The Effects of Macroeconomic Data Surprises on Implied Volatility

By

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Abstract

The implied volatility of equity options is often said to be inversely related to the value of the underlying asset. It is expected that when the value of an asset decreases, implied volatility increases, and the reverse is also anticipated. We test this intuition by observing the effects of nine economic data announcements on the VIX and S&P 500 indices. Specifically, we look for an increase in the VIX along with a decrease in the S&P 500 following worse than expected news, and the reverse for positive surprises. We analyze the effects of announcements regarding CPI, core CPI, non-farm payrolls, housing starts, GDP, retail sales, the Leading Indicators index, capacity utilization and construction spending, and find positive surprises in non-farm payrolls to cause negative changes in the VIX. We also observe a similar relationship between surprises in core CPI and changes in the VIX, and find unexpected core CPI figures to also affect the value of the S&P 500. Nevertheless, both the VIX and S&P 500 are not influenced by the other macroeconomic surprises at a statistically significant level.

I. Introduction

Volatility is the standard deviation of an asset's return over a period of time. Historical volatility is calculated using the following equations where S_i is defined as the value of the asset at time i:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (u_i - \bar{u})^2}{n-1}} \qquad u_i = \ln\left(\frac{S_i}{S_{i-1}}\right)$$

Implied volatility, on the other hand, is a measure of the market's expectation of future volatility and is calculated based on the value of traded options using an assumed option pricing model. Consequently, we expect the market's expectation of volatility to react to variables that affect the underlying asset. This hypothesis is supported by corporate finance theories which suggest that as equity is devalued, leverage ratios increase and stock prices become more volatile.

We attempt to test the hypothesis by examining how implied volatility reacts to changes in the price of the S&P 500 index. Since the S&P 500 is regarded as a market portfolio, a portfolio with negligible unsystematic risk, the clearest price changes will occur as a result of changes to the economy. Thus, we try to observe changes to both the S&P 500 and volatility in relation to macroeconomic data surprises, the difference between the expected and realized value for macroeconomic indicators. We expect the value of the S&P 500 to decrease and its implied volatility to increase with negative surprises, and the

reverse for positive surprises. The VIX index is used as the measure of the implied volatility.

For the purposes of this paper, we define a surprise to be the difference between an actual and an expected value for an economic data release. We obtain expected values in two ways; by forecasting a figure using the outputs of an autoregression on historical values, and by gathering market expectation figures from Yahoo Finance.[1] For our four main macroeconomic statistics, the Consumer Price Index (CPI), non-farm payroll employment, housing starts, and gross domestic product (GDP), we forecast expectations using an autoregressive model as well as gathering figures. For our remaining statistics, retail sales, the Leading Indicators index, capacity utilization and construction spending, we forecast based on only the gathered figures.

II. Review of Literature

The most extensive research on the relationship between economic data surprises and implied volatility was conducted by Nofsinger and Prucyk (2003). In their paper, 340 pre-market announcements from 1993 to 1994 are separated into three equal groups based on the resulting changes in the S&P 500. For example, if a particular announcement causes the index to appreciate more than the rate observed with two-thirds of the other announcements, it is placed into a group among other positive announcements. The results of Nofsinger and Prucyk (2003) show that negative

[1] Yahoo Finance obtains market expectations for economic data from Briefing.com. We believe that Briefing is in the business of surveying market analysts for their opinions.

announcements, on average, cause a spike in the implied volatility of S&P 100 options. For positive announcements, changes in implied volatility are less dramatic, but negative. Moreover, when announcements are further classified by macroeconomic statistic, Nofsinger and Prucyk (2003) find that the largest drop in consumer spending causes implied volatility to spike to over 38% while non-farm payrolls have the second biggest effect with an increase to 29%.

However, Ederington and Lee (1996) find that, on average, implied volatility in financial markets decrease on days with announcements regardless of the content of the announcement. They attribute this observation to the fact that some uncertainty is taken out of the market through data releases.[2] Furthermore, Flannery and Protopapadakis (2002) analyze the effects of 17 macroeconomic statistics on the S&P 500 from 1988 to 1992 and find only CPI and PPI to cause significant changes. Their results question the accuracy of the grouping in the analysis of Nofsinger and Prucyk (2003).

Finally, Kim and Verrecchia (1991a) confirm that traders react to the surprise factor in economic data releases. Their analysis indicates that greater anticipation for an announcement is followed by larger jumps in market portfolio prices. Anticipation is shown to be inversely related to the amount of private information available prior to a data release, and only small price changes are witnessed in situations where private information and opinions are abundant.

[2] Ederington and Lee (1996) do not observe changes in the implied of S&P 500 option. Instead, the implied volatility of T-bond and Eurodollar options are found to decrease after non-farm payroll and CPI announcements at a significance level of 0.01.

