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# Relationship between Inflation News and High Frequency Stock Returns

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## Introduction

Increases or decreases in stock prices will determine how much an investor's wealth will shrink or grow in the stock market. One set of important factors that influences the stock market is macroeconomic indicators, like inflation news. The Consumer Price Index (CPI) and The Producer Price Index (PPI) are among the most important measures of inflation conditions and overall economic conditions. Adams, McQueen and Wood have already identified the relationship between inflation news and stock return. In their paper published in 2004, they found the unexpected increases in both PPI and CPI could cause stock prices to fall. In their paper, they explored the responses of stock intraday data and the unexpected changes in the Producer Price Index and Consumer Price Index before and on the news announcement date from 1977 to 1987.

Many researchers have already studied the relationship between inflation and stock prices. *Using daily data, Schwert (1981) finds a negative relationship between CPI surprises and stocks, McQueen and Roley (1993) find the negative relationship insignificant for both measures of inflation, and Flannery and Protopapadakis (2002) find both CPI and PPI effects. Using 1-hour horizons, Jain (1988) finds a significant response to CPI news but not to PPI news.*

There are also some other studies that show how stock responds to unexpected changes in inflation. *Ederington and Lee (1993, 1995) find that Treasury bonds, Eurodollar, and deutsche mark futures prices respond quickly (within seconds) to scheduled macroeconomic news, Patell and Wolfson (1984), Greence and Watts (1996) and Gosnell, Keown, and Pinkerton (1996) find that stock prices respond within an hour to firm-specific news.*

In this article, I extend the research of Adams, McQueen and Wood (2004) by using the same method from 2009 to 2012 for S&P500 firms. That is, I analyze how the intraday stock returns are affected by inflation news using unexpected changes in CPI (Consumer Price Index) and PPI (Producer Price Index) as the inflation indicators from 2009 to 2012. Also, I examine how fast stocks will reflect the inflation news at the inflation announcement days.

## Data Collection

Each month, the Bureau of Labor Statistics (BLS) releases actual inflation data, including seasonally adjusted monthly percentage changes in Producer Price Index (all finished goods) and Consumer Price Index (all items, all urban consumers). All the inflation news is announced at 8:30 A.M. EST, before the stock market opens (all EST times here).

Standardized unexpected changes in CPI and PPI are based on a model of seasonal random walk with a drift. Specifically, this method is borrowed from the Standardized Unexpected Earnings (SUE) method for studying momentum in Ronnie Sadka's (2005) paper, *Momentum and Post-Earnings-Announcement Drift Anomalies: The Role of Liquidity Risk*. In his paper, the formula for SUE is as follows:

$$SUE_{i,t} = \frac{E_{i,q} - E_{i,q-4} - c_{i,t}}{\sigma_{i,t}}$$

*Where $E_{i,q}$ is the most recent quarterly earnings announced as of month t for stock i (not including announcements in month t), $E_{i,q-4}$ is earnings for the prior four quarters, and $\sigma_{i,t}$ are the standard deviation and average, respectly, of ($E_{i,q}$- $E_{i,q-4}$) over the preceding eight quarters.*

Chan, Jegadeesh, and Lakonishok (1996), and Chordia and Shivakumar (2002) have previously used this measure. Here, I replace earnings with CPI and PPI data to get the standardized unexpected CPI and PPI. The difference between the standardized unexpected CPI or PPI and the actual CPI or PPI data is the unanticipated inflation. This method of calculating the unanticipated inflation is different from that in Adams, McQueen and Wood (2004), who use Money Market Services International (MMS) survey data as their measure of expected inflation, and the difference between the announced data and this survey data is unanticipated inflation.

The S&P500 all stock intraday data is from Wharton Research Data Services (WRDS), NYSE TAQ, consolidated trades from time 9:30:00 a.m. to 11:00:00 a.m. on announcement dates (both CPI and PPI announcement date) from year 2009 to 2012. Stocks are grouped into five different size portfolios by ranking their market capitalization based on the prior year's ending prices and shares outstanding (from year 2008 to 2011), which is the same as the method used by Adams, McQueen and Wood (2004). They also use portfolio returns to diversify away bid-ask bounce and firm-specific noise.

