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The Pre-Monetary Policy Announcement Drift on the Stockholm Stock Exchange

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Abstract: This thesis investigates the existence and properties of pre-monetary policy announcement drifts on the Stockholm Stock Exchange. While previous literature has mainly focused on U.S. financial markets and monetary policy, our study investigates how monetary policy announcements made by the Federal Open Market Committee, the European Central Bank and the Swedish Riksbank affect the Swedish stock market. We document a significant 0.48% drift in equities on the Stockholm Stock Exchange in the day preceding Federal Open Market Committee monetary policy announcements. In addition, we document that monetary policy announcements made by the other central banks are not preceded by similar drifts. We employ a risk-based explanatory model that incorporates volatility- and liquidity risk, but fail to attribute the pre-FOMC announcement drift to changes in either metrics. Finally, we show that the pre-FOMC announcement drift appears to have diminished after information regarding its existence was made public in 2011. This final piece of suggestive evidence points towards the drift being a result of inefficient markets, rather than being a compensation for increased systematic risk.

Keywords: Monetary Policy, Macroeconomic Announcement, Pre-Announcement Drift, Abnormal Returns, Efficient Markets

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Table of Contents

1 Introduction

1.1 Purpose

This thesis' main purpose is to investigate the existence of a pre-monetary policy announcement drift in equities listed on the Stockholm Stock Exchange. If found, a natural secondary aim then becomes to explore and understand why such a drift can occur. In our investigation, pre-monetary policy announcement drifts are defined as abnormally large positive excess returns in anticipation of monetary policy announcements made by central banks. Our thesis draws inspiration from the research presented by Lucca and Moench (2015), where the authors discover a surprising mean 0.49% drift on the S&P 500 in the 24 hours preceding Federal Open Market Committee (FOMC) announcements. The pre-FOMC announcement drift forms a new and surprising connection between monetary policy announcements and the famous Equity Premium Puzzle, coined by Mehra and Prescott (1985). We aim to continue to investigate the puzzling drift by looking at return patterns on the Swedish stock market in conjunction with three different central banks' announcements. We conduct the first study of this kind on Sweden, which is a small economy with well-developed financial markets and an independent domestic central bank. In this setting, it becomes interesting to investigate whether there is a difference between return patterns ahead of foreign and domestic monetary policy announcements. With our study, we hope to uncover new information regarding whether the drift can be considered isolated to the FOMC in the U.S., or if it is a more general phenomenon relating to monetary policy announcements. We also aim to explain pre-monetary policy announcement drifts by employing both risk-based and alternative explanatory models. In conclusion, our study aims to answer the following two research questions:

"Is there a pre-monetary policy announcement drift on the Stockholm Stock Exchange?"

&

"If found, can the drift be explained using risk-based or alternative explanatory models?"

1.2 Background

Understanding how financial markets react to monetary policy announcements is crucial for policy makers and market participants alike. Our research relates to different branches of previous literature. A seminal study by Beaver (1968) investigates how financial market participants perceive the informational value of individual corporations' earnings announcements. This early study found that trading volume surged in weeks when earnings information was released, attributing the increased volume to investors revising their predictions about the company's future earnings and consequently rebalancing their portfolios. Later studies, that continued to study asset prices around earnings announcements have found several peculiarities, such as drifts in asset prices in the days following an earnings announcement (Bernard and Thomas, 1989) as well as in advance of the announcement (Lamont and Frazzini, 2007). Another, more closely related research field investigates how the financial markets react to changes in monetary policy. For example, Jensen and Johnson (1995) document that long-term equity returns are affected by changes in the discount rate and Thorbecke (1997) show that expansionary monetary policy have a positive effect on equity prices in the short-run. Focusing on monetary policy decision announcements, Bernanke and Kuttner (2005) develop a measure of the "surprise component" of Federal funds rate changes and prove that the unanticipated changes in monetary policy have a negative relationship with expected stock market returns. Several studies also find that unconditional returns around macroeconomic announcements are mean positive. For example, Savor and Wilson (2013) investigate unconditional returns on days of inflation, labor market and FOMC information releases. The authors find that irrespective of the informational content, systematic risk surges on announcement days, giving rise to large excess returns in compensation.

While literature examining conditional and unconditional market reactions to macroeconomic information releases is dense, studies of asset prices in anticipation of macroeconomic information releases is more scarce. Using intraday trading data on the S&P 500 from 1994 to 2011, Lucca and Moench (2015) document a 0.49% drift in excess returns in the 24 hours preceding FOMC monetary policy announcements. The drift is economically large, statistically highly significant and unconditional on the outcome of the announcement. The authors employ several explanatory models to the drift, with only partial success, concluding that the root cause of the drift remain a puzzle. It is in the light of the recent study by Lucca and Moench (2015) that we aim to investigate how the Swedish stock market behaves in anticipation of monetary policy releases by the FOMC, the European Central Bank (ECB) and the domestic Swedish Riksbank (Riksbank).

1.3 Scope of investigation

The scope of our thesis is limited to announcements from three monetary institutions; the Federal Reserve (Fed), the Riksbank and the ECB. Previous research has shown that both U.S. and Eurozone monetary policy have a large impact on international stock indices (Conover et al., 1999), while the Riksbank is responsible for the investigated market's domestic monetary policy. Our sample period is limited between January 1999 and February 2017 for two reasons. 1999 was the year which the ECB started conducting monetary policy with the formation of the Eurozone. The same year, the Riksbank was granted its statutory independence and started conducting monetary policy without political dependence. This ensures comparability in the cross-section between central banks and in addition contributes to the comparability over time. From a geographical point of view, the scope of the study is limited to the Swedish stock market. Sweden is particularly suitable since it is a small economy with a well-developed financial system and an independent, domestic central bank. Sweden has also been shown to be largely affected by foreign monetary policy by previous research (Conover et al., 1999).

1.4 Contribution

Our study presents several new and interesting insights. Firstly, we confirm the existence of a large and highly statistically significant 0.48% pre-FOMC announcement drift on the Stockholm Stock Exchange, but fail to confirm a similar drift for the Riksbank and the ECB. After a closer investigation, we conclude that three-day cumulative returns over announcement days are almost identical for the FOMC and the Riksbank, but the timing of the returns differ. While the FOMC returns are made almost entirely in advance of the announcement, the Riksbank returns seem split in two between the pre-announcement and announcement day. This indicates a temporal disconnection between systematic risk and excess returns for FOMC announcements that is not present for Riksbank announcements. We employ a risk-based explanatory model including volatility- and liquidity risk to explain the pre-FOMC announcement drift. In contradiction to previous research, we fail to attribute any explanatory value to unexpected changes in volatility and liquidity. We continue to explore behavioural explanation models. By dividing our data sample into two sub-samples – before and after information regarding the drift became publicly available – we see clear signs of the drift disappearing in the latter sub-sample, indicating that the pre-FOMC drift may instead have been driven by market inefficiencies.

2 Previous Research and Theoretical Framework

2.1 Monetary Policy Theory

The main objective of all monetary policy is to maintain price stability, which in practice is interpreted as maintaining a low and stable rate of inflation in the domestic economy. However, a "low and stable rate of inflation" can in turn be interpreted differently by different monetary policy makers. For example, the Riksbank and the Federal Reserve interpret this as a 2% inflation rate over time, while the ECB state an inflation rate target below 2% (Sveriges Riksbank 2011; European Union, 2012; Federal Reserve, 2017). In addition to the main objective, central banks may include several other objectives of their respective monetary policy. For example, the Fed's statutory objectives also include "maximum employment", interpreted as an unemployment rate of 4.5-5%, and "moderate long term interest rates", which is achieved through controlling inflation expectations (Federal Reserve, 2017). Monetary policy is principally conducted through controlling the main policy rate[1], for the Riksbank this is the repo rate. The repo rate indicates at which rate banks and financial institutions can deposit or borrow money overnight from the Riksbank (Riksbank, 2011). The way which the central banks' main policy rates affect the inflation and the rest of economy is named the "transmission mechanism". In short, the transmission mechanism states that policy rates affect the economy through three channels; the credit channel, the interest rate channel and the exchange rate channel. Through the credit channel the economy is affected by higher or lower access to credits and loans due to changes in the interest rates. Through the interest rate channel household consumption-to-saving-ratio is affected by interest rate changes. Through the exchange rate channel the value of the domestic currency changes with interest rates (Riksbank, n.d.). Decisions regarding monetary policy are made by each central bank's highest decision making organ. For the ECB, this is called the Governing Council, for the Riksbank the Executive Committee and for the Fed the Federal Open Market Committee. Decisions are made at pre-scheduled meetings held eight times a year by the Governing Council of the ECB and the FOMC, and six times a year by the Executive Board of the Riksbank (Sveriges Riksbank 2011; European Union, 2012; Federal Reserve, 2017).

Understanding how changes in monetary policy affects financial markets is important for both policy makers and market participants alike. An early study by Waud (1970) documents that monetary discount rate decreases produce positive stock market returns in the following periods. Further, Rozeff (1974) document that equity returns also incorporate contemporaneous monetary

[1] In recent times, as rates have dropped below zero, another monetary tool called quantitative easing (QE) has become increasingly used to stimulate the economy. In short QE is conducted by central banks purchasing treasury and corporate bonds, thus artificially increasing the amount of money floating in the market and pushing up inflation (ECB, 2017).

conditions, and in addition appear to anticipate future monetary policy changes. The author claims that this is proof that financial markets efficiently incorporate variations in monetary policy. More recently, Jensen and Johnson (1995) study the connection between long-term equity returns and discount rate changes in the U.S. between 1962 and 1991. They find that the U.S. stock market exhibits significantly greater returns and less volatility in periods following a Federal discount rate decrease than in periods following an increase. Jensen et al. (1996) extend their previous research by showing that monetary policy affects the way three common business forecasting variables, defined as the term premium, default premium and the dividend yield, explain variation in expected stock returns. The results indicate that monetary policy conditions are widely relevant for interpreting ex-ante signals about future returns. Our thesis takes aim at investigating both domestic and foreign monetary policy announcements' effect on the Swedish stock market. Conover et. al (1999) examine the effect of U.S. monetary policy on international stock exchanges between 1956 and 1995. They show that 17 international stock exchanges exhibit higher monthly returns in periods of monetary easing by the Federal Reserve. Interestingly, they also find that several stock markets, including Sweden, exhibit stronger correlation with U.S. monetary policy conditions than their domestic monetary policy. However, in the case of Sweden, the authors state that results may be subject to multicollinearity as the correlation between the U.S. and Swedish monetary policy is high (Conover et. al, 1999).

2.2 Macroeconomic Announcements and Financial Markets

Communicating the monetary policy decisions made by central banks to the public is a key part of conducting successful monetary policy. Consequently, central banks included in this study impose strict communication policies whose purpose is to enhance the effect of the monetary policy and to ensure the public's trust in the policy makers (European Union, 2012; Riksbank, 2016; Federal Reserve, 2017). For example, the Riksbank's communications policy is built around the two guiding principles of *openness* and *clarity* (Riksbank, 2016). On a more practical level, monetary policy decisions are initially communicated through a public press release followed by a press conference with the executive organ's chairman. The Riksbank release their announcement at 9:30 Central European Time (CET) on the day following the Executive Board's meeting, while the ECB and FOMC release their statements in the afternoon on the same day as the meeting at 13:45 CET and 14:15 Eastern Standard Time (EST) respectively (European Union 2012; Lucca & Moench, 2015; Sveriges Riksbank, 2016). As transparency has become more of a key concern for monetary policy makers, since 2015 all three central banks also release the protocol from the executive organ's meeting. The protocol, or "minutes", of the meetings state the voting numbers and argumentation from individual members, providing further insight into the decision-making process. The protocol is released approximately two weeks after the initial announcement of the monetary policy decision (Sveriges Riksbank 2011; European Union, 2012; Federal Reserve, 2017). Moreover, the central banks' announcements are preceded by a "quiet-period" (also known as a "purdah" or "blackout") during which decision makers are prohibited from discussing monetary policy with market participants, as this could potentially preempt the formal information release (European Union, 2012; Riksbank, 2016; Federal Reserve, 2017). The length of the period differs somewhat between central banks, but usually includes the seven days preceding a monetary policy announcement.

