# BEHAVIOUR OF MONTHLY CHANGES OF DJIA: 1896 to 2008

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***ABSTRACT***
We have explored three types of monthly anomalies in the DJIA for the period 1896 to 2008, and for four subperiods delineated based on structural changes in the economy. The only significant month effect occurred in September (mean of monthly percentage changes being negative and significantly less than for the other eleven months). The mean monthly change of September was negative for the entire data set as well as for each subperiod. However, the negative September effect was significant not in the first three subperiods, rather in the last subperiod, as well as for the entire data set. Two of the subperiods exhibited negative February effect at 3% level. For the entire data set, negative February effect was at a level of significance of 6.6% level. In the third subperiod, positive December effect was significant at 1% level, whereas it was significant at 8.8% level in the last subperiod. The negative September effect does not go away if we delete monthly changes of ±15% and ±10%. We also find that the negative September effect is more a result of the second half of September than first half. The second half of December experienced the highest mean change (1.51%) which was significantly higher than for the other 23 half-month periods, and the standard deviation was significantly lower compared to the other periods. We find the month effect varies with the time period we consider. One would expect the DJIA stocks to be free from seasonal patterns since each one of them are closely followed by a large number of analysts, and the existence of month effect would be surprising. However, given that no consistent pattern is detectable is a reflection of efficiency of the DJIA stocks to a large degree. We will add results from bootstrapping methodology to analyze if the negative September effect is validated by a very large data set.

## INTRODUCTION AND LITERATURE SURVEY

Since the time stock exchanges were first established, traders and investors have exhaustively looked for patterns in stock prices that they could exploit to realize superior returns. However, as early as 1900, Bachelier characterized security prices as being efficient. Over thirty years later came the landmark work by Cowles (1933) in which he documented the inability of forty-five professional agencies to forecast stock prices. The conclusion was that stock prices are random – in general they do not exhibit patterns. This was followed by the researches of Working (1934), Cowles and Jones (1937), Kendall (1953), and Osborne (1959, 1962). They documented that stock and commodity prices behave like a random walk – as if they are independent random drawings. These empirical works were buttressed by the theoretical work by Samuelson (1965) and Mandelbrot (1966). Fama (1965) also contributed to this body of literature which came to be termed the 'random walk hypothesis'. In 1970, Fama came up with the 'efficient markets hypothesis' (EMH).[1] This hypothesis postulates that stock prices reflect all available information; they change in response to new information; since new information by definition cannot be deduced from previous information, new information must be independent over time; if the arrival of new information is random, stock price changes are random, i.e., the changes cannot be anticipated; hence it is not possible to generate risk-adjusted abnormal returns from stocks. Bernstein (1992) provides an overview of the developments of the EMH.

The overall finding is that it is difficult to earn above-average profits by trading on publicly available information because it is already incorporated in securities prices.

However, some researchers have been able to identify profitable opportunities or anomalies that go against the concept of efficient markets. As a result, some academics have denounced the concept. The adherents of the new camp may possibly be increasing. Among the various anomalies discovered, the January effect is possibly the most well-known. It has been documented for financial markets across the globe. The first evidence of returns in January exceeding those of other months comes from Wachtel (1942). After thirty-three years, Officer (1975) presented further evidence followed by Rozeff and Kinney (1976).[2] These findings challenged the concept of efficient markets hypothesis that securities markets reflect all available information and hence it is not possible to garner positive risk-adjusted returns.

Reinganum (1983) has advanced the hypothesis that January experiences rebound in stock prices after tax-loss selling that is undertaken in December. The hypothesis is that before the end of the tax year, people sell stocks that have declined in price during the previous months so they may realize the capital losses; these investors put back the proceeds into the market in January; the higher demand for stocks push stock prices up creating the January effect. Reinganum found that within firm size classes, firms for which price decline was more pronounced had larger January returns. Ritter (1988) has documented that the ratio of stock purchases to sales of individual investors hits an annual low at the end of December and an annual high at the beginning of January.

Haugen and Lakonishok (1988) have advanced the hypothesis that the January effect is a result of simultaneous reentry into aggressive investment strategy by professional fund managers who have parked money in their performance benchmarks so as to lock in their investment performance during the previous year.

A major finding that comes out of the researches is the size effect: small-capitalization firms earn higher returns than large-capitalization firms. Banz (1981) and Reinganum (1981) were the first researchers to discover the small-firm effect. Their finding was supported by Brown, Keim, Kelidon and Marsh (1983), Kato and Schallheim (1985), Fama and French (1992), Berk (1995), Baker and Limmack (1998), and Garza-Gromez, Hodoshima and Kunimura (1998). Keim (1983), Reinganum (1983), Blume and Stambaugh (1983) and Roll (1983) find that majority of the return of small-capitalization stocks occurs in January -- in the first two weeks of the month. This phenomenon came to be known as the small-firm-in-January effect. Keim found that small firms outperformed large firms in every year from 1963 to 1979.

[1] In economics, Muth (1961) developed this hypothesis independently which was termed rational expectations hypothesis.

[2] Wachtel introduced the concept of January effect in 1942, but Rozeff and Kinney's article in the widely respected Journal of Financial Economics was the first evidence of January effect that attracted widespread attention.

It has been argued that the January effect is most pronounced for the smaller firms because the small firms are more volatile and more prone to price declines and hence more subject to tax-loss selling.

Arbel and Strebel (1983) found that the January effect was largest for firms neglected by institutional investors. This was termed the neglected-firm effect. The hypothesis is that small firms tend to be neglected by large institutional traders; this causes information deficiency which makes them riskier prompting investors to require higher returns.

Haugen and Jorion (1996) use center for Research in Security Prices data for the stocks in New York Stock Exchange form 1926 to 1993 and find that for smaller stocks January returns are significantly larger than for other months. This work also indicates, as well as work by Riepe (1998, 2001) that excess returns in January may be declining in latter years.

Agrawal and Tandon (1994) find for nineteen countries covering data for 1970’s and 1980’s that the mean January returns are high – significantly high for eleven countries. Hawawini and Keim (2000) survey international findings and show that the high returns for January relative to other months, if used as explanatory variable, better accounts for cross-sectional returns of stocks than the CAPM beta or some other data-driven models proposed in recent times.

We intend to contribute to this growing literature by exploring month effect in the Dow Jones Industrial Average – the most popular stock index in the world. The stocks in the DJIA being among the most closely followed should render them efficiently priced. Hence, one would not expect anomalies like month effect to be exhibited by the DJIA.

An earlier work using the same index is by Lakonishok and Smidt (1988). It uses data from 1897 to 1986. Not only do we use a longer data set, but we also use different statistical tests to analyze month effect. Lakonishok and Smidt’s primary concern is to explore anomalies in returns around the turn of the week, around the turn of the month, around the turn of the year, and around holidays. They do not rigorously explore month effects as we do. They test if the means of monthly percentage changes are significantly different from zero and also do a sign test on the percentage of positive returns. We explore month effect from May 1896 to December 2008 from two perspectives: (a) for a given period, if the mean of monthly percentage changes of each month was different from zero, and (b) for a given period, if the mean of monthly percentage changes for a month was different from the means of all the other months. We also explore month effect over four subperiods during which the economy underwent structural changes over the last century. For the entire data set of 1,348 months, January mean return was the fourth highest after July, August and December. This finding is similar to that of Lakonishok and Smidt who used data from 1897 to 1986. These findings reinforce the conclusions that the January effect is pronounced in the case of small firms and not in the case of large firms.

