Dispersed Macroeconomic Information: Announcements, Revisions & Stock Returns*

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Abstract

I analyze the link between macroeconomic announcement surprises, intradaily returns on the S&P500 Index, and the subsequent revisions to the announced data. I show that announcement-day returns contain information about the future revisions of the released figures. This information is unrelated to the initial announcement surprises and predicts the future revisions: Prices increase when the subsequent revisions will be positive. This observation is strongest for real activity and investment variables such as Nonfarm Payroll, Industrial Production, and Factory Orders. I develop a rational expectations trading model where the final payoff is the sum of non-overlapping fractions of the economy that were previously observed as private signals. A preliminary public announcement does not convey new information to the market per se, but rather allows investors to deduce other investors' information. In turn, this allows them to assess the inaccuracy of the public signal and therefore estimate its future revision. In equilibrium, the risky asset's price changes in anticipation of the public signal's revision, even though the initial surprise may be in the opposite direction.

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1 Introduction

On September 15, 2000, the Federal Reserve Board announced that Industrial Production in August 2000 had increased by 0.3%, while markets expected a decrease of 0.1%. Despite this good news, the S&P500 Index decreased by 1.02% over the day. The final number available in July 2007 was actually a decrease of 0.3%. The announcement-day decrease in the S&P500 Index accurately anticipated the subsequent downward revision of the released number: The market did not react in the direction of the announcement surprise of 0.4%, but rather in the direction of the future revision of the data -0.6%. While there may be alternative explanations of the market's reaction to the positive surprise in this particular example,[1] this paper presents empirical tests as well as a theoretical model establishing a systematic link between revisions to macroeconomic information and aggregate equity returns.

I show that announcement-day returns contain information about the future revisions of the announced data that is independent of the initial surprise: prices increase when the data will subsequently be revised upwards. On average, a 1% increase in the S&P500 Index on announcement-day implies a subsequent revision that is about 0.3 standard deviations larger than the initial announcement. This pattern is robust across macroeconomic announcements such as real activity variables (Nonfarm Payroll and Industrial Production), investment variables (Durable Goods Orders, Factory Orders, and Business Inventories), as well as the Trade Balance, Personal Income, Personal Consumption, and the PPI.

By identifying this effect, I shed new light on the question "how does macroeconomic information get into asset prices?" The idea that macroeconomic risk is a large share of systematic risk relies on the assumption that macroeconomic information actually gets impounded into prices. However, evidence from the previous literature about the impact of macroeconomic surprises on aggregate equity returns is relatively weak and the search for priced macroeconomic factors in the cross-section of expected returns has been difficult. An

[1] For example, a monetary response framework implies that following good news, the Federal Reserve might increase interest rates to avoid overheating and control inflation, which may be bad news for stocks.

important reason for this may be that initial macroeconomic announcements are extremely inaccurate signals of the true underlying state of the economy.

A variant of the above question suggested by my empirical findings therefore is "how does accurate information get into prices when inaccurate information gets released?" The information contained in public signals is already known by the market, as evidenced by the weak link between announcement surprises and returns. I posit that even though there may be no new information in public signals, their release is necessary for investors to learn about each other's information. This results in the impounding of more accurate private information into prices at the time of the public announcements.

Federal statistical agencies such as the Census Bureau significantly revise macroeconomic variables during the months and even years following the initial announcements. Early revisions (one to three months) mainly stem from reports or surveys that are submitted late by firms or individuals. Each month, the agencies extrapolate from the sample of reports received in order to obtain an economy-wide estimate. Annual revisions (one to five years) arise because of updates of the economy-wide benchmarks, such as the total number of workers or firms. The key, however, is that both early and annual revisions reflect the addition of new information in the agencies' reports that was not publicly available in the initial announcement.

I define the final revision of a macroeconomic announcement as the difference between the number available after as many rounds of revisions as possible, i.e. in July 2007, and the original announcement. The initial announcement surprise is defined as the difference between the realization of the announcement and the market median (consensus) expectation collected shortly prior to the announcement. Final revisions are of the same order of magnitude as initial surprises, both in terms of mean and standard deviation.

Standard models (made more precise in Section 5.1) cannot explain the empirical results of this paper. In these, rational investors know that public signals are noisy estimates of the true underlying state. They therefore take into account the noise in the releases: they expect that too high a release will lead to a downward revision and vice versa. In equilibrium, the signals enter prices with the "right" sign: good signals lead to an increase in prices, and vice versa. However, the increase is not as large as the actual release would suggest because rational investors expect the downward revision. The natural conclusion of these models is that returns and future data revisions are negatively related, which is contrary to my empirical findings.

To deliver a consistent explanation of the effect, I develop a rational expectations trading model with a novel information structure. The final payoff is defined as the weighted sum of private signals previously observed by individual investors. This dispersed information structure fits the actual structure of macroeconomic data: for example, the nationwide change in Factory Orders is the sum of every firm's change in orders. In the first period of the model, investors privately observe unequal and non-overlapping parts of the economy, which are reported to the government. Investors trade on these first-round private signals. Before the second period's trading, each investor observes a second-round private signal that may differ from his first-round signal. At the same time, the government releases the weighted sum of the first-round signals. The final (macroeconomic) value in the third period is the sum of the updated second-round signals.

The timing of the model corresponds to the way the federal agencies collect and disseminate information. The public signal, the sum of the first-round private signals, is released with a lag, which is consistent with macroeconomic announcements. For example, Nonfarm Payroll for a particular month gets released about a month after it is realized. In the meantime, however, updates of the private signals can occur and are not immediately transmitted to the government. At the time of the public signal, investors can assess the accuracy of the public release, and hence the future revision, from their second-round private signal and from the public signal. The public announcement is required for this information analysis to occur. In equilibrium, accurate information (the second-round updated private signals) gets impounded into prices at the same time as an inaccurate public signal is released. In the model, it is possible for a negative public signal to be released and for prices to actually rise because investors know that the true value is positive.

In equilibrium, the announcement-day return is positive in anticipation of a subsequent upward revision, consistent with my empirical results.

Macroeconomic announcements are often portrayed as resolving uncertainty. This paper argues that, given the magnitude of the revisions, initial announcements are in fact likely to heighten uncertainty, at least for investors with imprecise private information. They cannot assess the announcements' quality and they therefore update their beliefs using inaccurate public information. However, investors with precise private information can actually "learn" about the inaccuracy of the public signals and estimate the subsequent revisions of the released data. This differential learning by the investors with relatively precise private information is absent from the previous literature. In terms of information aggregation, it is less about macroeconomic information getting into prices through the announcement surprises, and more about impounding private information about future revisions.

There are two important points to note about the paper. It is focused on the aggregation of information at the time of initial macroeconomic announcements. As a result, although the results presented point to the fact that announcement-day returns can be used to forecast the final value of the released data, the paper is not just a forecasting exercise.[2] In addition, the paper is also not about trading strategies that may or may not be able to exploit these results.

In the next Section, I briefly discuss the existing literature. I then describe the data and discuss a preliminary decomposition of macroeconomic information in Section 3. The main empirical analysis is in Section 4. In Section 5, I develop a model of dispersed macroeconomic information that is consistent with the empirical results.

[2]Stock and Watson (2002) build a dynamic factor model using 215 predictors in order to forecast eight monthly macroeconomic time series.

2 Related Literature

To the best of my knowledge, this is the first paper that explicitly links macroeconomic revisions and aggregate equity returns. However, it is closely related to the following broad question that the previous literature addresses: Do macroeconomic announcements impact asset returns? This question has been attacked both from the empirical and theoretical sides.

On the empirical front, results are mixed. Andersen et al. (2007) analyze the impact of announcement surprises of 20 monthly macroeconomic announcements on high-frequency S&P500 Futures returns. They find that only Nonfarm Payroll, New Home Sales, Net Exports, and Inflation systematically move prices. Similarly, Flannery and Protopapadakis (2002) find that only Inflation and Money Supply move daily aggregate stock returns.[3] Adams, McQueen, and Wood (2004) confirm that Inflation moves intradaily returns of size-based portfolios.[4] However, none of these event studies analyze revisions to the macroeconomic announcements.

McQueen and Roley (1993) and Boyd, Hu, and Jagannathan (2005) find stronger relationships between macroeconomic announcements and stock returns after conditioning on the business cycle: in good times, good news is bad news for stocks. Andersen et al. (2007) follow this strategy and indeed find stronger results in their recession sample which contains only 21 observations. Even though these papers do not analyze revisions, the interpretation of the macroeconomic information that they highlight has to be taken into account in my empirical tests.

Using the Federal Reserve Bank of Philadelphia's Real-Time Data Set, Aruoba (2007), following Mankiw, Runkle, and Shapiro (1984) and Mork (1987), presents the most up-to-date analysis of macro variables' vintages. He shows that revisions are not well-behaved: they do not have a zero mean, they are as volatile as initial announcements and furthermore,

[3]Stronger results have been found between announcement surprises and foreign exchange or fixed income: Fleming and Remolona (1997, 1999), Balduzzi, Elton, and Green (2001), Andersen et al. (2003), and Green (2004), to cite just a few.

[4]Cenesizoglu (2006) analyzes the impact of macroeconomic news on both size and book-to-market sorted portfolios and finds similar results.

they are predictable using public information, not including prices, available at the time of the announcement. Krueger and Fortson (2003) analyze the relations between the various rounds of revisions to employment data. They find that the initial releases can be used to forecast the future benchmark releases. However, subsequent revisions are informative in the sense that they incorporate new information in the governments' reports that was not available at the time of the initial announcement. However, none of these papers link the revisions to asset returns.

On the theoretical front, models of price formation around public signals have predictions that are inconsistent with my empirical findings. Kim and Verrecchia (1991) develop a competitive rational expectations model with noisy private signals and a noisy public signal. Rational investors take into account the noise in the public signal: too high a signal will lead to a downward revision. However, in such models, signals always enter the price with the "right" sign. For example, a positive signal (good news) leads to an increase in the price of the risky asset at the time of the announcement. The result is that announcement-day returns and subsequent revisions are negatively related. These models are reviewed in more detail in Section 5.1.

Cenesizoglu (2007) develops a general equilibrium model where investors learn about the state of the economy via public announcements. In equilibrium, returns react significantly to announcement surprises only if investors' beliefs are sufficiently influenced by the announcement. However, he assumes that the external public signals are not noisy, i.e. there are no revisions, which is empirically inaccurate.

3 Announcements, Surprises and Revisions

3.1 Data Sample

U.S. macroeconomic information is released by various federal agencies at pre-specified dates and times. In this paper, I study 17 macroeconomic series whose characteristics are described in Table 1. I focus on Real Activity and Investment variables that are released on a monthly basis and that undergo revisions, such as Nonfarm Payroll, Industrial Production, and Factory Orders. The choice of the series is the same as in Andersen et al. (2003, 2007) with the following exceptions: Government Budget and Target Federal Funds Rate (no revisions), and indices (Consumer Confidence, NAPM, and Leading Economic Indicator) for which I could not obtain revised values. GDP is released on a quarterly basis and is used as a robustness check. The common sample of monthly surprises, intradaily stock returns, and final revisions for all 17 macroeconomic variables is August 1997 to December 2006 (113 months).[5]

I obtain market expectations from the Money Market Services database (MMS). The MMS data collected by Informa Global Markets contains the announcement dates, the market expectations, and the actual announced data for over 50 macroeconomic series since 1992.[6] The market consensus expectation is the median from about 40 money market economists' expectations surveyed each Friday regarding the coming week's announcements. I corrected mistakes in the MMS database by cross-checking it with the historical releases from the federal agencies' websites. Andersen et al. (2003) show that most of the MMS expectations do contain information, are unbiased, and do not appear significantly stale.[7]

I obtain 5-minute bars (open, high, low, close) on the S&P500 Index from Price-Data.com, starting in August 1997. Since most announcements occur at 8:30am when equity markets are closed, I constructed holding-period returns from close of the previous day to 9:35am, to 9:40am, to 9:45am, etc. The aim is to reduce the noise in aggregate equity returns by narrowing the window around the exact times of the announcements. The results in Andersen et al. (2003, 2007) suggest that the price discovery process around macro announcements takes place in the order of minutes. Obviously, these overlapping

[5] The sample of 20 monthly announcements and 5-minute S&P500 Futures returns in Andersen et al. (2007) is from January 1994 to December 2002 (108 months).