Macroeconomic information releases, such as monetary policy announcements, is one of the most widely relevant information flows to financial market actors (Bernanke and Kuttner, 2005). Below we review relevant literature investigating how financial markets react to macro-economic information releases. Research by Thorbecke (1997), Kuttner (2001) and Bernanke and Kuttner (2005) provide a refined way of analyzing conditional stock returns on days of monetary policy announcements. Bernanke and Kuttner (2005) show that U.S. stock markets reactions to FOMC announcements seem to stem from "monetary policy surprises", defined as the unexpected change in the Federal funds rate[2]. They conclude that an unexpected 25 basis point (bps) decrease in the Fed funds rate trigger an average 1% increase in equity prices. In addition, Kuttner (2001) has previously shown a similar surprise effect in the U.S. bond market. Related to the research by Bernanke and Kuttner (2005), recent research has explored market reactions to the information about future monetary policy actions revealed in monetary policy announcements. For example, Gürkaynak et al. (2005) find that separating FOMC announcement information in a "target factor", which is the current Fed funds rate target, and a "path factor", with information regarding the future Fed funds rate path, helps explain a larger part of returns in some asset classes. Also, Lucca and Trebbi (2009) analyze FOMC announcement statements and show that long-term treasury yields mainly react to changes in policy communication. In an international setting, Ehrmann and Fratzscher (2009) document significant heterogeneity across 50 international stock exchanges in response to U.S. monetary policy surprises[3]. Ehrmann and Fratzscher (2009) show that an unexpected 1% increase in the Fed funds rate lead to a negative 2.7% return on the day of the announcement on the average foreign stock exchange included in the study. Sweden is mentioned as one of the economies with the strongest response coefficient to U.S monetary policy changes. For Sweden, an unexpected 1% increase in the Fed funds rate lead to a negative 4.0% return on the day of the announcement. We also note a replicative study of ECB monetary policy surprises'

[2] The authors define the unexpected change in the Federal funds rate using the difference between the ex-post realized change and the ex-ante expected change by the Federal funds rate futures contracts.

[3] As defined by Gürkaynak et al. (2005) and Bernanke and Kuttner (2005).

effect on several European stock exchanges by Bohl et al. (2008), which finds similar results to Bernanke & Kuttner (2005) and Ehrmann and Fratzscher (2009), although this time not including Sweden in the investigation.

Several papers also examine unconditional asset price movements in conjunction with macroeconomic information releases. Jones, Lamont and Lumsdaine (1998) study unconditional fixed income returns in conjunction to inflation and labor market information releases. They find that bonds earn significantly higher returns on announcement days irrespective of the positive or negative implications of the released information. A recent study by Savor and Wilson (2013) examine unconditional equity returns on inflation, labor market and FOMC announcement days. The authors find that average returns are significantly higher on announcement days than other days for individual stocks and differently constructed portfolios alike. In addition, they find that systematic risk, measured by beta, does a good job in explaining excess returns on announcement days. The results should be put into perspective of previous literature that have rejected a proportional relationship between beta and excess returns, see for example Black, Jensen and Scholes (1972) on the subject.

2.3 The Pre-FOMC Announcement Drift

The semi-strong version of the Efficient Market Hypothesis (EMH) developed by Eugene F. Fama (1970) states that an asset's price should reflect all public information. Consequently, financial market participants should only react to flows of new, relevant information being made available to the public. The concept of "announcement drifts" states that asset prices exhibit momentum that violate the semi-strong version of the EMH. Previously, the phenomenon has mainly been documented in individual stock prices. The seminal paper by Beaver (1968) find that both volume and abnormal returns of individual stocks soar around earnings announcements, while Ball and Brown (1968) find that abnormal returns continue to drift upwards even in a period after "good news"-announcements. Bernard and Thomas (1989) find that such post-announcement drifts are difficult to explain by misspecified risk parameters, thus becoming very hard to reconcile with classic asset pricing theory. More recently Lamont and Frazzini (2007) look at returns in conjunction with earnings announcements for U.S. publicly traded firms between 1974 and 2004. They find a large and significant unconditional premium on days of earnings announcements, linking the phenomenon to increased levels of small-investor buying at announcement days. More interestingly they also document a large pre-announcement drift in the run-up to earnings announcements, which they attribute to large investors pre-empting the small investor buying on announcement days.

As seen in Section 2.2, a large literature has studied conditional and unconditional stock price reactions to monetary policy changes. However, research investigating equity prices in the period preceding macroeconomic announcements is more scarce. Using data from 1994 to 2011, Lucca and Moench (2015) discover a surprising 49 bps drift on the S&P 500 in the 24 hours preceding FOMC monetary policy announcements using a simple dummy variable regression. They also document that, on average, 24h-returns over FOMC announcements are flat, implying that the entire return premium is made in advance of the FOMC announcement. The authors further document that no other U.S. macroeconomic announcement exhibit a similar pattern, and show cross-sectional evidence that the pre-FOMC announcement drift is present on international stock indices. By examining the time-series of pre-FOMC announcement returns the authors find that the variation in pre-FOMC drift tends to correlate with the level of implied volatility, the slope of the treasury curve and show persistence when compared to the one year moving average of previous pre-FOMC announcement returns. The authors go to great lengths trying to explain the drift by employing different strands of previous research, but fail to find a single explanation for the puzzling drift. In the spirit of Lucca and Moench (2015), a very recent working paper by Karnaukh (2017) investigate pre-FOMC announcement movements in the Foreign Exchange (FX) market. She finds that a high (low) Fed funds rate three days before the FOMC announcement predicts a relative rise (fall) in the USD in the subsequent two-day period. The findings indicate a lag in the incorporation of information between the interest rate and FX markets which is hard to explain using conventional theory.

2.4 Explanatory Models

Below, we go into detail regarding the explanations offered to the pre-FOMC announcement drift in the abovementioned research. First, we start with more conventional risk-based explanatory models, paying special attention to liquidity and volatility risk. We continue to cover alternative explanatory models including potential information leakage or investor inattention. For the pre-FOMC returns to be in line with classic risk-return asset pricing theory, investors must somehow face larger non-diversifiable risk in the 24 hours preceding FOMC announcements. As mentioned, Savor and Wilson (2013) document that increased levels of systematic risk drive larger-than-normal excess returns on macroeconomic announcement days using a traditional market model. The results of Savor and Wilson (2013) are also consistent with consumption-based return models, which state that investors face higher systematic risk at dates which provide information about future consumption and payoff-patterns (Lucca and Moench, 2015). Further, a large set of models equate realized volatility with information flow (Ross, 1989) and market microstructure models such Kim and Verecchia (2013) show that trading volume surge around public announcements. Indeed, Lucca and Moench (2015) document that volatility and trading volume spike at FOMC announcements, while remaining low in the 24 hour pre-announcement window. These findings make the pre-FOMC drift hard to reconcile with standard risk-based explanations, especially since returns over the announcement window, i.e. when implied systematic risk is large, are flat (Lucca and Moench, 2015).

Lucca and Moench (2015) instead turn to alternative risk-based theories incorporating intertemporal aspects of volatility and liquidity to find matching explanations to the drift. Regarding asymmetric volatility, the authors consider the volatility feedback framework as emphasized by Pindyck (1984), French, Schwert and Stambaugh (1987) and fully modeled by Hentschel and Campbell (1992). The framework states that an unexpected decrease in volatility, because of its inherent persistence, leads to investors revising their estimates of future volatility. A sudden decrease in future volatility equals lower future risk, causing an upwards revision in current asset prices and positive contemporaneous returns. The volatility feedback framework fits the empirical data found by Lucca and Moench (2015) and could be interpreted if the drop in volatility in pre-announcement windows can be considered truly unexpected by investors (Lucca and Moench, 2015). A negative relationship between stock market returns and trading volume has been found in several cross-sectional studies (Haugen and Baker, 1996; Rouwenhorst, 1999). More recently, Amihud (2002) investigates how market-wide returns are correlated to expected and unexpected shocks of illiquidity[4] over time. The author propose that expected market illiquidity over time affects excess stock returns positively, suggesting that excess returns are partially due to an "illiquidity premium". Further, the author state that an unexpected contemporaneous shock of illiquidity raises expected future illiquidity, making investors that hold the asset demand larger future excess return in exchange, thus lowering contemporaneous stock prices. Lucca and Moench (2015) assess the explanatory power of the proposed models by decomposing implied stock market volatility and trading volume into an innovation and a one period lag using a simple first moment autoregressive model. The innovation and lagged parts of each metric represents the unexpected and expected parts of respective metric as visible to market participants. The authors include the variables as control variables in their main regression model and find that the coefficients of expected and unexpected volatility follow the volatility feedback framework, showing a significant negative relationship between unexpected increases in volatility and excess returns. In addition, the inclusion of the volatility variables in the model removes almost one third of the size of the pre-

[4] The author estimate illiquidity using a price impact measure "ILLIQ", which is defined as the daily ratio of absolute stock returns to its dollar trading volume, averaged over some time-period.

announcement dummy variable coefficient, although the coefficient remains statistically highly significant. The coefficients for the unexpected and expected trading volume were also found to be highly statistically significant in explaining excess returns, confirming a negative relationship between trading volume and stock market returns. However, while highly significant, the inclusion of the trading volume variables did not reduce the size or significance of the pre-FOMC dummy variable when included together with the volatility variables.

Both Lucca and Moench (2015) and Karnaukh (2017) continue to explore alternative explanations to their findings. These include potential information leakages, good news-surprises and investor inattention. Drifts caused by potential information leakages are deemed unrealistic for two reasons by Lucca and Moench (2015); the documented pre-FOMC announcement returns are mean positive and uncorrelated with the realized announcement returns. If information truly leaked to investors, the pre-FOMC drift would realistically follow the pattern of realized monetary policy changes. Attributing the pre-FOMC drift to investors incorporating unexpected good news into the asset price is also deemed unrealistic: first, investors would have to be consistently positively surprised over the sample period. Second, it is unclear why investors would incorporate such surprise-information only at the day before the announcement, and not at the announcement day itself (or any previous day when the information is available). Third, announcement day surprises (as documented by Bernanke and Kuttner, 2005) show that a 25 bps surprise change in the Fed funds rate generates an average 1% return. To account the whole 49 bps pre-FOMC drift investors would have to be consistently surprised by 12 bps target rate changes per meeting. Lucca and Moench (2015) show that historically the revision in expectations based on Fed funds futures average to only -1 bps in the 24 hour pre-announcement window, making the magnitude of the implied surprises unrealistically large.

Lucca and Moench (2015) and Karnaukh (2017) further explore potential explanations with foundation in behavioral finance theory. According to the asset price dynamics model presented by Duffie (2010), slow moving (inattentive) capital can cause positive price drifts ahead of large supply shocks. Lucca and Moench (2015) argue that inattentive investors might sell out of their positions ahead of FOMC announcements to escape trading with better informed investors, causing professional market participants to bear larger systematic risk, thus demanding larger excess returns ahead of the FOMC announcement. Although the model fits some of the empirical evidence found by Lucca and Moench, it is still unclear as to why it would be optimal for inattentive investors to sell out of their positions in the first place (Lucca and Moench, 2015). Karnaukh (2017) provides an extended argumentation on the inattentive investor explanation by combining several models of investor behavior: Bacchetta and Wincoop (2010) state that infrequent portfolio decisions are optimal to investors from a welfare perspective, while Mankiew and Ries (2002) and Sims (2003) find that it is costly for investors to constantly gather information. Kacperczyk et. al (2014) further show that investors allocate their attention towards shocks that have the most impact on returns. Under the abovementioned models, inattentive investors might not act until the day preceding monetary policy announcements if it has not previously caught their attention. As a piece of suggestive evidence, Lucca and Moench (2015) document that the number of articles in the financial press regarding the FOMC announcement peak in the days preceding the announcement, indicating that inattentive investors might not have had incentives to reallocate their positions until the days before the announcement.

Lastly, we quickly review another investor inattention story offered by Lamont and Frazzini (2007) to explain drifts in individual stock prices in advance of earnings announcements. Using a method developed by Lee and Ready (1991) analyzing imputed order flow from small and large investors, Lamont and Frazzini (2007) find that small investor buying soar around earnings announcements while large investor buying increases in the period preceding the announcement. The authors interpret this using the attention-grabbing hypothesis proposed by Lee (1992) and Barber and Odean (2008)[5] which states that small investors have limited attention and ability to sell short, causing stock prices to rise too much (or fall too little) in conjunction with big announcements or news. In the light of this, the authors explain pre-announcement drifts by large investors anticipating the net buying of small investors on announcement days, purchasing stock in advance of the announcement.