The next section describes the methodology used, description of data and descriptive statistics, analysis of results, and finally we summarize and conclude.

## RESEARCH METHODOLOGY

Our data consists of the percentage changes in the monthly closing values of the Dow Jones Industrial Average (DJIA) from May 1896 until December 2008. The DJIA is stock-price weighted and hence does not include dividends. It may seem that analysis of month effect will be affected by the omission of dividends. Lakonishok and Smidt (1988) find that this omission does not seem to affect their results with respect to month effect. Hence we do not include dividends.

In addition to analyzing the data for the entire period (May 1896 to December 2008), we divide the entire period into the following subperiods to gain deeper insight into the performance of DJIA:

- 1896 to 1928 (which includes the World War I);
- 1929 to 1945 (Great Depression years, and World War II);
- 1946 to 1972 (which includes the stable period after World War II and the Breton Woods fixed exchange rate era, and the break down of that era in 1972);

- 1973 to 2008 (which includes the volatile world we have lived in since the first oil crisis of 1973).

We hope to show that the month effect is sensitive to the time period under study.

We present distribution of the monthly percentage changes and test for normality through the Jarques-Bera statistic. This widely used statistics is based on the values of skewness and kurtosis of sample data. For large n, with skewness S and kurtosis K under the normality condition, the Jarques-Bera statistic $= \frac{n}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$ follows a Chi-square distribution with 2 degrees of freedom.

Many studies have used the dummy variable methodology to detect market seasonality. Chien, Lee and Wang (2002) provide statistical analysis and empirical evidence that the methodology may provide misleading results. We avoid this methodology.

We study the month effect in terms of monthly percentage changes in three different ways:

1. If the mean of monthly percentage changes is different from zero for the sample as well as for each month within the sample. We subject the mean percentage change for a given month *i* to the following hypothesis test: $H_o$: $\mu_i = 0$ vs. $H_o$: $\mu_i \neq 0$. Unless otherwise stated, significance in all cases is tested at 5% level.
2. If the means of the monthly percentage changes for a month is different from the other eleven months. We conduct the following hypothesis test for a given month *i*: $H_o$: $\mu_i = \mu_j$ vs. $H_o$: $\mu_i \neq \mu_j$, where j = {1, 2, …, i-1, i+1, ,,,, , 11, 12}. Since we found the variances for the periods i and j to be unequal in many cases, we decided to use the more conservative t-test assuming unequal variances.
3. If the variability of the percentage changes for a given month is significantly different from the remaining eleven months. We conduct the following hypothesis test for a given month *i*: $H_o$: $\sigma_i^2 = \sigma_j^2$ vs. $H_o$: $\sigma_i^2 \neq \sigma_j^2$, where j = {1, 2, …, i-1, i+1, ,,,, , 11, 12}.

In addition to standard t-test which assumes normal distribution of the data, we also use Kruskal-Wallis non-parametric test which tests for differences among several population medians, and does not depend on normal distribution of data. We also use Mood’s Median Test which performs a nonparametric analysis of a one-way layout. It is highly robust against outliers and errors in data. Further, we use Mann-Whitney test which performs a two-sample rank test for the difference between two population medians.

## THE DATA AND DESCRIPTIVE STATISTICS

The data consists of 1,348 end-of-month DJIA values and hence 1,347 values of monthly percentage changes. Data for August through November of 1914 is not included in the data set as the stock market was closed because of the First World War.

Over this period, the value of DJIA increased from 40.63 at the end of May 1896 to 8,776.39 at the end of December 2008 a 21,601% increase – with an average percentage change of 0.55% per month or 6.60% per year. The mean monthly percentage change in the DJIA for the total period is highly significant (p = 0.00). The standard deviation of the monthly percentage changes was 5.45% or 18.88% annualized, which is close to the 20.50% standard deviation of the annual returns of the S&P 500 Index for the period 1926 to 2005. The summary statistics of the monthly percentage changes for period 1896 to 2008 are given in Table 1.

**Table 1: Monthly Percentage Change in DJIA: 1896-2008**

| Monthly Percentage Change in DJIA 1896-2008 | |
|---|---|
| Observations | 1347 |
| Mean | 0.55 |
| Median | 0.83 |
| Minimum | -30.70 |
| Maximum | 40.18 |
| Standard Deviation | 5.45 |
| Skewness | -0.05 |
| Kurtosis | 5.86 |

As we can see in the histogram below of the monthly percentage changes in the DJIA for the entire period, the distribution is slightly skewed to the left as the mean of 0.55% is smaller than the median of 0.83% per month. The skewness equals –0.05 and the kurtosis equals 5.86. The Jarque-Bera statistic equals 459.91 for p-value of less than 0.01. Since the p-value is less than 0.05, the normality assumption is violated. When sample size is large, as is in our case, even unimportant deviations from normality become technically significant. For this reason, we need to use other bases of judgment such as histogram. If we examine, the histogram in Figure 1, the distribution appears quite normal in shape. Assuming normal distribution, the probability that DJIA would increase in any month is 54.01% and the probability for the decrease is 45.99%

**Figure 1: Histogram of % change of DJIA: 1896-2008**

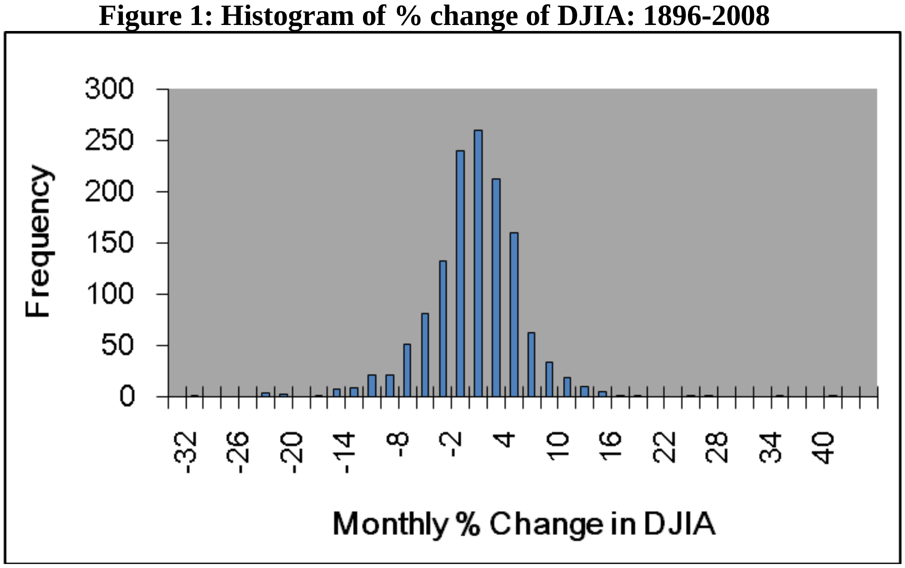



Table 2 shows the frequency of monthly increases every decade that were more than 10% and Table 3 shows the frequency of monthly decreases that were larger than -10%.

