THE BEHAVIOR OF U.S. PRODUCER PRICE INDEX: 1913 TO 2004

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Working Paper No. 2006-04

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ABSTRACT

This paper analyzes the behavior of U.S. PPI over the period January 1913 to March 2004 using monthly "all commodities index" values. The mean of monthly percentage index changes for the entire data set (0.23%) was significantly greater than zero. January, July and November had mean monthly percentage changes which were significantly greater than the mean changes of the other months over the entire period. March, May and September had mean percentage changes significantly lower than the other months. We find that there is some periodicity to all commodities index. The mean of monthly commodities index changes during the Republican presidencies (0.08%) was significantly lower than the mean changes during the Democratic presidencies (0.38%) and so were the medians. We slice the entire data into three sub-periods. We find that though the means and medians have significantly increased over the three sub-periods, the standard deviations of the means have decreased. Granger causality tests reveal that while oil prices affected the all commodities index and the finished goods index, the causal relationship is not true the other way at the 99% significance level. The findings have implications for policy makers, analysts, investors, and manufacturers.

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INTRODUCTION

The Producer Price Index (PPI) is the measure of average changes in prices charged by domestic producers for their output. There is almost no other gauge that is so affects every field of economics. For instances include growth and output; manufacturing prices and productivity; government taxes and spending programs that are indexed to Producer Price; budget deficits and debt; monetary policy; real financial profits, real median incomes and poverty rates. One of the U.S. PPI indexes – the index for finished goods – a measure of prices charged by producers of everything from cars to gasoline to oranges -- is a widely watched indicator of the health of the economy. Its changes bode well or ill for companies and stocks, and by turn for investors. Understanding of the behavior of PPI will help all those who use PPI data – especially policy makers, analysts, investors and manufacturers.

In this study, we look at the monthly effect of the all commodities series. The all commodities series starts from April 1913. For this series we look at monthly effect for the entire data set, as well as for three sub-periods. Then we look at month effect during Democratic and Republican presidencies to see if there is difference in the month effect based on the party in power in the White House. It has been pointed out that during Democratic governments unemployment went down at the cost of higher inflation, while during Republican governments' inflation was controlled at the cost of higher unemployment. This seems to suggest that there is indeed a very real economic difference in the policies of the two parties, and that Americans' choice at the ballot box makes a real difference, perhaps even more than they realize (Leonhaedt [2003]).

Finally, we look at Granger causality on oil price, all commodities index and finished goods index. Oil price changes may be an important determinant of PPI changes in recent years.

This will give us more insight about PPI changes. The findings have implications for policy makers, analysts, investors and manufacturers.

BACKGROUND AND ORIGIN

PPIs are used for a variety of different purposes. There is a general public interest in knowing the extent to which the prices of goods and services have risen. Also, it has long been customary in many countries to adjust levels of wages, pensions, and payments in long-term contracts in proportion to changes in relevant prices, a procedure known as index linking or contract escalation. For this reason, price indices have a long history. A very early example is a simple index compiled by William Fleetwood in 1707, which was intended to estimate the average change in the prices paid by Oxford University students over the previous two and a half centuries. Another 18th-century example is an index compiled by the legislature of Massachusetts in 1780 in order to index the pay of soldiers fighting in the Revolutionary War against England (see Diewert, 1993, for an account of the early history of index numbers).

During the 19th century, interest in price indices gathered momentum. In 1823 Joseph Lowe published a study on agriculture, trade, and finance in which he developed the concept of a price index as the change in the monetary value of a selected set, or basket, of goods and services, an approach still used today. He also noted the various uses for a price index, such as the linking of wages and rents, and the calculation of real interest. Diewert (1993) argues that Lowe can be considered "the father of the consumer price index." Later in the 19th century further important contributions were made, including those of Laspeyres (1871) and Paasche (1874), whose names are associated with particular types of price indices that are still widely used. Marshall (1887) advocated the use of chain indices, in which indices measuring price movements from one year to the next are linked together to measure price movements over longer periods of time.

During the 1920s several important developments occurred. In 1922, Irving Fisher published his monumental work, The Making of Index Numbers. This was prompted by Fisher's interest in inflation and his advocacy of the Quantity Theory of Money, in which changes in the

money supply were held to lead to corresponding changes in the price level. A good measure of changes in the price level was needed – that is, a good price index which led him into a systematic investigation of the properties of hundreds of different kinds of possible formulas for price indices.

Fisher's preferred index, the geometric average of the indices advocated by Laspeyres and Paasche, is now known as the Fisher index. The Fisher index (or the closely related Törnqvist index) remains the preferred measure from a theoretical point of view for most purposes. From the perspective of the economic approach to index number theory, these indices have been shown in most circumstances to provide an unbiased estimate of changes in the cost of living for consumers and for price changes for firms that maximize revenue and minimize costs. The Fisher index number formula can also be justified from the perspective of averaging two equally plausible fixed-basket index number formulas (the Laspeyres and Paasche formulas). The Fisher index also has a strong justification from the view point of the test approach to index number theory. The Törnqvist formula can also be justified from the viewpoint of the stochastic approach to index number theory.

In 1924, Konüs published a seminal paper laying down the foundations for the economic theory of the cost-of-living index, or COL index. A COL index is designed to measure the change in the cost of maintaining a given standard of living (or utility or welfare) as distinct from maintaining sufficient purchasing power to buy a fixed set of goods and services. In reality, consumers do not go on purchasing the same set of goods and services over time but adjust their expenditures to take account of changes in relative prices and other factors. The producer counterpart to the consumer's cost-of-living index is the fixed-input output price index. This economic approach to the theoretical foundations for the U.S. PPI was not fully developed until the 1970s: see Fisher and Shell (1972), Samuelson and Swamy (1974), and Archibald (1977).

In 1926, Divisia published a paper in which he proposed price and quantity indices that factor the change in the monetary value of some aggregate flow of goods and services over time

continuously and instantaneously into its price and quantity components. While Divisia's approach to index number theory is not immediately applicable, since price and quantity data are not available on a continuous basis, the Divisia index is useful conceptually when one has to choose between fixed-base indices or chained indices. Thus, by 1930 the theoretical foundations (from all of the above perspectives) for the compilation of price indices, including PPIs, had been laid. While there have been many refinements to index number theory from both an economic and statistical viewpoint during the mid- and late 20th century, the essential elements were already in place early in the century. Since its inception in 1902, it was termed the Wholesale Price Index (WPI). It was renamed "Producer Price Index" in 1978. At the same time, there was a shift in emphasis from one index encompassing the whole economy, to three main indexes covering the stages of production in the economy. By changing emphasis, the Bureau of Labor Statistics (BLS) eliminated the double counting phenomenon inherent in aggregate commodity-based indexes. The change from "Wholesale Price index" to "Producer Price Index" did not include a change in the index methodology, and the continuity of the price index data was unaffected. The name change reflects the theoretical model of the output price index that underlies the U.S. PPI. The Producer Price Index (PPI) is the measure of average changes in the prices received by domestic producers for their output.