[6] Some series start in 1985, such as Nonfarm Payroll and Industrial Production.

[7] Rigobon and Sack (2006) develop censoring and principal-component approaches that attempt to reduce the noise in the measurement of announcement surprises. However, their approaches are backward-looking since they deduce surprises from the price reactions. I choose to stay consistent with the existing literature and use the MMS expectations.

returns are highly correlated within a given day. Consistent with the S&P500 Futures data in Andersen et al. (2007), the mean returns of the S&P500 Index in any time interval are much smaller than the standard deviations, and they are approximately symmetric even though they are not normally distributed (excess kurtosis).

3.2 Announcements Surprises and Revisions

The methodologies of data collection, preliminary estimates, and announcements of macroeconomic series are similar across the federal agencies, although the detailed econometric techniques do differ. In Appendix A, I describe the process used by the Bureau of Labor Statistics for Nonfarm Payroll. In general, agencies receive monthly surveys about payroll or output from a representative sample of firms or sectors. The information contained in these surveys is then extrapolated to a nationwide estimate using lagged benchmarks, such as the total number of employees or firms.

I define the announcement surprise Sur_t as the difference between the actual announcement A_t at time t and the market's median expectation $E[A_t]$:

$$Sur_t \equiv A_t - E[A_t] \tag{1}$$

where the expectation is taken sometime before time t. The initial announcement A_t is often labeled as a preliminary estimate that will be subsequently revised. The first panel of Figure 1 shows the initial surprises to Nonfarm Payroll announcements from August 1997 to December 2006.

Macroeconomic announcements undergo substantial revisions in the months and sometimes years following their initial releases. There are three main reasons for revisions to occur: late reports, benchmark updates, and methodological changes. Appendix A also contains a description of the revision process for Nonfarm Payroll. The key point is that revisions due to late reports and benchmark revisions are informative in the sense that they incorporate new information in the federal agencies' reports that was not available at the time of the initial announcement.

Methodological changes are not necessarily informative, but they are infrequent. Two examples of methodological changes are the introduction of a probability-based sample by the Bureau of Labor Statistics in 2000 and the change in base year for Industrial Production in 1998. Another example that affected almost all macroeconomic series is the industry reclassification from SIC codes to NAICS codes in 1997.

I define the *final* revision of an announcement, $Rev_{T,t}$, as the difference between the final value F_T of the macro data available from the federal agencies at time T and the original announcement A_t:

$$Rev_{T,t} \equiv F_T - A_t \tag{2}$$

where T is July 2007. The choice of T as July 2007 is based on the previous literature that defines the final published revision as the most accurate measure of the corresponding macroeconomic variable. F_T is the government's best estimate of the "true" underlying state variable. This 10-year sample is short enough that including benchmark revisions does not distort these final values.[8] I obtain the final values of the macro variables F_T using the time series available in July 2007 from the various federal agencies' websites.

The second panel of Figure 1 shows the final revisions $Rev_{T,t}$ for Nonfarm Payroll for t running from 1997 to 2006.[9] From both panels of Figure 1, I posit that there are no time-series patterns in either surprises or revisions. Importantly, they do not tend to systematically increase or decrease in recessions or expansions. For Nonfarm Payroll, the average surprise and revision are statistically different from zero, but that bias is homogenous across time. Surprises and revisions are both stationary and neither have any serial correlation patterns (results not reported here). These summary statistics are qualitatively similar for all macroeconomic variables.

The absence of patterns in the revisions was confirmed via telephone conversations

[8]Over a 40-year sample, it is possible that benchmark revisions in the 2000s affecting the 1970s estimates actually distort the way the economy looked in the 1970s.

[9]The average final value of +127,000 employees is slightly larger than the average monthly growth of the working population ($\sim$ +100,000), suggesting that over that period, the U.S. economy had a positive net job creation.

with analysts at the Bureau of Labor Statistics and the Census Bureau. The revisions do not appear to be systematically driven by, for example, private small firms from California submitting their surveys late. The volatility of revisions seems to have decreased over time. This may be due to the choice of the cut-off date (T) as July 2007, which reduces the total number of revisions for the last quarter of the sample. According to the Bureau of Labor Statistics, it is possible that recent technological improvements, such as electronic survey submissions, lead to more accurate initial estimates and hence smaller revisions.

Table 2 presents summary statistics about the final revisions $Rev_{T,t}$ of all 17 macroeconomic series. The average revision is rarely significant, but the standard deviations, along with the minima and maxima, suggest that there is a lot of variability in final revisions for most series. Unemployment, the CPI, and Housing Starts are noteworthy exceptions. Figure 1 and Table 2 show that final revisions are often larger than the initial surprises, and the volatility of revisions is often as large as, if not larger than, the volatility of surprises. Tests not reported here show that absolute final revisions are larger than absolute surprises about 50% of the time. Furthermore, revisions and surprises tend to be negatively correlated, which suggests that market expectations are relatively good estimates of the final revised value.

Revisions are extremely frequent and economically large. Across all 17 macroeconomic series, more than 96% of initial announcements eventually get revised. Absolute revisions are often larger than absolute surprises: 47% of the time for Nonfarm Payroll, 66% for Factory Orders, and 23% for the PPI, for example. Absolute revisions can also be viewed as a percentage of the absolute initial announcements: 290% for Nonfarm Payroll, 49% for Business Inventories, and 4% for the Trade Balance, for example. For conciseness, I am not reporting these statistics for all series but most are the in same range as Business Inventories.

3.3 Decomposing Macroeconomic Information

To investigate how macroeconomic information gets into prices, I define the "true" surprise $TSur_{T,t}$ as:

$$
\begin{aligned}
TSur_{T,t} &\equiv F_T - E[A_t] &(3)\\
&= F_T - A_t + A_t - E[A_t] \\
&= Rev_{T,t} + Sur_t &(4)
\end{aligned}
$$

where the surprise Sur_t and revision $Rev_{T,t}$ are from equations (1) and (2) respectively. If the final value is indeed the best estimate of the underlying state variable, equation (3) represents the total amount of information that the federal agencies impart to the market after many rounds of revisions. This can be decomposed according to equation (4) into the initial surprise and the subsequent revision, representing two channels through which the information gets into prices.

One question that arises from the decomposition (4) is whether announcements A_t contain information about the final values F_T beyond what is already incorporated in the market expectations $E[A_t]$. Table 3 shows the results of two regressions addressing this issue for five macroeconomic series: F_T on A_t and F_T on $E[A_t]$. For all five series (with qualitatively similar results for the other twelve) the difference in R^2 between the two regressions is positive and significant in about half of the series. This suggests that there is at least some information released in the actual announcements.

A second question that arises from the decomposition (4) is whether the expectations $E[A_t]$ forecast the actual announcements A_t or the final value F_T. The second and third regressions in Table 3 show that expectations seem to be more accurate predictors of the announcements rather than the final values in about more than half of the series. However, this fact is reversed for Nonfarm Payroll and Business Inventories. This split pattern holds for the other 12 series, suggesting that expectations are relatively good predictors of the announcements but that they also do take into account potential subsequent revisions.

Macroeconomic information is fundamentally dispersed across the economy: GDP is the sum of every firm's net output, Nonfarm Payroll is the sum of every firm's payroll, etc. The individual pieces of information about individual firms' output or payroll are observed on a continuous basis by investors. Therefore a large share of these pieces of information are observed by investors who get that information into prices. This dispersed structure reflects the fact that expectations are good predictors of the announcements, which in turn is in agreement with the previous literature showing a weak impact of initial surprises on aggregate equity returns.

4 Empirical Analysis

The decomposition described in the previous Section suggests that, besides initial surprises, there is a second channel for information about fundamental macroeconomic variables to get into prices. In this Section, I show that there is a systematic link between announcement-day returns and the subsequent revisions to the released data: prices increase on announcement day in anticipation of an upward future revision, independent of the sign of the initial surprise. This result is robust across macroeconomic variables, such as Industrial Production and Business Inventories.

4.1 Empirical Framework

As is shown in Table 1, units of measurement differ across macroeconomic variables. In order to alleviate this problem and facilitate comparison across announcements, I follow the previous literature in using standardized surprises and revisions. These are constructed by dividing the surprises and revisions, equations (1) and (2), by their respective sample standard deviation for each announcement:

$$\overline{Sur}_t = \frac{Sur_t}{\sigma_{Sur}} = \frac{A_t - E[A_t]}{\sigma_{Sur}} \tag{5}$$

$$\overline{Rev}_{T,t} = \frac{Rev_{T,t}}{\sigma_{Rev}} = \frac{F_T - A_t}{\sigma_{Rev}} \tag{6}$$

where σ_{Sur} is the sample standard deviation of the surprises and σ_{Rev} is the sample standard deviation of the revisions. The sample standard deviations are different for each announcement but since they are constant for each announcement, the normalizations do not affect the statistical significance of the coefficients or the fit of the regressions.

Following the decomposition of macroeconomic information in Section 3.3, I separate the information in announcement-day prices that is linked to surprises and revisions. The initial step is to isolate the return response to the initial surprise. Since revisions to prior months' announcements are released at the same time as the new announcement, I also want to separate the return response to these prior revisions. I therefore estimate, as a first step, the following "return-response" linear regression model:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \delta' \cdot \overline{Rev}_{t,t-s} + \kappa' \cdot \overline{Sur}_t^{other} + \varepsilon_t \tag{7}$$

where r_t is the intradaily announcement-day return on the S&P500 Index and $\overline{Sur}_t$ is the normalized surprise announced at time t. $\overline{Rev}_{t,t-s}$ is the normalized revision to the $t-s$ announcement released at time t.[10] For Nonfarm Payroll, I control for the simultaneous release of the revisions to the prior two months' announcements. $\overline{Sur}_t^{other}$ is the normalized surprise to any simultaneous announcements. For example, Unemployment is released in the same report as Nonfarm Payroll. The return-response residuals ε_t contain the information in announcement-day prices that is orthogonal to the initial surprise, the revision(s) of the prior month(s)' announcement, and the surprise to any simultaneous announcement.

The second and key step of my empirical framework concerns the link between the residual information in announcement-day prices and the future revisions to the macroeconomic data. I therefore estimate, as a second step, the following "revision forecasting"

[10] Similarly to the normalized surprises and revisions, I define the normalized prior revisions as $\overline{Rev}_{t,t-s} = \frac{Rev_{t,t-s}}{\sigma}$ where σ is the sample standard deviation of $Rev_{t,t-s}$.

linear regression model:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \delta \cdot \overline{Rev}_{t,t-s} + \kappa \cdot \overline{Sur}_t^{other} + \varepsilon_{T,t} \tag{8}$$

where $\overline{Rev}_{T,t}$ is the normalized final revision at time T of the announcement at time t. Controlling for Sur_t, $Rev_{t,t-s}$, and Sur_t^{other} follows from Aruoba (2007) who shows that revisions are forecastable using the initial announcement. He does not include initial surprises, but does include prior months' revisions, quarter dummies, and time trends as forecasting variables. His findings do not reveal any systematic pattern as to which variables forecast revisions, besides the initial release.