[5] Lamont and Frazzini (2007) refer to the working paper (pre-publication) version of Barber and Odean (2008).

3 Hypotheses

With respect to the research presented in Section 2, we propose to split our study into two parts. Initially, we aim to investigate whether a pre-monetary policy announcement drift exists on the Stockholm Stock Exchange. Lucca and Moench (2015) find that U.S. equities exhibit a significant drift in the 24 hours preceding a FOMC announcement, in addition previous research has found that U.S. monetary policy have large international impact. However, there is no research confirming a pre-FOMC drift on the Stockholm Stock Exchange, and further, no research has been conducted on possible drifts in advance of either ECB or Riksbank monetary policy announcements. With respect to the lack of previous evidence, we adopt the following hypotheses regarding pre-FOMC, pre-Riksbank and pre-ECB announcement drifts on the Stockholm Stock Exchange:

H1.1: The excess returns on the Stockholm Stock Exchange are not abnormally large in the day preceding Federal Open Market Committee monetary policy announcements.

H1.2: The excess returns on the Stockholm Stock Exchange are not abnormally large in the day preceding Swedish Riksbank monetary policy announcements.

H1.3: The excess returns on the Stockholm Stock Exchange are not abnormally large in the day preceding European Central Bank monetary policy announcements.

Secondly, if a pre-monetary policy announcement drift is found, we aim to investigate potential explanations of the drift. At large, the literature connects changing levels of volatility and liquidity to variations in systematic risk and expected excess returns. In addition, previous research examining asset price movements on and around information releases have included the two parameters as key components in explanatory models. Especially, Lucca and Moench (2015) find that unexpected changes in volatility and liquidity affect asset returns and reduce the size of the unexplained pre-FOMC drift. With respect to the results presented by Lucca and Moench (2015), we hypothesize the following regarding the roles of volatility and liquidity in a risk-based explanation to pre-monetary policy announcement drifts on the Stockholm Stock Exchange:

H2: Changes in stock market volatility and liquidity help explain the pre-monetary policy announcement drift.

Lastly, Lamont and Frazzini (2007), Lucca and Moench (2015) and Karnaukh (2017) all present comprehensive theoretical frameworks revolving around investor inattention as a possible explanation of pre-announcement drifts. As a final part of our thesis, we evaluate the opportunity that a found drift has a behavioral explanation in two ways. First, as our thesis is conducted more than five years after the first working paper including Lucca and Moench's findings (Lucca and Moench, 2011) was published, approximately one third of our sample is recorded after information regarding the drift was made publicly available. Lucca and Moench (2015) argue that significant patterns of pre-FOMC announcement drifts in U.S. equities have been in investors plain view for an extended period, which points towards a fundamental explanation of the drift. We hypothesize that if any found drift has disappeared after it has become publicly available, it is not to be considered as a compensation for increased systematic risk, and may instead be caused by irrational market behavior. Secondly, we evaluate the presented behavioral explanatory models using our empirical findings in combination with data of monetary policy news coverage in Swedish business press around announcement days. If the presented theoretical frameworks hold, the media coverage in advance of monetary policy announcements should rise sharply and correlate with the size of the drift.

4 Method

4.1 Main Regression Model

To test our first set of hypotheses (H1.1-1.3) we adopt the research method used by Lucca and Moench (2015), however slightly modified due to differences in the availability of data. The initial purpose of this study is to assess the existence of a pre-monetary policy announcement drift on the Stockholm Stock Exchange. To test this formally, we propose a very simple dummy variable regression model shown as Equation 1.

Equation 1

$$Y_t = \beta_0 + \beta_1 D_t + \varepsilon_t$$

Where:

Y_t: The %-log cum-dividend daily excess returns on the OMXSB

D_t: Explanatory dummy variable equal to 1 on defined pre-announcement days

The dependent variable Y_t is the logarithm of daily cum-dividend excess returns on the OMX Stockholm Benchmark Index (OMXSB) (explained in more detail in Section 4.8). We use log-returns in line with previous research for several reasons: raw returns are assumed to follow a log-normal distribution and subsequent log-return normality, raw-log equality for small return windows and arithmetic additivity (Brooks, 2014). The proposed model captures the mean effect of pre-monetary policy dates on returns in the coefficient of the dummy variable β_1, while the constant β_0 shows the mean return on all other days. More specifically; if the constant is omitted in the regression, β_1 measures the mean log daily excess return on pre-announcement (event) days. Alternatively, if the constant is present, β_1 measures the difference in daily excess returns on pre-announcement days from all other (non-event) days. Given our hypotheses, the relevant measure for abnormality is whether mean returns are different on event versus non-event days and thus the specification with the constant present is suitable. However, a specification omitting the constant is interesting when evaluating the pre-announcement drift in absolute numbers, and will therefore be included in the results.

4.2 Defining Event Windows

We look for abnormal returns on the Stockholm Stock Exchange on the day preceding monetary policy announcements made by three different central banks separately. We define announcement days as days when a monetary policy announcement is released. Lucca and Moench (2015) define the relevant pre-FOMC announcement window using intraday tick data between 2:00 pm EST on the day before the announcement to 2:00 pm EST on the day of the announcement, capturing returns up until 15 minutes before the announcement is released. Due to limited availability of intraday data for the Stockholm Stock Exchange, we define the relevant event window as the nearest observable 24 hour window on the Stockholm Stock Exchange preceding a monetary policy announcement using daily closing ticks recorded at 17:30 CET each trading day. As we investigate three separate central banks' announcements on the same stock exchange, the relevant event window changes amongst the banks due to differences in announcement timing.

Monetary policy announcements by the FOMC are released eight days a year at approximately 2:15 pm EST, which translated into CET implies that announcements are made at 20:15 in the evening (Lucca and Moench, 2015). The Stockholm Stock Exchange opening hours are from 9:00 to 17:30 CET. This means FOMC announcements are made after the exchange has closed for the day. Consequently, our defined pre-announcement window is the close-to-close return between the day before and the day of the FOMC announcement. The Riksbank's monetary policy announcements are released six times a year at 9:30 CET (Sveriges Riksbank, 2016), however the frequency of monetary policy meetings and announcements are above six for most of the sample period. The closest data point before 9:30 CET on the announcement day is the closing tick on the NASDAQ OMX on the previous day. The relevant event window for the Riksbank announcements is the close-to-close return from the closing price two days before the announcement to the closing price on the day before the announcement. The ECB releases its monetary policy press releases at 13:45 CET (European Union, 2012), thus the last data point before the announcement is the closing tick on the previous day. The relevant event window for the ECB announcements is the close-to-close return from the closing price two days before the announcement to the closing price on the day before the announcement.

4.2.1 Specifications of the Main Regression Model

To investigate pre-announcement drifts for each central bank separately, we introduce three specifications of the model presented as Equation 1. Specification 1.1 includes the pre-FOMC dummy variable which is equal to 1 between 17:30 CET on the day before a FOMC announcement and 17:30 CET on the day of a FOMC announcement. Specification 1.2 includes the pre-Riksbank dummy variable which is equal to 1 between 17:30 CET two days before a Riksbank announcement and 17:30 CET on the day before a Riksbank announcement. Specification 1.3 includes the pre-ECB dummy variable which is equal to 1 between 17:30 CET two days before an ECB announcement and 17:30 CET on the day before an ECB announcement. The dependent variable in all specifications is defined as the %-log daily cum-dividend excess return on the OMXSB.

4.3 Test for Hypotheses 1.1-1.3

To test our initial set of hypotheses presented in Section 3, we run the proposed main regression model specifications for the three central banks separately and define the null and alternative hypothesis as follows:

$$\mathbf{H_0}: \beta_1 = 0 \text{ , } \mathbf{H_1}: \beta_1 \neq 0$$

The null hypothesis states that there should be no difference in mean daily excess returns in the defined pre-announcement windows versus on all other trading days, while the alternative hypothesis states that mean excess returns on days preceding monetary policy announcements are statistically different from excess returns on all other trading days.

4.4 Defining Volatility and Liquidity

If concluded that a drift is present, we want to test our second hypothesis by introducing volatility and liquidity as control variables in our main regression model specified as Equation 1.

4.4.1 Measuring Stock Market Volatility

Lucca and Moench (2015) use the Chicago Board Options Exchange (CBOE) Volatility Index (VIX) to measure the implied stock market volatility on the S&P 500. The VIX level is calculated using the expected annualized change in the S&P 500 over the next 30 days, as indicated by stock options (CBOE, n.d.). With respect to Lucca and Moench's (2015) methodology, we use the SIX Volatility Index (SIX VX), which is calculated using an identical procedure and measures the implied volatility on the OMXS30 and can be considered a robust measure for implied volatility on the Stockholm Stock Exchange.

4.4.2 Measuring Stock Market Liquidity

In the research presented in Section 2.4, Amihud (2002) proposes a price impact measure of illiquidity based on the ratio between an assets absolute return and its dollar denominated volume for the same period. However, recent research has indicated that most of the effect proved by Amihud (2002) can be attributed to changes in volume excluding the price impact component (Lou and Shu, 2017). In addition, the illiquidity measure proposed by Amihud (2002) does not support the daily granularity needed to isolate pre-announcement day returns separately. Lucca and Moench (2015) employ a simpler measure of daily stock market liquidity defined as the daily volume of the SPDR S&P 500 (SPY) Exchange Traded Funds (ETF) in relation to its 21 day (one month) average.

As one key feature of our study is to achieve comparable results to those of Lucca and Moench (2015), we adopt the definition of relative stock market liquidity used by Lucca and Moench (2015) and chose a similar proxy in the XACT OMXSB ETF, which replicates the OMXSB.

4.4.3 Expected and Unexpected Volatility and Liquidity

To assess the roles of volatility and liquidity using the theoretical frameworks proposed by Lucca and Moench (2015), it becomes important to decompose both variables into parts that can be considered expected and unexpected by market participants. In line with Lucca and Moench (2015) we use a simple first-order autoregressive (AR) model to estimate the unexpected part of liquidity and volatility.

Equation 2

$$X_t = b_o + b_1 X_{t-1} + I_t$$

Where:

X_t: The value of variable X at time t

X_{t-1}: The one period lagged value of variable X

I_t: The residual part of X_t unexplained by the model

Equation 2 estimates the residual I_t as the contemporaneous innovation of X_t which can be considered unexpected by market participants under the simple assumption that they are making predictions based on the previous period level.

4.5 Alternative Regression Model

Equation 3

$$Y_t = \beta_o + \beta_1 D_t + \beta_2 \mathrm{Liq(lag)}_t + \beta_3 \mathrm{Liq(innov.)}_t + \beta_4 \mathrm{Vol(lag)}_t + \beta_5 \mathrm{Vol(innov.)}_t + \varepsilon_t$$

Where:

Y_t: The %-log cum-dividend daily excess returns on the OMXSB

D_t: Explanatory dummy variable equal to 1 on defined pre-announcement days

$\mathrm{Liq(lag)}_t$: The one period lagged relative trading volume of the XACT OMXSB ETF

$\mathrm{Liq(innov.)}_t$: The contemporaneous innovation of the relative trading volume of the XACT OMXSB ETF

$\mathrm{Vol(lag)}_t$: The one period lagged level of the SIX VX

$\mathrm{Vol(innov.)}_t$: The contemporaneous innovation of the level of the SIX VX

The innovations of volatility and liquidity are exported and used as control variables together with their respective lagged component X_{t-1} in our alternative regression model. Together the innovation and lag represent unexpected and expected components of contemporaneous liquidity and volatility. The alternative model is presented as Equation 3 above.

4.6 Test for Hypothesis 2

To test our second hypothesis, we propose a formal test using the model presented as Equation 3. For the new control variables to be considered explanatory they must fulfill two criteria: (1) reach a statistically significant level in explaining daily log excess returns, to test this we propose the following formal null and alternative hypotheses:

$$\mathbf{H_0}: \beta_2,\ \beta_3,\ \beta_4,\ \beta_5 = 0\ ,\ \mathbf{H_1}: \beta_2,\ \beta_3,\ \beta_4,\ \beta_5 \neq 0$$

(2) reduce the size and significance from the pre-announcement dummy variable $\boldsymbol{\beta_1}$ when compared to a regression using the main regression model (without the control variables included).