The limitation of the traditional U.S. PPI methodology was its commodity orientation, which was not well suited with the industry orientation of most other Federal economic time series. The PPI's exclusive commodity classification scheme made it difficult to evaluate producer price movements with data for other economic variables that were articulated in terms of the Standard Industrial Classification (SIC). These weaknesses in the U.S. PPI program, combined with increased development of the theory of price indexes in preretail markets, spurred several changes in terminology and operations during the 1970s. In 1978 there was a change in the program name from Wholesale Price Index to Producer Price Index, which was intended to reemphasize the fact that the PPI program continues to be based on prices received by producers

from whoever makes the first purchase. Also in 1978, the new classification was accompanied by a shift in the Bureau's analytical focus from the All Commodities Price Index (which was popularly called "the" Wholesale Price Index) to the Finished Goods Price Index and the other commodity-based stage of processing (SOP) price indexes. This overhaul was phased in gradually, until the transition to the current methodology, which was essentially completed in January 1986.

We could not come across any article exploring the monthly seasonality in the U.S. PPI. Two remotely related articles are by Adams, McQueen and Wood (2004), and by Colclough and Lange (1982). The first one looks at the effects of inflation news on high frequency stock returns. The second one explores the causal relationship between consumer and producer price changes. This paper will fill in the gap in literature by providing us with a better understanding of the monthly seasonality in U.S. PPI from 1913 to 2004.

The next three sections describe the methodology used, the data used, and then analysis results. We analyze the entire data period, and then analyze after divide the data into three sub-periods based on structural changes in the economy: The final section draws some conclusions.

RESEARCH METHODOLOGY

The goal of this research is to analyze, for the length of period of study, if there is a monthly effect in Producer Price Index – an indicator of inflation – and if so, does it mostly result during the Democratic presidency or Republican presidency. We use the all commodities index. We set up three hypotheses that are tested to analyze the behavior of monthly percentage changes of the U.S. all-commodities index (a) for the entire data period, (b) for Democratic periods, and (c) for Republican periods. The all commodities data runs from April 1913 to March 2004.

We study month effect in three different ways [this methodology follows from Hamid and Dhakar (2003)]:

1. If the mean of monthly changes is different from zero for the sample as well as for each month within the sample. We do this by subjecting 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 there is a month effect based on the means of the monthly percentage changes. We compare the mean of percentage changes for a given month with the means of percentage changes over all the remaining eleven months for the same period. We do this by conducting the following hypothesis test for a given month *i*: H_o: $\mu_i = \mu_j$ vs. H_o: $\mu_i \neq \mu_j$. Since we found the variances for the periods i and j to be unequal in many cases, we use the more conservative t-test assuming unequal variances.

3. If there is a month effect based on the variances of the monthly percentage changes. We compare the variance of percentage changes for a given month with the variances of percentage changes of the other months. We do this by conducting the following hypothesis test for a given month *i*: H_o: $\sigma_i^2 = \sigma_j^2$ vs. H_o: $\sigma_i^2 \neq \sigma_j^2$.

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.

In addition to standard t-tests, we do Kruskal-Wallis nonparametric tests for differences in population medians. In important cases, we do the Mood's Median test, which is more robust against outliers.

To gain deeper insight into the month effect, we divide the entire period into three sub-periods:

- 1913 to 1945 (which includes the First World War, the Great Depression years, and the Second World War);

- 1946 to 1972 (which includes the Breton Woods fixed exchange rate era, and the break down of that era in 1972);
- 1973 to 2004 (which includes the volatile world we live in since the first oil crisis of 1973).

We analyze the behavior of PPI seasonality for (a) the entire data, (b) the three sub-periods, (c) the Democratic presidencies, and (d) the Republican presidencies.

DATA

Our data constitutes of monthly percentage changes of index of "all commodities" in the U.S. from April 1913 to March 2004. Month effect is analyzed based on the "all commodities index". Finished goods index (data available from 1947 to 2003) is used in Granger causality tests with respect to oil price. Oil price is obtained from British Petroleum Statistical Review. The commodities data consists of 520 months during which a Republican was president, and 573 months during which a Democrat was a president. That gives us 1,093 months of observations.

STATISTICAL ANALYSIS

(A) All commodities: Entire data

Firstly, we explore month effect for the entire "all commodities" data set (1913-2004). On this data set we conduct the three types of tests mentioned above to explore the three types of month effects. Table 1 shows the statistical outputs and results of the tests.

a. Month effect: Mean monthly percentage change greater than zero (Ho: $\mu_i = 0$ and Ha: $\mu_i \neq 0$)

Table 1 shows, the mean monthly commodities price percentage changes for the entire data set of 0.23% is significantly greater than zero ($p = 0.00$).

Except for April, August and December, the remaining nine months experienced mean monthly percentage changes significantly greater than zero. There is a seasonality here: three months in a row experienced significant positive mean percentage changes, followed by a month in which the mean of percentage changes is not significantly different from zero at the 5% level of significance. This pattern recurs over the year.

b. Month effect: Mean percentage change of a month different from the other eleven months (H_o: $\mu_i = \mu_j$ vs. H_o: $\mu_i \neq \mu_j$, where j represents the other 11 months**)**

As Table 1 also shows, alternate months, January, March, May, July and September experienced mean monthly percentages which were significantly greater than the mean changes of the other months. Only November experienced mean percentage change significantly lower than the other months. Once again we have a periodicity here. The peak of means is reached in July. Then we see a falling trend until December. The peak in July may possibly be attributable to higher demand created by higher purchases by manufacturers to build up inventory for the impending Christmas season.[1] It appears that demand falls thereafter which should lead to falling means.

Kruskal-Wallis nonparametric test for difference in medians of monthly index changes for the entire data set shows a difference at 5.8% level (the Kruskal-Wallis H-statistic = 19.27, p-value = 0.058). January, July and September had higher average ranks based on medians (in descending order). October had the lowest average rank, followed by November.