By the Frisch-Waugh theorem, the above two-step regression framework is equivalent, in terms of the β coefficient, to a single regression with the intradaily returns r_t in place of the residuals from the first-step regression. However, separating the analysis into two regressions allows a clear identification of the information aggregation processes. The announcement surprises may contain information that gets impounded into prices and/or prices might aggregate information independent of the surprise but related to the final value of the macroeconomic variable.

Roll (1984) shows that daily returns on orange juice futures are good predictors of the error in the national weather forecast of the future minimum temperature for the upcoming night. The causality of his regressions is unambiguous: weather drives prices. It is less clear whether macroeconomic variables drive prices or vice versa: weak employment data may push stocks down, but decreasing stock prices may lead to layoffs. However, macroeconomic announcements release information about prior months, whereas current prices may only influence future data. During telephone conversations with analysts at the Bureau of Labor Statistics and the Census Bureau, I was assured that the federal agencies do *not* use current market returns to revise past data. It is therefore reasonable to assume that the causality of my regressions is from past data to current prices.

4.2 Information Interpretation: Good News is Good News

Analyzing the link between macroeconomic information announcements and aggregate equity returns depends on the interpretation of the information, which may itself be linked to the business cycle. For example, good news in good times may be bad news for stocks. Boyd et al. (2005) show that an increase in Unemployment is associated with a marginally significant rise in the S&P500 Index in expansions (on announcement days). In contrast, an increase in unemployment in recessions leads to a much more significant decrease in the stock market. Since the economy is in an expansionary cycle most of the time, the stock market tends to rise when bad unemployment news is released. The story that is often used to rationalize why the stock market falls when good economic news is released is that there is an expectation by the market that the Federal Reserve is more likely to increase interest rates. In order to avoid overheating of the economy and ramping inflation, the Federal Reserve will make borrowing more costly, which is bad news for stocks.

Information for equity markets can be split into two parts: news about cash flows and news about discount rates. Campbell and Vuolteenaho (2004) follow this intuition in order to split beta into a cash flow beta and a discount rate beta. Positive news about future cash flows leads to an increase in price (numerator of the present value formula), but this increase can be offset if the market raises the discount rate of these cash flows (denominator in the present value formula). As such, the theoretical impact of macroeconomic news on equity prices is unclear and it is therefore an empirical question. The first-step return-response regression (7) allows me to identify the direction of the market's interpretation of the news. A positive γ' coefficient suggests that good news is good news, whereas a negative coefficient implies that good news is actually bad news.

My sample (August 1997 to December 2006) contains a full Federal Funds Rate cycle: flat around 5% until 2001, decrease to 1% until 2004, and increase to about 5% in 2006. The stock market peaked in March 2000 and the NBER declared the 8-month period from March 2001 to November 2001 as a recession. The risk of overheating, and hence the expectation of rate increases, exists mainly at the peak of the business cycle, which may be the case in the first three years of my sample. I will control for this in my robustness checks.

4.3 Results

In this section, I provide evidence of the systematic link between announcement-day returns and subsequent revisions to the macroeconomic data: prices rise when the future revisions will be positive. I focus on three real activity and investment variables, Nonfarm Payroll, Industrial Production, and Factory Orders, before generalizing the evidence using the other variables. The results are most striking for Industrial Production, where initial surprises have no effect on returns, even though these same returns contain information about the future revisions of the announced figures.

4.3.1 Nonfarm Payroll

The first panel in Table 4 presents the results of the return-response regression (7) and the second panel shows the results of the forecasting regression (8). The coefficients and their respective robust standard errors[11] are presented across the columns. Each row represents a different regression where the intradaily return r_t is over the interval shown in the first column. The results are presented only for some of the intradaily returns mainly for clarity, but adding every 5-minute interval from open to close does not yield much more insight.

The first panel shows that the initial announcement surprise does move the S&P500 Index at 9:45am. The positive and significant coefficient on the surprise shows that good news is good news in my sample. While the coefficient is of the same magnitude, the sign is the reverse of Andersen et al. (2007). Beber and Brandt (2007) find a much smaller, but positive, coefficient using the daily return of a portfolio of cyclical stocks that belong to the S&P100 Index. Revisions to the two previous months' announcements do not move prices at all and neither does the simultaneous release of Unemployment.

[11]Throughout the empirical results, all regression coefficients are presented with their White standard errors correcting for heteroscedasticity.

The first key result in the second panel is that the β coefficient on ε_t is positive and highly significant at 9:45am. The 0.304 coefficient on the intradaily return can be interpreted in the following way: a 1% increase in the S&P500 Index from the close of the day prior to an announcement to 9:45am on announcement day forecasts an average 0.3 standard deviation increase in the subsequent revision compared to the initial announcement. This large effect shows that announcement-day prices contain information that is independent of the initial surprise, but that is related to the final value of Nonfarm Payroll.

The second key result in the second panel is the high R^2 of almost 28% at 9:45am. Running the same tests (not reported), but without the return residuals as forecasting variable, leads to an R^2 of about 18%.[12] This further supports the idea that announcement-day prices aggregate information that is unrelated to the initial announcement surprise but related to the future revision of the released data.

The γ coefficient on the surprise in the second panel is significant and negative, as expected from the large negative correlation between revisions and surprises. However, the coefficients on prior revisions are insignificant throughout. As a result, and in the interest of clarity, I will not include prior revisions in my tests with other macroeconomic announcements.

It is well established in the market place that Nonfarm Payroll is one of the most followed monthly macroeconomic series. Its impact on the market is significant and short-lived, consistent with the idea that the information contained in the report and investors' private information about future revisions get impounded into prices rapidly.

4.3.2 Industrial Production

Table 5 presents the results for Industrial Production of the same procedure as for Nonfarm Payroll. Since Industrial Production and Capacity Utilization are released by the Federal Reserve Board in the same report each month, it is essential to add the Capacity Utilization announcement surprise in the first panel's regression. Neither Industrial Production nor

[12] This is consistent with Aruoba (2007) whose forecasting regressions have an R^2 of about 15% for Nonfarm Payroll revisions, using only the initial announcement and prior revisions.

Capacity Utilization impact the intradaily return of the S&P500 Index, consistent with the results of Andersen et al. (2007).

The main result of this paper is that announcement-day returns do contain information about the future revised value of Industrial Production. This fact provides indirect evidence that, actually, aggregate equity returns do react to macroeconomic information. The key results are the same as for Nonfarm Payroll: significant positive forecasting coefficient on the return residual at 9:45am and a high R^2 of about 9%. Again, there seems to be a lot of information in prices about the future revisions of Industrial Production since including the return residuals leads to an increase of about 5% in forecasting power. Compared to Nonfarm Payroll, the slower decline of the forecasting power of the return residuals for Industrial Production may be due to the fact that it is arguably much less followed: the information therefore takes more time to get impounded into prices.

The link between revisions to Industrial Production announcements and aggregate equity returns is particularly striking given the negative results from the the previous literature. Flannery and Protopapadakis (2002) highlight the fact that measures of overall economic activity, such as Industrial Production, do not influence aggregate stock returns. I argue that this is mainly due to the fact that the actual initial macroeconomic announcements are very imprecise. Hence the link between imprecise information and noisy equity returns may indeed be difficult to find. The fact that announcement-day returns of a broad market index such as the S&P500 Index do contain information about the future revisions to Industrial Production provides indirect evidence of the impact of this information on equity returns.

4.3.3 Factory Orders: Real-Time Effect

The announcement of Factory Orders is at 10am and therefore allows for a real-time test of my framework. Figure 2 shows the β coefficient on the return residuals in the second-step regression. The coefficient is insignificant before the announcement, but rises in value and becomes highly significant at 10am, with a t-stat of 2.62 at 10:15am. This Figure shows that narrowing the return interval around the time of the announcement does allow a substantial reduction in the noise in returns and therefore a cleaner analysis of the effect.

The announcement needs to be released for investors to trade and impound their information into prices, both their private information and their interpretation of the released data. The real-time impact seems to take about an hour or so to unravel. Results not reported here show that using the return residuals from close-to-close of the day before the announcement and the day after the announcement lead to insignificant β coefficients with values close to zero.

4.3.4 Other Macroeconomic Series

Table 6 presents the results of the first- and second-step regressions for six macroeconomic series: Durable Goods Orders, Business Inventories, Trade Balance, Personal Income, Personal Consumption, and the PPI. For the first five series, the return interval reported is chosen using the following rule: close of the previous day to 15 minutes after the opening of the market (9:45am) since all announcement times are before 9:30am. For the PPI, the return interval is chosen to maximize the significance of the β coefficient on the return residuals in the second-step regression.

The first-step regression results show that only Durable Goods Orders and Personal Income impact prices.[13] However, for all six series, the announcement-day returns do contain information about the final values of the macroeconomic variables that is independent of the initial surprises. The remaining eight series from Table 1 are not shown here since the results are insignificant for all of them, no matter what the choice of the return interval is. For the CPI, this is not surprising since it almost does not get revised at all.

One interpretation of the lack of significance of the β coefficient on the return residuals in the second-step regression is that most of the necessary information about the macroeconomic fundamental is in prices after the initial announcement.[14] For example,

[13] Personal Income and Personal Consumption are released in the same report each month. However, only Personal Income surprises seem to have an impact on aggregate equity returns.

[14] I thank Hayne Leland for suggesting this alternative interpretation.

the R^2 of the regression of F_T on A_t in Table 3 for Retail Sales is about 81%. This interpretation implies that the public announcements do convey relevant information that is immediately impounded into prices.

The results shown here raise some interesting questions for future research. First, for Durable Goods Orders, the β coefficient on the return residuals is negative, which suggests that information about Durable Goods is interpreted differently by the market than the other macroeconomic variables. Second, the fact the forecasting effect is absent from all real estate related series (Construction Spending, New Home Sales, and Housing Starts) is surprising and warrants further investigation. Perhaps using a real-estate related index rather than the S&P500 Index would yield more fruitful results.

Veronesi (2000) develops a model of a pure-exchange economy where there is uncertainty over the drift of the dividend process. Investors observe a public noisy signal of that drift and the precision of the information has a direct impact on equilibrium asset returns. His main result is that more precise signals tend to decrease the equity premium, implying that there is no risk premium for noisy signals.[15] My empirical results suggest an alternate reason for this effect. Even if the public signal is imprecise, some investors are able to correctly assess this imprecision. In equilibrium, announcement-day returns include the "correct" information with respect to the final value of the macroeconomic variable and hence no premium is required.

To summarize, I present evidence that announcement-day prices contain a significant amount of information about the final value of the released data that is independent of the initial surprise: prices rise in anticipation of future upward revisions. The result is particularly strong for Real Activity and Investment variables, such as Nonfarm Payroll, Industrial Production, and Factory Orders. This result suggests that macroeconomic information does move prices and that somehow, the release of imprecise information allows

[15] A possible implication of this theoretical result is that it might strengthen the empirical results of Easley, Hvidkjaer, and O'Hara (2002), who show that a measure of the probability of private information-based trading is priced in the cross-section of expected returns. If the releases of noisy public signals do not result in a risk premium, then investors may demand an even larger premium for the possibility of private-information trading.

the incorporation of more precise information into prices.

4.4 Robustness Checks

As a robustness check, I perform all the tests in this paper with the intradaily return on the Dow Jones Industrial Average and on the NASDAQ 100 Index. The results are qualitatively similar. For Nonfarm Payroll, the β coefficient on the return residuals in Table 4 is insignificant quickly after 9:45am, but it actually becomes significant again when choosing the end of the return interval later in the afternoon. Using close-to-close returns yields qualitatively similar results: $\beta = 0.118$ with a t-stat of 2.42. Using daily returns, I can extend the data sample to 1992 to 2006 and the forecasting result holds: $\beta = 0.127$ with a t-stat of 2.33. I also test the robustness of this result by using the daily return on the CRSP value-weighted index and the result is again similar, albeit weaker: $\beta = 0.124$ with a t-stat of 2.17.