**Table 2: Monthly Increases Larger than 10%: 1896 to 2005**

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1896-1928 | | | 4 | 1 | 2 | 1 | 1 | 3 | 3 | | 3 | 1 | 19 |
| 1929-1945 | | 1 | | 2 | 1 | 4 | 1 | 2 | 1 | | 2 | | 14 |
| 1946-1972 | | | | | | | | 1 | | | | | 1 |
| 1973-2008 | 3 | | | 2 | | | | 1 | | 2 | | | 8 |
| Total | 3 | 1 | 4 | 5 | 3 | 5 | 2 | 7 | 4 | 2 | 5 | 1 | 42 |

**Table 3: Monthly Decreases Larger than 10%: 1896 to 2008**

| Period | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1896-1928 | | 1 | 1 | | 1 | 1 | 3 | | 2 | 2 | 2 | 3 | 16 |
| 1929-1945 | | 1 | 3 | 2 | 3 | 1 | | | 3 | 4 | 3 | 2 | 22 |
| 1946-1972 | | | | | | | | | | | | | 0 |
| 1973-2008 | | | | | | 1 | | 3 | 3 | 2 | 1 | | 10 |
| Total | 0 | 2 | 4 | 2 | 4 | 3 | 3 | 3 | 8 | 8 | 6 | 5 | 48 |

There were a total of 90 such instances from 1896 to 2008. Of those, 35 occurred during 1896-1928 (in 32 ½ years), 36 occurred during 1929-1945 (in 17 years), just one occurred during 1946-1972 period and the remaining 18 occurred during 1973-2008. Over the entire period, August experienced 7 increases larger than 10% followed by 5 each in April, June and November. Over the entire period, September and October have suffered 8 decreases larger than 10%, followed by November with 6 decreases, and December with 5 decreases.

Looking at individual values of the monthly percentage changes, the DJIA increased by as much as 40.18% during April 1933 and declined by as much as 30.70% in September 1931 (Table 4). In the post-Second World War period, the biggest increase was 14.41% in January 1976 and the biggest decline was 23.22% in October 1987 (the month that included "Black Monday").

## ANALYSIS OF RESULTS

### 1896 to 2008

The months with significant mean percentage increases in the DJIA are August with 1.26%, followed by July with 1.25%, December with 1.17% and January with 1.05% (Table 4).

**Table 4: Monthly Percentage Change in DJIA from 1896-2008**

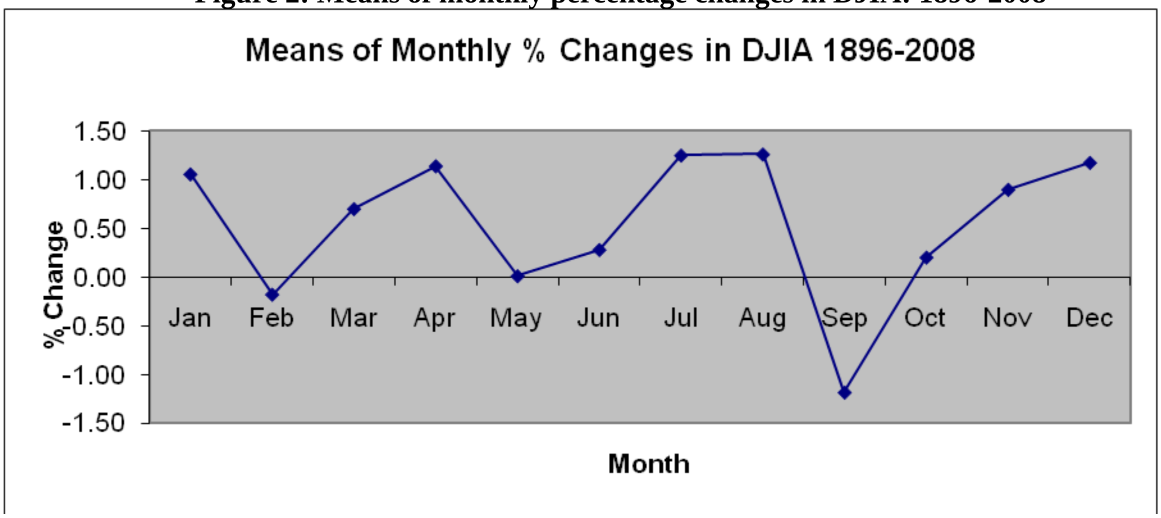
| Period 1896-2008 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 1347 | 112 | 112 | 112 | 112 | 112 | 113 | 113 | 112 | 112 | 112 | 112 | 113 |
| Mean | 0.55 | 1.05 | -0.18 | 0.70 | 1.14 | 0.01 | 0.28 | 1.25 | 1.26 | -1.19 | 0.20 | 0.90 | 1.17 |
| Median | 0.83 | 1.01 | 0.02 | 1.19 | 0.85 | 0.21 | -0.03 | 1.15 | 1.43 | -0.72 | 0.76 | 1.11 | 1.79 |
| Minimum | -30.70 | -8.64 | -15.62 | -23.67 | -23.43 | -21.70 | -17.72 | -14.08 | -15.13 | -30.70 | -23.22 | -14.04 | -23.58 |
| Maximum | 40.18 | 14.41 | 13.20 | 12.59 | 40.18 | 14.65 | 24.26 | 26.66 | 34.83 | 13.49 | 10.65 | 16.35 | 10.78 |
| Standard Deviation | 5.45 | 4.52 | 4.06 | 5.11 | 6.39 | 5.45 | 5.42 | 5.46 | 5.89 | 6.02 | 5.97 | 5.69 | 4.68 |
| p-value (m=0) | 0.000 | 0.015 | 0.638 | 0.151 | 0.062 | 0.987 | 0.586 | 0.017 | 0.026 | 0.039 | 0.723 | 0.098 | 0.009 |
| p-value (t test) | | 0.228 | 0.057 | 0.750 | 0.305 | 0.275 | 0.579 | 0.158 | 0.183 | 0.002 | 0.515 | 0.500 | 0.148 |
| p-value (F test) | | 0.004 | 0.000 | 0.169 | 0.009 | 0.514 | 0.474 | 0.503 | 0.124 | 0.062 | 0.092 | 0.273 | 0.013 |
| Mean % Change | Positive | Positive | | | | | | Positive | Positive | Negative | | | Positive |
| Month Effect (Mean) | | | | | | | | | | Lower | | | |
| Month Effect (Var) | | Lower | Lower | | Higher | | | | | | | | Lower |

Note: "Positive" implies the mean of monthly percentage changes was significantly greater than zero; "Negative" implies the mean of monthly percentage changes was significantly less than zero; "Higher" implies the mean or the variance of the monthly percentage changes of a month was significantly higher than those of the other months; "Lower" implies the mean or the variance of the monthly percentage changes of a month was significantly lower than those of the other months

The two-month periods July and August have experienced the most mean percentage increases of any two consecutive months. September experienced the most negative mean percentage change (-1.19%), which is significant at 4% level, and also significantly lower than the rest of the year. The variances of January, February and December are lower than those of the other months (the standard deviation of monthly changes of all three are below 5%); April's variance is higher than those of the other months (corresponds to its widest range between maximum and minimum monthly changes.)