III. Data

The VIX and S&P 500 Indices

The VIX index represents the implied volatility of the value of the S&P 500. Values for the index are quoted percentages and represent the implied volatility of a synthetic, 30-day, at-the-money option on the S&P 500. For example, a VIX level of 25 indicates that the annualized implied volatility of the synthetic option for the next 30 days to be 25%. Hence, the VIX index is often referred to as a fear gauge. When the index was first introduced in 1993, its values were calculated based on eight at-the money call and put options on the S&P 100. Today, the calculation is based off of a wide range of S&P 500 options that are traded on the Chicago Board of Options Exchange. The options vary according to their strike price and maturity.

S&P 500 and VIX Index values are obtained from Yahoo Finance according to the date of an economic data release. Since economic data announcements occur at either 8 or 10 a.m., we obtain market close values for both indices for the trading day prior to an announcement as well as market open and close values for the trading day during which the announcement is made. For instance, to see how the market reacts to a surprise in employment, a macroeconomic statistic usually released on a Friday, we compare the market close values from Thursday to both the market open and close values from Friday. We compile data in this manner for a five-year time period from January 2003 to December 2007.

Macroeconomic Data

Monthly values along with their release dates for the first four macroeconomic statistics, the Consumer Price Index (CPI), non-farm payroll employment, housing starts, and gross domestic product (GDP), are obtained from the Bureau of Labor statistics, the Census Bureau, and the Bureau of Economic Analysis for the years 1998 through 2007. The values from 1998 through 2002 are used in autoregressions that forecast the market expectation figures from 2003 to 2007. For retail sales, the Leading Indicators index, capacity utilization and construction spending, monthly values from 2003 to 2007 are obtained from Yahoo Finance.

A description of the macroeconomic statistics and the reason for their selection is discussed below. Furthermore, Table 1 offers descriptive statistics on announcement figures and on surprise factors calculated based on published expectations.

a. The Consumer Price Index (CPI) gauges inflation in the price of consumer goods and is expected to have a significant impact on asset values. As prices of consumer goods increase, the purchasing power of individuals decrease, causing the economy to contract and equity prices to decline. Monthly changes in CPI are obtained from the Bureau of Labor Statistics as seasonally adjusted rates. We also look at changes in core CPI, the basket of goods that does not contain products in the categories of energy or food.

b. Non-farm payroll employment measures the number of jobs in the economy from non-farm businesses and government agencies and indicates the productive capability of a nation. A decline in employment indicates less job creation from new businesses as well as a contraction in revenues or profitability from existing businesses. Less than expected growth in non-farm payrolls foreshadow slower economic growth and declining equity values. We obtain seasonally adjusted monthly growth figures for non-farm payrolls from the Bureau of Labor Statistics, quoted in thousands.

c. Housing starts indicate the number of residential units under construction. This figure represents over 25% of all investment and is a good indicator of the overall health of the economy. As the number of houses under construction declines, economists generally expect a future contraction in overall spending. Equity markets react by predicting slower growth and devaluing stocks. The Census Bureau publishes seasonally adjusted, monthly figures for housing starts, also quoted in thousands.

d. GDP is the value of all goods and services produced in an economy, and annualized percent changes in this statistic are released quarterly by the Bureau of Economic Analysis. A higher or lower than expected value for GDP growth specifies that the economy has expanded or contracted differently than what was forecasted, and the market should adjust its valuations accordingly.

e. Retail sales are heavily tied to the health of the economy since receipts from retail stores account for almost half of total consumption. We look at monthly percent changes in retail sales excluding auto sales due to the seasonality of car shopping. Surprises in retail sales should indicate an unexpected growth or contraction in the economy and indicate a needed correction in equity values.

f. Leading Indicators is a ten component index of predictive economic statistics, and changes in the index are published monthly as a percentage. The value of the index is based off of the spread between 10-year treasury notes, measure of the money supply, length of the manufacturing workweek, new orders of consumer goods and materials, the value of the S&P 500 index, vendor performance, average weekly level of jobless claims, new issuances of building permits, consumer expectations, and new orders for non-defense capital goods. Leading Indicators encompasses many aspects of the economy gauged with the original statistics, but is a single figure. A drop in the value of this index should signal a slow down in the economy and cause devaluation in stocks.

g. Monthly capacity utilization figures measure the available slack in industrial production and is a secondary way of measuring inflation. When utilization surpasses 85%, the economy is said to be under inflationary pressures as manufacturers increase prices and decrease the purchasing power of individuals. Therefore, we also analyze changes in the VIX and S&P 500 indices in relation to

surprises in capacity utilization. We expect stock prices to decrease as a result of inflation due to increased capacity utilization. Finally, it is important to note that a significant drop in capacity utilization may also indicate a decrease in economic output, resulting in ambiguous changes in implied volatility.

h. Construction spending gauges expenditures on all new constructions, residential, non-residential and public, within an economy. It is a broader yet more volatile measure than housing starts, which only counts the number of residential units under construction. Together, residential, non-residential and public constructions represent the majority of investment in the economy, and changes in construction spending can affect the economy and equity prices. Monthly changes in construction spending are reported as percentages.