4.7 Method for Evaluating Alternative Explanatory Models

The timing of our thesis presents another opportunity to evaluate whether the drift can be explained using alternative explanation models. As our thesis is conducted more than five years after the first working paper including Lucca and Moench's findings (Lucca and Moench, 2011) was published, approximately a third of our sample is recorded post-publishing. Lucca and Moench (2015) argue that significant patterns of pre-FOMC announcement drifts have been in investors plain view for an extended period, suggesting that this points towards a fundamental explanation of the drifts. We test this hypothesis by re-estimating our main regression model shown as Equation 1 for a post-release sub-sample, defined as October 1 2011 to February 28 2017. We also evaluate the behavioral frameworks presented, which all revolve around inattentive investors becoming aware of the pending release of information. Both Lucca and Moench (2015) and Karnaukh (2017) refer to the number of articles written about the FOMC as a proxy for how likely it is that the average investor is aware of the announcement. The research show that on average, the number of articles written about the FOMC announcement in the business press increase drastically in the days preceding an announcement. We will present similar media data for the FOMC, Riksbank and the ECB and compare these patterns to potential drifts found on the Stockholm Stock Exchange to see if there is a correlation between media coverage and drift size.

4.8 Empirical Data

In previous studies of announcement drifts using market microstructure, high frequency tick data have been used to obtain granular data points of asset returns before and around announcements. The amount of intraday tick data available is very limited for smaller stock exchanges, such as the NASDAQ OMX. Thus, the geographical scope of this study limits the use of tick data without shortening the relevant time series and the number of observed events grossly. Instead we use daily stock index data which is more readily available and can be considered an acceptable substitute considering the purpose of this study.

4.8.1 Time-Series Data

We choose the OMX Stockholm Benchmark Total Return Index as a proxy for the Stockholm Stock Exchange for two reasons: it has the longest available time-series of a total return index on the Stockholm Stock Exchange, and is constructed as a benchmark index for the whole Stockholm Stock Exchange. We collect daily (closing price) index levels from January 1 1999 to 28 February 2017, amounting to 4 560 daily observations. We collect daily levels of the 10-year Swedish Government Bond Rate for the sample time-series directly from the Riksbank webpage. After calculating excess returns, we are left with 4 559 observation of daily log cum-dividend excess returns on the Stockholm Stock Exchange.

Table 4.1
Summary Statistics

	Mean	SD	Min	Max	P1	P99	Obs.
OMXSB	0.022	1.471	-8.448	9.160	-4.179	3.929	4559
Implied Volatility	20.39	8.74	9.30	77.92	10.62	54.65	3222
Liquidity	1.31	5.07	0.0002	207.74	0.02	12.2	2685

Table 4.1 reports summary statistics for our collected time-series data. OMXSB is the %-log cum-dividend daily excess returns on the OMXSB calculated using the Swedish 10Y Government Bond Rate, the sample period is from January 1 1999 to February 28 2017. Implied Volatility is the level of the SIX VX, the sample period is between May 7 2004 and February 28 2017. Liquidity is the daily trading volume on the XACT OMXB ETF relative to its 21 day average, the sample period is between March 16 2006 and February 28 2017.

Using Thomson Reuters Datastream, we collect daily index levels for the SIX VX from May 5 2004 to February 28 2017 and daily trading volume on the XACT OMXSB ETF from February 14 2006 to February 28 2017. After calculating the trading volume relative its 21 day moving average, the sample of relative runs from March 16 2006 to February 28 2017 with a total of 2 685 observations. The total number of observations of the SIX VX is 3 222. In Table 4.1 we present summary statistics for our collected time-series data. We can see that the daily excess return for our sample period is 0.022%, with a corresponding annualized cum-dividend excess return of approximately 5.7% (using the standard 252 trading days) on the OMXSB between 1999 to 2017. We also note that the standard deviation, as well as min- and max values, of the daily excess returns are large when compared to the mean. This indicates that our sample distribution exhibits the fat tails that are common in return data. Also notable is that the liquidity sample mean is above 1, which indicates that the trading volume on the XACT OMXSB exhibit an increasing trend over our sample period.

4.8.2 Monetary Policy Announcement Data

Monetary policy announcement dates between January 1 1999 and 28 February 2017 are collected directly from the respective central bank's webpage and press releases. We collect 145 FOMC announcements, 138 Riksbank announcements and 245 ECB announcements. After retrieving the total number of announcements, we treat the data by excluding unscheduled announcements, announcements made on days when the Stockholm Stock Exchange is closed and announcements made on days directly following a day when the Stockholm Stock Exchange is closed. We also exclude announcements on days when more than one monetary policy announcement is made. We end up with 138 FOMC announcements, 113 Riksbank announcements and 221 ECB announcements. In Tables A1.1-1.3 in the Appendix we show the complete set of monetary policy announcements, including removed observations, for the three central banks.

4.8.3 Media Coverage Data

We assess the media coverage of each central bank in the days around its monetary policy announcement days using Retriever. We collect the daily number of articles in the online and print versions of the Swedish business paper "Dagens Industri" including mentions of the keywords "Fed", "Riksbank" or "ECB" between January 1 1999 and February 28 2017. The total number of articles regarding the Federal Reserve is 3663 or 0.55 articles per day, the Riksbank is 7657 or 1.15 articles per day and the ECB is 5251 or 0.79 articles per day.

5 Results

In this section, we present our findings. Initially we will review descriptive statistics of our data for returns on pre-monetary policy announcement days and other days separately. We continue investigating the cumulative returns on the OMXSB around monetary policy announcements and time variation in the pre-announcement returns. Moving on, we present the results of our main regression model and move onto testing our alternative regression model including volatility- and liquidity measures. We end the section by presenting suggestive evidence relating to behavioral explanation models of the drift.

5.1 Descriptive Statistics

Table 5.1

Pre-Monetary Policy Announcement Returns on the OMXSB

	Pre-Announcement Window					All Other Days				
	Mean	**SD**	**Min**	**Max**	**Obs.**	**Mean**	**SD**	**Min**	**Max**	**Obs.**
FOMC	0.480	1.25	-2.47	6.04	138	0.008	1.48	-8.45	9.16	4421
Riksbank	0.203	1.34	-4.80	4.26	113	0.016	1.47	-8.45	9.16	4446
ECB	0.004	1.66	-4.88	4.59	221	0.023	1.46	-8.45	9.16	4338

Table 5.1 reports summary statistics for mean returns on specified pre-announcement windows of the three central banks and for all other days. The sample period is from January 1 1999 to February 28 2017, the returns shown are %-log cum-dividend daily excess returns on the OMXSB. For the FOMC the pre-announcement window is the 17:30-17:30 window ending on the day of the announcements, for the Riksbank and the ECB it is the 17:30-17:30 window ending the day before the announcements.

Looking at returns decomposed into pre-announcement and other days, we see varying patterns for the different central banks. We find the most striking pattern on pre-FOMC announcement days, which display a mean excess return of 0.48% for the whole sample period. Annualizing the returns, we see that an investor on average would earn an excess return of 3.9% by just trading on the eight pre-FOMC announcement days each year. Further, the mean excess return on all other days is on average 0.008%, displaying a significant decline if compared to the 0.022% sample average shown in Table 4.1. This indicates that pre-FOMC returns are accounting for more than 60% of average excess returns on the OMXSB for the sample period. Looking at the result for pre-Riksbank announcement days, returns are still noticeably large at approximately 0.20%. However, the difference in average returns when comparing the 0.022% sample mean to the 0.016% mean on non-pre-Riksbank announcement days, show that pre-Riksbank returns are not accounting for similarly large part of total excess returns. For the ECB, returns on pre-announcement days do not indicate the existence of a positive drift, quite the opposite returns are on average below the mean excess returns for all other days. If we look at standard deviations on FOMC and Riksbank pre-announcement days, we see that they are below the metric's level for all other days. This indicate that the large means on pre-announcement days are not driven by extreme outlier values. Another evidence in support of this is the min- and max values, which are significantly closer to zero on pre-announcement days than for the sample at large. Another noticeable difference between the FOMC and Riksbank is the size of the minimum value on pre-announcement days, which for the Riksbank is almost twice as pronounced as for the FOMC. In addition, the maximum value on pre-FOMC announcement days is more than twice the absolute size of the minimum value. This indicates that pre-FOMC announcement returns omit a left tail of negative returns that is present on the pre-Riksbank announcement days and in the sample at large. In Graph A1 in the Appendix we include plotted density functions for excess returns on pre-FOMC announcement days, pre-Riksbank announcement days and for the whole sample, which confirms that returns pre-FOMC days display a significant positive skew, while returns on pre-Riksbank announcement days are skewed slightly negative.

Table 5.1.1

Pre-Announcement Returns in Different Time Intervals

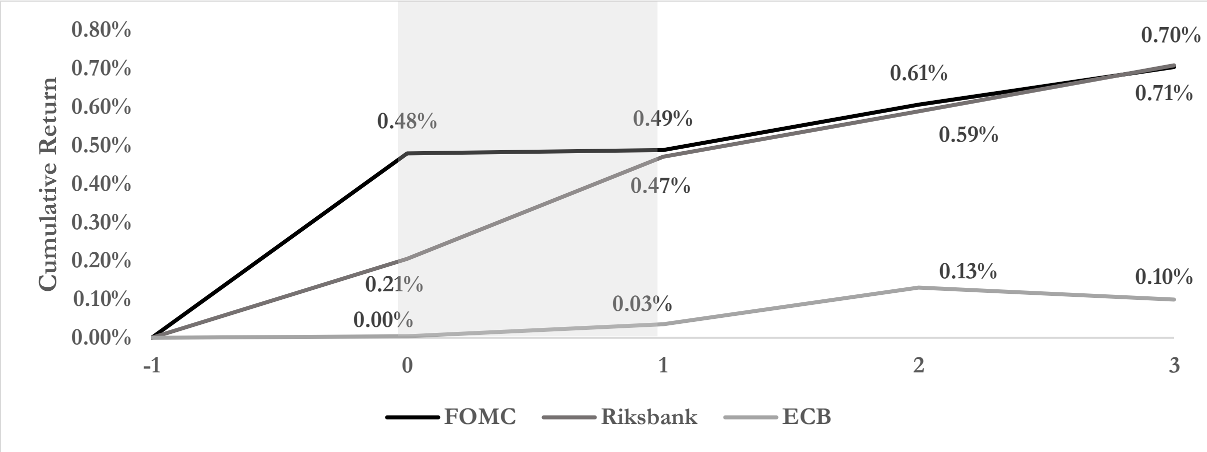
	1999-2004			**2005-2010**			**2011-2016**		
	Mean	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**
FOMC	0.528	1.183	46	0.686	1.416	47	0.203	1.104	44
Riksbank	0.376	1.354	52	-0.125	1.579	32	0.262	0.965	28
ECB	-0.060	1.911	100	0.188	1.599	65	-0.105	1.189	55

Table 5.1.1 reports %-log cum-dividend daily excess returns on the OMXSB on pre-monetary policy announcement days for three separate time spans: (1) January 1 1999 to December 31 2004, (2) January 1 2005 to December 31 2010 and (3) January 1 2011 to December 31 2016.

By splitting pre-announcement returns into three 6-year intervals we gauge the time variability in pre-announcement drifts. For the pre-FOMC announcement days, mean returns are on average very large in the first sub-sample periods, dropping to a relatively low mean of 20 bps from January 2011. It is noticeable that pre-FOMC returns remain positive for all three sub-sample intervals. Pre-Riksbank announcement returns show more variability, averaging a negative 13 bps between years 2005 to 2010 after being mean positive 37 bps in the preceding period. However, the pre-Riksbank announcement returns recover and display 27 bps mean pre-announcement returns in the following interval. It appears like pre-FOMC announcement returns are persistently positive, but declining in recent years, while pre-Riksbank announcement returns show larger variability between positive and negative. It is also apparent that pre-FOMC and pre-Riksbank announcement returns do not correlate over time.

5.1.1 Mean Cumulative Returns

Graph 5.1.2
Cumulative Returns on Monetary Policy Announcement Days



Graph 5.1.2 shows %-log cum-dividend daily excess returns the OMXSB for the three central banks on days surrounding monetary policy announcements. The graph starts at the closing price two days prior to the announcement and ends with the closing price two days after the day of the announcement. The grey faded area marks the announcement day.

