data availability. Because of confidential business information, energy intensities are calculated at the industry level, not at the firm level. Thus, variations in energy intensity among firms in an industry are masked. Further, both manufacturing value added and energy use data apply only to domestic operations.

While many of the DJIA firms are conglomerates engaged in many kinds of businesses, most still identify themselves with one manufacturing business. The industry energy intensity chosen for a given firm is that of the industry associated with that main production of the firm. The more diversified a firm's product line, the less likely it is that the chosen industry energy intensity is truly representative of the firm's total production.

Finally, only the manufacturing firms in the DJIA are included in the analysis, and since the same set of firms were not in existence in the same form from 1974 to 1998 it is impossible to separate the price-weight and component mix effects.

### **Components for DJIA in 1974**

The DJIA average for May 24, 1974 was 816.65, with a Dow divisor of 1.598, leaving the sum of the prices of the Dow Industrials to be 1305. Of the 30 stocks in the DJIA on that day, 26 were largely manufacturing and used in this analysis, with the remaining four italicized in Table 4 below. The prices of these 26 stocks made up 87 percent of the DJIA value.

**Table 4. Composition of the DJIA on May 24, 1974**

Allied Chemical	General Electric	<i>Sears Roebuck &amp; Co.</i>
Aluminum Company of America	General Foods	Standard Oil of Calif.
American Can	General Motors	Standard Oil (N.J.)
<i>American Telephone &amp; Telegraph</i>	Goodyear	Swift & Co.
American Tobacco	International Harvester	Texas Corporation
<i>Anaconda</i>	International Nickel	Union Carbide
Bethlehem Steel	International Paper	United Aircraft
Chrysler	Johns-Manville	U. S. Steel
DuPont	Owen's-Illinois Glass	Westinghouse Electric
Eastman Kodak	Procter & Gamble	<i>Woolworth</i>

**Adding the 1974 Energy Intensities**

Total manufacturing off-site-produced energy consumption for heat and power for 1974 was 13.3 quadrillion BTUs, and manufacturing value added was almost a trillion dollars in \$1998, for an all-manufacturing average energy intensity of 13.8 thousand BTUs per dollar. The unweighted arithmetic average for the 26 industrial DJIA stocks was 32.9 thousand BTUs per dollar. This difference reflects the preponderance of energy-intensive industries represented in the DJIA. When the individual manufacturing industry energy intensities were weighted by their 1974 price shares of the DJIA, the price-weighted energy intensity indicator was 32.4 thousand BTUs per dollar, almost the same as the unweighted arithmetic average.

**Components for DJIA in 1998**

The DJIA average for May 26, 1998 was 8963.718, with a Dow divisor of 0.2508932, leaving the sum of the prices of the Dow Industrials to be 2249. Of the 30 stocks in the DJIA on that day, 22 were largely manufacturing and used in this analysis, with the remaining eight italicized in Table 5 below. The prices of these 22 stocks made up 70 percent of the DJIA value.

**Table 5. Composition of the DJIA on May 26, 1998**

<i>American Telephone &amp; Telegraph</i>	Eastman Kodak	Merck & Company
Allied-Signal	Exxon	Minn. Mining & Manu.
ALCOA	General Electric	<i>Morgan J.P.</i>
<i>American Express</i>	General Motors	Philip Morris Companies
Boeing	Goodyear	Procter & Gamble
Caterpillar	Hewlett-Packard	<i>Sears Roebuck &amp; Co.</i>
Chevron Corp.	International Business Machines	<i>Travelers Group</i>
Coco-Cola	International Paper	Union Carbide
<i>Disney</i>	Johnson & Johnson	United Technologies
DuPont	<i>McDonald's Corp.</i>	<i>Wal-Mart Stores</i>

## Adding the 1998 Energy Intensities

Total manufacturing off-site-produced energy consumption for heat and power for 1998 was 17.7 quadrillion BTUs, and manufacturing value added was almost 1.9 trillion dollars in \$1998, for an all-manufacturing average energy intensity of 9.4 thousand BTUs per dollar. The unweighted arithmetic average for the 22 industrial DJIA stocks was 19 thousand BTUs per dollar, again reflecting the preponderance of energy-intensive industries represented in the DJIA.