The cyclicity of the means of monthly percentage changes for the entire period are clearly portrayed in Figure 2. On average, there has been a big drop from August to September and then an increasing trend until December. For short-term traders, on average August is the month for short selling DJIA stocks, and September is the month to close the position. On average, a short-term trader stands to gain significantly by buying at the end of September, and selling at the end of December.

**Figure 2: Means of monthly percentage changes in DJIA: 1896-2008**




Kruskal-Wallis test of difference in medians (Table 5) of monthly changes shows significant difference in the medians (H-statistic = 29.37; p = 0.002). December has the highest median followed by July and August. September has the lowest (negative) median.

**Table 5: Results of Kruskal-Wallis Test of Difference in Monthly Medians: 1896-2005**

| Month | # of Obs | Median | Average Rank | Z Value | Rank |
|---|---|---|---|---|---|
| 1 | 109 | 1.00009 | 685.6 | 0.85 | 6 |
| 2 | 109 | 0.06867 | 579.4 | -2.21 | 11 |
| 3 | 109 | 1.28293 | 676.9 | 0.60 | 4 |
| 4 | 109 | 0.50305 | 662.8 | 0.19 | 8 |
| 5 | 109 | 0.22787 | 622.0 | -0.98 | 9 |
| 6 | 110 | 0.06920 | 616.0 | -1.16 | 10 |
| 7 | 110 | 1.75596 | 712.0 | 1.62 | 2 |
| 8 | 109 | 1.41258 | 691.0 | 1.01 | 3 |
| 9 | 109 | -0.76041 | 531.3 | -3.59 | 12 |
| 10 | 109 | 0.78808 | 660.8 | 0.14 | 7 |
| 11 | 109 | 1.15106 | 691.6 | 1.02 | 5 |
| 12 | 110 | 1.84837 | 741.7 | 2.48 | 1 |
| Overall | 1311 | | 656.0 | | |

Similarly, Mood's Median test also shows significant difference in the medians of the twelve months (Chisquare = 26.21; p = 0.01).[3] So the negative September effect is also supported by nonparametric test.

**1896 to 1928**

Table 6 shows the mean change of 0.68% per month for 1896 to 1928 is significantly different from zero.

**Table 6: Monthly Percentage Change in DJIA from 1896-1928**

| Period 1896-1928 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 387 | 32 | 32 | 32 | 32 | 32 | 33 | 33 | 32 | 32 | 32 | 32 | 33 |
| Mean | 0.68 | 0.70 | -0.93 | 1.86 | 0.37 | 0.65 | -0.46 | 1.00 | 2.46 | -0.59 | 0.81 | 1.64 | 0.62 |
| Median | 0.74 | 0.48 | -0.99 | 2.82 | 0.34 | 0.05 | -0.23 | 2.35 | 2.59 | -0.30 | 0.93 | 1.05 | 2.26 |
| Minimum | -23.58 | -8.64 | -12.05 | -11.48 | -9.02 | -11.99 | -11.03 | -14.08 | -9.10 | -13.89 | -14.80 | -12.88 | -23.58 |
| Maximum | 18.00 | 7.29 | 6.64 | 12.59 | 18.00 | 14.65 | 10.50 | 10.68 | 14.47 | 12.76 | 9.65 | 16.35 | 10.78 |
| Standard Deviation | 5.60 | 4.15 | 3.98 | 5.98 | 5.12 | 5.71 | 5.18 | 6.16 | 5.20 | 6.33 | 5.72 | 6.51 | 6.45 |
| p-value ($\mu$=0) | 0.018 | 0.344 | 0.194 | 0.089 | 0.688 | 0.523 | 0.617 | 0.355 | 0.012 | 0.600 | 0.429 | 0.163 | 0.587 |
| p-value (t test) | | 0.969 | 0.027 | 0.248 | 0.725 | 0.980 | 0.201 | 0.748 | 0.051 | 0.240 | 0.890 | 0.380 | 0.955 |
| p-value (F test) | | 0.016 | 0.008 | 0.325 | 0.256 | 0.472 | 0.288 | 0.247 | 0.311 | 0.184 | 0.470 | 0.133 | 0.145 |
| Mean % Change | Positive | | | | | | | | Positive | | | | |
| Month Effect (Mean) | | | Lower | | | | | | | | | | |
| Month Effect (Var) | | Lower | Lower | | | | | | | | | | |

Note: See "Notes" below Table 4.

The means of month-wise changes show significant positive mean for only August (2.46%) – which is significant at 1% level – but it is significantly different from the mean changes of the other months at 5.1% level. The mean monthly change of February (-0.93%) is significantly lower than the mean changes of the other 11 months at 3% level. On average, there is a rebound in March (mean monthly change is 1.86%). As we found for the entire sample, we find for this subperiod also we find January and February exhibited variances of monthly changes which were lower than the variances of the other months. The standard deviation was highest for September (6.33%), but not significantly different than for other months.

**1929 to 1945**

Table 7 shows the mean monthly change for the second subperiod (0.16%) is not significantly different from zero. This was the result of the turmoil of the Depression years, and might have been also caused by the Second World War. June, July and August generated mean changes between 2.78% and 4.05%, and for five months, the mean changes were negative. But none of them were significantly greater than zero at 5% level. Only the mean of August (4.05%) was significantly different from zero at 9% level. It was different from the mean changes of the other months at 8% level.

[3] Output is not shown for brevity.

**Table 7: Percentage Change in DJIA from 1929-1945**

| Period 1929-1945 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 204 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Mean | 0.16 | 1.01 | 1.10 | -2.68 | 0.23 | -1.81 | 3.73 | 2.78 | 4.05 | -2.81 | -1.98 | -1.77 | 0.01 |
| Median | 0.84 | 1.11 | 0.84 | -1.53 | -1.88 | 0.25 | 3.31 | 3.50 | 1.32 | -0.18 | -0.14 | -1.26 | 1.25 |
| Minimum | -30.70 | -7.11 | -15.62 | -23.67 | -23.43 | -21.70 | -17.72 | -9.85 | -6.18 | -30.70 | -20.36 | -12.64 | -17.01 |
| Maximum | 40.18 | 7.51 | 13.20 | 7.80 | 40.18 | 13.46 | 24.26 | 26.66 | 34.83 | 13.49 | 9.13 | 11.32 | 6.35 |
| Standard Deviation | 8.62 | 4.25 | 5.87 | 7.64 | 13.14 | 9.67 | 9.50 | 8.58 | 9.20 | 9.94 | 8.25 | 6.85 | 5.85 |
| p-value ($\mu$=0) | 0.797 | 0.340 | 0.451 | 0.167 | 0.942 | 0.450 | 0.125 | 0.201 | 0.088 | 0.261 | 0.338 | 0.301 | 0.993 |
| p-value (t test) | | 0.448 | 0.516 | 0.130 | 0.979 | 0.388 | 0.120 | 0.204 | 0.083 | 0.211 | 0.282 | 0.250 | 0.921 |
| p-value (F test) | | 0.001 | 0.031 | 0.287 | 0.015 | 0.291 | 0.315 | 0.536 | 0.378 | 0.235 | 0.441 | 0.127 | 0.029 |
| Mean % Change | | | | | | | | | | | | | |
| Month Effect (Mean) | | | | | | | | | | | | | |
| Month Effect (Var) | | Lower | Lower | | Higher | | | | | | | | Lower |

Note: See “Notes” below Table 4.