The Mood's Median test (which is more robust against outliers) more strongly shows that there is significant difference in the medians of the monthly index changes (Chi-square = 21.07, p-value = 0.034).

[1] In another study by two of the authors, it was found the peak mean of monthly changes of CPI from 1913 to 2003 was also in July, with a falling trend thereafter until December.

c. Month effect: Variance of monthly percentage changes of each month different from the variances of other months (H_o: $\sigma_i^2 = \sigma_j^2$ vs. H_o: $\sigma_i^2 \neq \sigma_j^2$, where j represents the other 11 months**)**

Table 1 shows that only February, April and August do not exhibit any month effect with respect to variances. Five of the remaining nine months exhibited higher variances and four exhibited lower variances compared to the other months. But no periodicity is discernible in this case.

Figure 1 below graphs the mean monthly percentage changes for the "all commodities" index for the entire period. As mentioned earlier, the increase in July may correspond to greater demand for commodities for building up finished goods inventory prior to the Christmas season. The decrease in the means for subsequent months may correspond to lower demand by manufacturers as Christmas time nears. The increase in January is harder to explain.

Analysis of sub-periods

To gain deeper insight, we next explore month effect by dividing the entire period into three sub-periods based on presumed structural changes in the economy: 1913 to 1945 (which includes the First World War, the Great Depression years, and the Second World War); 1946 to 1972 (which includes the Breton Woods fixed exchange rate era, and the break down of that era in 1972); 1973 to 2004 (which includes the volatile world, and floating exchange rate system we live in since the first oil crisis of 1973).

All commodities index: 1913-1945

As Table 1 above shows, whereas for the entire data set, as well as for nine months the mean monthly percentage changes were significantly greater than zero, Table 2 below shows that the mean for the all commodities index for the sub-period 1913 to 1945, in spite of two world Wars, was not significantly greater than zero. Only the mean price change for the month of July was significantly greater than zero (0.63% vs. 0.12% for the entire sub-period). Prices tend to increase

in times of wars. But any increase that may have occurred during the World Wars was possibly dampened by the years of the Great depression. For example, whereas the mean of all commodities index was 1.40% for July 1, 1914 to July 31, 1918 (First World War), and 0.30% from December 1941 to August 1945 (the U.S. essentially entered the Second World War with the bombing of Pearl Harbor on December 7, 1941[2]), it was 0.05% for February 1913 to December 1938 (the Second World War started on January 1, 1939; it was 0.10% from February 1913 to November 1941[3]). An interesting finding is that the average of the changes of all commodities index January 1939 to November 1941 is 0.52% whereas from December 1941 to August 1945, it was 0.30% -- lower than when the U.S. was not in full-fledged war. This may speak of controlled profiteering by wholesalers when the U.S. actually entered the war – a possible reflection of patriotism. However, from April 1941 to November 1941, the mean of monthly changes is 1.61% -- which may reflect the effect of speculation that the U.S. might enter the War. (From the time the Second World War started in Europe in January 1939 to December 1940, the mean was 0.16%.)

During the worst period of the depression years, September 1929 to December 1933, the mean of monthly changes was -0.58%, which depressed the overall mean for the first sub-period.

There was also a little bit of month effect in terms of variance as can be seen from the last row of the table below (March, June and August with lower variances, and December with higher variance compared to the other months).

Kruskal-Wallis test for the 1913-1945 period shows no significant difference in the medians of monthly index changes (Kruskal-Wallis H-statistic = 12.42, p = 0.33). This is consistent with our finding from t-tests (the second last row of the Table 4). The Mood's Median

[2] The Second World War essentially ended with the bombing of Nagasaki on August 15, 1945).
[3] The U.S. essentially entered the Second World War full-fledged after the bombing of Pearl Harbor on December 7, 1941.

test also shows that there is no significant difference in the medians (Chi-square = 6.27, p-value = 0.854).

All commodities index: 1946-1972

This was an era of fixed-exchange rates and relative domestic progress and prosperity. It was an era in which America helped Europe to rise up from the ashes of the Second World War under the Marshall Plan, and also helped Japan to get back to its feet. (The Marshall Plan itself was worth $120 billion in today's dollars.) Compared to the previous sub-period, the mean of monthly changes in commodities prices was doubled (0.12% vs. 0.25%) and this is significantly greater than zero (Table 3). Four months (January, March, July and December) exhibited mean monthly changes significantly greater than zero. Only one month, April experienced mean of monthly changes (-0.02%) significantly less than the other 11 months. No month exhibited mean monthly change significantly greater than the other months. Seven months (January through June and December) experienced volatility significantly less than the other months; October experienced significantly higher volatility.

So, this sub-period underwent some significant month effect compared to the previous sub-period. The Vietnam War, started full-fledged with the Congressional authorization obtained by President Johnson in August 1964. The mean of the sub-period August 1964 to December 1972 is 0.26% as compared to 0.25%, which means the war, far away from America, did not affect producer prices in the U.S. If we extend the analysis to include the period from August 1964 to the Paris ceasefire accord, the mean was 0.27%, and it was a high 0.47% if we consider the entire war period (finally ending on April 30, 1975).

Kruskal-Wallis test for difference in the medians of the monthly index changes for the 1946-1972 sub-period shows significant difference (Kruskal-Wallis H-statistic = 21.70, p = 0.03). January has the highest average rank based on median, followed by July which is what we find for means in the above table. October has the lowest average rank – same as we found for the

1913-1945 subperiod. The Mood's Median test also shows that there was significant difference in the medians (Chi-square = 23.71, p-value = 0.015).

However, the standard deviation of the monthly changes of this entire sub-period (1.01%) is lower than the standard deviation for the previous sub-period (1.76%). F-test for differences in the variances shows significant difference for a p value = 0.00. The lower variance during the second sub-period may be attributable to the stability after the Second World War, and the Breton Woods system of fixed exchange rates that came into effect after 1945, and fell apart in 1972.

All commodities index: 1973-2004

From a mean monthly change of 0.12% in the first sub-period to 0.25% in the second sub-period, the mean increased to 0.34% in the third sub-period and is significantly greater than zero. Six months experienced mean monthly changes significantly greater than zero compared to four months in the second sub-period (Table 4).