The S&P500 Index peaked on March 24, 2000, decreased until the end of 2002, and recovered about two-thirds of its value by the end of 2006. This strong reversion to the mean may bias my estimates in a non-trivial fashion. Furthermore, the NBER declared the eight-month period from March 2001 to November 2001 as a recession. I therefore repeat my tests pre- and post-peak as well as pre- and post-recession. The results are qualitatively similar in all periods, even though they are insignificant pre-bubble, which may be due to the small size of the sample. Lastly, excluding the recession sample does not affect the results at all.

It is important to note that the bias in surprises (bias in expectations) and revisions shown in Figure 1 does not affect my empirical results at all. The reason is that the bias is homogenous across time, i.e. there is no time-related trend in the bias. As a result, the measured surprise can be defined as the true surprise plus a constant (the bias) and a white noise component. In my tests, the constant term biases the estimates of the α intercept and the white noise component just gets added on to the residuals, to no effect. As a result, the β coefficient is not affected by this.

Correlations between revisions across time may lead to biases in the regression coefficients. However, the vectors of revisions, surprises, and lagged revisions used in the tests are for *different* announcement dates across rows. Moreover, revisions and surprises are stationary and there are no serial correlation patterns in either of them.

It is also possible that the macroeconomic variables are correlated among themselves. For example, if Nonfarm Payroll is high, then Industrial Production is also high in the same month. This would suggest that a large fraction of the relevant macroeconomic information for a particular month is contained in the first few early announcements corresponding to that month. Nonfarm Payroll is widely viewed as the most important monthly announcement and it is possible that Nonfarm Payroll actually forecasts some of the other macroeconomic announcements in the same month. This might explain the lack of significance in my tests for some of the macroeconomic series, such as Consumer Credit. However, Factory Orders and Business Inventories are released in the second half of each month and the results are significant for both series.

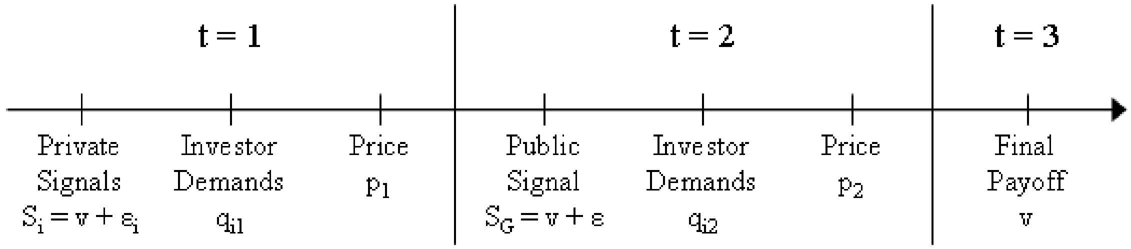
GDP is a heavily followed number that undergoes significant revisions for each quarter. There is an Advance GDP announcement during the first month following the end of a quarter. Preliminary and Final GDP are revisions to this Advance GDP announcement, released in the following two months. Furthermore, Final GDP undergoes benchmark revisions and a final time series is available from the Bureau of Economic Analysis. The return residuals contain information about future revisions only for the announcement of Preliminary GDP: β = -0.316 with a t-stat of 2.32 (return from close to 11:45am). It is important to note that tests on GDP contain 75% fewer observations, i.e. only 28 independent data points.

5 Theoretical Analysis

The above empirical results are puzzling in light of the standard asymmetric information framework where returns and revisions are systematically negatively related. In this Sec-

Figure 3
Timing of the Standard Model

This figure presents the timing of the standard public information model. S_i is the private signal to investor i. q_{it} is the demand of investor i at time t. p_t is the price in period t. S_G is the public signal. ν is the final payoff of the risky security. ε_i and ε are noise terms.



tion, I first review these standard models. Second, I develop a different information structure that better reflects the way federal agencies collect and disseminate macroeconomic information. This alternate structure is consistent with my empirical findings with the equilibrium price increasing when the subsequent revision to the released data is upward.

5.1 Review of Standard Models

Rational expectations models with asymmetric information and public signals take many different forms, but all share a common structure. Figure 3 shows a timeline of the standard model that I refer to. In these models, private signals precede the public signal and all signals are modeled as “truth plus noise”. For ease of presentation in the Figure, I have split demands and prices even though they are set simultaneously in a general equilibrium setting. The empirical results in the previous section are inconsistent with the predictions of these models.

Kim and Verrecchia (1991) present a three-date competitive trading model with a continuum of risk-averse and differentially informed agents. In the first period, agents receive independent noisy private signals $S_i = \nu + \varepsilon_i$ of the end-of-period payoff ν. In the second period, a noisy public signal $S_G = \nu + \varepsilon$ is released. Agents with precise private information (low signal variance) update their beliefs less if the public signal has a lower precision, but poorly informed agents update more. This differential updating generates trading volume at the time of the public announcement. In equilibrium, an investor's demand in the second round of trading decreases in the precision of his private information. Since he updates less, a well informed agent trades less than a poorly informed one when a noisy signal is released.

This feature of the equilibrium demands suggests that a well informed investor does not exercise his information advantage when the public announcement is released. He knows how wrong the public signal is and he, in addition, knows that the poorly informed investor is updating using inaccurate information. Nevertheless, he does not take advantage of his information power since he has already done so in the first period.

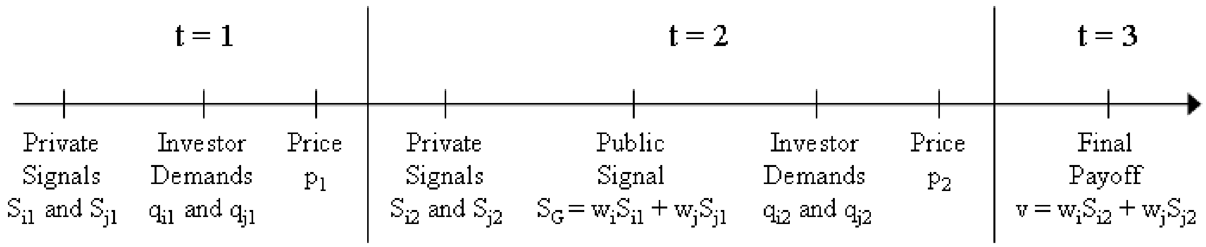
In terms of equilibrium prices, such models also have counter-factual implications. In Kim and Verrecchia (1991), the price change $p_2 - p_1$ is negatively related to the future revision in the public signal $\nu - S_G$. In the first period, optimal demands are based on the private signals, which are noisy signals of ν. On average, the price p_1 is therefore proportional to ν. In the second period, the public signal enters the price with the "right" signal: a good signal moves the price up and a bad signal moves the price down. The price p_2 is therefore proportional to S_G. Consequently, the price change $p_2 - p_1$ is proportional to $S_G - \nu = -(\nu - S_G)$, which is inconsistent with my empirical findings.

The economic intuition for the negative relation between price change and subsequent revision is given by the information structure. Investors know that if the public signal is, for example, above average, then it is likely to be due to a positive noise shock and hence that the revision will be downwards. Nevertheless, in equilibrium, the positive public signal will move the price up. These price dynamics are independent of the price formation mechanism as long as the public signal is unknown to all participants before its release. Kim and Verrecchia (1991) have a competitive model but Pasquariello and Vega (2007) have a strategic two-date trading model with public information, which has the same equilibrium prediction: returns and revisions are negatively related.

Section 4.2 presents empirical and theoretical evidence showing that good news in good times may be bad news for stocks. This monetary response function argument implies

Figure 4
Timing of Dispersed Macroeconomic Information Model

This figure presents the timing of the new model of dispersed macroeconomic information with revisions. S_{it} is the private signal to investor i at time t. q_{it} is the demand of investor i at time t. p_t is the price in period t. S_G is the public signal. ν is the final payoff of the risky security.



that announcement surprises and stock returns may be contemporaneously negatively correlated. As a result, combining the standard rational expectations model with the "good news is bad news" story automatically yields my empirical result: announcement-day returns and future revisions being positively related. However, as is shown by the first-step regressions in my empirical analysis, good news is good news.

5.2 A Model of Dispersed Macroeconomic Information

The model is a pure exchange economy with three dates, labeled as t =1, 2, and 3. Figure 4 shows a timeline of the model. Trading occurs at $t = 1$ and $t = 2$. There is one risky asset with a liquidation value ν, which is realized at $t = 3$. There are two risk-neutral investors, i and j, who trade in the risky asset. The investors observe non-overlapping fractions of the economy, labeled w_i and w_j where $w_i + w_j = 1$. Each investor can be viewed as the representative agent of a class of investors which collectively observes a fraction of the entire economy. The non-overlapping feature makes the model tractable without any loss of generality. The structure of the model (weights, timing, distributions, and price functions) are common knowledge.

At $t = 1$, the investors receive independent first-round private signals S_{i1} and S_{j1} about the value of the fraction of the economy they observe. The private signals are drawn from a continuous distribution with unconditional expectation $E[S_1] = \bar{S}$. The signals can be interpreted as the preliminary values of Nonfarm Payroll. Each investor transmits his signal to the government, which releases the weighted sum of both pieces of information as a public signal S_G at $t = 2$:

$$S_G = w_i S_{i1} + w_j S_{j1} \quad \text{where} \quad w_i + w_j = 1. \tag{9}$$

At $t = 2$, the investors receive independent second-round private signals S_{i2} and S_{j2} about their respective fractions of the economy, which *may* be different from the first-round private signals. The signals' unconditional expectations are also $\bar{S}$, and the conditional expectations are $E[S_{i2}|S_{i1}] = E[S_{i2}|S_G] = S_{i1}$ and the same holds for j. The intuition for these conditional expectations is that the value of Nonfarm Payroll may or may not get revised, but one cannot learn this from just observing the $t = 1$ signals or the public signal S_G. In the sense of Kim and Verrecchia (1997), the amount of pre-announcement information is complete, since all the pieces of the final payoff ν are in the economy before the public signal gets released.

The central point of my information structure is that the end-of-period value of the risky asset is equal to the value of the entire economy, which is the weighted sum of the updated second-round private signals:

$$\nu = w_i S_{i2} + w_j S_{j2} \quad \text{where} \quad w_i + w_j = 1. \tag{10}$$

This information structure mirrors the actual structure of macroeconomic information. GDP is the sum of every firm's net output, Nonfarm Payroll is the sum of every firm's payroll, etc. The individual signals are the exogenous "dispersed" pieces of the macroeconomic information and the end-of-period payoff is the total macroeconomic information.[16]

At $t = 1$ and based on his first-round private information S_{i1}, investor i decides to

[16] The fact that the weights can be arbitrarily close to one, i.e. one investor observes the entire economy, may seem unrealistic. However, Alan Greenspan was known to often talk with the CEOs of the largest firms in the country in order to get a real-time measure of the economy. It is plausible that these individuals do indeed represent a large fraction of the economy, the rest being positively correlated with the performance of their firms.

trade q_{i1} shares of the risky asset. At $t = 2$ and based on his updated second-round private information S_{i2} and the public signal S_G, he decides to trade q_{i2} shares of the risky asset. Investor i maximizes his expected profit over both rounds of trading:

$$\max_{q_{i1},q_{i2}} E\left[q_{i1}(\nu - p_1) + q_{i2}(\nu - p_2)|I_i\right] \tag{11}$$

where ν is the value of the risky asset at $t = 3$, p_1 is the equilibrium price at $t = 1$, and p_2 is the equilibrium price at $t = 2$. I_i is investor i's conditioning information set at each time: $I_{i1} = \{S_{i1}\}$ and $I_{i2} = \{S_{i1}, S_{i2}, S_G\}$. At $t = 2$, investors do not need to condition on p_1, the price at $t = 1$, since the release of S_G makes p_1 redundant. Knowing one's first-round private signal, the weights, and the public signal allows an immediate calculation of the other investor's first-round private signal via equation (9).