The variance effect is exactly similar to what we found for the entire data: lower variances for January, February and December, and higher variance for April compared to the other months. But the standard deviations for different months ranged from 4.25% (January) to 13.14% (April), compared to 4.10% (February) to 6.10% (September) for the entire period.

## 1946 to 1972

The mean monthly change of the third subperiod (0.58% -- which equals the mean monthly change for the entire data) was significantly different from zero at 0.00% level (Table 8). The mean monthly change of March (1.40%), July (1.53%) and December (2.11%) were significantly different from zero. The mean changes of three months were negative of which the mean changes of February (-0.64%) and June (-0.81%) were significantly lower than the means of other months at 5% level. The mean change of December was significantly higher than those of the other months.

**Table 8: Percentage Change in DJIA from 1946-1972**

| Period 1946-1972 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 324 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| Mean | 0.58 | 0.75 | -0.64 | 1.40 | 1.36 | -0.45 | -0.81 | 1.53 | 0.18 | -0.58 | 0.60 | 1.50 | 2.11 |
| Median | 1.03 | 1.34 | 0.07 | 1.55 | 1.87 | -0.19 | -0.67 | 1.93 | 1.12 | -0.76 | 0.39 | 1.15 | 2.90 |
| Minimum | -9.24 | -8.35 | -7.12 | -2.85 | -6.30 | -7.81 | -8.49 | -6.61 | -6.96 | -8.86 | -5.43 | -9.24 | -4.20 |
| Maximum | 10.09 | 8.17 | 4.51 | 5.92 | 8.51 | 5.67 | 6.24 | 7.40 | 4.87 | 7.34 | 5.79 | 10.09 | 7.08 |
| Standard Deviation | 3.57 | 4.17 | 2.78 | 2.39 | 3.66 | 3.62 | 3.61 | 3.79 | 3.44 | 4.05 | 3.05 | 4.14 | 2.71 |
| p-value ($\mu$=0) | 0.004 | 0.358 | 0.241 | 0.005 | 0.065 | 0.522 | 0.255 | 0.045 | 0.793 | 0.466 | 0.314 | 0.070 | 0.000 |
| p-value (t test) | | 0.822 | 0.027 | 0.086 | 0.258 | 0.132 | 0.045 | 0.180 | 0.530 | 0.128 | 0.969 | 0.230 | 0.005 |
| p-value (F test) | | 0.149 | 0.054 | 0.006 | 0.459 | 0.487 | 0.483 | 0.359 | 0.416 | 0.194 | 0.145 | 0.160 | 0.039 |
| Mean % Change | Positive | | | Positive | | | | Positive | | | | | Positive |
| Month Effect (Mean) | | | Lower | | | | Lower | | | | | | Higher |
| Month Effect (Var) | | | | Lower | | | | | | | | | Lower |

Note: See “Notes” below Table 4.

But the variance of December was significantly lower than for other months; so was the variance of March. Standard deviations of monthly changes were greatly subdued during this period of fixed exchange rate system ranging from 2.39% (March) to 4.17% (January). The lull in the aftermath of the Second World War, massive international reconstruction efforts, and the Breton Woods fixed exchange rate system brought a stabilizing influence in the DJIA.

**1973 to 2008**

As Table 9 shows, the mean monthly change of the last subperiod (0.60%) was significantly different from zero at 1% level, and higher than for the previous subperiod. The mean monthly change of April (2.09%) and December (1.53%) were significantly higher than zero. Whereas in the previous period four months suffered negative mean monthly changes, in this subperiod it was two months: August (-0.32% -- not significant), and September (-1.41%) which was significantly different from zero at 6.9% level, and significantly different from the mean changes of the other months at 1% level. The mean changes of April and December are different from the other months at 3% level and 7% level.

**Table 9: Percentage Change in DJIA from 1973-2008**

| Period 1973-2008 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 432 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Mean | 0.60 | 1.61 | 0.23 | 0.74 | 2.09 | 0.64 | 0.14 | 0.54 | -0.32 | -1.41 | 0.38 | 1.04 | 1.53 |
| Median | 0.70 | 0.97 | 0.75 | 1.19 | 1.05 | 0.31 | 0.17 | 0.28 | 0.54 | -1.14 | 0.65 | 1.66 | 1.41 |
| Minimum | -23.22 | -7.37 | -7.42 | -8.97 | -4.40 | -5.63 | -10.19 | -6.20 | -15.13 | -12.37 | -23.22 | -14.04 | -6.23 |
| Maximum | 14.41 | 14.41 | 8.79 | 7.84 | 10.56 | 8.28 | 5.61 | 9.04 | 11.47 | 6.71 | 10.65 | 8.56 | 9.47 |
| Standard Deviation | 4.48 | 5.29 | 3.87 | 3.61 | 3.96 | 3.21 | 3.36 | 3.83 | 5.49 | 4.50 | 6.57 | 5.16 | 3.02 |
| p-value (m=0) | 0.006 | 0.076 | 0.724 | 0.227 | 0.003 | 0.238 | 0.808 | 0.407 | 0.732 | 0.069 | 0.728 | 0.236 | 0.005 |
| p-value (t test) | | 0.232 | 0.557 | 0.815 | 0.025 | 0.937 | 0.407 | 0.918 | 0.295 | 0.008 | 0.833 | 0.595 | 0.074 |
| p-value (F test) | | 0.091 | 0.128 | 0.046 | 0.178 | 0.006 | 0.014 | 0.112 | 0.050 | 0.481 | 0.001 | 0.132 | 0.002 |
| Mean % Change | Positive | | | | Positive | | | | | | | | Positive |
| Month Effect (Mean) | | | | | Higher | | | | | Lower | | | |
| Month Effect (Var) | | | | Lower | | Lower | Lower | | | | Higher | | Lower |

Note: See “Notes” below Table 4.

The standard deviation for this subperiod (4.48%) was higher than that of the previous subperiod (3.57%). This may be attributable to the breakdown of the Breton Woods system, as well the effect of great volatility in oil prices, commodity prices, interest rates, and technological innovations which caused greater and speedier information flows. It is also partly attributable to the ‘dot-com’ mania, the stock market bubble, and the subsequent burst, which affected smaller stocks more than it affected larger stocks. March, May, June and December saw lower variances, and October exhibited higher variances compared to the other months. So for three subsequent subperiods December saw lower variances compared to the other months. It appears from the positive mean changes for December (specially for the last two subperiods) there was less end-of-year selling of DJIA stocks which are large and stable. The other aspect to note is that only in the last subperiod October saw highest standard deviation of monthly changes (6.57%). The highest standard deviation of monthly changes that a month went through was in April during 1929 to 1945 (13.14%).