However, the incidence of month effect in terms of variance is not more pronounced in this sub-period compared to the second sub-period. With greater volatility in oil prices during this sub-period, we would expect commodities prices to be more volatile. And the conventional wisdom is that commodities prices have become more volatile in the last three decades. But that is not reflected through a comparison of the variance effects of the last two sub-periods. However, six of the months exhibit variance effects in this sub-period (two higher variances and four lower) compared to seven months in the second sub-period (one higher variance and six lower). So we find that whereas one month in the second sub-period exhibited higher variance, in the third sub-period, two months exhibited higher variance.

Kruskal-Wallis test for difference in the medians of the monthly index changes for the 1973-2004 subperiod shows significant difference (Kruskal-Wallis H-statistic = 25.81, p = 0.01). May has the highest average rank, followed by January, with November bearing the lowest average rank. This roughly follows what we find based on t-tests as shown in the above table. The

Mood's Median test also shows that there was significant difference in the medians (Chi-square = 30.47, p-value = 0.001).

Though the Breton Woods system fell apart, and commodities prices were perceived to have become more volatile in the last couple of decades, the standard deviation of monthly percentage changes was the lowest in this sub-period (0.83%). The standard deviation in the third sub-period is significantly lower than that of the second sub-period (p value = 0.00).

A comparisons of the means of the three sub-periods shows that the mean of sub-period 1 (0.12%) and sub-period 2 (0.25%) are not significantly different for a p value = 0.21. The mean of sub-period 2 (0.25%) is not significantly different from the mean of sub-period 3 (0.34%) for a p value = 0.24. Only the mean of sub-period 1 (0.12%) is significantly different from the mean of sub-period 3 (0.34%) for a p value = 0.03. In all three cases, we do 2-tailed tests assuming unequal variances. The medians have increased over the three sub-periods: 0.00, 0.00, 0.24. So though the means and medians have significantly increased at least between sub-periods 1 and 3, the standard deviations of the means have not increased. In other words, month-to-month volatility has become more stable in recent decades. The breakdown of the Breton Woods system has not led to greater volatility in commodity prices. It may partly be the effect of increased use of risk management instruments over the last three decades.

Kruskal-Wallis test for differences in the medians of the three sub-periods shows significant differences (H statistic = 11.21, p value = 0.00). Mood's Median test for differences in the three medians yield similar result (Chi-square = 44.37, p value = 0.00). Kruskal-Wallis test for differences in the medians of the first two sub-periods show no significant difference (H statistic = 1.51, p value = 0.22). However, the more robust, Mood's Median test for the first two sub-periods shows significant difference in the two medians (Chi-square = 4.69, p value = 0.03).

So, the overall finding for the three sub-periods is that the means and medians have increased over each sub-period, but the standard deviations of the means have decreased.

Month effect during Republican and Democratic presidencies

We analyze all commodities index behavior during Republican presidents and Democratic presidents. For both periods, we explored the three types of month effect stated earlier. Table 5 shows the names of presidents from April 1913 until present, and their political affiliations. There have been 16 presidents in this 90-year period.

Table 6 shows for each of the 12 months the number of Democratic and Republican presidential months. Since we found percentage changes of the "all commodities index", so from 521 and 574 observations shown in Table 1 we have 520 and 573 data points.

A. Month effect during Republican presidents

Table 7 below shows the statistical output for all commodities index during Republican presidents (521 months) over the period 1913-2004.

a. Month effect: Mean monthly percentage change greater than zero (Ho: $\mu_i = 0$ and Ha: $\mu_i \neq 0$)

As Table 7 above shows, since all the p-values for t-test are greater than 0.05, we reject the Ho hypothesis and accept the alternative one; neither the mean monthly change of the entire data set, nor of any month was significantly greater than zero during Republican presidencies. Inflation, as measured by commodities prices, was rather under control with Republican presidents in the White House. As any economist knows, this state of affairs is caused by a number of factors, among which are presidential actions, actions of the Federal Reserve System, and the actions of the Congress.

b. Month effect: Mean percentage change of a month different from the other eleven months (H_o: $\mu_i = \mu_j$ vs. H_o: $\mu_i \neq \mu_j$, where j represents the other 11 months**)**

No month exhibited the second type of month effect as we can see in Table 7; the mean of monthly changes of none of the months was different from those of the other months based on t-tests. Kruskal-Wallis test for difference in the medians of the monthly index changes also gives a similar finding; there is no significant differences in the medians of various months (Kruskal-Wallis H-statistic = 12.21, p = 0.35). January had the highest average rank based on median followed by July, though the result is not significant. The Mood's Median test also does not detect any significant difference in the medians (Chi-square = 13.66, p-value = 0.25). The overall median of monthly index changes during Republican period was 0.085%.

c. Month effect: Variance of monthly percentage changes of each month different from the variances of other months (H_o: $\sigma_i^2 = \sigma_j^2$ vs. H_o: $\sigma_i^2 \neq \sigma_j^2$, where j represents the other 11 months**)**

Table 7 shows the standard deviation of the monthly changes for January was higher than those of the other eleven months, whereas September's and November's were lower than those of the other months. Overall, month effects under Republican presidents was not significant. Inflation, measured by all commodities index, appears to have been rather low. The mean monthly change of five of the months (April, June, October, November and December) were negative, though not significantly different from zero. The Great Depression years presumably contributed to these outcomes. Figure 2 graphs the monthly percentage change in all commodities index under Republican presidents. Rise in commodities prices in July and August is evident, but not by as much as we saw in case of the entire data set.

B. Month effect during Democratic presidents

a. Month effect: Mean monthly percentage change greater than zero (Ho: $\mu_i = 0$ and Ha: $\mu_i \neq 0$)

As Table 8 shows, the mean of commodities price index over the 574 Democratic months (0.38%) is significantly greater than zero. Seven of the 12 months experienced monthly commodities price changes significantly greater than zero. This implies that PPI was higher during Democratic presidents than during Republican presidents. An analysis of the causative factors would be interesting. Is it the alleged "infatuation" of "big government" of Democratic presidents; is it imprudent monetary policy pursued during Democratic presidents? If war periods cause higher prices, Democrats have had more than their share of war presidents: Woodrow Wilson was the war president during First World War, Franklin Delano Roosevelt was the war president during Second World War, Harry Truman was the war president during Korean War, and Kennedy and Johnson presided over about half of the Vietnam War. The Depression Years, which depressed prices greatly, was presided over by Republican President Herbert Hoover.

The mean of monthly changes during First World War is 1.40% during which period Woodrow Wilson – a Democrat – was the president.

The mean of monthly changes during Second World War was 0.40%. Franklin Delano Roosevelt and Harry Truman – both Democrats – were presidents.