Table 1

Descriptive Statistics for Economic Data

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Mean Announcement	0.252%	0.175%	106	1800	3.11%
Standard Deviation	0.324%	0.100%	109	280	1.49%
Mean Surprise	-0.002%	-0.012%	-21	8	-0.24%
Standard Deviation	0.142%	0.101%	86	107	0.70%

	Retail Sales	*Leading Indicators*	*Capacity Utilization*	*Construction Spending*
Mean Accouncement	0.422%	0.018%	79.77%	0.173%
Standard Deviation	0.601%	0.391%	2.27%	0.646%
Mean Surprise	0.046%	-0.049%	-0.039%	-0.043%
Standard Deviation	0.451%	0.183%	0.315%	0.583%

IV. Predicting Market Expectations Using Autoregressions

To predict the market's expectation of releases on the first four macroeconomic statistics (CPI, non-farm payroll employment, housing starts, and GDP), we use a model based on historical releases as shown by the following equation:

$$X_t = a + \sum_{i=1}^{k} (b_{t-i} \times X_{t-i})$$

In this model, X_t is the prediction for the market's expectation of a release and b_{t-i} is the coefficient on a release that has occurred during a prior period. To determine a value for the coefficients, autoregressions are run on historical releases. If the coefficient is statistically significant at a 90% confidence interval, the prior release and its coefficient are used in the equation. For example, the autoregression on non-farm payrolls shows that three months of lag are statistically explanatory, indicating that the figures from October, November and December of 2002 should be used to predict a value for January 2003. Furthermore, new autoregressions are run after every six months to update the coefficient and intercept values. Predictions for July 2003 are based off of autoregressions on figures from January 1998 to June 2003 while predictions for January 2004 are based off of autoregressions on figures from January 1998 to December 2003.

Overall, the autoregessions seem to indicate that changes in non-farm payrolls are the most dependent on previous changes. As shown in Table 2, three months of releases are statistically explanatory of next month's release in all ten autoregressions on non-farm payrolls. On average, a future change in non-farm payrolls seems to be best predicted by summing the intercept value with 25% of the release from one month prior, 35% of the release from two months prior, and 25% of the release from three months prior.

Table 2

Autoregressions on Non-farm Payrolls

Coefficients	Jan-98-Dec-02	Jan-98-Jun-03	Jan-98-Dec-03	Jan-98-Jun-04	Jan-98-Dec-04	Jan-98-Jun-05	Jan-98-Dec-05	Jan-98-Jun-06	Jan-98-Dec-06	Jan-98-Jun-07
Intercept	2.77	3.84	7.73	11.57	12.71	15.20	16.62	19.43	18.58	18.16
(p-value)	*0.884*	*0.824*	*0.632*	*0.469*	*0.420*	*0.320*	*0.278*	*0.196*	*0.205*	*0.200*
1st Lag	0.258	0.253	0.251	0.261	0.273	0.267	0.271	0.299	0.232	0.289
(p-value)	*0.067*	*0.049*	*0.039*	*0.016*	*0.016*	*0.014*	*0.010*	*0.022*	*0.003*	*0.003*
2nd Lag	0.401	0.372	0.358	0.356	0.335	0.366	0.335	0.307	0.322	0.314
(p-value)	*0.003*	*0.003*	*0.003*	*0.002*	*0.003*	*0.001*	*0.002*	*0.002*	*0.002*	*0.001*
3rd Lag	0.232	0.257	0.264	0.250	0.246	0.226	0.245	0.232	0.294	0.230
(p-value)	*0.098*	*0.044*	*0.031*	*0.035*	*0.032*	*0.038*	*0.021*	*0.004*	*0.018*	*0.016*

The percent change in CPI proves to be unrelated to previous changes for the monthly figures up to June 2005. However, autoregressions that include releases after June 2005 indicate that a change in CPI can be predicted based on the figures from the previous two months, as shown in the Table 3. Accordingly, market expectations for the months after December 2005 are calculated as a constant value of about 0.23% plus 30% of the change from one month prior less 35% of the change from two months prior. For December 2005 and before, we formulate an expectation by taking a simple average of all prior releases and report it in place of intercept values.