There are two different returns that will be used in this article; one is the announcement-spanning transaction return and the other is the trade-by-trade return. Announcement-spanning transaction return is calculated by using the stock's prior day's close price and the announcement day prices (like first 1 minute price, or first 5 minute price etc.). All the prices at the same time are

calculated into the trade weighted prices. In order to make it easier to follow the stock prices, I delete all prices before 9:30:00 a.m., following the stock market open time, from 9:30:00 a.m.

## Theory and Econometric Model

There are two models that will be used for my empirical tests:

First, in order to test the relationship between inflation news and stock returns, the following econometric model will be used:

$$R_t^q = \alpha + \beta^q * \Pi_t^q + \varepsilon_t^q$$

Here, $R_t^q$ is the transaction return for $q^{th}$ size-based portfolio (size 5 is the smallest, 1 is the largest portfolio) in the specific time interval (minute, hour, day) at the inflation announcement day, including CPI announcement day and PPI announcement day. $\Pi_t^q$ is the unanticipated inflation portion. As mentioned before, both unanticipated changes in CPI and PPI are calculated in the same way by using SUE method.

The null hypothesis is inflation has no effects on stock returns, i.e., $\beta^q=0$. The empirical work will test this null hypothesis and show the significance level accordingly. I run 10 regressions for these 5 size-based portfolios for CPI and PPI separately, at different time intervals on each announcement day.

Second, In order to test how fast stocks response to inflation, I create the following model:

$$R_{t+i}^q = \alpha + \beta_i^q * \Pi_t^q + \varepsilon_{t+i}^q$$

Here, $R_{t+i}^q$ is the return for $q^{th}$ size-based portfolio (size 1 is the smallest, 5 is the largest portfolio) in the $t+i^{th}$ interval at the inflation announcement day. $\Pi_t^q$ is the unanticipated inflation portion. The null hypothesis is inflation has no effects on stock returns, where, $\beta_i^q=0$ ($H_2$: $\beta_1=0$, $\beta_2=0\ldots\ \beta_{19}=0$) for PPI and CPI news, respectively.

## Empirical Results

Table 1: Summary Statistics for Size-based Quintile Portfolios on PPI and CPI Announcement Days (January 2009 – December 2012)

| | 1 | 2 | 3 | 4 | 5(Large) |
|---|---|---|---|---|---|
| A. PPI: 15-minute horizon returns: | | | | | |
| Mean Return (%) | 1.128 | .680 | .559 | .407 | .601 |
| Standard Deviation (%) | 8.470 | 7.241 | 7.250 | 6.315 | 6.001 |
| Number of Stocks in Portfolio that trade: | | | | | |
| Average | 91 | 97 | 98 | 98 | 98 |
| Maximum | 98 | 101 | 100 | 101 | 99 |
| Minimum | 79 | 89 | 95 | 92 | 95 |
| Trade-by-trade returns: | | | | | |
| Mean Return (%) | .001 | .0006 | .0004 | .0001 | .0002 |
| Standard Deviation (%) | .291 | .252 | .240 | .193 | .170 |
| Number of Stocks in Portfolio that trade: | | | | | |
| Average | 84 | 97 | 99 | 97 | 98 |
| Maximum | 88 | 99 | 102 | 100 | 100 |
| Minimum | 78 | 96 | 97 | 95 | 97 |
| B. CPI: 15-minute horizon returns: | | | | | |
| Mean Return (%) | 2.029 | 1.530 | 1.253 | 1.041 | 1.126 |
| Standard Deviation (%) | 11.546 | 8.977 | 8.748 | 7.537 | 7.257 |
| Number of Stocks in Portfolio that trade: | | | | | |
| Average | 97 | 100 | 100 | 100 | 100 |
| Maximum | 101 | 101 | 102 | 101 | 101 |
| Minimum | 90 | 100 | 99 | 100 | 99 |
| Trade-by-trade returns: | | | | | |
| Mean Return (%) | .0018 | .001 | .0007 | .00035 | .00034 |
| Standard Deviation (%) | .339 | .302 | .264 | .281 | .163 |
| Number of Stocks in Portfolio that trade: | | | | | |
| Average | 84 | 98 | 99 | 98 | 98 |
| Maximum | 88 | 99 | 102 | 100 | 100 |
| Minimum | 78 | 96 | 97 | 95 | 97 |

Note: The 15-minute and trade-by-trade return are for the first 15 minutes on the announcement day for PPI(panel A) and CPI(Panel B). Transaction data is from TAQ data from WRDS. Sizes(market capitalization) of portfolio are calculated each year on the prior year's ending price and shares outstanding.