When the individual manufacturing industry energy intensities were weighted by their 1998 price shares of the DJIA, the price-weighted energy intensity indicator was 19.6.

## Decomposition of the Intensity Difference

At the same time that the price-weighted manufacturing portion of the DJIA fell from 87 to 70 percent, the price-weighted manufacturing energy intensity indicator fell from 32.4 to 19.6 thousand BTUs per dollar. Energy intensity differences are usually a function of energy efficiency changes, structural changes, and interactions between the two (Roop 1989). The drop of 12.8 in this energy indicator is a function of many factors, including changes in energy efficiency, the price-weights and composition of the DJIA, and changes of products within firms and industries. Keeping price-weights and composition of the DJIA constant but varying the energy efficiencies between the 1974 and 1998 values permits a rough approximation of the those two main component effects.

**Table 6. Calculation Results of DJIA-Related Energy Intensity Indicator**

	<b>Calculated with 1974 Intensities</b>	<b>Calculated with 1998 Intensities</b>
<b>1974 Composition &amp; Price Weights</b>	<b>32.4</b>	
<b>1998 Composition &amp; Price Weights</b>		<b>19.6</b>

## Change Attributable Mainly to Energy Efficiency

As shown in Table 7, if the 1974 composition mix weighted by 1974 prices had been produced with 1998 intensities, the constructed manufacturing energy intensity indicator for the DJIA industries would have been 25.4. Since the only difference between this combination of price weights-composition-intensity and the combination used to compute the 1974 indicator value of 32.4 is the difference in intensity, the difference between the 25.4 thousand BTUs per dollar and the 1974 value of 32.4 thousand BTUs per dollar, or 7, is largely attributable to energy efficiency change. Also included in this component of the total change, however, is any change in energy intensity attributable to changes in the mixes of products within industries.



**Table 7. Components of Changes in DJIA-Related Energy Intensity Indicator**

	<b>Calculated with 1974 Intensities</b>	<b>Calculated with 1998 Intensities</b>
<b>1974 Composition &amp; Price Weights</b>	32.4	<b>25.4</b>
<b>1998 Composition &amp; Price Weights</b>		19.6

### **Change Attributable Mainly to Price Weights and Components**

The constructed indicator value of 25.4 mentioned above reflects the 1974 composition mix weighted by 1974 prices and 1998 industrial energy intensities. The only difference between this mix and the calculated 1998 value of 19.6 is the difference in the composition and price weights. The difference between the 25.4 and the 1998 value of 19.6, or 5.8, is largely attributable to the difference in composition and price weights.