One of the most striking findings by Lucca and Moench (2015) is that while mean returns were large and positive in the day before FOMC announcements, mean returns on the day of announcements remain flat. In graph 5.1.2 we plot the cumulative returns for the four days surrounding monetary policy announcements. In Graph A2.1-2.3 in the Appendix we plot the separate cumulative returns for each bank including pointwise 95% confidence intervals. We see that returns around the FOMC announcements on the OMXSB follow the pattern found by Lucca and Moench (2015) on the S&P 500 – large and significantly different from zero in anticipation of the announcement, and flat once the announcement is made. For the Riksbank we see a different pattern. Instead of the large pre-announcement gain followed by flat announcement day return, mean returns before and on the day of the Riksbank announcements appear to be split evenly at approximately 0.2% per day. Moreover, we see that mean cumulative returns for the FOMC and Riksbank start to converge at the end of the announcement day. In addition, mean four-day cumulative returns for the FOMC and Riksbank add up to 0.70% and 0.71% respectively. This could be interpreted as while the FOMC and Riksbank announcements give rise to very similar total announcement return premiums, the FOMC premium is made almost entirely in advance of the announcement, whereas the Riksbank premium is split between the day before and the day of the announcement. This indicates a temporal disconnect between apparent systematic risk and earned premium, which is much more pronounced for returns around FOMC than Riksbank announcements.

5.2 Main Regression Model Results

Table 5.2
Main Regression Model Results

(1.1) FOMC	Constant present	Omitted Constant
Dummy	**0.472*** **	**0.480*** **
	[0.108]	[0.106]
Constant	**0.008**	**-**
	[0.022]	-
Dummy t-stat.	4.36	4.54
No. Obs.	4559	4559
(1.2) Riksbank	Constant Present	Omitted Constant
Dummy	**0.184**	**0.203**
	[0.127]	[0.125]
Constant	**0.018**	**-**
	[0.022]	-
Dummy t-stat.	1.45	1.61
No. Obs.	4559	4559
(1.3) ECB	Constant Present	Omitted Constant
Dummy	**-0.019**	**0.004**
	[0.114]	[0.111]
Constant	**0.023**	**-**
	[0.022]	-
Dummy t-stat.	-0.17	0.04
No. Obs.	4559	4559

Table 5.2 reports the results from the main regression model for the FOMC, Riksbank and ECB pre-announcement days. The dependent variable is the daily cum-dividend %-log daily excess return on the OMXSB and the explanatory variable is a dummy variable that is equal to 1 on defined pre-announcement windows for each bank. Robust standard errors are shown within brackets.
*** p<0.01, ** p<0.05, * p<0.1

Results from our main regression model defined as Equation 1 are presented in Table 5.2. We interpret the coefficients on our dummy variables differently if the constant is present or omitted. With the constant present, the coefficient on our dummy measures the difference between mean returns on pre-announcement days from all other days. With the constant omitted, the coefficient measures the mean returns on pre-announcement days, and can be compared with mean returns presented in Table 5.1. For the FOMC, mean pre-announcement excess returns on the OMXSB are found to be statistically highly significantly different from excess returns on all other days. The difference in returns on pre-FOMC announcement days and other days is estimated to 0.47%, which is very similar in size to the pre-FOMC announcement drift found on the S&P 500 by Lucca and Moench (2015). For the Riksbank however, we find that the 0.2% mean excess returns on pre-announcement days are not statistically different from mean excess returns on all other days at any conventional significance level. With the constant present, the null hypothesis for the β_1 can only be rejected with a p-value of 0.15. The results of the regressions are also consistent with our findings in Table 5.1.1, where pre-announcement returns for the Riksbank display more variability over time than pre-FOMC announcement returns, which are persistently positive for our three sub-sample periods. For the ECB, as already suggested by the summary statistics, we find no sign of any difference in returns on pre-announcement days than on other days.

Referring to our initial hypotheses H1.1-1.3 presented in Section 3, we fail to reject the null hypothesis for the Riksbank and the ECB announcements, while for the FOMC announcements we reject the null hypothesis with very high confidence, and conclude that mean excess returns on pre-FOMC announcement days are higher than mean excess returns on all other days. The pre-FOMC announcement drift discovered by Lucca and Moench (2015) on the S&P 500 is also present on the OMXSB with equal strength. The results are also consistent with research by Conover et al. (1999), confirming that U.S. monetary policy's large impact on the Stockholm Stock Exchange is also exhibited in a pre-announcement drift. A pre-Riksbank announcement drift is not confirmed by our regression model at any conventional significance level. This is in line with the descriptive statistics, which reveal that pre-Riksbank announcement returns display large variability over periods of time. In addition, cumulative return patterns show that a large part of the Riksbank announcement premium is earned on the day of the announcement, instead of in the pre-announcement window. For the ECB, we find no evidence of unusual return patterns on pre-announcement or announcement days on the OMXSB. While this supports our initial hypothesis, the fact that Swedish equities do not exhibit any sign of an announcement premium for ECB monetary policy announcements is quite surprising.

5.3 Alternative Regression Model Results

After concluding that a drift exists ahead of FOMC announcements, we move on to our second question regarding potential causes of such drifts. Under our second hypothesis, we investigate whether volatility- and liquidity risk can help explain the pre-FOMC announcement drift. Lucca and Moench (2015) found that levels of realized volatility and liquidity dropped below average in their pre-FOMC announcement window. In Table A2 in the Appendix we report the descriptive statistics of implied stock market volatility, as measured by the SIX VX, and liquidity, as measured by the trading volume on the XACT OMXSB relative to its 21 day average, decomposed into pre-FOMC announcement days and all other days. The table shows that levels of realized trading volume seem to be below average on pre-FOMC announcement days, while the SIX VX show no deviation. We do however note that realized volatility, as measured by the standard deviation in Table 5.1, is lower for pre-FOMC announcement days than for all other days.

Table 5.3
Alternative Regression Model Results

	(1.1) FOMC	
Dummy	**0.462*** **	**0.464*** **
	[0.149]	[0.150]
Liq. (lag)	**0.022**	**-**
	[0.019]	-
Liq. (innov.)	**-2.757**	**-**
	[2.677]	-
Vol. (lag)	**0.285**	**-**
	[0.522]	-
Vol. (innov.)	**-0.287**	**-**
	[0.533]	-
Constant	**3.65**	**0.010**
	[3.473]	[0.280]
Adj. R2	0.003	0.003
Dummy t-stat.	3.10	3.09
Obs.	2746	2746

Table 5.3 reports the results from our alternative regression model. The sample period is from March 16 2006 and February 28 2017. The dependent variable is the %-log cum-dividend daily excess returns on the OMXSB. Dummy is a dummy variable equal to 1 on defined pre-FOMC announcement windows. Liq. (lag) is the one day lagged relative trading volume on the XACT OMXSB ETF. Liq. (innov.) is the contemporaneous innovation of the trading volume on the XACT OMXSB ETF estimated using Equation 2. Vol. (lag) is the one day lagged level of the SIX VX. Vol. (innov.) is the contemporaneous innovation of the level of the SIX VX estimated using Equation 2. Robust standard errors are shown within brackets. *** p<0.01, **p<0.05, * p<0.1

We run our alternative regression model including the pre-FOMC dummy variable as well as proxies for the unexpected and expected parts of stock market volatility and liquidity. The results are presented in Table 5.3 together with a benchmark regression over the same sample period, only including the pre-FOMC dummy as an independent variable. In the benchmark regression, the pre-FOMC returns is of similar size and statistical significance as the results presented in Table 5.2

at 0.46%. In the regression including volatility- and liquidity measures, the pre-FOMC dummy remains highly statistically significant and only loses 0.002 percentage points in terms of size, while all the included explanatory variables fail to reach any conventional statistical significance level. Looking at the coefficients, we note that the estimated coefficients on the innovation and lagged component of volatility correspond with the theory provided by the volatility feedback framework, as well as the empirical findings of Lucca and Moench (2015). Also, the liquidity variables appear similar to Lucca and Moench's (2015) estimations in terms of sign and size. However, estimated standard errors are very large and indicate that all our estimated coefficients are far from relevant significance levels. Another important result is that the adjusted R-square remains very low in the augmented model, indicating that the included variables lack explanatory value for daily stock returns. This is inconsistent with Lucca and Moench (2015), which find that explanatory value increases drastically with the inclusion of the variables. In conclusion, we cannot reject our null hypothesis and find no evidence that volatility- and liquidity risk explain the pre-FOMC announcement drift on the Stockholm Stock Exchange.

5.4 Evaluation of Behavioral Explanatory Models

In the last part of this section, we examine suggestive evidence that points towards a behavioral explanation of the pre-FOMC announcement drift. In Table 5.1.1, we saw that the positive mean returns in pre-FOMC announcement windows seemed to have diminished in the most recent time-period. To investigate this in further detail, we plot the 12-month moving average of pre-FOMC announcement returns in graph A3 included in the Appendix. Included in the plot is a vertical line depicting the timing of the first public information release regarding the pre-FOMC announcement drift by Lucca and Moench (2011) in September 2011. Using ocular inspection, the moving average of pre-FOMC announcement returns do indeed seem to revert towards zero right after September 2011. To test this more formally, we re-run our main regression model using two sub-samples: pre- and one post-release of Lucca and Moench's (2011) working paper. The results are presented in Table 5.4. We see that for our post-release sub-sample, we can no longer reject the null hypothesis that mean pre-FOMC announcement excess returns are different from mean returns on all other days at any conventional statistical significance level. In addition, we conclude that this drop in significance seems to be driven by relatively lower pre-FOMC announcement returns, rather than larger standard deviations or variations in total equity risk premium. By comparison, the mean annual equity risk premium between January 1999 and October 2011 is 2.4% on the Stockholm Stock Exchange, while annualized mean pre-FOMC excess returns for the same period is equal to 4.6%. In the post-release sub-sample, the mean annual equity risk premium between October 2011 and February 2017 is equal to 13.8%, while annualized mean pre-FOMC excess returns for the post-release sample is equal to 2%. This shows that the drop in pre-FOMC announcement drift appears even more significant when compared to the total equity risk premium earned on the Stockholm Stock Exchange. We do however stress that the small number of FOMC announcement in the latter sub-sample may not be enough to conclude that pre-FOMC returns have truly disappeared. This will be discussed in more detail in Section 6.3.

Table 5.4
Sub-Sample Regression Model Results

	October 2011 - February 2017		January 1999 - October 2011	
(1.1) FOMC	Constant present	Omitted Constant	Constant present	Omitted Constant
Dummy	**0.197**	**0.246***	**0.582*****	**0.572*****
	[0.136]	[0.132]	[0.140]	[0.137]
Constant	**0.049**	-	**-0.009**	-
	[0.031]		[0.029]	
Dummy t-stat.	1.45	1.86	4.16	4.18
No. Obs.	1358	1358	3197	3197
No. FOMC-releases	39	39	99	99

Table 5.4 reports the results from two sub-sample regressions using the pre-FOMC dummy. The dependent variable is the %-log cum-dividend daily excess return on the OMXSB. The independent variable is a pre-FOMC announcement dummy equal to 1 in defined pre-announcement windows. The first subsample is October 1 2011 to February 28 2017, the second subsample is January 1 1999 to September 31 2011.
*** p<0.01, ** p<0.05, * p<0.1

According to theory reviewed by Lucca and Moench (2015) and Karnaukh (2017), investors may have cost-based incentives to make infrequent portfolio decisions (Bacchetta and Wincoop, 2010). In addition, they might also face informational constraints and thus cannot constantly gather information (Mankiw and Ries 2002; Sims 2003). In support, Tetlock (2011) shows that investors can react to stale news. In Graph A4 in the Appendix we plot the mean number of articles related to each central bank in days surrounding each bank's monetary policy announcements, which serves as a proxy for the attention each type of monetary policy announcement receives in a Swedish stock market setting. News articles regarding the Riksbank show the most pronounced pick-up in advance of its monetary policy announcements, followed by the ECB and the FOMC. However, while the number of articles published indeed do rise sharply in anticipation of announcements, their internal orders of magnitude are inconsistent with pre-announcement drifts on the Stockholm Stock Exchange. The theory fails to explain why pre-FOMC drifts are large, while pre-Riksbank (and pre-ECB) announcement drifts are significantly smaller, when Riksbank monetary policy announcements raise the largest attention in the Swedish business press. Lastly, considering the "attention-grabbing" hypothesis promoted by Lamont and Frazzini (2007), the return patterns and sharp rise in media coverage could possibly fit the drifts before- and over Riksbank announcement days. However, the theory does not support the surge followed by flat returns properties of the pre-FOMC drift. Also, further investigation using the order inflow characterization developed by Lee and Ready (1991) cannot be done to confirm the theory further, as the decomposition of investors into large and small can no longer be done reliable (Lamont and Frazzini, 2007).