Table 3

Autoregressions on CPI

Coefficients	Jan-98-Dec-02	Jan-98-Jun-03	Jan-98-Dec-03	Jan-98-Jun-04	Jan-98-Dec-04	Jan-98-Jun-05	Jan-98-Dec-05	Jan-98-Jun-06	Jan-98-Dec-06	Jan-98-Jun-07
Intercept	0.2	0.2	0.2	0.2	0.2	0.2	0.237	0.243	0.221	0.220
(p-value)							*0.000*	*0.000*	*0.000*	*0.000*
1st Lag							0.294	0.276	0.330	0.336
(p-value)							*0.003*	*0.004*	*0.001*	*0.000*
2nd Lag							-0.383	-0.364	-0.360	-0.323
(p-value)							*0.000*	*0.000*	*0.000*	*0.001*

Market expectations for changes in core CPI and GDP are also calculated as a simple average of prior figures due to insignificant autoregression results. For core CPI, the expectation is calculated to be 0.2% for every month, while the average GDP growth rate is usually an annualized figure of 3.3%. Since housing starts are expected to have an upward trend due to economic and population growth, we base expectations for this figure on a six month historical average. A plot of the historical averages can be seen in Appendix A for core CPI and GDP and in Figure 3 for housing starts.

Overall, the market expectations that we forecast seem to correlate well with the market expectations found on Yahoo Finance for economic releases where an autoregressive relationship exists. As can be seen in Figures 1 and 2, expectations forecasted using autoregressions for changes in CPI and non-farm payroll move similarly to the published expectations over time. The exception to this observation can be seen in Figure 3. The results of six month historical averaging for housing starts appear to correlate well with the published expectations.

Figure 1

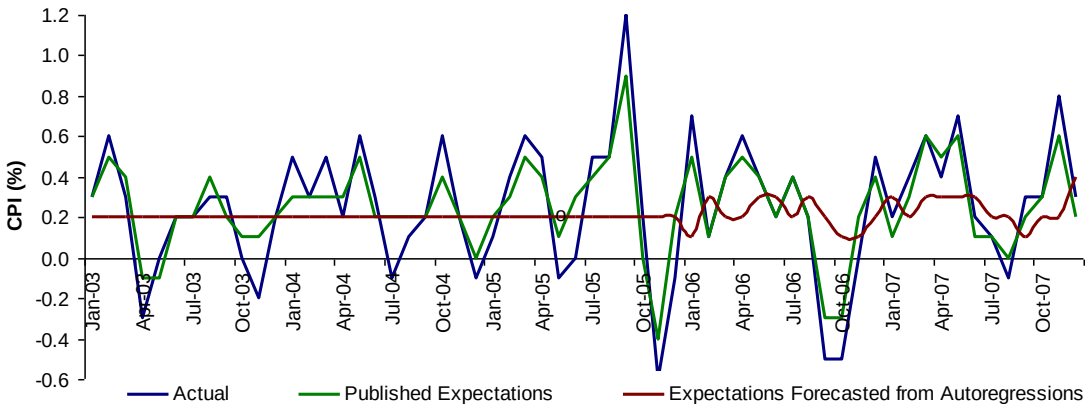


Figure 2

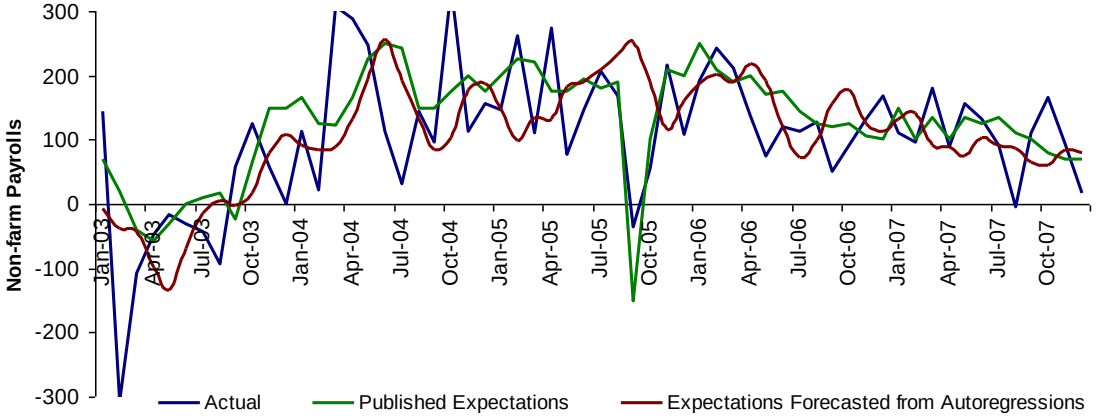
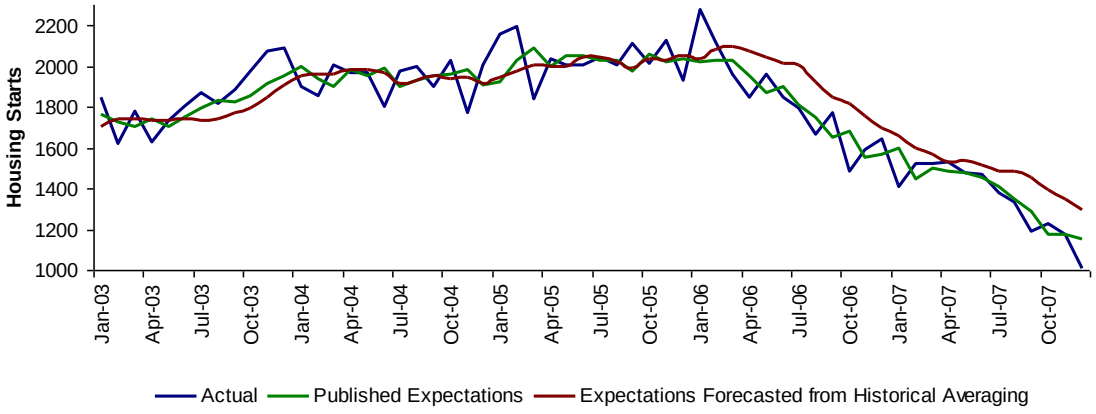