In this version of the model, investors do not condition on prices within each period. Using a general equilibrium setting where prices and demands are simultaneously determined would probably yield more robust quantitative insights, but would not change the main qualitative result of the model. By conditioning on prices, investors would impound more of their private information into prices and learn less from the public signal. However, since prices are not fully revealing and the government compiling the public signal does not condition on prices, the learning dynamics underlying Proposition 1 would have the same direction (i.e. same sign), albeit dampened.

The two informed investors trade between each other and face a noisy excess demand curve in each period. Equilibrium prices are equal to the expectations of the final payoff ν given the available public information at each round of trade plus a "demand impact" term:

$$p_1 = E[\nu] + b(q_{i1} + q_{j1} + u_1) \tag{12}$$

$$p_2 = E[\nu|S_G] + d(q_{i2} + q_{j2} + u_2) \tag{13}$$

where b and d are exogenous constants, and u_1 and u_2 are demand shocks from liquidity traders ($E[u] = 0$). The coefficients b and d can be interpreted as the λ coefficient in Kyle (1985), where $1/\lambda$ is the market liquidity of the risky asset. Both investors are strategic in the sense that they know that their demands will adversely impact prices. I therefore expect that, in equilibrium, both b and d will be positive. This reduced-form price structure is similar to Dow and Gorton (1993) as well as Brunnermeier and Pedersen (2005). The liquidity shocks allow prices to only be partially revealing, since one investor cannot determine whether a price increase is due to an increase in demand from the other investor or from a positive liquidity shock. The intercepts are the expected prices with no trading, which is consistent with the neo-classical framework where prices incorporate public information even without any transactions taking place.

5.3 Model Equilibrium

The equilibrium is a symmetric Nash equilibrium. Within each period, each investor best-responds to the other's demand taking into account the adverse impact of both demands on prices. This is analogous to a Cournot duopoly where the investors have private information about the unknown production cost. In this model, the investors have dispersed private information about the common unknown final payoff of the risky asset $\nu = w_i S_{i2} + w_j S_{j2}$. All proofs appear in Appendix B.

The equilibrium is solved by backwards induction and is symmetric between i and j. The first step in the derivation of the equilibrium is to obtain optimal demands for each investor. At $t = 2$, the first-order condition of investor i is, taking the demand of investor j, q^*_{j2}, as given:

$$q_{i2} = \frac{E[\nu|S_{i1}, S_{i2}, S_G] - E[\nu|S_G] - dq^*_{j2}}{2d} \tag{14}$$

This is a best-response function and the optimal demand of investor i is:

$$q^*_{i2} = \frac{2E[\nu|S_{i1}, S_{i2}, S_G] - E[\nu|S_{j1}, S_{j2}, S_G] - E[\nu|S_G]}{3d} \tag{15}$$

which is obtained by solving the system of two best responses for q_{i2}^* and q_{j2}^*. By combining the optimal demands for both i and j, the equilibrium price at $t = 2$ is:

$$p_2^* = \frac{1}{3}E[\nu|S_G] + \frac{1}{3}(E[\nu|S_{i1}, S_{i2}, S_G] + E[\nu|S_{j1}, S_{j2}, S_G]) + du_2. \tag{16}$$

These equilibrium demands and prices can be plugged back into the maximization problem. q_{i2}^* and p_2^* do not depend on q_{i1} since the private signals are independent, and hence the maximizations at $t = 1$ and $t = 2$ are independent of each other. The first-order condition at $t = 1$ therefore is:

$$q_{i1} = \frac{E[\nu|S_{i1}] - E[\nu] - bq_{j1}^*}{2b}. \tag{17}$$

As before, the optimal demand is obtained by solving the system of two best responses:

$$q_{i1}^* = \frac{2E[\nu|S_{i1}] - E[\nu|S_{j1}] - E[\nu]}{3b}. \tag{18}$$

And the equilibrium price is:

$$p_1^* = \frac{1}{3}E[\nu] + \frac{1}{3}(E[\nu|S_{i1}] + E[\nu|S_{j1}]) + bu_1. \tag{19}$$

Lemma 1 shows that the optimal demands form a global maximum in both trading periods.

Lemma 1. *The optimal demands q_{i1}^* and q_{i2}^*, equations (18) and (15), represent a global maximum if and only if $b \geq 0$ and $d \geq 0$.*

Lemma 1 verifies the conjecture that the slope coefficients in the price functions are positive. Hence prices rise when investors buy and fall when investors sell. Lemma 2 verifies that these global maxima in each period are unique.

Lemma 2. *The symmetric Nash equilibria at $t = 1$ and $t = 2$, equations (18) and (15), are unique.*

The second and final step in the derivation of the equilibrium is to plug the optimal demands into the price functions, and substitute for all the conditional expectations of the final payoff. Using the two equilibrium prices, equations (16) and (19), I derive the following expression for the return between $t = 1$ and $t = 2$:

$$\begin{aligned}\Delta p \quad \equiv \quad p_2^* - p_1^* \quad = \quad & \frac{1}{3}(E[\nu|S_G] - E[\nu]) + (du_2 - bu_1) \\ & + \frac{1}{3}(E[\nu|S_{i1}, S_{i2}, S_G] - E[\nu|S_{i1}]) \\ & + \frac{1}{3}(E[\nu|S_{j1}, S_{j2}, S_G] - E[\nu|S_{j1}]).\end{aligned} \tag{20}$$

The first term in the above expression is the unconditional shock due to the public signal. The last two terms are the shocks due to each investor's optimal demand. All the conditional expectations are given in Lemma 3.

Lemma 3. *The expectations in the price change, equation (20), are given by the following set of equations. Unconditional expectations:*

$$E[\nu] = \bar{S} \tag{21}$$

$$E[\nu|S_G] = S_G. \tag{22}$$

Conditional expectations at $t = 1$ for agent i, with symmetric expressions for j:

$$E[\nu|S_{i1}] = w_i S_{i1} + w_j \bar{S}. \tag{23}$$

Conditional expectations at $t = 2$ for agent i, with symmetric expressions for j:

$$E[\nu|S_{i1}, S_{i2}, S_G] = w_i S_{i2} + w_j S_{j1}. \tag{24}$$

Proposition 1 provides the link between the equilibrium return and the (subsequent) revision in the public signal.

Proposition 1. *The equilibrium return $\Delta p \equiv p_2^* - p_1^*$ and the future revision to the public* *signal $\nu - S_G$ are related in the following way:*

$$\nu - S_G = 3\Delta p - 2(S_G - \bar{S}) - 3(du_2 - bu_1) \tag{25}$$

where ν is the final payoff of the risky security, S_G is the public signal, $\bar{S}$ is the unconditional expected ν (and S_G), u_1 and u_2 are the noise trading shocks, and b and d are the slope coefficients of the price functions.

The key step and intuition for the equilibrium stems from the conditional expectations of ν calculated by each investor at $t = 2$, i.e. after having observed their second-round private signals as well as the public signal. The release of the public signal allows each investor to perfectly calculate the other investor's first-round signal, though not his second-round signal. The information aggregation mechanism that underlies my model is the fact that the release of an inaccurate public signal allows some investors to calculate what other investors have observed. Put differently, some investors are able to assess the inaccuracy of the public signal. This information power allows them to forecast the future revision of the public signal, and hence have an accurate measure of the final payoff. Equilibrium prices therefore rise in anticipation of an upward revision of the public signal.

Brunnermeier (2005) differentiates between "informational efficiency" and "informativeness". The former refers to the information in the price relative to the pooled information in the economy and the latter measures how informative the price is in absolute terms. In my model, prices are informationally efficient but they are also not perfectly informative since they convey preliminary information whereas the end-of-period payoff is a function of the second-round information.

A more restrictive version of the model, where only one of the two investors sees an additional private signal in the second round, makes the intuition even stronger. In this case, the release of the public signal allows the investor who receives a second-round private signal to perfectly forecast ν. This is because the public signal allows him to calculate the other investor's first-round signal, which is equal to the second-round signal.

Assuming that investor i does not receive a new second-round private signal, $S_{i2} = S_{i1}$, the conditional expectations at $t = 2$ in Lemma 3 become:

$$\begin{aligned} E[\nu|S_{i1}, S_{i2}, S_G] &= w_i E[S_{i2}|S_{i1}, S_{i2}, S_G] + w_j E[S_{j2}|S_{i1}, S_{i2}, S_G] \\ &= w_i S_{i2} + w_j E[S_{j2}|S_{j1}, S_{i1}, S_{i2}, S_G] \\ &= w_i S_{i1} + w_j S_{j1} \\ &= S_G \qquad (26) \\ E[\nu|S_{j1}, S_{j2}, S_G] &= w_i E[S_{i2}|S_{j1}, S_{j2}, S_G] + w_j E[S_{j2}|S_{j1}, S_{j2}, S_G] \\ &= w_i E[S_{i2}|S_{i1} = S_{i2}, S_{j1}, S_{j2}, S_G] + w_j S_{j2} \\ &= w_i S_{i2} + w_j S_{j2} \\ &= \nu \qquad (27) \end{aligned}$$

since $S_G = w_i S_{i1} + w_j S_{j1}$. The equilibrium price change for this simpler information structure is equal to the price change in Proposition 1, but the economic intuition for it is even clearer. The public signal allows investor j to figure out the signal of investor i and hence exactly calculate ν. However, investor i cannot perform this task and his expectation of ν remains the public signal itself. The equilibrium does not unravel since, despite being risk-neutral, investor j does not trade an arbitrarily large amount due to its adverse effect on the equilibrium price (b and d are positive).

5.4 Implications of the Model

Proposition 1 implies that there is a positive relation between the equilibrium return and the subsequent revision to the publicly announced data. The main empirical prediction of the model therefore is:

$$Rev \equiv \nu - S_G = \alpha + \beta \cdot r + \gamma \cdot Sur + \varepsilon \qquad (28)$$

where Rev is the revision of the public signal, $r = p_2 - p_1$ is the announcement-day return, and $Sur = S_G - \bar{S}$ is the announcement surprise. The theoretical conjecture is that $\beta > 0$ and that $\gamma < 0$, which is consistent with my empirical results: returns and revisions are positively related, and surprises and revisions are negatively related.

As is mentioned in the Introduction, the fundamental question addressed in this paper is "how does information get into prices?" A variant of this question in the context of noisy public announcements is "how does accurate information get into prices when inaccurate information gets released?" The model highlights the fact that the public signal is necessary for investors to be able to assess how inaccurate it is and as a result impound their more accurate private information. This process does require trading and is consistent with the findings of Evans and Lyons (2007) who show that about two-thirds of the effect of macro news is transmitted to exchange rates via order flow.

The model has an additional empirical prediction beyond equation (28). The information structure implies that the release of an inaccurate public signal allows some investors to assess its inaccuracy by estimating the information of other investors. This error analysis ought to be more important (or easier) when the public signal is very different from the consensus expectation. The coefficient on the return residuals in the second-step regression of my empirical framework, equation (8), should therefore only be significant for highly positive and highly negative surprises.

In order to test this assertion, I run the same forecasting regressions as before on 3 surprise quantiles: quantile 1 = low (negative) surprises, quantile 2 = medium (negative and positive) surprises, and quantile 3 = high (positive) surprises. The results are presented in Table 7 for Nonfarm Payroll and in Table 8 for Industrial Production. The β coefficient on the return residuals is significant, and positive, for the lowest and highest quantiles, and is insignificant for the middle quantile. Similar tests for Factory Orders and Business Inventories show the same qualitative pattern.