Table 1 summarizes the statistics for 15-minute transaction return and trade-by-trade return, their mean return and standard deviation and also the number of stocks trades for each portfolios. Because the portfolio is ranked by the prior year's market capitalization, I delete some new

stocks that recently joined S&P 500, about 6 for each portfolio. Panel A is a summary for PPI announcement day, and panel B is a summary for CPI announcement day. The 15-minute transaction return on CPI announcement day is higher than on PPI announcement day. Relative to other traded stocks in each portfolio, large stocks are more likely to trade in the first 15 minutes of the day.

Table 2 shows Beta coefficients and p-values from a regression of size-based quintile portfolio announcement-spanning transaction return on PPI and CPI surprises ranging from 1 minute (first row) to 1 day (last row). PPI results are reported in panel A, and CPI results are in panel B.

The results in Table 2 show a negative relationship between stock returns and unanticipated inflation, especially for PPI results in panel A. In panel A, a PPI surprise of 1 percentage point induces a large stock portfolio response of -0.405% in the first 1 minute of trading. It is significant that the PPI announcement has a negative effect on stock returns in different time interval except 1 day. That is, 20 out of 25 regressions in panel A are significant at the 99% confidence interval. In panel B, there are only a few regressions that show insignificant negatively correction. One reason for stock return significantly negative with PPI but not CPI is that PPI announcement is often one day earlier than CPI. The PPI measure the prices of good in the production process, which is sooner than CPI. Also, when the PPI announcement is released, people can use it to predict the coming CPI announcement.

Table 3 and Table 4 are the results of testing how fast the stock responds to PPI and CPI announcement. In panel A in both tables, the stocks do not “instantaneously” move to a new price soon after inflation news is released.

## Conclusion

During the period 2009 to 2012, stock returns are negatively related with the unanticipated portion PPI on the announcement day. Stock returns are insignificant related with CPI. Stocks do not “instantaneously” move to a new price after the inflation news. It takes some time for the stock to respond to the inflation information. Further studies will cover the period from 2001 to 2012 and will compare the results from Adams, McQueen and Wood (2004) to check how the inflation news affects stock return in different period.

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Table 2 Beta Coefficients and P-Values from a regression of size-based Quintile Portfolio Returns on CPI and PPI surprises by using the model of $R_t^q = \alpha + \beta^q * \Pi_t^q + \varepsilon_t^q$

| | **A. PPI** | | | | | **B. CPI** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Horizon | 5 | 4 | 3 | 2 | 1 | **5** | **4** | 3 | 2 | 1 |
| 1 minute | -.405 | -.174 | -.291 | -.154 | -.224 | .243 | -.017 | -.073 | .817 | .097 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.258) | (.884) | (.493) | (.427) | (.088) |
| 5 minutes | -.372 | -.161 | -.283 | -.15 | -.224 | .103 | -.017 | -.089 | .098 | .190 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.632) | (.885) | (.391) | (.330) | (.044) |
| 15 minutes | -.271 | -.186 | -.351 | -.154 | -.275 | .073 | -.006 | .033 | .065 | .132 |
| | (.000) | (.002) | (.000) | (.007) | (.000) | (.721) | (.959) | (.752) | (.490) | (.172) |
| 1 hour | -.314 | -.148 | -.241 | -.194 | -.154 | .169 | .049 | .033 | -.100 | .091 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.423) | (.663) | (.752) | (.317) | (.354) |
| 1 day | .317 | .128 | .122 | .53 | .139 | -.603 | -.139 | -.523 | .303 | -.0713 |
| | (.170) | (.000) | (.000) | (.134) | (.000) | (.459) | (.443) | (.029) | (.494) | (.891) |

Note: $R_t^q$ is the announcement-spanning transaction return at different time, from at 1 minute, to 1 day. $\Pi_t^q$ is the unanticipated percentage portion of PPI or CPI. 5 size-based portfolios are calculated by the prior year's market capitalization, from small (1) to large (5).