Figure 3



V. Regressions Against the VIX and S&P 500

To run regressions against changes in the VIX and S&P 500, we calculate surprise factors for each economic data release by subtracting either the market expectation that we

calculate or the published expectation from the realized values. Effectively, the surprise factor is negative if any realized figure is lower than market expectations. Changes in the VIX and S&P 500 indices are calculated as their values at market close on the day of an economic data release less their values at market close on the previous trading day. By running regressions on changes in the VIX and S&P 500 indices against the corresponding surprise factors, we obtain a relationship between economic data surprises and implied volatility, and economic data surprises and equity prices.

Surprises calculated from the expectations that we forecast prove to be insignificantly related to changes in the VIX. We see in Table 4 that the coefficients on a surprise in non-farm payrolls, housing starts and GDP are negative as expected, but none are statistically significant at a confidence interval of 90%. Furthermore, a change in the value of the VIX is positively correlated with a surprise in core CPI, but negatively correlated with a surprise in CPI, a counterintuitive result. Of the other five economic indicators, the coefficients for a surprise in core CPI and non-farm payrolls are the most significant with p-values of 0.2 and 0.3, respectively.

Table 4

VIX Regressions Based on Expectations Forecasted from Autoregressions

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Intercept	-0.154	-0.108	0.056	-0.352	0.079
Coefficient	-0.171	2.13	-0.001	-0.00004	-0.061
p-value	0.698	0.202	0.303	0.968	0.781
R^2	0.003	0.028	0.018	0.00003	0.005

Changes in the S&P 500 index also prove to be insignificantly correlated with the surprises calculated from the expectations that we forecast. In Table 5, a positive surprise in non-farm payrolls, housing starts and GDP are shown to increase the value of the S&P 500 while higher than expected results for core CPI decrease its value. However, regression results show that coefficients on surprises in non-farm payrolls, housing starts and GDP are not statistically significant beyond a 50% confidence interval while a higher than expected CPI produces gains in the S&P 500.

Table 5

S&P 500 Regressions Based on Expectations Forecasted from Autoregressions

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Intercept	0.031	-0.531	-1.722	1.872	-0.334
Coefficient	0.646	-23.623	0.008	0.002	0.367
p-value	0.869	0.109	0.582	0.816	0.852
R^2	0.0005	0.044	0.005	0.001	0.002

When we run the regressions using surprise factors calculated from the published expectations, we find the results to be slightly more promising. In Table 6, the coefficients on surprises in non-farm payrolls, housing starts and GDP are still negative, but with a much improved p-value of 0.113 for the coefficient on surprises in non-farm payrolls. The regression on surprises in non-farm payrolls indicates that the unexpected creation of 100,000 jobs coincides with a 0.2 percentage point reduction in the VIX. Furthermore, the coefficient on surprises in CPI becomes positive as we would expect. Looking at how the new surprise factors relate to the value of the S&P 500, we find p-values to be much improved. However, only the coefficient on surprises in core CPI is

statistically significant at a 90% confidence interval. A surprise increase of 0.1% in monthly core CPI is predicted to decrease the value of the S&P 500 by nearly 2.3 points.