The mean of monthly changes during the Korean War was 0.28%, and Harry Truman was the president for most of the period of the war.

The mean of monthly changes during the worst period of the Vietnam War (August 1964 to January 1973) was 0.27%. However, Lyndon Johnson was the Democratic president up until January 1969, followed by Richard Nixon. An interesting finding is that from February 1973 to April 30, 1975, when the South Vietnamese government fell, the mean of monthly changes was 1.22% -- and Republicans Nixon and Ford were in power. The Vietnam War cost $118 billion,

and started the inflationary cycle that engulfed the Carter presidency (February 1977 to January 1981). The mean of monthly changes during this period was 0.87%.

The mean of the worst months of the depression years under Herbert Hoover – a Republican – was 0.588% – (as we noted earlier) which helped to lower the overall mean under Republican presidencies.

So, it is not surprising the Democratic presidencies experienced higher means compared to Republican presidencies.

b. Month effect: Mean percentage change of a month different from the other eleven months (H_o: $\mu_i = \mu_j$ vs. H_o: $\mu_i \neq \mu_j$, where j represents the other 11 months**)**

Though the mean of seven months was significantly greater than zero (Table 8), no month exhibited the second type of month effect; the mean monthly change of none of the months was different from the other months. We get similar finding from Kruskal-Wallis test for difference in the medians of the monthly index changes; there is no significant differences in the medians of various months (Kruskal-Wallis H-statistic = 10.46, p = 0.49). As in the Republican period, January had the highest average rank based on median followed by July, though the result is not significant. The Mood's Median test also does not detect any significant difference in the medians (Chi-square = 9.84, p-value = 0.55). The overall median of monthly index changes during Democratic periods was 0.16% compared to 0.09% for the Republican periods.

c. Month effect: Variance of monthly percentage changes of each month different from the variances of other months (H_o: $\sigma_i^2 = \sigma_j^2$ vs. H_o: $\sigma_i^2 \neq \sigma_j^2$, where j represents the other 11 months**)**

There was quite a bit of variance effect (Table 8). Four months exhibited lower standard deviation (March, May, June, August), and three months exhibited higher standard deviation (July, October

and December). The standard deviations are higher under Democratic than under Republican presidents.

C. Democrats Vs. Republicans: Entire data: monthly means

As Figure 4 shows, except for February, commodities price changes have been higher under Democratic presidents for all other months. The monthly rising and falling trends are similar, but under Democratic presidents, it was always higher except in February, when it was higher under Republican presidents (0.001% vs. 0.09%).

Two sample test assuming unequal variances shows a mean for the Republican period of 0.08% and for Democratic period of 0.37% with a significant difference between the two (p value = 0.00). The variances of the Republican vs. Democratic periods (0.95% vs. 2.29%) is also significantly different with a p value = 0.00. We use the assumption of unequal variance after doing F-test which shows an F-statistic of 0.42, and a p-value = 0.00 which shows significant difference in the variances of the means during Republican and Democratic periods.

Kruskal-Wallis test for difference of medians of monthly index changes during Republican and Democratic periods (0.08% vs. 0.16%) is significantly different (H statistic = 13.92, and p-value = 0.00).

Republicans and Democrats over three sub-periods

We also identified the months with Republican presidents and Democratic presidents during the three sub-periods: 1913-1945, 1946-1972 and 1973-2004, and analyzed the three types of month effects which produced six tables. We do not present the six tables for the sake of brevity. Table 9 below summarizes the findings from the six tables.

As can be inferred from Table 9, inflation measured by all commodities index changes was lower in each of the three sub-periods under Republican presidency compared to Democratic

presidency. In the first sub-period (1913-1945), the mean of monthly commodities price changes was -0.05% and not significantly different from zero. Republicans were in the White House from March 1921 to April 1933, which spawns the Depression years. This may explain the negative mean.

Though on average, months under Democratic presidencies saw higher commodities price changes, the incidence of the second and third type of month effects was higher during Republican presidencies. This implies that that when we sub-divide the data period, the month to month mean changes during Democratic presidencies was not so much prevalent as it was during Republican presidencies.

GRANGER CAUSALITY TEST

PPI changes are caused by many factors. One important causative factor is presumed to be oil price changes. The Granger causality test is used to determine if there is a "Granger" causal relationship between oil prices (represented by British Petroleum Statistical Review) and all commodities index, and between oil prices and finished goods index (seasonally adjusted), and vice versa. Annual data from 1913 to 2003 for the all commodities index and from 1947 to 2003 for finished goods index were obtained (earlier data for finished goods index was not available). The data series were checked for stationarity using unit roots test. The Augmented Dickey Fuller test for unit roots showed that the oil price series was stationary after first order differencing I(1), and the all commodities index and finished goods index series were stationary after second order differencing I(2).

The Granger (1969) approach to the question of whether X causes Y is to analyze how much of the current value of Y can be explained by the past values of Y and then to see whether adding lagged values of X can improve the explanatory power. Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged X's are statistically significant. Two-way causation is frequently the case; X Granger causes Y and Y

Granger causes X. It is important to note that the statement "X Granger causes Y" does not imply that it is the effect or the result of X. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term.

The Granger causality test was performed to check if there was a bi-directional causal relationship between oil prices and finished goods index and oil prices and all commodities index. The tests reveal that while the oil prices affected the all commodities index the causal relationship is not true the other way at the 99% significance level (Table 10). Also, changes in the oil prices affect the changes in the finished goods index at the 99% confidence level and the relationship does not hold good the other way.

CONCLUSION

The paper sought to explore the behavior of U.S. PPI over the period January 1913 to March 2004 using all commodities index monthly series that gave us 1094 monthly index changes from 1,095 data points. We looked at the seasonality of the all commodities index via month effect. We looked at three types of month effect: if the mean of monthly index changes of the entire data set, and of a given month was significantly different from zero; if the mean of monthly changes for a month was different from the means of the other eleven months; if the variance of the monthly changes for a month was different than the variances of the other eleven months. The mean of monthly percentage index changes for the entire data set (0.23%) was significantly greater than zero ($p = 0.00$). January, March, May, July, September had mean monthly percentages, which were significantly greater than the mean changes of the other months over the entire period and November is the only month with mean monthly percentage change which was significantly less than the mean changes of the other months. There is overall support from nonparametric tests. We find that there is some periodicity to all commodities index with a high point reached in July for the entire data set and during Democratic presidential months (and August in case of Republican presidencies) and then a falling trend until December, and a rise in January, a fall in

February, and then a slow rising trend until August. The mean of monthly commodities index changes in the 521 months of Republican presidencies (0.08%) was significantly lower than the mean of the 574 months of Democratic presidencies (0.38%) and so were the medians. This was true for the entire data sample as well as for three sub-periods we studied. We have put forward some probable causative factors that might have accounted for that. One causative factor might be the overwhelming incidence of war presidents under Democratic presidencies. Nonparametric Kruskal-Wallis and Mood's Median tests generally support the findings from standard t-tests. We slice the entire data into three sub-periods. We find that though the means and medians have significantly increased over the three sub-periods, the standard deviations of the means have decreased. In other words, month-to-month volatility of all commodities index has become more stable in recent decades.