Referring to our hypothesis in the ending paragraph of Section 3, while we do not find support for the explanatory frameworks presented, it appears that the pre-FOMC drift is considerably smaller after information regarding its existence has been made publicly available. In addition, we fail to reject the null hypothesis that mean returns on pre-FOMC announcement days are different from mean returns on all other days in our post-release sub-sample, and thus cannot confirm the existence of a pre-FOMC drift on the Stockholm Stock Exchange after September 2011. These results support the hypothesis that the pre-FOMC drift is a result of market inefficiencies, rather than being compensation for increased systematic risk.

6 Discussion

6.1 Evaluation of Results

In Graph A1 in the Appendix we plot the density functions for the mean returns on pre-FOMC announcement days, pre-Riksbank announcement days and the whole sample. We see that our whole sample of log-excess returns exhibit a slight negative skew, as well as the large kurtosis and fat tails common in financial return data. The density of pre-FOMC returns display a relatively large positive skew which is optically visible by the lack of a left tail, while the kurtosis is slightly smaller than for the whole sample. Pre-Riksbank announcement returns instead display a negative skew more in line with the whole sample, but also exhibit a relatively lower kurtosis. The fact that both pre-FOMC and pre-Riksbank announcement returns have thinner tails than the whole distribution of returns indicates that the large pre-announcement mean returns are not driven by outliers. To further confirm this, we drop the top and bottom 1% and 5% of all returns and re-run our three specifications of the main regression model. The results are included in Table A3 in the Appendix and show that excluding extreme values do not change the results presented in Table 5.2.

As seen in Graph A1, our return distribution exhibits levels of skewness and kurtosis that may conflict our assumption of normality in the Ordinary Least Squares (OLS) regression. This may indicate that the OLS estimated standard errors of our coefficients provide a poor approximation to the small sample distribution of pre-announcement returns. To assess the reliability of our estimated sample standard errors, we conduct a bootstrap exercise in line with Lucca and Moench (2015). We draw with replacement from pre-announcement and other day returns separately an equal length time-series. For the new series, we re-estimate the coefficients using our main regression model. This procedure is repeated 1 000 times for the full sample of FOMC and Riksbank pre-announcement returns as well as the post-release sub-sample of pre-FOMC returns from Table 5.4. The results are posted in Table A4 included in the Appendix. In short, we find that bootstrapped standard errors are very similar to those reported in Table 5.2 and 5.4 and conclude that estimated standard errors from our empirical distribution under the normality assumption can be considered good estimates.

In Section 5.4, we present suggestive evidence that the pre-FOMC drift has diminished after information regarding its existence was made publicly available by re-running our dummy variable regression model for one pre- and one post-release sub-sample. It is however unclear to which extent we can draw conclusions from the results in the small latter sub-sample. By assuming a constant variance and mean over time, a post-release sample size of 70 FOMC announcements would suffice to confirm a significant post-release drift using our main OLS regression model and a 95% confidence interval. However, when evaluating a test, it is also important to take the statistical power of the test into account. Statistical power is defined as the probability to reject the null hypothesis when the alternative hypothesis is in fact true. To assess the statistical power of our sub-sample regression, we calculate the Minimum Detectable Effect (MDE) developed by Bloom (1995). The MDE states the smallest true effect of an experiment that can be detected for a given level of statistical power and significance. Adopting a two-tailed test using a t-distribution with power of 80% and significance level of 95%, we see that the MDE for our pre- and post-release sub-samples are approximately equal to 0.38%. For our pre-release sample, the observed mean of 0.58% show that the observed difference in mean returns between pre-FOMC announcement days and other days display high statistical power. More importantly, under the same assumptions as above, the post-release sample of FOMC announcements would have to increase to about 150 to meet the stated MDE requirements. In conclusion, we would have to wait an additional 14 years to be able to confirm the existence of a post-release drift at current levels, indicating that ceteris paribus the results of our sub-sample regression will hold for an extended period of time.

6.2 Robustness Tests

Our OLS regression model rests on the assumption of homoscedasticity in the variance of the error terms. Heteroscedasticity occurs when the variance of the error terms changes with the values of our independent variables, resulting in understated standard errors of estimated coefficients. To test for possible heteroscedasticity in our regression models, we initially perform a White Test, which adopts the null hypothesis of homoscedasticity and as an alternative hypothesis of unrestricted homoscedasticity. Running the test on our different specifications of the main and alternative regression model, we find inconclusive results. The test rejects the null hypothesis for the alternative regression model, but do not reject homoscedasticity in regressions including only pre-FOMC, pre-Riksbank and pre-ECB announcement dummy variables. To further probe for heteroscedasticity we decide to also perform the more general Breusch-Pagan/Cook-Weisberg (B-P/C-W) Test. The test assumes a null hypothesis of homoscedastic error terms, while the alternative hypothesis states heteroscedasticity. Running the B-P/C-W Test we also find inconclusive results, however different from the White Test's. Using the B-P/C-W Test we also reject homoscedasticity for pre-FOMC and pre-ECB specifications of our main regression model. The results from both tests are reported in Table A5 in the Appendix. Although the results of the two tests are inconclusive for some of our models, they do show that heteroscedasticity cannot be reliably rejected. To account for the potential heteroscedasticity, we use Huber-White heteroscedasticity-consistent standard errors in all our regressions.

Autocorrelation occurs when the error terms of an OLS regression model correlate over time. Similar to heteroscedasticity, the presence of autocorrelation does not interfere with the point estimates of coefficients, but instead distorts standard errors and may consequently lead to false significance levels. To formally test for autocorrelation over time we employ the Breusch-Godfrey Test for serial correlation. The test assumes the null hypothesis of no serial correlation. We test for autocorrelation in the residuals of our main and alternative regression models with up to five lags (to account for day-of-the-week factors), with the results included in Table A6 in the Appendix. We only find χ^2 values that imply a rejection of our null hypothesis at 4-period lagged values for our main regression model specifications, and for the 4- and 5-period lagged values for our alternative regression model. Economic intuition does not clearly state why autocorrelation should be present only in the four-period lag and not, for example, in first order lags. Considering the test results, also referring to the results of our bootstrapped standard errors in Table A4 in the Appendix, we conclude autocorrelation do not seem to cause any significant distortions in our estimated standard errors.

6.3 Evaluation of Method

Table 6.1
Mean Daily Returns around Announcement Days

Days to Announcement	FOMC	Riksbank	ECB
-4	-0.143	0.070	0.197
-3	-0.159	0.208	0.144
-2	-0.108	-0.097	0.016
-1 (Event Day)	**0.480**	**0.205**	**0.004**
0	0.007	0.266	0.030
1	0.118	0.117	0.096
2	0.099	0.120	-0.032
3	0.017	-0.126	-0.008
4	-0.082	0.100	-0.117
9-Day Mean	**0.025**	**0.096**	**0.037**

Table 6.1 displays mean %-log daily cum-dividend excess returns on days surrounding monetary policy announcement days for the three central banks. The sample period is from January 1 1999 to February 28 2017.

Our main regression model aims to perform a simple test to see if daily returns are unusually large on certain pre-announcement days. One concern with the methodology of this study may be that we chose to limit the relevant event window to the last trading day ahead of the announcement, which is in line with the findings of Lucca and Moench (2015). In table 6.1 we show mean excess returns for the eight days surrounding monetary policy announcement days for the three central banks included in our study. We note that returns in an extended 9-day event window do not deviate from normal daily mean return patterns. However, we do note that mean returns in the days before the FOMC event day are on average negative. While the negative means are not statistically significant when tested using an Equation 1 dummy variable regression model, they are economically large when compared to sample mean daily returns. This pattern is not consistent with the findings of Lucca and Moench (2015) and do to some extent undermine the statement that pre-FOMC returns have accounted for a large amount of annualized excess returns over the sample period.

Another potential cause for concern is that pre-announcement event windows end with differing amounts of time left until the announcement is made depending on the central bank. For example, while the event window ends only 2 hours and 45 minutes before FOMC announcements, the pre-announcement event window ends more than 12 hours ahead of both Riksbank and ECB announcements. As seen in Lucca and Moench (2015), the pre-announcement trading hours on the day of the FOMC announcement account for almost 30% of the whole drift. This indicates that our use of daily data may limit the comparability of drifts between the central banks. Especially considering the Riksbank returns patterns, there is a possibility that some of the returns attributed to the announcement day may in fact have been earned in pre-announcement window. However, also referring to Lucca and Moench (2015), the pre-FOMC announcement drift on the S&P 500 was clearly visible and statistically highly significant when using daily data on the day before the announcement. With regards to this, we conclude that a study using daily returns should be able to produce sufficient results.

The abovementioned concerns regarding differing pre-announcement windows are related to the lack of intraday data available on the Stockholm Stock Exchange. Access to intraday tick data would have allowed us to investigate the individual pre-announcement return windows up until the minutes preceding the announcement. It would also eliminate the discrepancies in pre-announcement window specifications between central banks. In addition, intraday data would allow for a much more granular evaluation of movements in volatility and liquidity under our second hypothesis. Instead, we are forced to use proxies for both stock market volatility and liquidity. While this method is consistent with Lucca and Moench (2015), there may be demographical factors affecting our proxies differently. This is especially critical since Lucca and Moench (2015) find that their proxies for market volatility and liquidity significantly increase their explanatory value, while our study does not find a similar increase for the included variables. This points towards our proxies being of inferior quality when compared to their U.S. counterparts.

To test our risk-based explanatory models including liquidity- and volatility risk, we decompose the metrics into what is assumed to be expected and unexpected parts for a market participant in line with the method adopted by Lucca and Moench (2015). However, in contradiction to Lucca and Moench (2015), we do not find that the decomposition enhances the explanatory value of our model. While this may be caused by several factors, such as differences in data discussed above, there is also some methodological concerns. For one, the research method adopted from previous studies does not include a formal fitting of the AR-model to the data. The argument being that the unexpected and expected components should be modeled as observable to market participants, which are assumed to make predictions based on the previous period levels. A more formal fitting of the model to empirical data may greatly improve the explanatory value of the introduced control variables. However, this also means stepping away from theoretical frameworks and losing comparability with the results from Lucca and Moench, 2015. Additionally, one important feature of the decomposition into expected and unexpected components is that it allows us, with reliance on theory, to make a causal assumption between liquidity, volatility and stock market returns (Lucca and Moench, 2015). However, we have no reliable way of testing if the contemporaneous proxies for unexpected liquidity and volatility are truly unexpected by market participants, and consequently can have a causal inference on stock returns. This makes us very reliant on the accuracy of our theoretical models, which may or may not hold in practice.

7 Conclusion

7.1 Implications for Future Research

While our study contributes with several new discoveries regarding pre-announcement drifts on the Swedish stock market, we fail to find explanatory models that fit our empirical data. One very striking result of our study is that the pre-announcement drift appears to be exclusive to the FOMC announcements, even when researching is conducted on a foreign stock market with an independent domestic central bank. Thus, to further pursue an explanation of the puzzling drift, one key component may be to isolate the unique characteristics of FOMC announcements that other monetary policy- and macroeconomic announcements lack.

The last piece of suggestive evidence presented in the Section 6.4 points towards that the pre-FOMC announcement drift may have disappeared from stock markets after it became publicly known. The disappearance of the drift points towards a non-risk based explanation of the drift, however, previously claimed behavioral explanatory models do not fit our empirical data. With this in mind, we urge that future research continue to employ new behavioral frameworks to explain the puzzling drift. Our research also discovers peculiar return patterns in conjunction to Riksbank monetary policy announcements. Excess returns seem to be split between pre-announcement and announcement days. While we fail to prove the existence of a positive pre-Riksbank announcement drift, understanding the specifics of how the Stockholm Stock Exchange incorporate new macroeconomic information from the Riksbank is an relatively unexplored area of research. We do however recognize that one main hinder for conducting such research is the lack of sufficient samples of intraday trading data, which in time will become more readily available.

7.2 Concluding Remarks

In this study, we set out to investigate how the Swedish stock market behaves in anticipation of relevant monetary policy announcements. We draw inspiration from a 2015 study by Lucca and Moench, which discovers a large and unexplained drift in U.S. equity prices in the 24 hours ahead of FOMC monetary policy announcements. In the spirit of Lucca and Moench's study, we investigate movements on the OMXSB in the days preceding FOMC, Riksbank and ECB monetary policy announcements. In our study, we reveal a 0.48% drift in anticipation of FOMC announcements on the Stockholm Stock Exchange that is statistically highly significant and persistently positive over time. The results imply that more than 60% of the excess return on the Stockholm Stock Exchange between 1999 and 2017 has been made in pre-FOMC announcement windows. We do also find evidence of a drift in anticipation of Riksbank monetary policy announcements, however, the drift does not show the same persistence over time periods and is followed by an equally large surge on announcement days. For the ECB, we do not find any evidence of pre-announcement or announcement drift on the Stockholm Stock Exchange.