Table 6

VIX Regressions Based on Published Expectations

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Intercept	-0.161	-0.146	-0.017	-0.351	0.057
Coefficient	0.313	1.331	-0.002	-0.0003	-0.144
p-value	0.751	0.337	0.113	0.768	0.733
R^2	0.002	0.016	0.043	0.002	0.007

S&P 500 Regressions Based on Published Expectations

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Intercept	0.054	-0.2045	-1.068	1.747	-0.001
Coefficient	-3.232	-22.645	0.022	0.007	2.707
p-value	0.712	0.0621	0.178	0.545	0.476
R^2	0.002	0.059	0.031	0.006	0.029

From Table 7, we see that regressions run on the additional four statistics also prove to be disappointing. As we would expect, surprises in retail sales are shown to negatively correlate with changes in the VIX and positively correlate with changes in the S&P 500, but the coefficients are not significant at a 90% confidence interval. Similarly, surprises in capacity utilization correlate with changes in the VIX and S&P 500 as we had hypothesized, but the coefficients are also statistically insignificant. Finally, surprises in the Leading Indicators index and construction spending prove to be highly unreliable for explaining a change in both the VIX and S&P 500.

Table 7

VIX Regressions Based on Published Expectations

	Retail Sales	*Leading Indicators*	*Capacity Utilization*	*Construction Spending*
Intercept	0.193	-0.017	0.037	0.004
Coefficient	-0.436	-0.210	0.740	0.016
p-value	0.234	0.774	0.204	0.941
R^2	0.029	0.002	0.033	0.000

S&P 500 Regressions Based on Published Expectations

	Retail Sales	*Leading Indicators*	*Capacity Utilization*	*Construction Spending*
Intercept	-1.174	-0.949	-0.047	3.194
Coefficient	5.173	4.511	-4.910	-0.770
p-value	0.155	0.439	0.228	0.752
R^2	0.042	0.012	0.029	0.002

Finally, we test for more substantial results by modifying the dependent variables. Using published market expectations have improved results, but we are also concerned about additional factors that may affect VIX values. Seeing how most economic data releases for these five variables occur at 8:30 am, one hour prior to trading of the VIX, we believe that changes to the VIX may be priced in by market open. Consequently, we recalculate the change in the VIX as its value at market open less its value at market close on the previous trading day.[3]

From Table 8, we can immediately see that the coefficient on surprises in non-farm payrolls and core CPI have become highly significant with p-values of 0.0002 and 0.022, respectively. However, the coefficients on surprises in housing starts and GDP have become positive, which is against the hypothesis, and p-values for the rest of the statistics are still above 0.1. Furthermore, Nofsinger and Prucyk (2003) had found consumer

[3] Market open values for the VIX are available starting October 2003, limiting the number of observations in each regression.

spending to cause the greatest movements in implied volatility, yet retail sales figures, a large portion of consumer spending, do not seem to confirm their observations.

Table 8

VIX Regressions Based on Published Expectations (Market Close to Open)

	CPI	*Core CPI*	*Non-farm Payrolls*	*Housing Starts*	*GDP*
Intercept	-0.088	-0.077	-0.157	-0.015	0.099
Coefficient	0.26	1.793	-0.003	0.001	0.307
p-value	0.617	0.022	0.0002	0.399	0.164
R^2	0.005	0.101	0.247	0.014	0.117

	Retail Sales	*Leading Indicators*	*Capacity Utilization*	*Construction Spending*
Intercept	0.131	N/A	0.041	N/A
Coefficient	-0.171	N/A	0.317	N/A
p-value	0.242	N/A	0.168	N/A
R^2	0.028	N/A	0.038	N/A

VI. Conclusion

In general, the results of this paper are in line with previous findings. We see that surprises in non-farm payroll announcements cause the VIX index to behave in the predicted manner. Regressions based on published market expectations reveal that a surprise of -100,000 non-farm jobs causes the VIX index to increase by 0.2 percentage points over one full trading day. This is a notable change in implied volatility considering that the mean surprise is -21,000 jobs with a standard deviation of 86,000. Furthermore, at market open, a surprise of -100,000 non-farm jobs is predicted to increase the VIX index by 0.3 percentage points with a significance of nearly 100%. Looking at Figure 4, a plot of surprises in non-farm payrolls against changes in the VIX, we find standard errors to be larger for positive surprises. This is confirming of the results of Nofsinger and

Prucyk (2003) who had found negative non-farm payroll announcements to cause the second largest spikes in implied volatility with milder reactions to positive announcements.