The month effect for the various sub-periods in terms of mean of a month being different from the means of the other months shows the following patterns:

1896-2008: Positive December (p=0.01), Negative September (p = 0.002) and February (p = 0.06)

1896-1928: Positive August (p = 0.051), and negative February (p = 0.03)

1929-1945: mean change of none of the months is significantly different from those of the other months even at 10% level

1946-1972: Positive December (p = 0.01), negative February (p = 0.03) and June (p = 0.05)

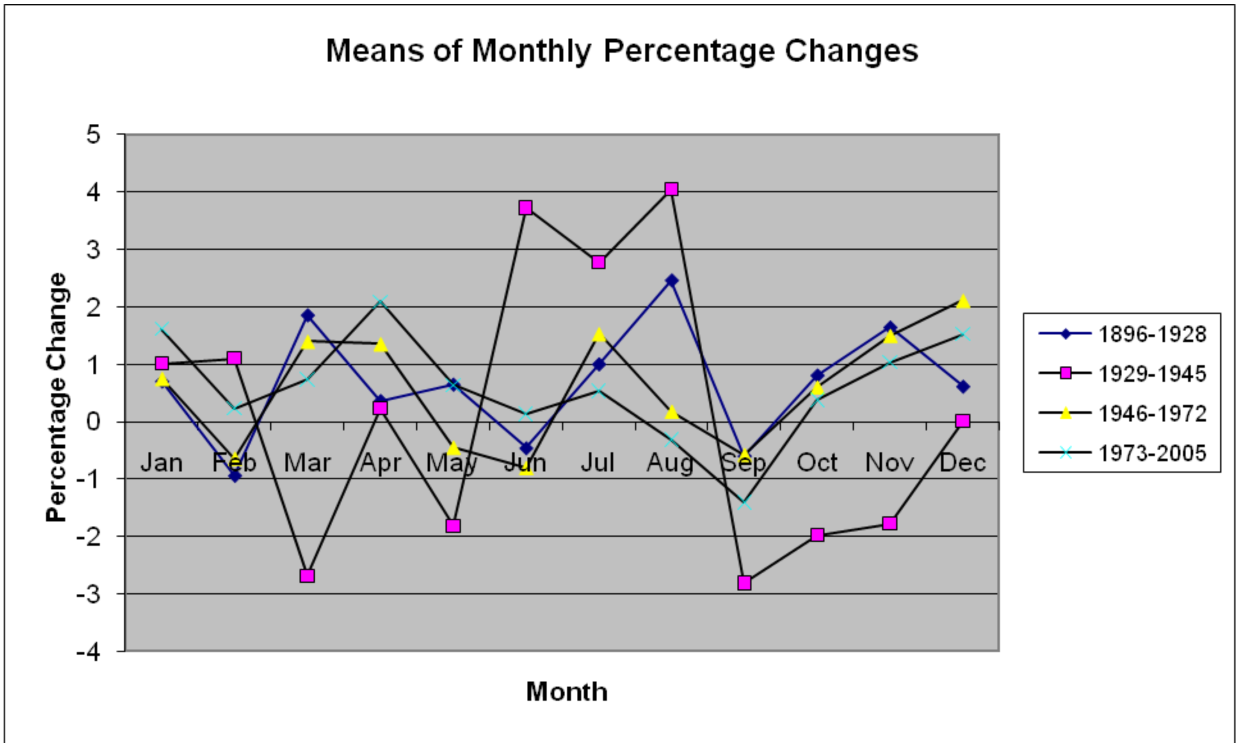
1973-2008: Positive April (p=0.03) and December (p=0.07), and negative September (p = 0.01)

The mean monthly change of September was negative for the entire period as well as for each subperiod. However, the negative September effect was significant not in the first three subperiods, rather in the last subperiod, as well as for the entire period. Two of the subperiods exhibited negative February effect at 3% level. For the entire period, negative February effect was at a level of significance of 6.1% level. In the third subperiod, positive December effect was at 1% significance level, whereas it was significant at 1.3% level in the last subperiod.

**Comparisons of mean of monthly changes over four subperiods**

Figure 3 graphically contrasts the means of monthly changes over the four subperiods. At least for 8 months of 1929-1945 subperiod, means of monthly changes were way off the rest of the means (three in the positive territory and five in the negative territory). The Depression years caused the overall mean of this subperiod to be the lowest of all subperiods. The mean monthly changes underwent wild swings. For example, from a high of 4.05% in August, it went to a low of -2.81% in September. That had a significant impact on the mean changes of August and September when we consider the entire period. The means of monthly changes of the other three subperiods moved rather closely.

**Figure 3: Comparisons of means of monthly percentage changes of DJIA:1896-1928 vs. 1929-1945 vs. 1946-1972 vs. 1973-2008**




As Table 10 shows, Kruskal-Wallis test of the medians of monthly changes of the four subperiods do not show any significant difference (H-statistic = 0.38; p = 0.94). Though not significantly different, the third subperiod has the highest median followed by the first.

**Table 10: Results of Kruskal-Wallis Test of Difference in Average Medians of Monthly Changes of Four Subperiods**

| Subperiod | # of Obs | Median | Average Rank | Z Value | Rank |
|---|---|---|---|---|---|
| 1 | 387 | 0.7393 | 662.6 | 0.41 | 2 |
| 2 | 204 | 0.8362 | 643.7 | -0.51 | 3 |
| 3 | 324 | 1.0328 | 652.6 | -0.19 | 1 |
| 4 | 396 | 0.7299 | 658.7 | 0.17 | 4 |
| Overall | 1311 | | 656.0 | | |

Similar is the result from Mood's Median test (Chisquare = 0.99; p = 0.80).

We used t- tests to find differences in the means of the six pairs that can be formed with the four subperiods. No significant difference was revealed. We used nonparametric Mann-Whitney tests to find differences in the medians of the six pairs that can be formed with the four subperiods. Again, no significant difference was revealed.[4]

We used F-test to detect differences in the standard deviations of the six pairs obtained from four subperiods. Interestingly we find the variances of each subperiod to be highly significantly different at levels of significance of 0.00 in each case.[5] The second subperiod has the highest standard deviation, then the first, then the last, and the third subperiod has the lowest standard deviation. From 8.62% standard deviation of monthly changes that we found for the second subperiod, it came down to 3.57% (a fall of about 59%). In the last subperiod, it increased to 4.51% (an increase of over 26%).

**Month Effect Sans Outliers**

We wanted to see how the results would change if we excluded months in which the change was larger than ±15% (Case 1) or ±10% (Case 2). Specifically, we wanted to see if the negative September effect for the entire data set may have been significant because of few large drops in that month. On reviewing the results of this line of analysis, we find that the mean percentage change was 0.63% for Case 1 (excluding ±15%) and 0.67% Case 2 (excluding ±10%) as compared to 0.55% for the entire data set (1896-2008), which shows the larger monthly changes were more negative than positive.

For the entire period (1896-2008) without removing any outliers, we have found that September had the most negative monthly average decline of 1.19%, which was significantly different from the remaining months. When we remove the months with changes larger than ±15% (20 instances), we find that the month of December with the largest mean positive increase of 1.56% also becomes significantly different than the remaining months (Table 11).