The results of the first-step regression across quantiles for Nonfarm Payroll further confirm that good news is good news. For the negative-surprise quantile, a one-standard deviation increase in surprises has positive impact of 33 basis points on the S&P500 Index. The coefficient is positive (insignificant) for medium surprises. For high surprises, the coefficient is negative (insignificant) but the intercept is significantly positive, suggesting that the Index increases by 69 basis points conditional on the surprise being high.

6 Conclusion

Intradaily announcement-day returns on the S&P500 Index contain information about the future revisions, and hence final values, of macroeconomic variables that is independent of the initial announcement surprises. Prices rise following the initial announcement in anticipation of a future upward revision of the data announced. These results, strongest for real activity variables such as Nonfarm Payroll and Industrial Production, are indirect evidence that aggregate equity returns do indeed react to macroeconomic information. Since macroeconomic information is fundamentally dispersed across the economy, a large fraction of it is held as "private" information by individual investors who, pooled together, have much more information than is contained in the initial government releases. As a result, the fact that initial surprises do not move prices but that prices do contain information about future revisions suggests that, overall, returns do impound macroeconomic information at great speed and accuracy.

The model, together with the empirical findings, yield fresh light on the extensive event study literature that attempts to explain a large fraction of price movements using, among others, public information. The findings in Roll (1988) are consistent with the low R^2's found in studies such as Andersen et al. (2007): an average R^2 close to 1% using 5-minute return windows. It may be that these event studies have low power because they are fundamentally flawed. If public signals do not convey any new information to the market, then the results are not surprising. My theoretical and empirical framework suggest that public announcements may just be "mechanisms" for private information to get impounded into prices, justifying the relation between announcement-day returns and subsequent revisions. These insights may provide the basis for more robust analysis of the role of information releases on price volatility.

Preliminary tests not reported here using bond returns to forecast future revisions do not seem to yield any positive results. This would suggest that the informational effect discovered in this paper is about cash flows and not about discount rates. It would be extremely valuable to analyze more industry-specific announcements (and maybe even firm-specific earnings announcements) and measure the information aggregation process using sector indices. Unfortunately, sector-specific Exchange Traded Funds (ETF) are too recent to perform robust statistical tests. One could further analyze how the information aggregates across sectors and into the overall index, perhaps shedding further light on the findings of Hong, Torous, and Valkanov (2007) who show that the returns on some industries lead the aggregate stock market.

Appendices

A Bureau of Labor Statistics' Methodology for Nonfarm Payroll

Nonfarm Payroll is released on a monthly basis as part of the Current Employment Statistics (CES) report by the Bureau of Labor Statistics (BLS) at 8:30am on the third Friday after the conclusion of the reference week, which is the week which includes the 12th of the month.[17] Each monthly report tabulates the previous month's estimated change in payroll, the previous two months' revised changes in payroll, the average changes during the previous two quarters, as well as a complete breakdown of these nationwide numbers (split by industries, age, etc.).

The CES program[18] is an estimate of the nation's employment based on the responses (surveys) from about 160,000 businesses and government agencies representing approximately 400,000 worksites. This sample accounts for about one-third of total nonfarm payroll employment and is constructed to be as representative as possible. The nationwide change in nonfarm payroll is estimated by extrapolating this sample using the latest available Unemployment Insurance (UI) tax numbers. The UI "universe count" tabulates the total number of employees covered by UI laws and is available on a lagged quarterly basis. It contains individual employer records for over eight million establishments covering nearly 97% of total nonfarm employment, which therefore provides a national benchmark for the sample-based estimates.

For a particular month, the BLS releases its initial Nonfarm Payroll estimate based on the received surveys and the lagged UI numbers. However, for the month in question, the BLS continues to receive payroll information from firms after the initial release. The result is that in the following month's report, the BLS also releases a revision to the previous release based on the late surveys received. This process continues for three months.

Each year, the BLS revises the payroll estimates to an almost-complete count of the payroll employment using the new UI reports. This is called the benchmark revision. It also includes updated data about the birth and death of firms during the past year. Each annual benchmark revision can affect the prior five years of data.

[17] It is released on Thursday if the 4th of July falls on a Friday. However, it is still released on Friday if that Friday is Good Friday and markets are closed. In November 1998, the Employment Situation Report was released by mistake 24 hours before schedule.

[18] The CES program is also known as the Payroll or Establishment Survey.

B Proofs

Lemma 1

Proof. The Hessian matrix is:

$$\begin{pmatrix} -2b & 0 \\ 0 & -2d \end{pmatrix}$$

which is negative semi-definite if and only if $-2b \leq 0$ and $4bd \geq 0$. These conditions are equivalent to $b \geq 0$ and $d \geq 0$. □

Lemma 2

Proof. The best-response functions for i and j, equations (14) and (17), are strictly decreasing in the other investor's demand. By the single-crossing condition, the equilibria are therefore unique. □

Lemma 3

Proof. The first two are straightforward from the definitions of the signals:

$$\begin{aligned} E[\nu] &= w_i E[S_{i2}] + w_j E[S_{j2}] \\ &= w_i \bar{S} + w_j \bar{S} \\ &= \bar{S} \qquad \text{(B-1)} \\ E[\nu|S_G] &= w_i E[S_{i2}|S_G] + w_j E[S_{j2}|S_G] \\ &= w_i S_{i1} + w_j S_{j1} \\ &= S_G. \qquad \text{(B-2)} \end{aligned}$$

The conditional expectations from the $t = 1$ maximizations are also straight applications of the information structure:

$$\begin{aligned} E[\nu|S_{i1}] &= w_i E[S_{i2}|S_{i1}] + w_j E[S_{j2}|S_{i1}] \\ &= w_i S_{i1} + w_j \bar{S} \qquad \text{(B-3)} \\ E[\nu|S_{j1}] &= w_i \bar{S} + w_j S_{j1}. \qquad \text{(B-4)} \end{aligned}$$

The expectations from the $t = 2$ optimizations are the key step in the derivation:

$$\begin{aligned}
E[\nu|S_{i1}, S_{i2}, S_G] &= w_i E[S_{i2}|S_{i1}, S_{i2}, S_G] + w_j E[S_{j2}|S_{i1}, S_{i2}, S_G] \\
&= w_i S_{i2} + w_j E[S_{j2}|S_{j1}, S_{i1}, S_{i2}, S_G] \\
&= w_i S_{i2} + w_j S_{j1} \qquad \text{(B-5)} \\
E[\nu|S_{j1}, S_{j2}, S_G] &= w_i S_{i1} + w_j S_{j2} \qquad \text{(B-6)}
\end{aligned}$$

since knowing S_{i1} and S_G allows investor i to calculate S_{j1} exactly (and vice versa for investor j). □

Proposition 1

Proof. Plugging the conditional expectations from Lemma 3 into the price change, equation (20), gives:

$$\begin{aligned}
\Delta p &= \frac{1}{3}(S_G - \bar{S}) + (du_2 - bu_1) \\
&\quad + \frac{1}{3}(w_i S_{i2} + w_j S_{j1} - w_i S_{i1} - w_j \bar{S}) \\
&\quad + \frac{1}{3}(w_i S_{i1} + w_j S_{j2} - w_i \bar{S} - w_j S_{j1}) \\
&= \frac{1}{3}(S_G - \bar{S}) + \frac{1}{3}\nu - \frac{1}{3}\bar{S} + (du_2 - bu_1) \\
&= \frac{2}{3}(S_G - \bar{S}) + \frac{1}{3}(\nu - S_G) + (du_2 - bu_1). \qquad \text{(B-7)}
\end{aligned}$$

The proposition follows from a straightforward rearrangement of equation (B-7). □

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Figure 1
Surprises and Revisions to Nonfarm Payroll Announcements

The first panel presents the initial surprises Sur_t to Nonfarm Payroll announcements that occurred between August 1997 and December 2006. The dashed line is the sample average surprise (-24,000 employees). For an announcement at time t, the initial surprise is the difference between the announced value and the market median expectation. The second panel presents the final revisions $Rev_{T,t}$ to the same announcements and the dashed line is the sample average revision (20,000 employees). For an announcement at time t, the final revision is the difference between the final value available at time $T =$ July 2007 and the announced value at time t. Over this sample, the average announced value is 107,000 employees, the average expectation is 131,000 employees, and the average final value is 127,000 employees.

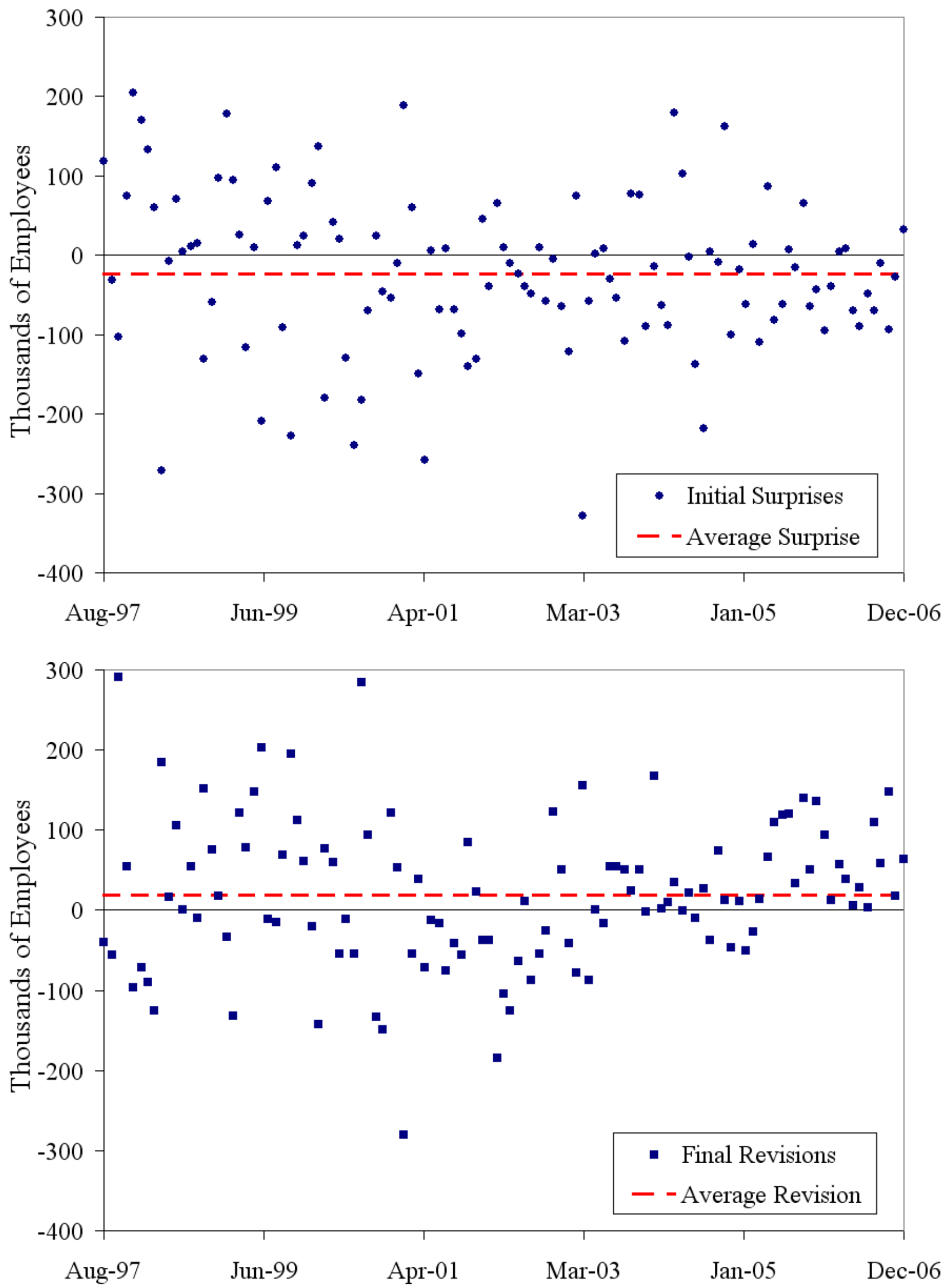

Figure 2
Forecasting Revisions to Factory Orders

This figure presents the values and ±1 White standard error range of the β coefficient in the second-step forecasting regression of final revisions $\overline{Rev}_{T,t}$ to Factory Orders announcements:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step return-response regression:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \varepsilon_t.$$

r_t is the return on the S&P500 Index from close of the day prior to the announcement to the announcement-day time indicated along the horizontal axis. $\overline{Sur}_t$ is the normalized surprise of the initial announcement at date t. The γ' coefficient is insignificant for all return intervals (values not reported here). Factory Orders are released at 10am. The sample period is from August 1997 to December 2006. Each regression has 112 observations.