Figure 4

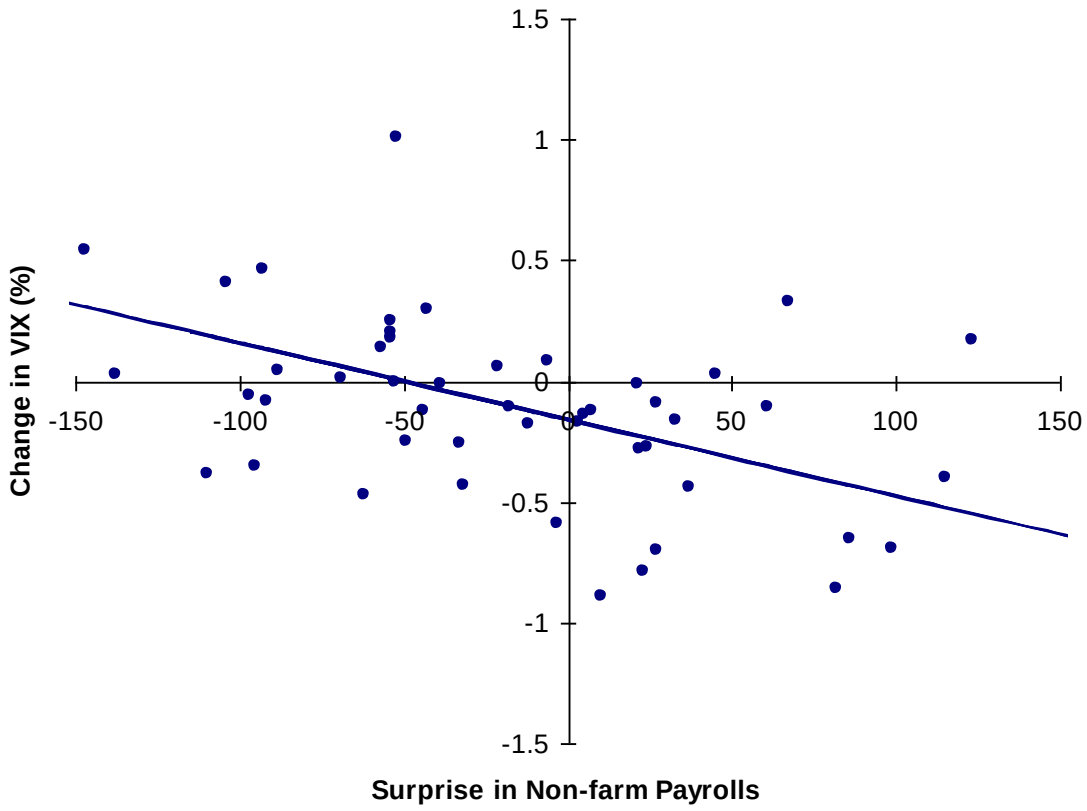
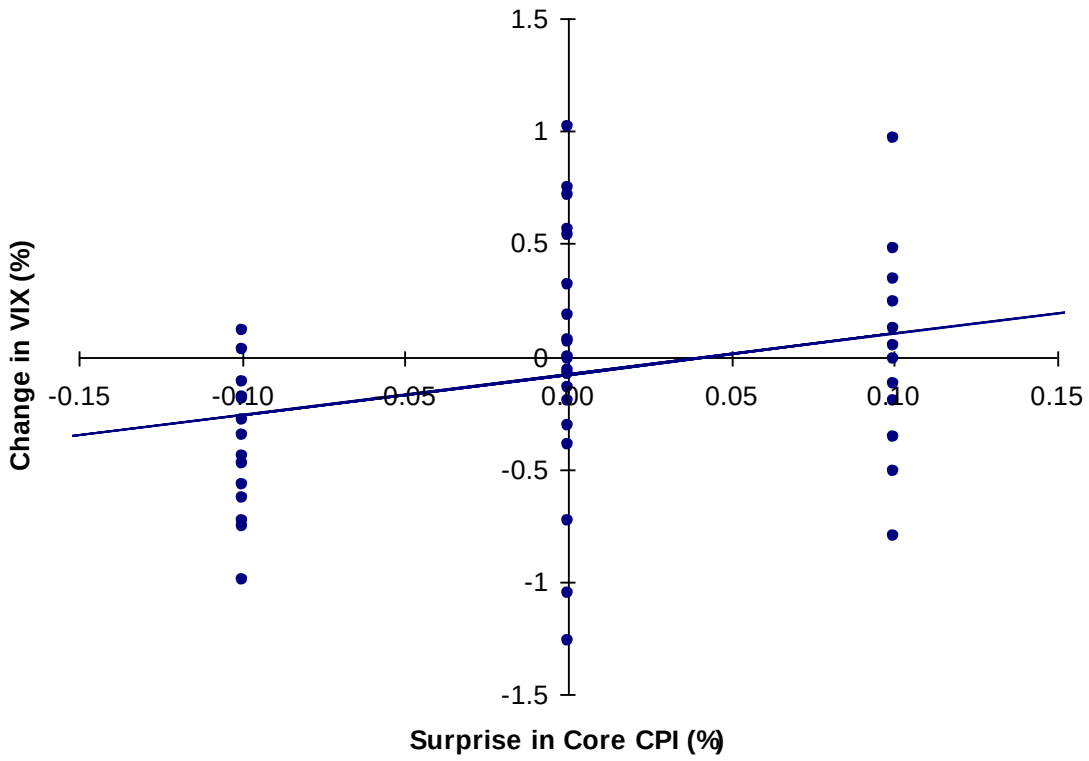