**Table 11: Excluding Months with Changes larger than ± 15%: 1896-2008**

| Period 1896-2008 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 1327 | 112 | 111 | 111 | 109 | 109 | 110 | 112 | 110 | 111 | 110 | 111 | 111 |
| Mean | 0.63 | 1.05 | -0.04 | 0.92 | 0.85 | 0.53 | 0.07 | 1.02 | 1.10 | -0.92 | 0.60 | 0.76 | 1.56 |
| Median | 0.83 | 1.01 | 0.07 | 1.28 | 0.85 | 0.25 | -0.08 | 1.10 | 1.43 | -0.69 | 0.83 | 1.06 | 1.90 |
| Minimum | -14.80 | -8.64 | -12.05 | -11.48 | -12.28 | -11.99 | -11.03 | -14.08 | -10.41 | -14.77 | -14.80 | -14.04 | -12.53 |
| Maximum | 14.65 | 14.41 | 13.20 | 12.59 | 12.46 | 14.65 | 12.23 | 10.68 | 14.47 | 13.49 | 10.65 | 14.26 | 10.78 |
| Standard Deviation | 4.69 | 4.52 | 3.80 | 4.57 | 4.43 | 4.47 | 4.40 | 4.92 | 4.75 | 5.35 | 5.21 | 5.52 | 3.68 |
| p-value (m=0) | 0.000 | 0.015 | 0.908 | 0.037 | 0.047 | 0.217 | 0.862 | 0.030 | 0.016 | 0.072 | 0.230 | 0.151 | 0.000 |
| p-value (t test) | | 0.298 | 0.061 | 0.484 | 0.584 | 0.820 | 0.173 | 0.374 | 0.273 | 0.002 | 0.956 | 0.792 | 0.007 |
| p-value (F test) | | 0.304 | 0.001 | 0.358 | 0.205 | 0.248 | 0.178 | 0.240 | 0.441 | 0.022 | 0.061 | 0.008 | 0.000 |
| Mean % Change | Positive | Positive | | Positive | Positive | | | Positive | Positive | | | | Positive |
| Month Effect (Mean) | | | | | | | | | | Lower | | | Higher |
| Month Effect (Var) | | | Lower | | | | | | | Higher | | Higher | Lower |

When we remove the months with changes larger than ±10% (90 instances), we find that the month of February with a small mean decline of 0.05% also becomes significantly different from the remaining months (Table 12). Whereas, September and December are significantly different than the remaining months with p-values under 0.01, February is different with a much higher p-value of 0.028. Thus, the September effect does not go away when outliers are excluded, but we find a very significant positive December effect and a less significant February effect.

[4] Results are not reported for brevity.
[5] Results are not reported for brevity.

**Table 12: Excluding Months with Changes larger than ± 10%: 1896-2008**

| Period 1896-2008 | All | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 1257 | 109 | 109 | 104 | 105 | 105 | 105 | 108 | 103 | 100 | 102 | 100 | 107 |
| Mean | 0.65 | 0.69 | -0.05 | 0.85 | 0.68 | 0.27 | -0.05 | 1.30 | 0.78 | -0.65 | 1.17 | 0.97 | 1.83 |
| Median | 0.83 | 0.93 | 0.07 | 1.19 | 0.50 | 0.23 | -0.13 | 1.37 | 1.32 | -0.54 | 0.97 | 1.11 | 1.90 |
| Minimum | -9.93 | -8.64 | -7.68 | -9.12 | -9.02 | -9.91 | -9.93 | -9.85 | -9.10 | -9.70 | -8.47 | -9.24 | -6.23 |
| Maximum | 9.85 | 8.17 | 8.79 | 9.53 | 8.67 | 8.28 | 8.33 | 9.85 | 9.78 | 7.34 | 9.65 | 9.83 | 9.47 |
| Standard Deviation | 3.89 | 4.02 | 3.42 | 3.75 | 3.95 | 3.75 | 3.79 | 4.38 | 3.91 | 3.89 | 4.09 | 4.20 | 2.95 |
| p-value (m=0) | 0.000 | 0.074 | 0.872 | 0.023 | 0.080 | 0.463 | 0.900 | 0.003 | 0.045 | 0.099 | 0.005 | 0.023 | 0.000 |
| p-value (t test) | | 0.911 | 0.028 | 0.582 | 0.936 | 0.276 | 0.051 | 0.106 | 0.732 | 0.001 | 0.184 | 0.432 | 0.000 |
| p-value (F test) | | 0.330 | 0.035 | 0.305 | 0.425 | 0.299 | 0.366 | 0.042 | 0.495 | 0.499 | 0.243 | 0.143 | 0.000 |
| Mean % Change | Positive | | | Positive | | | | Positive | Positive | | Positive | Positive | Positive |
| Month Effect (Mean) | | | Lower | | | | | | | Lower | | | Higher |
| Month Effect (Var) | | | Lower | | | | | Higher | | | | | Lower |

During the first period (1896-1928), there were three months with changes larger than ±15% and 35 months with changes larger than ±10%.[6] We observe a negative month effect in February before removing outliers. On removing the three months with changes over ±15%, we see a positive month effect in August in addition to the negative month effect in February. On removing 35 months with changes in excess of ±10%, we see a complete change to a negative month effect in September and positive month effect in December.

During the second period (1929-1945), there were 15 months with changes in excess ±15% and 36 months with changes larger than ±10%. Incidentally, there have been only five other months with changes in excess of ±15% in all of the remaining periods. This period had the largest ever decline of 30.70% and the largest ever increase of 40.18%. In spite of such large fluctuations, there was no month effect whatsoever during this period even when the outliers were removed.

During the third period (1946-1972), there was no month with percentage change larger than ±15% and only one month with change larger than ±10%. As a result, the negative month effects observed in February and June and positive month effect in December remained unchanged when the lone outlier was removed. Significantly, no month effect was observed for September during this period.

In the last period (1973-2005), there were only two months with changes larger than ±15% (both negative) and 18 months with changes larger than ±10%. During this period, only a negative September effect was observed, which remained unchanged when the outliers were removed.

We also looked at the variances of monthly percentage changes for the entire period. Before removing any outliers, April had higher variance compared to the other months and January, February and December had lower variances. On excluding the 20 months with changes larger than ± 15%, September, and November had higher variances and February and December had lower variances (Table 11). On excluding 90 months with changes larger than ±10%, only July had variance larger than the other months and February and December had lower variances than other months (Table 12).

**Half-Monthly Effect**

Continuing our search for anomalies, we divided each month into two parts – first half and second half. This gave us 24 half-monthly periods. We then tested the previous three hypotheses for 1896-2008:

We summarize our findings below (from Tables 13 A and B) with I indicating the first-half of the month and II the second half of the month:

1. The mean of percentage changes for the half-monthly periods during 1896-2008 was 0.28%, which was statistically significant with a p-value of less than 0.01.

[6] Tables for the rest of this section will be provided on request.

2. The means of percentage changes for Jan I, March I, April I, July I, and December II were significantly greater than zero. Mean of percentage changes for September II was significantly lower than zero.