Table 3 Beta Coefficients and p-Values from the regression of Size-Based Quintile Portfolio Returns on PPI Surprises Using 1-Minute Calendar Returns and Trade-by-Trade Returns $R_{t+i}^{q} = \alpha + \beta_i^q * \Pi_t^q + \varepsilon_{t+i}^q$

| | **A. 1-minute Intervals** | | | | | **B. Trade-by-Trade Intervals** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Horizon | 5 | 4 | 3 | 2 | 1 | **5** | **4** | 3 | 2 | 1 |
| 0 | .495 | .759 | .828 | .778 | .947 | -.010 | -.012 | -.018 | -.016 | -.015 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.010) | (.042) | (.003) | (.011) | (.046) |
| 1 | .489 | .763 | .821 | .765 | .949 | -.014 | -.009 | -.011 | .000 | -.010 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.038) | (.046) | (.568) | (.089) |
| 2 | .489 | .761 | .809 | .772 | .942 | -.001 | -.009 | -.001 | -.003 | -.014 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.681) | (.023) | (.797) | (.518) | (.005) |
| 3 | .489 | .761 | .806 | .773 | .932 | -.005 | -.003 | -.003 | -.003 | .003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.039) | (.442) | (.397) | (.308) | (.444) |
| 4 | .489 | .763 | .808 | .773 | .937 | -.006 | -.007 | -.002 | -.003 | -.006 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.026) | (.020) | (.498) | (.341) | (.087) |
| 5 | .489 | .761 | .808 | .773 | .939 | .001 | -.005 | -.003 | -.000 | .003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.685) | (.045) | (.371) | (.877) | (.314) |
| 6 | .489 | .761 | .808 | .773 | .939 | -.002 | -.001 | -.010 | .001 | .003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.271) | (.580) | (.131) | (.674) | (.363) |
| 7 | .489 | .761 | .808 | .773 | .939 | -.001 | -.008 | -.086 | -.001 | -.006 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.076) | (.611) | (.025) |
| 8 | .489 | .761 | .808 | .773 | .939 | -.003 | .004 | -.052 | -.000 | .000 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.339) | (.067) | (.073) | (.686) | (.964) |
| 9 | .489 | .761 | .808 | .773 | .939 | .002 | -.003 | .146 | -.003 | -.005 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.308) | (.141) | (.088) | (.194) | (.019) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | .489 | .761 | .808 | .773 | .938 | -.002 | .000 | -.002 | .000 | -.002 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.342) | (.846) | (.293) | (.796) | (.359) |
| 11 | .489 | .761 | .808 | .773 | .938 | -.002 | -.004 | .000 | -.001 | .001 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.104) | (.037) | (.592) | (.464) | (.577) |
| 12 | .489 | .761 | .808 | .773 | .938 | .000 | -.002 | -.002 | .001 | -.008 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.945) | (.153) | (.164) | (.442) | (.007) |
| 13 | .489 | .761 | .808 | .773 | .938 | .000 | -.003 | -.002 | .000 | .002 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.662) | (.035) | (.247) | (.845) | (.381) |
| 14 | .489 | .761 | .808 | .773 | .938 | -.003 | .000 | -.167 | -.001 | -.003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.021) | (.798) | (.084) | (.385) | (.080) |
| 15 | .489 | .761 | .808 | .773 | .938 | .002 | .000 | .166 | -.001 | -.003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.07) | (.878) | (.086) | (.424) | (.093) |
| 16 | .489 | .761 | .808 | .773 | .938 | .000 | -.001 | -.003 | -.001 | .000 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.616) | (.467) | (.021) | (.412) | (.780) |
| 17 | .489 | .761 | .808 | .773 | .938 | .002 | .000 | .000 | -.002 | -.002 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.114) | (.857) | (.846) | (.141) | (.238) |
| 18 | .489 | .761 | .808 | .773 | .938 | -.003 | -.004 | -.002 | .000 | .002 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.044) | (.008) | (.116) | (.643) | (.339) |
| 19 | .489 | .761 | .808 | .773 | .938 | .002 | .000 | .002 | .002 | -.003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.092) | (.681) | (.228) | (.200) | (.095) |

Note: $R_{t+i}^{q}$ is the return for the q[th] size-based portfolio(1 is smallest, and 5 is largest) in the i[th] interval after PPI announcement made at time t. $PPI_{t}^{q}$ is the unanticipated percentage portion. Table entries are $\beta_{i}^{q}$ coefficient with the related p-values.