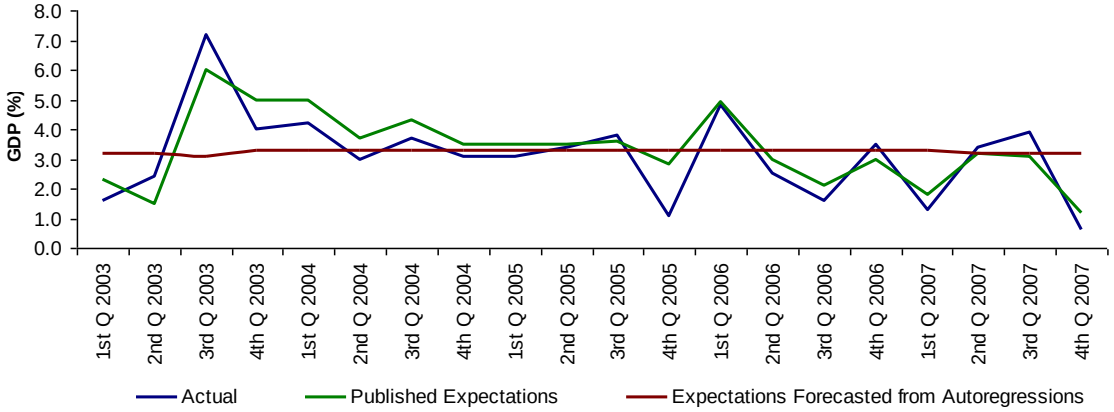
Figure 5

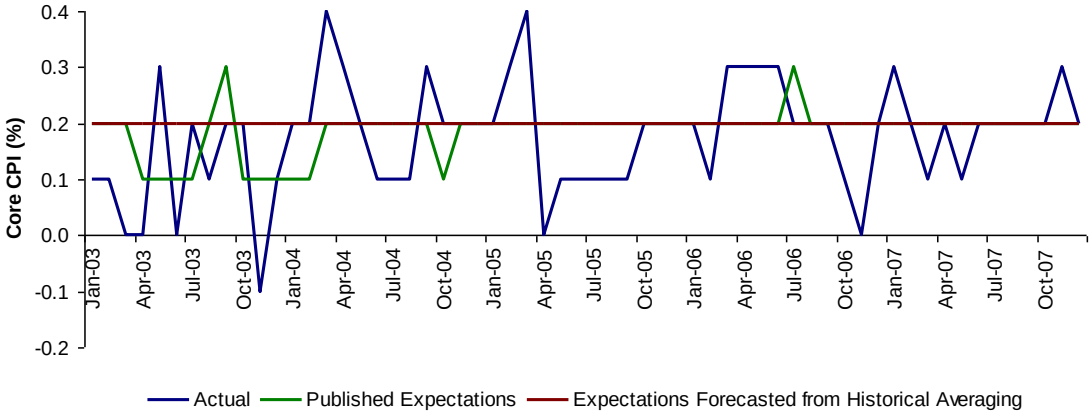


Unexpected announcement figures for core CPI also cause the VIX to behave according to prediction with high significance. A plot of surprises in core CPI against changes in the VIX can be seen in Figure 5. However, like Flannery and Protopapadakis (2002), we find the S&P 500 unmoved by any macroeconomic statistic other than inflation. Only surprises in core CPI figures are able to explain changes in the S&P 500 at statistically significant figures. A percentage increase in monthly core CPI is predicted to increase the S&P index by over 22 points with a significance of nearly 95%. On the other hand, surprises in non-farm payrolls only affect the market at a significance of about 80% and the existence of a volatility skew is questioned. Although negative surprises in non-farm payrolls cause an increase in implied volatility, the underlying asset's value does not

decrease accordingly. Finally, since most other macroeconomic statistics do not bring about predictable changes in the VIX, we are unable to refute the findings of Ederington and Lee (1996).

Appendix A


GDP (%)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1st Q 2003
2nd Q 2003
3rd Q 2003
4th Q 2003
1st Q 2004
2nd Q 2004
3rd Q 2004
4th Q 2004
1st Q 2005
2nd Q 2005
3rd Q 2005
4th Q 2005
1st Q 2006
2nd Q 2006
3rd Q 2006
4th Q 2006
1st Q 2007
2nd Q 2007
3rd Q 2007
4th Q 2007
Actual
Published Expectations
Expectations Forecasted from Autoregressions


Core CPI (%)
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Jul-07
Oct-07
Actual
Published Expectations
Expectations Forecasted from Historical Averaging

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