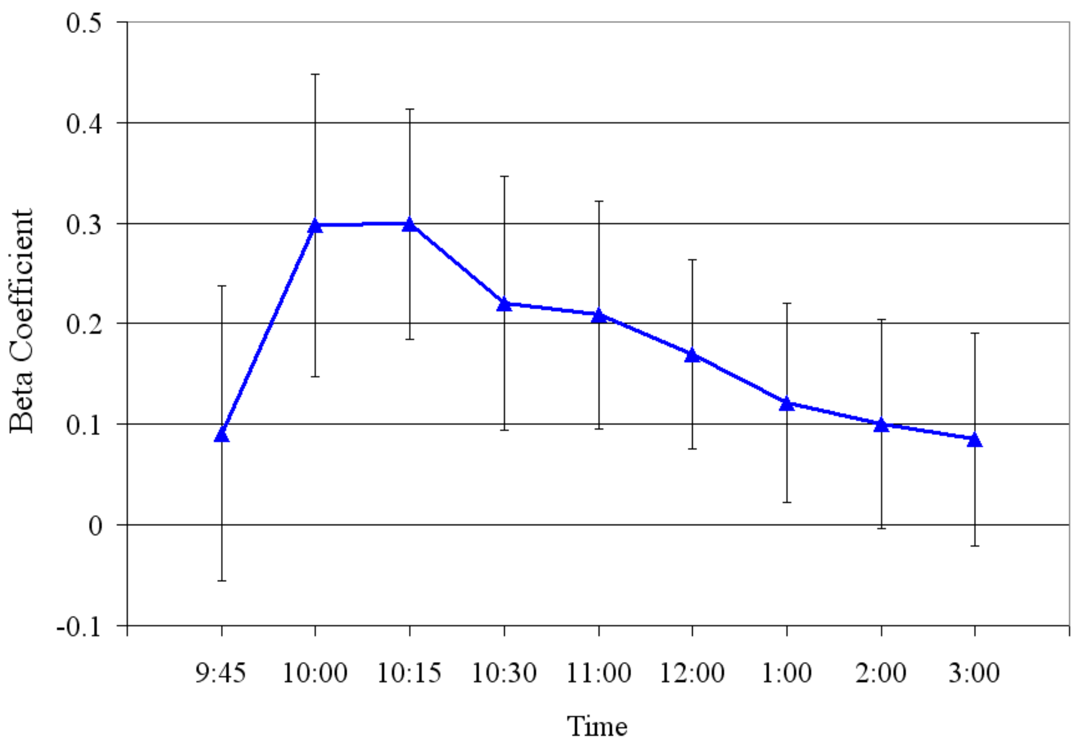

Table I
U.S. Monthly Macroeconomic Announcements

This table presents all the macroeconomic variables used in this paper. All announcements take place on a monthly basis. The reporting agencies are the Bureau of Labor Statistics (BLS), the Census Bureau (CB), the Federal Reserve Board (FRB), and the Bureau of Economic Analysis (BEA).

Macroeconomic Series	Agency	Release Time	Number Reported
Real Activity:			
Nonfarm Payroll	BLS	8:30am	Change in Thousands of Employees
Unemployment[a]	BLS	8:30am	Percent
Retail Sales	CB	8:30am	Percentage Change
Industrial Production	FRB	9:15am	Percentage Change
Capacity Utilization[b]	FRB	9:15am	Percent
Consumer Credit	FRB	3:00pm	Change in Billions of Dollars
Investment:			
Durable Goods Orders	CB	8:30am	Percentage Change
Factory Orders	CB	10:00am	Percentage Change
Construction Spending	CB	10:00am	Percentage Change
Business Inventories	CB	8:30am/10:00am[c]	Percentage Change
Others:			
Trade Balance	BEA	8:30am	Billions of Dollars
Personal Income	BEA	8:30am	Percentage Change
Personal Consumption[d]	BEA	8:30am	Percentage Change
PPI	BLS	8:30am	Percentage Change
CPI	BLS	8:30am	Percentage Change
New Home Sales	CB	10:00am	Thousands of Houses
Housing Starts	CB	8:30am	Millions of Units

[a]Unemployment is released in the same report as Nonfarm Payroll.
[b]Capacity Utilization is released in the same report as Industrial Production.
[c]Business Inventories are released at 8:30am prior to 2003 and at 10:00am afterwards.
[d]Personal Consumption is released in the same report as Personal Income.

Table II
Summary Statistics for Macroeconomic Revisions

This table presents summary statistics about final revisions $Rev_{T,t}$. The first column shows the macroeconomic series analyzed in this paper. The second column reports the average revisions. The standard errors are reported in parentheses below the coefficients. The third column contains the sample standard deviation of the revisions. The fourth and fifth columns contain the minimum and maximum revisions. The sixth column shows the ratio of the variances of revisions and surprises. The p-values of the variance ratio test are reported in parentheses below the ratio. The sample period is from August 1997 to December 2006. Each series has 113 observations. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Macroeconomic Series	$\overline{Rev_{T,t}} = 0$	$\sigma_{Rev_{T,t}}$	Min	Max	$\frac{\sigma^2_{Rev_{T,t}}}{\sigma^2_{Sur_t}} = 1$
Nonfarm Payroll	19.062**	92.272	-281	291	0.915
	(8.680)				(0.350)
Unemployment	-0.008	0.060	-0.2	0.2	0.449***
	(0.006)				(0.000)
Retail Sales	0.077*	0.488	-1.2	1.5	0.724***
	(0.046)				(0.001)
Industrial Production	0.025	0.341	-0.9	0.8	1.137
	(0.032)				(0.176)
Capacity Utilization	0.387***	0.880	-1.4	1.9	2.582***
	(0.083)				(0.000)
Consumer Credit	3.440***	4.978	-8.9	20.5	0.937
	(0.468)				(0.493)
Durable Goods Orders	0.043	2.572	-9	8.5	0.885
	(0.242)				(0.199)
Factory Orders	-0.045	1.681	-6.1	5.7	2.229***
	(0.158)				(0.000)
Construction Spending	0.236**	0.990	-3.4	2.9	1.029
	(0.093)				(0.763)
Business Inventories	-0.004	0.175	-0.4	0.4	0.706
	(0.016)				(0.001)
Trade Balance	0.070	1.786	-12.4	3.5	0.713***
	(0.168)				(0.000)
Personal Income	0.025	0.348	-1.9	1.5	1.460***
	(0.033)				(0.000)
Personal Consumption	0.082***	0.274	-0.7	0.7	1.474***
	(0.026)				(0.000)
PPI	-0.003	0.209	-0.6	0.4	0.467***
	(0.020)				(0.000)
CPI	0.004	0.077	-0.1	0.2	0.550***
	(0.007)				(0.000)
New Home Sales	-13.513***	54.275	-147	144	0.785**
	(5.106)				(0.011)
Housing Starts	-0.001	0.047	-0.288	0.132	0.517***
	(0.004)				(0.000)

Table III
Explanatory Power of Announcements and Expectations

This table presents the results to three regressions for five macroeconomic variables. First, I test the explanatory power of the initial announcements with respect to the final values:

$$F_T = \alpha + \beta \cdot A_t + \varepsilon_T.$$

Second, I test the explanatory power of the market median expectations with respect to the final values:

$$F_T = \alpha' + \beta' \cdot E[A_t] + \varepsilon'_T.$$

Third, I test the explanatory power of the market median expectations with respect to the initial announcements:

$$A_t = \alpha'' + \beta'' \cdot E[A_t] + \varepsilon''_t.$$

The sample period is from August 1997 to December 2006. Each regression has 113 observations. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Macroeconomic Series	Regression	Constant	Slope	R^2
Nonfarm Payroll	F_T on A_t	29.325***	0.905***	0.726
		(10.264)	(0.051)	
	F_T on $E[A_t]$	-26.294*	1.163***	0.653
		(13.917)	(0.080)	
	A_t on $E[A_t]$	-33.070***	1.070***	0.623
		(11.978)	(0.071)	
Industrial Production	F_T on A_t	0.050	0.862***	0.637
		(0.032)	(0.071)	
	F_T on $E[A_t]$	-0.013	1.084***	0.465
		(0.041)	(0.120)	
	A_t on $E[A_t]$	-0.064**	1.212***	0.679
		(0.032)	(0.085)	
Durable Goods Orders	F_T on A_t	0.081	0.815***	0.611
		(0.232)	(0.094)	
	F_T on $E[A_t]$	-0.069	1.407***	0.320
		(0.321)	(0.192)	
	A_t on $E[A_t]$	-0.165	1.632***	0.480
		(0.264)	(0.164)	
Factory Orders	F_T on A_t	0.024	0.775***	0.531
		(0.151)	(0.104)	
	F_T on $E[A_t]$	-0.001	0.815***	0.498
		(0.154)	(0.116)	
	A_t on $E[A_t]$	-0.021	1.022***	0.884
		(0.068)	(0.039)	
Business Inventories	F_T on A_t	-0.042**	1.140***	0.875
		(0.020)	(0.041)	
	F_T on $E[A_t]$	-0.053	1.281***	0.596
		(0.042)	(0.110)	
	A_t on $E[A_t]$	0.010	1.046***	0.590
		(0.038)	(0.104)	

Table IV
Forecasting Revisions to Nonfarm Payroll

This table presents the results of the forecasting regressions of final revisions of monthly changes in Nonfarm Payroll. The first panel shows the regression of the intradaily S&P500 Index return r_t on the normalized surprise $\overline{Sur}_t$ of the initial Nonfarm Payroll announcement at date t, the normalized revision $\overline{Rev}_{t,t-1}$ of the previous month's announcement $(t-1)$ released at the same time as the announcement t, the normalized revision $\overline{Rev}_{t,t-2}$ of the announcement two months prior $(t-2)$, also released at the same time as the announcement t, and on the normalized surprise $\overline{Sur}_t^{UN}$ of the simultaneous initial announcement of Unemployment:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \delta' \cdot \overline{Rev}_{t,t-1} + \zeta' \cdot \overline{Rev}_{t,t-2} + \kappa' \cdot \overline{Sur}_t^{UN} + \varepsilon_t.$$

r_t is measured from the close of the day prior to the announcement to the announcement-day time indicated in the first column. In the second panel, the dependent variable is the normalized revision $\overline{Rev}_{T,t}$ available at T = July 2007 of the initial Industrial Production announcement at date t:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \delta \cdot \overline{Rev}_{t,t-1} + \zeta \cdot \overline{Rev}_{t,t-2} + \kappa \cdot \overline{Sur}_t^{UN} + \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step regression. Nonfarm Payroll and Unemployment are announced at 8:15am. The sample period is from August 1997 to December 2006. Each regression has 112 observations. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Return Interval	α'		$\overline{Sur}_t$	$\overline{Rev}_{t,t-1}$	$\overline{Rev}_{t,t-2}$	$\overline{Sur}_t^{UN}$	R^2
Close - 9:45	0.099		0.145**	-0.025	0.132	-0.028	0.070
	(0.089)		(0.066)	(0.081)	(0.081)	(0.070)	
Close - 10:00	0.072		0.117*	0.031	0.132	0.060	0.073
	(0.103)		(0.068)	(0.073)	(0.083)	(0.076)	
Close - 10:15	0.067		0.048	0.094	0.069	0.119	0.060
	(0.109)		(0.071)	(0.078)	(0.090)	(0.075)	
Close - 10:30	0.011		0.041	0.067	0.150	0.110	0.079
	(0.110)		(0.069)	(0.087)	(0.093)	(0.073)	
Return Interval	α	ε_t	$\overline{Sur}_t$	$\overline{Rev}_{t,t-1}$	$\overline{Rev}_{t,t-2}$	$\overline{Sur}_t^{UN}$	R^2
Close - 9:45	-0.029	0.304***	-0.436***	0.077	0.173	0.099	0.278
	(0.109)	(0.116)	(0.105)	(0.113)	(0.110)	(0.076)	
Close - 10:00	0.033	0.152	-0.359***	0.018	0.160	0.110	0.211
	(0.097)	(0.116)	(0.096)	(0.106)	(0.105)	(0.073)	
Close - 10:15	-0.014	0.147	-0.414***	0.029	0.170	0.078	0.234
	(0.109)	(0.099)	(0.104)	(0.106)	(0.104)	(0.077)	
Close - 10:30	-0.019	0.124	-0.414***	0.030	0.171	0.080	0.232
	(0.110)	(0.096)	(0.105)	(0.106)	(0.105)	(0.078)	