We proceed to explain the pre-FOMC drift by employing different explanatory models to the found drift. We initially consider risk-based explanations with foundations in unexpected shifts in stock market liquidity and volatility, employed by Lucca and Moench (2015) with some success. We however fail to confirm that the pre-FOMC drift on the Stockholm Stock Exchange is explained by either volatility- or liquidity risk. We move on investigating several behavioral frameworks with foundations in investor inattention. Again, we do not find matching empirical data to the presented explanations. As a final exercise, we investigate whether pre-FOMC returns have changed since the information regarding their existence became public. In this case, we do see that the pre-FOMC drift seems to diminish after the release of Lucca and Moench's September 2011 working paper. In addition, when re-estimating our main regression model on a post-release sub-sample we fail to reject the null-hypothesis that pre-FOMC returns are significantly different from returns on other days. This supports the hypothesis that the pre-FOMC drift is a result of inefficient markets, rather than being a compensation for increased systematic risk.

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Appendix

Table A1.1

FOMC Monetary Policy Announcement Days 1999-2017

Year								
1999	03-Feb	30-March	18-Maj	30-Juni	24-Aug	05-Okt	16-Nov	21-Dec
2000	02-Feb	21-March	16-Maj	28-Juni	22-Aug	03-Okt	15-Nov	19-Dec
2001	31-Jan	20-March	15-Maj	27-Juni	21-Aug	02-Okt	06-Nov	11-Dec
2002	30-Jan	19-March*	07-Maj	26-Juni	13-Aug	24-Sep	06-Nov	10-Dec
2003	29-Jan	18-March*	06-Maj	25-Juni	12-Aug	16-Sep	28-Okt	09-Dec
2004	28-Jan	16-March	04-Maj	30-Juni	10-Aug	21-Sep	10-Nov	14-Dec
2005	02-Feb	22-March	03-Maj	30-Juni	09-Aug	20-Sep	01-Nov	13-Dec
2006	31-Jan	28-March	10-Maj	29-Juni	08-Aug	20-Sep	25-Okt	12-Dec
2007	31-Jan	21-March	09-Maj	28-Juni	07-Aug	18-Sep	31-Okt	11-Dec
2008	30-Jan	18-March	30-Apr	25-Juni	05-Aug	16-Sep	29-Okt	16-Dec
2009	28-Jan	18-March	29-Apr	24-Juni	12-Aug	23-Sep	04-Nov	16-Dec*
2010	27-Jan	16-March	28-Apr	23-Juni	10-Aug	21-Sep	03-Nov	14-Dec
2011	26-Jan	15-March	27-Apr	22-Juni	09-Aug	21-Sep	02-Nov	13-Dec
2012	25-Jan	13-March	25-Apr	20-Juni	01-Aug	13-Sep	24-Okt	12-Dec
2013	30-Jan	20-March	01-Apr*	19-Juni	31-Juli	18-Sep	30-Okt	18-Dec
2014	29-Jan	19-March	30-Apr	18-Juni	30-Juli	17-Sep	29-Okt	17-Dec
2015	28-Jan	18-March*	29-Apr*	17-Juni	29-Juli	17-Sep	28-Okt*	16-Dec
2016	27-Jan	16-March	27-Apr	15-Juni	27-Juli	21-Sep	02-Nov	14-Dec
2017	01-Feb	-	-	-	-	-	-	-

Table A1.1 reports all days where the FOMC has made a monetary policy announcement between January 1 1999 and February 28 2017. The dates marked with a * have been removed from our final sample of announcement days. The number of included announcement per year: 1999: 8, 2000: 8, 2001: 8, 2002: 7, 2003: 7, 2004: 8, 2005: 8, 2006: 8, 2007: 8, 2008: 8, 2009: 7, 2010: 8, 2011: 8, 2012: 8, 2013: 7, 2014: 8, 2015: 5, 2016: 8, 2017: 1. The total number of announcements included in the final sample is 138

Table A1.2

Riksbank Monetary Policy Announcement Days 1999-2017

Year									
1999	15-Jan	29-Jan	12-Feb	26-Feb	12-March	25-March	09-Apr	23-Apr	07-Maj
	21-Maj	03-Juni	18-Juni	02-Juli	13-Aug	27-Aug	17-Sep	06-Okt	12-Nov
2000	04-Feb	23-March	05-Maj	08-Juni*	07-Juli	16-Aug	10-Okt	07-Dec	-
2001	02-Feb	27-March	27-Apr	31-Maj	06-Juli	24-Aug	17-Sep*	16-Okt	05-Dec
2002	08-Feb	19-March*	26-Apr	06-Juni*	05-Juli	16-Aug	17-Okt	15-Nov	05-Dec*
2003	07-Feb	18-March*	25-Apr	05-Juni*	04-Juli	15-Aug	16-Okt	05-Dec	-
2004	06-Feb	01-Apr*	29-Apr	28-Maj	24-Juni	20-Aug	14-Okt	09-Dec	-
2005	28-Jan	15-March	29-Apr	21-Juni	24-Aug	20-Okt	02-Dec	-	-
2006	20-Jan	23-Feb	28-Apr	20-Juni	30-Aug	26-Okt	15-Dec	-	-
2007	15-Feb	30-March	04-Maj	20-Juni	07-Sep	30-Okt	19-Dec	-	-
2008	13-Feb	23-Apr	03-Juli*	04-Sep*	08-Okt*	23-Okt	04-Dec*	-	-
2009	11-Feb	21-Apr	02-Juli*	03-Sep*	22-Okt	16-Dec*	-	-	-
2010	11-Feb	20-Apr	01-Juli	02-Sep*	26-Okt	15-Dec	-	-	-
2011	15-Feb	20-Apr	05-Juli	07-Sep	27-Okt	20-Dec	-	-	-
2012	16-Feb	18-Apr	04-Juli	06-Sep*	25-Okt	18-Dec	-	-	-
2013	13-Feb	17-Apr	03-Juli	05-Sep*	24-Okt	17-Dec	-	-	-
2014	13-Feb	09-Apr	03-Juli*	04-Sep*	28-Okt	16-Dec	-	-	-
2015	12-Feb	18-March*	29-Apr*	02-Juli	03-Sep*	28-Okt*	15-Dec	-	-
2016	11-Feb	21-Apr*	06-Juli	06-Sep	27-Okt	21-Dec	-	-	-
2017	15-Feb	-	-	-	-	-	-	-	-

Table A1.2 reports all days where the Riksbank has made a monetary policy announcement between January 1 1999 and February 28 2017. The number of announcements made per year has varied between 18 in year 1999 and 6 in years 2009-2014 and 2016. The dates marked with a * have been removed from our final sample of announcement days. The number of included announcement per year: 1999: 18, 2000: 7, 2001: 8, 2002: 6, 2003: 6, 2004: 7, 2005: 7, 2006: 7, 2007: 7, 2008: 3, 2009: 3, 2010: 5, 2011: 6, 2012: 5, 2013: 5, 2014: 4, 2015: 3, 2016: 5, 2017: 1. The total number of announcements included in the final sample is 113.

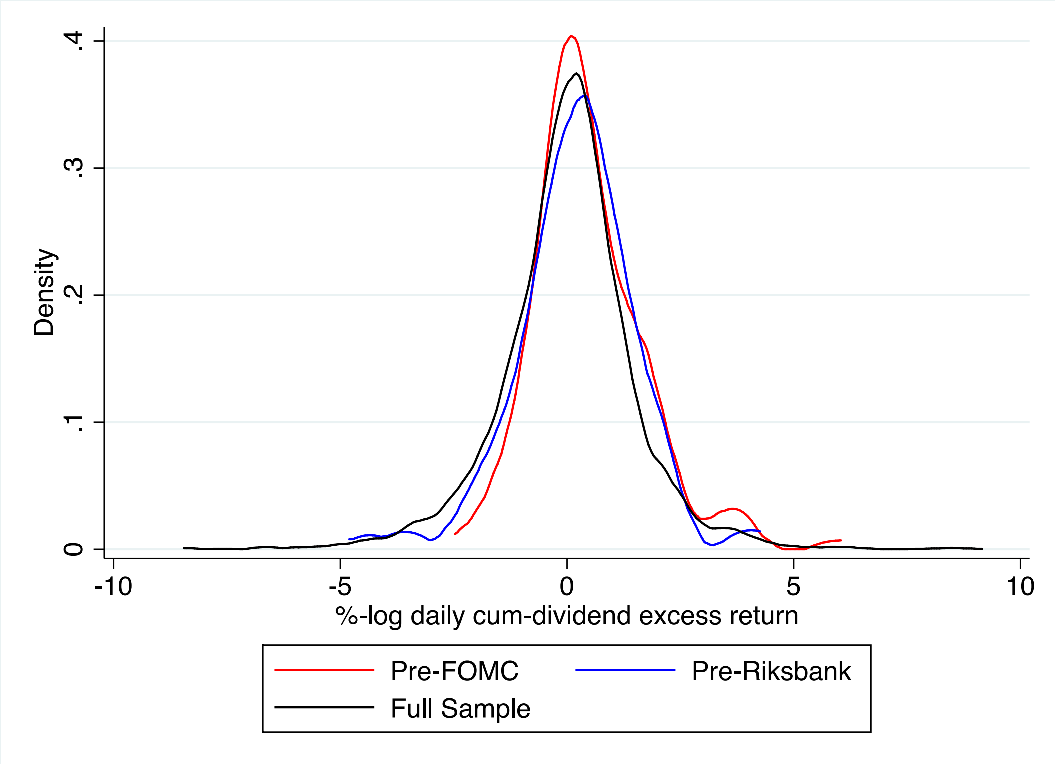
Table A1.3

European Central Bank Monetary Policy Announcements 1999-2017

Year												
1999	07-Jan	21-Jan	18-Feb	04-Mar	18-Mar	08-Apr	22-Apr	06-Maj	20-Maj	02-Juni	17-Juni	01-Juli
	15-Juli	29-Juli	26-Aug	09-Sep	23-Sep	07-Okt	21-Okt	04-Nov	18-Nov	02-Dec	15-Dec	-
2000	05-Jan	20-Jan	03-Feb	17-Feb	02-Mar	16-Mar	30-Mar	13-Apr	27-Apr	11-Maj	25-Maj	08-Juni*
	21-Juni	06-Juli	20-Juli	03-Aug	31-Aug	14-Sep	05-Okt	19-Okt	02-Nov	16-Nov	30-Nov	14-Dec
2001	04-Jan	18-Jan	01-Feb	15-Feb	01-Mar	15-Mar	29-Mar	11-Apr	26-Apr	10-Maj	23-Maj	07-Juni
	21-Juni	05-Juli	19-Jul	02-Aug	30-Aug	13-Sep	17-Sep*	27-Sep	11-Okt	25-Okt	08-Nov	06-Dec
2002	03-Jan	07-Feb	07-Mar	04-Apr	02-Maj*	06-Juni*	04-Juli	01-Aug	12-Sep	10-Okt	07-Nov	05-Dec*
2003	09-Jan	06-Feb	06-Mar	03-Apr	08-Maj	05-Juni*	10-Juli	31-Juli	04-Sep	02-Okt	06-Nov	04-Dec
2004	08-Jan	05-Feb	04-Mar	01-Apr*	06-Maj	03-Juni	01-Juli	05-Aug	02-Sep	07-Okt	04-Nov	02-Dec
2005	13-Jan	03-Feb	03-Mar	07-Apr	04-Maj	02-Juni	07-Juli	04-Aug	01-Sep	06-Okt	03-Nov	01-Dec
2006	12-Jan	02-Feb	02-Mar	06-Apr	04-Maj	08-Juni	06-Juli	03-Aug	31-Aug	05-Okt	02-Nov	07-Dec
2007	11-Jan	08-Feb	08-Mar	12-Apr	10-Maj	06-Juni*	05-Juli	02-Aug	06-Sep	04-Okt	08-Nov	06-Dec
2008	10-Jan	07-Feb	06-Mar	10-Apr	08-Maj	05-Juni	03-Juli*	07-Aug	04-Sep*	02-Okt	08-Okt*	06-Nov
	04-Dec*	-	-	-	-	-	-	-	-	-	-	-
2009	15-Jan	05-Feb	05-Mar	02-Apr	07-Maj	04-Juni	02-Juli*	06-Aug	03-Sep*	08-Okt	05-Nov	03-Dec
2010	14-Jan	04-Feb	04-Mar	08-Apr	06-Maj	10-Juni	08-Juli	05-Aug	02-Sep*	07-Okt	04-Nov	02-Dec
2011	13-Jan	03-Feb	03-Mar	07-Apr	05-Maj	09-Juni	07-Juli	04-Aug	08-Sep	06-Okt	03-Nov	08-Dec
2012	12-Jan	09-Feb	08-Mar	04-Apr	03-Maj	06-Juni*	05-Juli	02-Aug	06-Sep*	04-Okt	08-Nov	06-Dec
2013	10-Jan	07-Feb	07-Mar	04-Apr	02-Maj*	06-Juni*	04-Juli	01-Aug	05-Sep*	02-Okt	07-Nov	05-Dec
2014	09-Jan	06-Feb	06-Mar	03-Apr	08-Maj	05-Juni	03-Juli*	07-Aug	04-Sep*	02-Okt	06-Nov	04-Dec
2015	22-Jan	05-Mar	15-Apr	03-Juni	16-Juli	03-Sep*	22-Okt	03-Dec	-	-	-	-
2016	21-Jan	10-Mar	21-Apr*	02-Juni	21-Juli	08-Sep	20-Okt	08-Dec	-	-	-	-
2017	19-Jan	-	-	-	-	-	-	-	-	-	-	-