Table 4 Beta Coefficients and p-Values from the regression of Size-Based Quintile Portfolio Returns on CPI Surprises Using 1-Minute Calendar Returns and Trade-by-Trade Returns $R_{t+i}^{q} = \alpha + \beta_i^q * \Pi_t^q + \varepsilon_{t+i}^q$

| | **A. 1-minute Intervals** | | | | | **B. Trade-by-Trade Intervals** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Horizon | 5 | 4 | 3 | 2 | 1 | **5** | **4** | 3 | 2 | 1 |
| 0 | .495 | .759 | .828 | .778 | .947 | .014 | .016 | .023 | -.078 | .086 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.908) | (.535) | (.528) | (.007) | (.065) |
| 1 | .489 | .763 | .821 | .765 | .949 | -.051 | -.033 | -.032 | -.075 | .016 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.662) | (.102) | (.323) | (.002) | (.565) |
| 2 | .489 | .761 | .809 | .772 | .942 | -.005 | .016 | .008 | .058 | .056 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.970) | (.331) | (.698) | (.002) | (.014) |
| 3 | .489 | .761 | .806 | .773 | .932 | .028 | .027 | -.004 | .038 | -.008 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.014) | (.074) | (.809) | (.024) | (.654) |
| 4 | .489 | .763 | .808 | .773 | .937 | -.005 | .012 | -.017 | -.026 | -.033 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.657) | (.447) | (.250) | (.102) | (.062) |
| 5 | .489 | .761 | .808 | .773 | .939 | .001 | .011 | -.004 | .010 | .014 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.943) | (.386) | (.771) | (.475) | (.375) |
| 6 | .489 | .761 | .808 | .773 | .939 | .041 | -.014 | .035 | -.015 | -.036 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.191) | (.009) | (.224) | (.019) |
| 7 | .489 | .761 | .808 | .773 | .939 | -.003 | .035 | .001 | 032 | -.024 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.754) | (.000) | (.922) | (.015) | (.073) |
| 8 | .489 | .761 | .808 | .773 | .939 | -.008 | -.008 | .008 | -.012 | .029 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.346) | (.399) | (.403) | (.303) | (.024) |
| 9 | .489 | .761 | .808 | .773 | .939 | -.004 | -.004 | -.017 | .004 | -.052 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.624) | (.653) | (.153) | (.725) | (.000) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | .489 | .761 | .808 | .773 | .938 | .030 | -.021 | .009 | -.007 | .010 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.000) | (.022) | (.413) | (.441) | (.471) |
| 11 | .489 | .761 | .808 | .773 | .938 | -.010 | -.030 | .006 | .009 | -.004 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.139) | (.001) | (.526) | (.314) | (.746) |
| 12 | .489 | .761 | .808 | .773 | .938 | .006 | -.003 | -.018 | .001 | -.015 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.331) | (.777) | (.055) | (.951) | (.155) |
| 13 | .489 | .761 | .808 | .773 | .938 | .000 | -.013 | -.004 | -.005 | .020 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.993) | (.107) | (.658) | (.518) | (.048) |
| 14 | .489 | .761 | .808 | .773 | .938 | -.008 | -.011 | .012 | -.017 | .012 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.182) | (.099) | (.146) | (.057) | (.197) |
| 15 | .489 | .761 | .808 | .773 | .938 | .003 | .000 | -.003 | .031 | -.003 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.634) | (.996) | (.681) | (.000) | (.767) |
| 16 | .489 | .761 | .808 | .773 | .938 | .018 | -.005 | -.016 | -.025 | -.001 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.002) | (.459) | (.066) | (.002) | (.945) |
| 17 | .489 | .761 | .808 | .773 | .938 | .007 | .003 | .007 | -.003 | -.023 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.222) | (.698) | (.347) | (.739) | (.044) |
| 18 | .489 | .761 | .808 | .773 | .938 | .009 | -.011 | -.027 | -.001 | -.017 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.099) | (.093) | (.000) | (.869) | (.046) |
| 19 | .489 | .761 | .808 | .773 | .938 | -.003 | -.006 | .004 | -.003 | -.018 |
| | (.000) | (.000) | (.000) | (.000) | (.000) | (.590) | (.330) | (.588) | (.605) | (.076) |

Note: $R_{t+i}^{q}$ is the return for the q[th] size-based portfolio(1 is smallest, and 5 is largest) in the i[th] interval after CPI announcement made at time t. $CPI_t^q$ is the unanticipated percentage portion. Table entries are $\beta_i^q$ coefficient with the related p-values.