Table V
Forecasting Revisions to Industrial Production

This table presents the results of the forecasting regressions of final revisions of monthly changes in Industrial Production. The first panel shows the regression of the intradaily S&P500 Index return r_t on the normalized surprise $\overline{Sur}_t$ of the initial announcement of Industrial Production at date t and on the normalized surprise $\overline{Sur}_t^{CU}$ of the simultaneous initial announcement of Capacity Utilization:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \kappa' \cdot \overline{Sur}_t^{CU} + \varepsilon_t.$$

r_t is measured from the close of the day prior to the announcement to the announcement-day time indicated in the first column. In the second panel, the dependent variable is the normalized revision $\overline{Rev}_{T,t}$ available at $T =$ July 2007 of the initial announcement at date t:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \kappa \cdot \overline{Sur}_t^{CU} + \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step regression. Industrial Production and Capacity Utilization are released simultaneously at 9:15am. The sample period is from August 1997 to December 2006. Each regression has 111 observations. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Return Interval	α'		$\overline{Sur}_t$	$\overline{Sur}_t^{CU}$	R^2
Close - 9:45	0.103		-0.022	0.046	0.003
	(0.063)		(0.069)	(0.065)	
Close - 10:00	0.044		-0.038	0.079	0.009
	(0.062)		(0.065)	(0.065)	
Close - 10:15	0.008		0.009	0.049	0.006
	(0.068)		(0.065)	(0.067)	
Close - 10:30	0.001		0.011	0.048	0.005
	(0.074)		(0.076)	(0.074)	
Return Interval	α	ε_t	$\overline{Sur}_t$	$\overline{Sur}_t^{CU}$	R^2
Close - 9:45	0.068	0.338***	-0.166	-0.050	0.088
	(0.095)	(0.119)	(0.158)	(0.161)	
Close - 10:00	0.062	0.321**	-0.164	-0.047	0.080
	(0.096)	(0.129)	(0.159)	(0.161)	
Close - 10:15	0.060	0.209*	-0.144	-0.066	0.059
	(0.095)	(0.113)	(0.158)	(0.159)	
Close - 10:30	0.060	0.152	-0.144	-0.066	0.050
	(0.095)	(0.111)	(0.160)	(0.159)	

Table VI
Forecasting Revisions to Other Announcements

This table presents the results of the forecasting regressions of final revisions for six macroeconomic series. For each series, the first row shows the results of the return-response regression of the intradaily S&P500 Index return r_t on the normalized surprise $\overline{Sur}_t$ of the initial announcement at date t:

$$r_t \quad = \quad \alpha' \quad + \quad \gamma' \cdot \overline{Sur}_t \quad + \quad \varepsilon_t.$$

r_t is measured from the close of the day prior to the announcement to 15 minutes after the opening of the market on announcement-day. For each series, the second row contains the results of the revisions-forecasting regression where the dependent variable is the normalized revision $\overline{Rev}_{T,t}$ available at $T =$ July 2007 of the initial announcement at date t:

$$\overline{Rev}_{T,t} \quad = \quad \alpha \quad + \quad \beta \cdot \varepsilon_t \quad + \quad \gamma \cdot \overline{Sur}_t \quad + \quad \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step regression. For the PPI, the end of the return interval is chosen to maximize the significance of β. Personal Income and Personal Consumption are released in the same report. $\overline{Sur}_t^{PC}$ is the announcement surprise to Personal Consumption. The sample period is from August 1997 to December 2006. Each regression has 111, 112, or 113 observations, depending on the number of announcements that fell on days when markets are closed. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Macroeconomic Series	Constant	ε_t	$\overline{Sur}_t$	$\overline{Sur}_t^{PC}$	R^2
Durable Goods Orders	0.019		0.077*		0.024
Close - 9:45	(0.047)		(0.045)		
	0.045	-0.416**	-0.249		0.126
	(0.090)	(0.170)	(0.154)		
Business Inventories	0.013		-0.088		0.016
Close - 9:45	(0.067)		(0.062)		
	0.014	0.280***	0.016		0.040
	(0.093)	(0.095)	(0.101)		
Trade Balance	-0.065		0.039		0.005
Close - 9:45	(0.052)		(0.052)		
	0.010	0.138*	-0.416**		0.196
	(0.093)	(0.074)	(0.170)		
Personal Income	0.057		0.126***	-0.034	0.070
Close - 9:45	(0.047)		(0.033)	(0.046)	
	0.066	0.167*	0.060	0.092	0.039
	(0.096)	(0.090)	(0.224)	(0.098)	
Personal Consumption	0.261***	0.161*	-0.087	-0.404***	0.183
Close - 9:45	(0.095)	(0.093)	(0.079)	(0.106)	
PPI	-0.024		-0.009		0.001
Close - 11:05	(0.066)		(0.055)		
	-0.012	0.188*	-0.569***		0.339
	(0.078)	(0.112)	(0.081)		

Table VII
Forecasting Revisions to Nonfarm Payroll by Surprise Quantile

This table presents the results of the forecasting regressions of final revisions of monthly changes in Nonfarm Payroll for three surprise quantiles. Quantile 1 = low (negative) surprises. Quantile 2 = medium (negative and positive) surprises. Quantile 3 = high (positive) surprises. The first panel shows the regression of the intradaily S&P500 Index return r_t on the normalized surprise $\overline{Sur}_t$ of the initial Nonfarm Payroll announcement at date t, the normalized revision $\overline{Rev}_{t,t-1}$ of the previous month's announcement $(t-1)$ released at the same time as the announcement t, the normalized revision $\overline{Rev}_{t,t-2}$ of the announcement two months prior $(t-2)$, also released at the same time as the announcement t, and on the normalized surprise $\overline{Sur}_t^{UN}$ of the simultaneous initial announcement of Unemployment:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \delta' \cdot \overline{Rev}_{t,t-1} + \zeta' \cdot \overline{Rev}_{t,t-2} + \kappa' \cdot \overline{Sur}_t^{UN} + \varepsilon_t.$$

r_t is measured from the close of the day prior to the announcement to 9:45am on announcement-day. In the second panel, the dependent variable is the normalized revision $\overline{Rev}_{T,t}$ available at T = July 2007 of the initial Industrial Production announcement at date t:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \delta \cdot \overline{Rev}_{t,t-1} + \zeta \cdot \overline{Rev}_{t,t-2} + \kappa \cdot \overline{Sur}_t^{UN} + \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step regression. Nonfarm Payroll and Unemployment are released simultaneously at 8:15am. The sample period is from August 1997 to December 2006. Each regression has 37 observations. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	α'		$\overline{Sur}_t$	$\overline{Rev}_{t,t-1}$	$\overline{Rev}_{t,t-2}$	$\overline{Sur}_t^{UN}$	R^2
Quantile 1	0.075		0.331**	0.239*	0.287**	0.121	0.307
	(0.222)		(0.137)	(0.134)	(0.139)	(0.139)	
Quantile 2	0.108		0.428	0.001	0.078	-0.034	0.040
	(0.171)		(0.546)	(0.134)	(0.113)	(0.125)	
Quantile 3	0.691***		-0.263	-0.342*	0.258	-0.082	0.200
	(0.214)		(0.208)	(0.196)	(0.185)	(0.098)	
	α	ε_t	$\overline{Sur}_t$	$\overline{Rev}_{t,t-1}$	$\overline{Rev}_{t,t-2}$	$\overline{Sur}_t^{UN}$	R^2
Quantile 1	0.131	0.623**	-0.267	0.168	0.175	0.148	0.282
	(0.289)	(0.244)	(0.258)	(0.148)	(0.232)	(0.128)	
Quantile 2	0.168	-0.076	0.321	-0.055	0.252	0.127	0.125
	(0.214)	(0.221)	(0.600)	(0.237)	(0.156)	(0.132)	
Quantile 3	0.186	0.409*	-0.793**	0.172	0.127	0.041	0.265
	(0.264)	(0.212)	(0.368)	(0.219)	(0.188)	(0.193)	

Table VIII
Forecasting Revisions to Industrial Production by Surprise Quantile

This table presents the results of the forecasting regressions of final revisions of monthly changes in Industrial Production for three surprise quantiles. Quantile 1 = low (negative) surprises. Quantile 2 = medium (negative and positive) surprises. Quantile 3 = high (positive) surprises. The first panel shows the regression of the intradaily S&P500 Index return r_t on the normalized surprise $\overline{Sur}_t$ of the initial announcement of Industrial Production at date t and on the normalized surprise $\overline{Sur}_t^{CU}$ of the simultaneous initial announcement of Capacity Utilization:

$$r_t = \alpha' + \gamma' \cdot \overline{Sur}_t + \kappa' \cdot \overline{Sur}_t^{CU} + \varepsilon_t.$$

r_t is measured from the close of the day prior to the announcement to 9:45am on announcement-day. In the second panel, the dependent variable is the normalized revision $\overline{Rev}_{T,t}$ available at T = July 2007 of the initial announcement at date t:

$$\overline{Rev}_{T,t} = \alpha + \beta \cdot \varepsilon_t + \gamma \cdot \overline{Sur}_t + \kappa \cdot \overline{Sur}_t^{CU} + \varepsilon_{T,t}$$

where ε_t are the residuals from the first-step regression. Industrial Production and Capacity Utilization are released simultaneously at 9:15am. The sample period is from August 1997 to December 2006. Each regression has 37 observations. White standard errors are reported in parentheses below the coefficients. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	α'		$\overline{Sur}_t$	$\overline{Sur}_t^{CU}$	R^2
Quantile 1	0.348		0.198	0.122	0.041
	(0.219)		(0.214)	(0.137)	
Quantile 2	0.171		0.391	0.141	0.061
	(0.144)		(0.542)	(0.216)	
Quantile 3	0.144		-0.105	0.001	0.016
	(0.167)		(0.132)	(0.041)	
	α	ε_t	$\overline{Sur}_t$	$\overline{Sur}_t^{CU}$	R^2
Quantile 1	0.395*	0.238*	0.038	0.132	0.069
	(0.216)	(0.129)	(0.240)	(0.166)	
Quantile 2	0.342	0.059	-1.304	0.463	0.072
	(0.346)	(0.543)	(1.669)	(0.436)	
Quantile 3	-0.315	0.783**	0.178	-0.198	0.151
	(0.425)	(0.349)	(0.389)	(0.161)	