Granger causality tests reveal that while oil prices affected the all commodities index the causal relationship is not true the other way at the 99% significance level. Also, changes in the oil prices affect the changes in the finished goods index at the 99% confidence level; the relationship does not hold good the other way. We find some sort of seasonality in U.S. PPI; we have differences in level of PPI changes between Republican presidency and Democratic presidency; and we find Granger causality between oil price and U.S. PPI. The findings have implications for policy makers, analysts and investors. Hamid and Dhakar (2002) found significantly negative September changes in the DJIA for the last century. Here we find the mean of monthly changes for all commodity index for July was the highest. Could that have caused the negative September effect in the DJIA? This is a question we would like to pursue in the future.

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Table 1: Test of Month Effects of All Commodities Index: Entire Data

Period April 1913-March 2004	ALL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	0.23	0.47	0.05	0.25	0.21	0.24	0.15	0.56	0.37	0.28	0.06	0.11	0.08
Median	0.09	0.39	0.00	0.00	0.16	0.29	0.00	0.28	0.00	0.09	0.00	0.00	0.00
Standard Deviation	1.29	1.42	1.38	0.96	1.24	1.09	0.89	1.61	1.16	1.10	1.53	1.36	1.51
p-value (μ_i =0)	0.00	0.00	0.00	0.00	0.75	0.00	0.01	0.00	0.11	0.00	0.04	0.00	0.12
p-value (t test)	0.00	0.00	0.10	0.00	0.17	0.00	0.88	0.00	0.83	0.00	0.98	0.00	0.35
p-value (F test)	0.00	0.00	0.11	0.00	0.19	0.00	0.00	0.00	0.31	0.00	0.01	0.00	0.00
Mean % Change	**P**	**P**	**P**	**P**		**P**	**P**	**P**		**P**	**P**	**P**	
Month Effect (Mean)		**H**		**H**		**H**		**H**		**H**		**L**	
Month Effect (Variance)		**H**		**L**		**L**	**L**	**H**		**L**	**H**	**H**	**H**

Notes:
1. "Positive (P)" implies that the mean percentage change was greater than zero. "Negative" implies that the mean percentage change was significantly less than zero.
2. "Higher (H)" implies the mean percentage change was positive and significantly greater than the rest of the months. "Lower (L)" implies that the mean percentage change was negative and significant smaller than the rest of the months.

Figure 1: Mean % Change of All Commodities Index: Entire Data

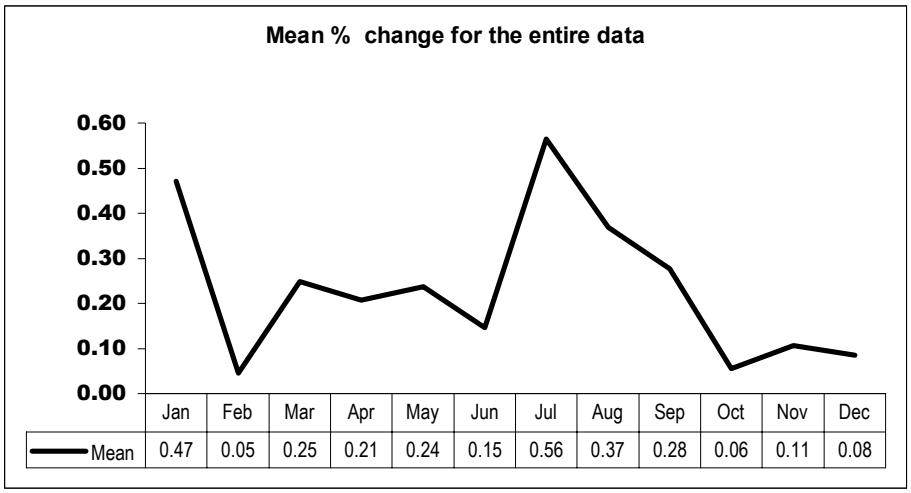

Table 2: Test of Month Effects of All Commodities Index: 1913-1945

Period 1913-1945	**ALL**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Observations	396	32	33	33	33	33	33	33	33	33	33	33	33
Mean	0.12	0.25	-0.33	0.17	0.26	0.26	0.04	0.63	0.43	0.46	-0.34	-0.03	-0.15
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00
Standard Deviation	1.76	2.10	1.90	1.26	1.85	1.85	1.25	1.67	1.29	1.49	1.91	2.08	2.32
p-value (m=0)	0.17	0.5	0.33	0.45	0.43	0.43	0.87	0.04	0.07	0.08	0.32	0.93	0.71
p(t test)		0.71	0.16	0.83	0.66	0.70	0.70	0.08	0.18	0.18	0.16	0.65	0.48
p(F test)		0.10	0.30	0.01	0.38	0.40	0.01	0.35	0.01	0.1	0.28	0.11	0.02
Mean % Change								P					
Month Effect (Mean)													
Month Effect (Var)				L			L		L				H

Table 3: Test of Month Effects of All Commodities Index: 1946-1972

Period 1946-1972	ALL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Observations	324	27	27	27	27	27	27	26	27	27	27	27	27
Mean	0.25	0.45	0.13	0.24	-0.02	0.1	0.13	0.42	0.26	0.12	0.20	0.30	0.31
Median	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00
Standard Deviation	1.01	0.66	0.76	0.58	0.51	0.46	0.58	0.64	0.84	0.96	1.61	0.91	0.78
p-value (m=0)	0.00	0.00	0.37	0.04	0.83	0.26	0.27	0.00	0.12	0.52	0.52	0.1	0.05
p(t test)		0.13	0.41	0.91	0.01	0.13	0.28	0.11	0.96	0.46	0.86	0.77	0.69
p(F test)		0.00	0.03	0.00	0.00	0.00	0.00	0.05	0.11	0.36	0.00	0.25	0.04
Mean % Change	P	P		P				P					P
Month Effect (Mean)					L								
Month Effect (Var)		L	L	L	L	Lr	L				H		L