**Table 13A: Half-Monthly % Change in DJIA – January to June for 1896-2008**

| 1896-2008 | All | Jan I | Jan II | Feb I | Feb II | Mar I | Mar II | Apr I | Apr II | May I | May II | Jun I | Jun II |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 2694 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 113 | 113 |
| Mean | 0.28 | 0.72 | 0.36 | 0.14 | -0.28 | 0.80 | -0.09 | 1.12 | -0.13 | 0.05 | -0.06 | 0.52 | -0.13 |
| Median | 0.41 | 0.61 | 0.39 | 0.19 | -0.09 | 0.82 | 0.24 | 0.79 | 0.04 | 0.09 | 0.58 | 0.11 | -0.56 |
| Minimum | -22.89 | -6.67 | -11.28 | -9.26 | -9.16 | -10.17 | -22.23 | -12.00 | -12.99 | -13.72 | -14.75 | -11.20 | -15.37 |
| Maximum | 23.51 | 11.39 | 9.87 | 12.64 | 6.76 | 20.84 | 7.88 | 18.06 | 23.51 | 11.08 | 10.55 | 13.14 | 18.23 |
| Standard Deviation | 3.73 | 3.40 | 3.42 | 3.04 | 2.79 | 3.54 | 4.00 | 3.64 | 4.06 | 3.71 | 3.80 | 3.57 | 3.82 |
| p-value (m=0) | 0.00 | 0.03 | 0.27 | 0.62 | 0.29 | 0.02 | 0.80 | 0.00 | 0.73 | 0.89 | 0.86 | 0.12 | 0.71 |
| p-value (t test) | | 0.16 | 0.81 | 0.64 | 0.04 | 0.12 | 0.32 | 0.01 | 0.27 | 0.50 | 0.34 | 0.46 | 0.24 |
| p-value (F test) | | 0.09 | 0.10 | 0.00 | 0.00 | 0.23 | 0.16 | 0.38 | 0.11 | 0.49 | 0.40 | 0.26 | 0.37 |
| Mean % Change | Positive | Positive | | | | Positive | | Positive | | | | | |
| Month Effect (Mean) | | | | | Lower | | | Higher | | | | | |
| Month Effect (Var) | | | | Lower | Lower | | | | | | | | |

**Table 13B: Half-Monthly % Change in DJIA – July to December for 1896-2008**

| 1896-2008 | All | Jul I | Jul II | Aug I | Aug II | Sep I | Sep II | Oct I | Oct II | Nov I | Nov II | Dec I | Dec II |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Count | 2694 | 113 | 113 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 112 | 113 | 113 |
| Mean | 0.28 | 0.84 | 0.40 | 0.63 | 0.56 | -0.36 | -0.87 | 0.31 | -0.03 | 0.82 | 0.16 | -0.28 | 1.47 |
| Median | 0.41 | 1.07 | 0.58 | 0.59 | 0.51 | -0.15 | -0.43 | 0.81 | 0.53 | 0.47 | 0.55 | 0.70 | 1.00 |
| Minimum | -22.89 | -10.88 | -14.45 | -10.84 | -10.52 | -13.50 | -19.89 | -12.35 | -21.23 | -16.37 | -13.65 | -22.89 | -3.83 |
| Maximum | 23.51 | 8.11 | 19.33 | 22.58 | 14.37 | 14.60 | 10.58 | 10.81 | 8.84 | 13.16 | 10.21 | 8.54 | 10.82 |
| Standard Deviation | 3.73 | 3.36 | 3.98 | 3.79 | 3.70 | 3.69 | 3.96 | 4.08 | 4.19 | 4.46 | 3.41 | 4.40 | 2.54 |
| p-value (m=0) | 0.00 | 0.01 | 0.29 | 0.08 | 0.11 | 0.30 | 0.02 | 0.42 | 0.94 | 0.05 | 0.63 | 0.50 | 0.00 |
| p-value (t test) | | 0.07 | 0.74 | 0.31 | 0.41 | 0.06 | 0.00 | 0.92 | 0.43 | 0.19 | 0.70 | 0.17 | 0.00 |
| p-value (F test) | | 0.07 | 0.17 | 0.43 | 0.47 | 0.45 | 0.19 | 0.10 | 0.05 | 0.01 | 0.10 | 0.01 | 0.00 |
| Mean % Change | Positive | Positive | | | | | Negative | | | | | | Positive |
| Month Effect (Mean) | | | | | | | Lower | | | | | | Higher |
| Month Effect (Var) | | | | | | | | | Higher | Higher | | Higher | Lower |

3. The means of percentage changes for February II and September II were significantly lower (and negative) than the means of percentage changes for the remaining 23 half-monthly periods. April I and December II experienced significantly higher means than the remaining 23 half-monthly periods.
4. Standard deviations of the percentage changes for February I, February II, and December II were significantly lower than the remaining 23 half-monthly periods. In other words, the mean percentage changes for these half-monthly periods were significantly more consistent than the other half-monthly periods. October II, November I and December I experienced significantly higher standard deviations.

Considering whole months, as we did earlier, we found that in descending order, July, August and December experienced the highest mean changes. We now find that the higher means of July was attributed to the first halves of the months and for December, the second half. The second half of December experienced the highest mean change (1.47%) which was significantly higher than for the other 23 half-month periods, and the standard deviation was significantly lower compared to the other periods.

## SUMMARY AND CONCLUSION

We have explored three types of anomalies in the DJIA – if the mean of monthly percentage changes of each month over a period was different from zero, if the mean of monthly percentage changes for a month during a period is different from the means of all the other months in the period, and if the variance of monthly percentage changes for a month during a period is different from the variances of all the other months in the period. For the 1,347 monthly changes in our study, we find that the mean of monthly percentage changes was a significant 0.55% or 6.60% annualized. We find that the only significant month effect occurred in September (mean of monthly percentage changes being negative and significantly less than for the other eleven months) with a mean decline of -1.19%. It is hard to explain the significant negative returns for September. One possible reason might be that the volatility of daily percentage changes of October is high (this is our next area of investigation); if that is the case, we would expect significant number of investors to sell in September and stay away from stocks until October is over. Another possible reason might be higher number of home closings in September which would possibly cause some sell-offs in the month to make down payments[7]. August experienced the largest mean increase of 1.26%, followed by July (1.25%), December (1.17%) and January (1.05%). These means are significantly greater than zero. But none of these means are significantly different from the mean changes of the other months.

The mean monthly change of September was negative for the entire data set as well as for each subperiod. However, the negative September effect was significant not in the first three subperiods, rather in the last subperiod, as well as for the entire data set. Two of the subperiods exhibited negative February effect at 3% level. For the entire data set, negative February effect was at a level of significance of 6.1% level. In the third subperiod, positive December effect was significant at 1% level, whereas it was significant at 1.3% level in the last subperiod.

We investigated if the negative September effect may have been because of some large outliers. We deleted monthly changes of ±15% and ±10%. The negative September effect does not go away. We also find that the negative September effect is more a result of the second half of September than first half. The second half of December experienced the highest mean change (1.47%) which was significantly higher than for the other 23 half-month periods, and the standard deviation was significantly lower compared to the other periods.

So the month effect varies with the time period we consider. December's mean change was significantly positive in two of the four subperiods; February's mean change was significantly negative in two of the four subperiods. One would expect the DJIA stocks to be free from seasonal patterns since each one of them are closely followed by a large number of analysts, and the existence of month effect would be surprising. However, given that no consistent pattern is detectable is a reflection of efficiency of the DJIA stocks to a large degree.

[7] This point was mentioned by a seminar participant who worked in real estate business and saw many closings in September compared to the other months.

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