### **Other Components of Total Change**

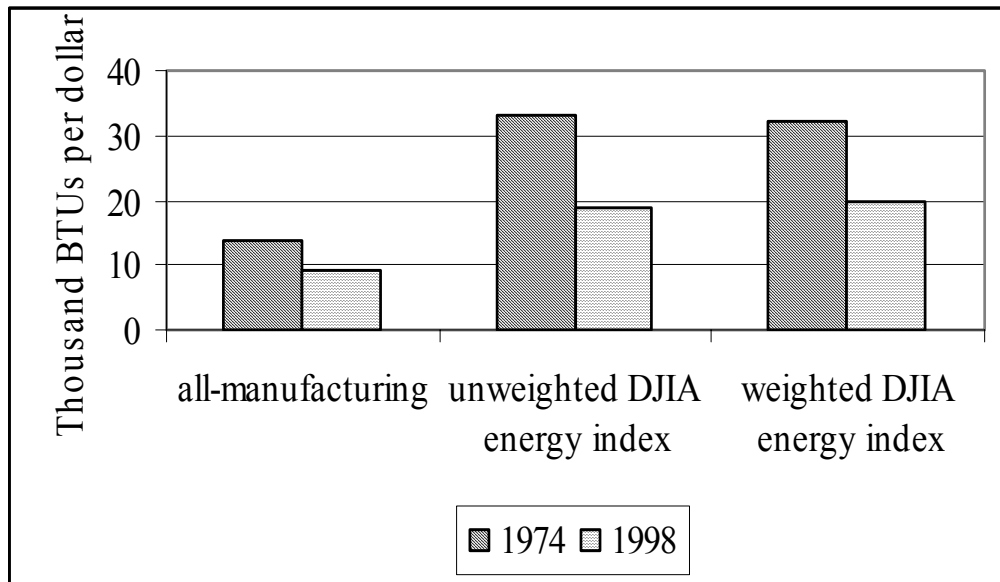
While these two differences, the 7 largely attributable to energy efficiency change and the 5.8 largely attributable to the difference in composition and price weights, total the total difference of 12.8 between the 1974 and 1998 indicator values, it is clear that a lot is going on that is not captured in this component disaggregation of this indicator. As mentioned earlier in the discussion of limitations of the indicator, it cannot capture the effects of changes in firm (as opposed to industry) energy intensity or changes in energy intensity that reflect differences in product mix within a firm or industry.

### **Overall Changes in the Energy Intensity of Manufacturing**

According to EIA, the 1974 derived energy use for off-site-produced energy for heat and power for manufacturing was 13.337 quadrillion BTUs (Energy Information Administration 1992). The 1974 value-added for manufacturing was almost a trillion dollars in \$1998 (Department of Commerce 1976), for an energy intensity ratio of 13.85 thousand BTUs per 1998 dollar. By 1998, total manufacturing off-site-produced energy consumption for heat and power had increased to 17.7 quadrillion BTUs (Energy Information Administration 2003), a 33 percent increase. Manufacturing value added had almost doubled, to almost 1.9 trillion dollars in \$1998 (Department of Commerce 2000), with the all-manufacturing energy intensity decreasing by 32 percent to 9.4 thousand BTUs per dollar.

How do the changes in the constructed DJIA energy indicator compare to the all-manufacturing energy intensity changes? As shown in Figure 4, from 1974 to 1998 the all-manufacturing average energy intensity decreased by 32 percent. The unweighted version of the constructed DJIA energy intensity indicator decreased by 41 percent, and the weighted version by 40 percent. These are not large differences, but they do reflect the relatively high energy intensity of manufacturing industries in the DJIA.

**Figure 4. Intensity Changes Among MECS All-Manufacturing and Constructed Indicators**



## Conclusion

Over the 24 years of the analysis period, 1974 to 1998, the number of manufacturing stocks in the Dow Jones Industrial Average went from 26 to 22, and the percentage of the value of the average attributable to manufacturing dropped from 87 to 70 percent. The DJIA-related energy indicator constructed in this paper fell by 40 percent. This is not unreasonable, since the manufacturing industries in the DJIA were more energy-intensive than average and therefore had greater incentives for energy efficiency improvements.

The decrease in the constructed energy intensity indicator was roughly decomposed into two effects. The effect of improvements in energy efficiency was estimated to account for about 55 percent of the total, and the effect of changes in the price weights and composition of the DJIA was estimated to account for the remaining 45 percent.

The weighting of those energy-intensive industries did decrease somewhat over the period. In 74 the price weights for industries with above average energy intensities totaled 62 percent of the total, compared to 1998's 43 percent.

And how do most analysis papers end? They end with a call for more analysis. Many of the firms represented are conglomerates with varied production lines in different industries that may be anywhere in the world. A more in-depth effort could disaggregate the value-added of each firm to allow the component parts to be associated with more specific industrial energy efficiencies, thereby solving a portion of the mix problem.

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