Table 4: Test of Month Effects of All Commodities Index: 1973-2004

Period 1973-2004	ALL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Observations	375	32	32	32	31	31	31	31	31	31	31	31	31
Mean	0.34	0.70	0.36	0.34	0.36	0.52	0.28	0.28	0.40	0.21	0.34	0.08	0.14
Median	0.24	0.47	0.28	0.25	0.46	0.43	0.2	0.17	0.09	0.1	0.26	0.09	0.20
Standard Deviation	0.83	0.97	1.06	0.87	0.82	0.43	0.61	0.94	1.29	0.65	0.76	0.34	0.67
p-value (m=0)	0.00	0.00	0.06	0.03	0.02	0.00	0.02	0.11	0.09	0.08	0.02	0.18	0.26
p(t test)		0.03	0.89	0.99	0.89	0.03	0.60	0.73	0.76	0.30	0.95	0.00	0.10
p(F test)		0.11	0.03	0.39	0.50	0.00	0.02	0.19	0.00	0.04	0.28	0.00	0.06
Mean % Change	P	P		P	P	P	P				P		
Month Effect (Mean)		H				H						L	
Month Effect (Var)			H			L	L		H	L		L	

Table 5: US Presidents, political party, and period

President Names	Political Party	Begin Period		End Period	
		Month	Year	Month	Year
Woodrow Wilson	**Democratic**	April	**1913**	March	**1921**
Warren Gamaliel Harding	**Republican**	April	**1921**	August	**1923**
Calvin Coolidge	**Republican**	September	**1923**	March	**1929**
Herbert Clark Hoover	**Republican**	April	**1929**	March	**1933**
Franklin Delano Roosevelt	**Democratic**	April	**1933**	April	**1945**
Harry S. Truman	**Democratic**	May	**1945**	January	**1953**
Dwight David Eisenhower	**Republican**	February	**1953**	January	**1961**
John Fitzgerald Kennedy	**Democratic**	February	**1961**	November	**1963**
Lyndon Baines Johnson	**Democratic**	December	**1963**	January	**1969**
Richard Mihous Nixon (2)	**Republican**	February	**1969**	August	**1974**
Gerald Rudolph Ford	**Republican**	September	**1974**	January	**1977**
Jimmy Carter	**Democratic**	February	**1977**	January	**1981**
Ronald Reagan	**Republican**	February	**1981**	January	**1989**
George H. W. Bush	**Republican**	February	**1989**	January	**1993**
Bill Clinton W. J.	**Democratic**	February	**1993**	January	**2001**
George W. Bush	**Republican**	February	**2001**	**Now**	

Potus Presidents of the United States: www.ipl.org/div/potus/

Table 6: Summary data distributions

MONTH	REPUBLICAN	DEMOCRATIC	TOTAL
January	44	48	92
February	45	47	92
March	45	47	92
April	43	48	91
May	43	48	91
June	43	48	91
July	43	48	91
August	43	48	91
September	43	48	91
October	43	48	91
November	43	48	91
December	43	48	91
TOTAL	521	574	1,095

Table 7: Test of Month Effects of All Commodities Index: Republicans Presidents

April 1913-March 2004	All	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean	0.08	0.24	0.09	0.14	-0.11	0.06	-0.05	0.24	0.29	0.19	-0.05	-0.08	-0.06
Median	0.09	0.34	0.00	0.00	0.19	0.29	0.00	0.23	0.00	0.10	0.08	0.00	0.00
Standard Deviation	0.97	1.19	1.11	0.86	1.08	1.05	0.86	1.13	1.13	0.63	0.87	0.64	0.94
p-value (μ=0)	0.07	0.19	0.57	0.27	0.51	0.71	0.69	0.18	0.1	0.05	0.73	0.44	0.66
p(t test)		0.35	0.91	0.59	0.24	0.92	0.32	0.33	0.19	0.24	0.35	0.13	0.31
p(F test)		0.04	0.12	0.14	0.19	0.26	0.13	0.09	0.10	0.00	0.17	0.00	0.39
Mean % Change													
Month Effect (Mean)													
Month Effect (Var)		H								L		L	

Figure 2: Mean % Change of All Commodities Index during Republican presidents

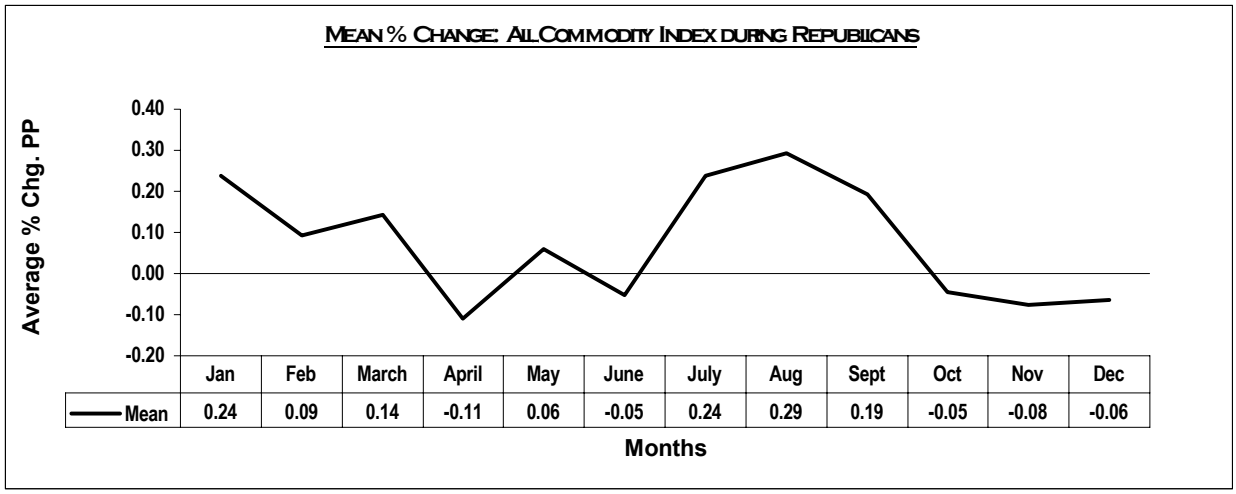

Table 8: Test of Month Effects of All Commodities Index: Democratic Presidents

April 1913-March 2004	ALL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	0.38	0.68	0.00	0.35	0.49	0.40	0.32	0.86	0.44	0.35	0.15	0.27	0.22
Median	0.16	0.47	0.00	0.00	0.00	0.27	0.00	0.32	0.00	0.04	0.00	0.04	0.30
Standard Deviation	1.43	1.58	1.61	1.04	1.32	1.10	0.89	1.91	1.20	1.40	1.94	1.76	1.88
p-value (m=0)	0.00	0.01	0.99	0.03	0.01	0.02	0.02	0.00	0.02	0.09	0.60	0.29	0.43
p(t test)	0.00	0.17	0.10	0.86	0.54	0.91	0.68	0.07	0.58	0.90	0.39	0.66	0.54
p(F test)	0.00	0.35	0.28	0.001	0.11	0.00	0.00	0.01	0.05	0.24	0.01	0.08	0.02
Mean % Change	P	P		P	P	P	P	P	P				
Month Effect (Mean)													
Month Effect (Var)				L		L	L	H	L		H		H

Figure 3: Mean % Change of All Commodities Index during Democratic presidents

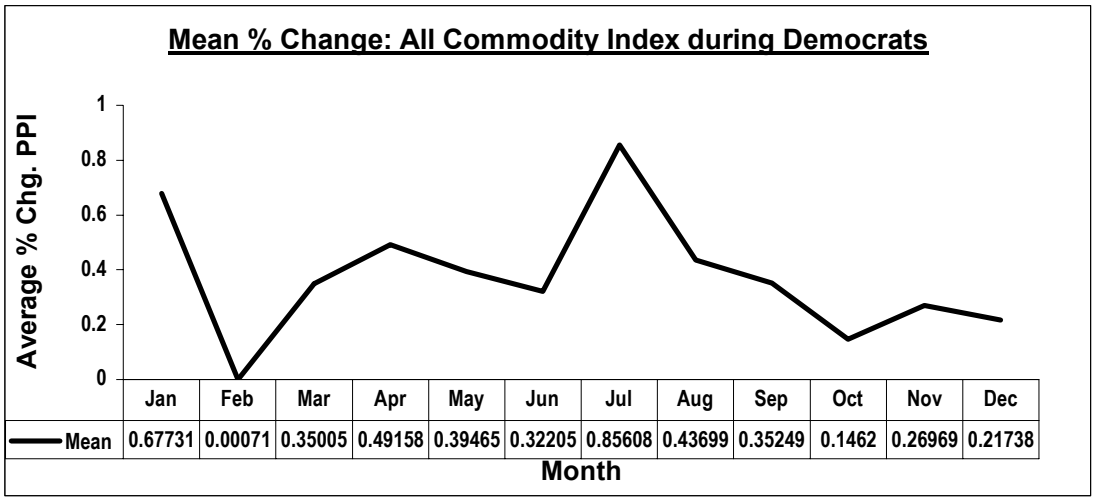

Figure 4: Mean % Change of All Commodities Index during Democrat vs. Republican presidents: Compared to entire data set (in red)

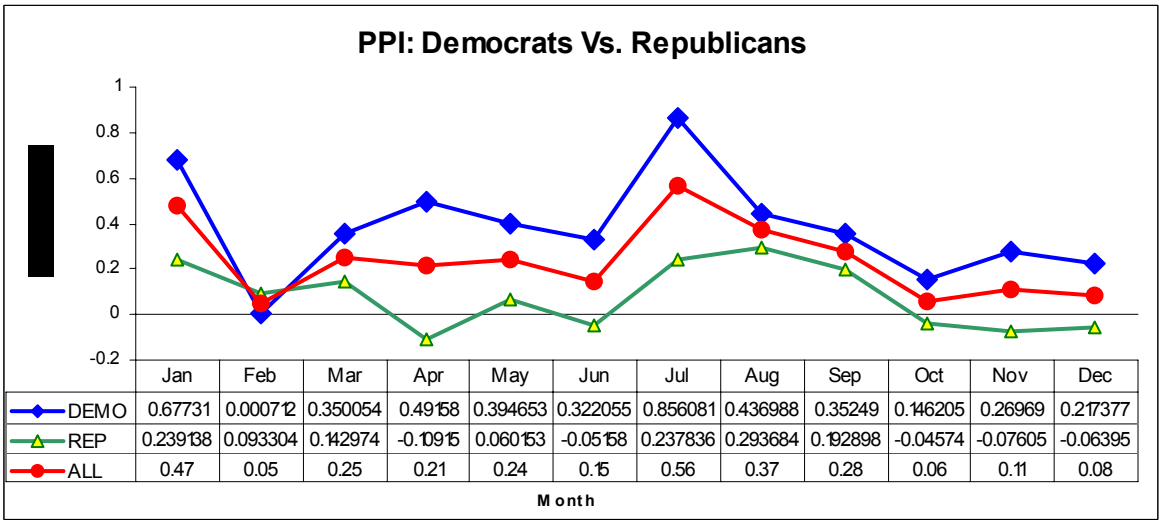

Table 9: Comparison of All Commodities Indexes During Republican and Democratic Presidents Over Three Sub-periods

Sub-Periods	Republican			Democrats		
	$\mu = 0$ $\mu \neq 0$	Month Effect (Mean)	Month Effect (Var.)	$\mu = 0$ $\mu \neq 0$	Month Effect (Mean)	Month Effect (Var.)
1913-1945	-0.05 (146)	None	11 Months All Lower Variances	0.41* (249)	None	March & Jan (Lower)
1946-1972	0.18* (143)	Jan, Feb, Mar, July (Positive)	Jan (Lower) Dec (Higher)	0.31* (181)	Apr (Lower)	6 Months (Lower) July & Oct (Higher)
1973-2004	0.29* (231)	Jan, May, June (Positive)	May & Nov (lower) Aug (Higher)	0.41* (144)	Nov (Lower)	Jan (Higher) May & Nov (Lower)

* Significantly different from zero at 0% level. Numbers in brackets are numbers of observations under each sub-period.

Table 10: Pairwise Granger Causality Tests: All Commodities Index (ACI), Finished Goods Index (FGI) and Oil Price- Monthly Data

Panel 1-1913 M01 2003 M12 / Lags: 4

Null Hypothesis:	Obs	F-Statistic	Probability
FGI does not Granger Cause OIL	257	2.60	0.04
OIL does not Granger Cause FGI		23.91	0.00
ACI does not Granger Cause OIL	257	2.03	0.09
OIL does not Granger Cause ACI		20.98	0.00