Table A1.3 reports all days where the ECB has made a monetary policy announcement between January 1 1999 and February 28 2017. The number of announcements made per year has varied between 24 in years 2000 and 2001 to 8 in years 2015 and 2016. The dates marked with a * have been removed from our final sample of announcement days. The number of included announcement per year: 1999: 23, 2000: 23, 2001: 23, 2002: 19, 2003: 11, 2004: 11, 2005: 12, 2006: 12, 2007: 11, 2008: 9, 2009: 10, 2010: 11, 2011: 12, 2012: 10, 2013: 9, 2014: 10, 2015: 7, 2016: 7, 2017: 1. The total number of announcements included in the final sample is 221.

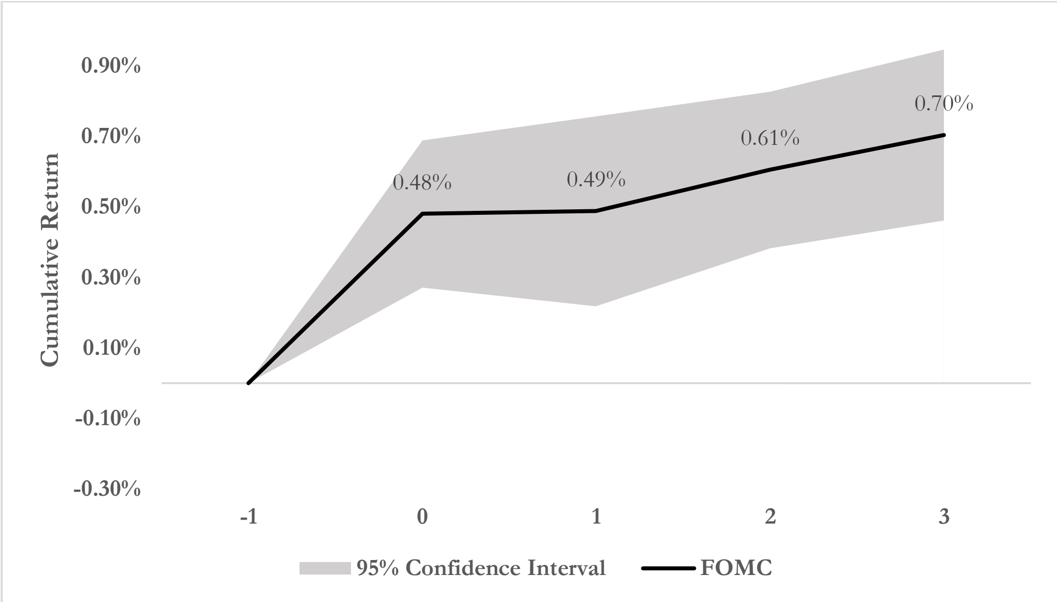
Graph A1
Density Plots for Daily Excess Returns



	Pre-FOMC	Pre-Riksbank	Full Sample
Skew	1.049	-0.452	-0.054
Kurtosis	5.628	5.129	6.493

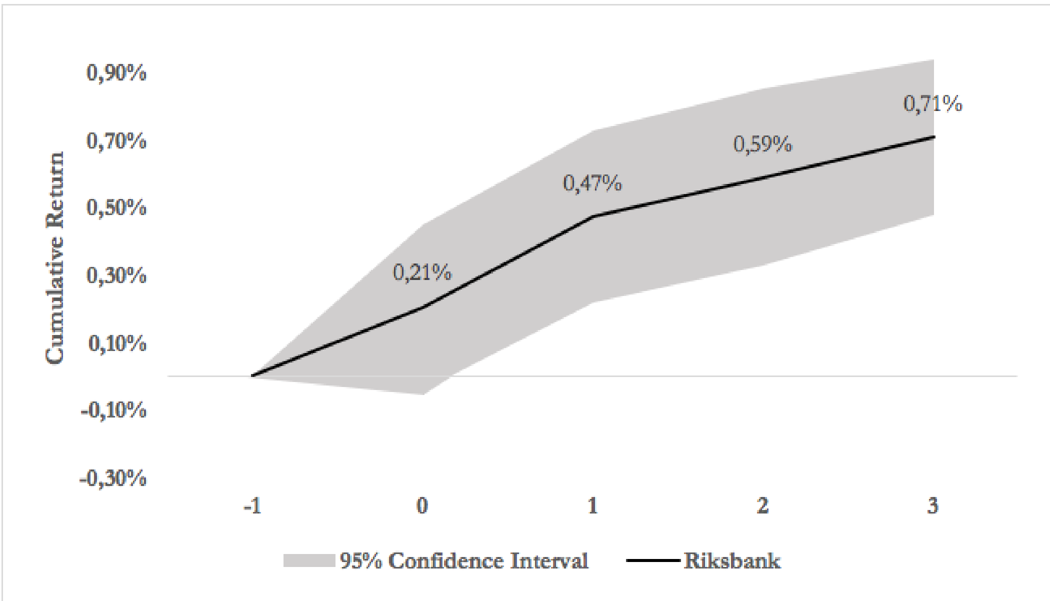
Graph A1 plots the empirical densities for %-log cum-dividend excess returns on the OMXSB on pre-FOMC announcement days, pre-Riksbank announcement days and for the total sample. The table presents the values of the skew and kurtosis for the two sub-samples and the full sample.

Graph A2.1
Mean Cumulative Returns around FOMC Announcement



Graph A2.1 shows mean %-log cumulative cum-dividend excess returns on the OMXSB from the day before FOMC monetary policy announcements to two days after the announcement has been made. The sample period is January 1 1999 to February 28 2017. The grey area shows the pointwise 95% confidence intervals.

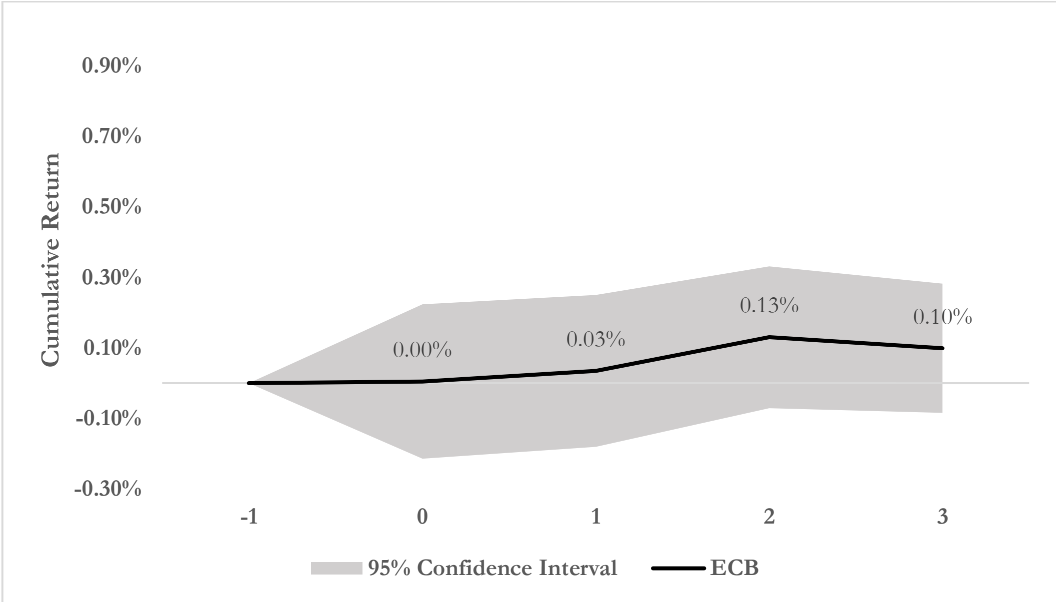
Graph A2.2
Mean Cumulative Returns around Riksbank Announcement



Graph A2.2 shows mean %-log cumulative cum-dividend excess returns on the OMXSB from the day before Riksbank monetary policy announcements to two days after the announcement has been made. The sample period is January 1 1999 to February 28 2017. The grey area shows the pointwise 95% confidence intervals.

Graph A2.3

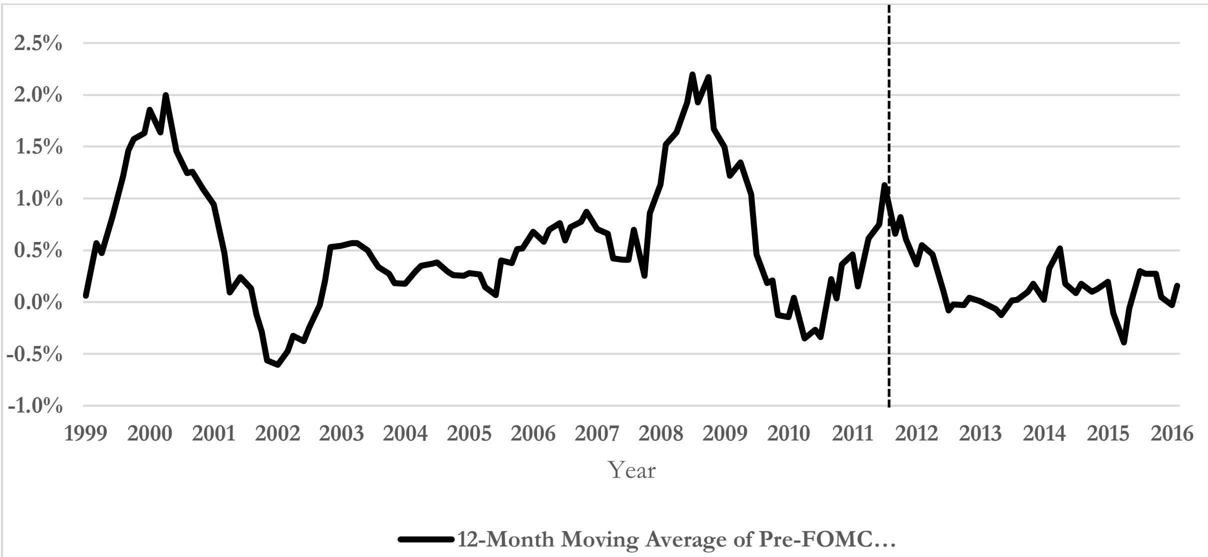
Mean Cumulative Returns around ECB Announcement



Graph A2.3 shows mean %-log cumulative cum-dividend excess returns on the OMXSB from the day before ECB monetary policy announcements to two days after the announcement has been made. The sample period is January 1 1999 to February 28 2017. The grey area shows the pointwise 95% confidence intervals.

Graph A3

12-Month Moving Average of Pre-FOMC Returns



Graph A3 shows the time-series of 12-month (past eight announcements) moving average pre-FOMC %-log cum-dividend daily excess returns on the OMXSB

Table A2

Pre-FOMC Announcement Volatility and Liquidity

Implied Volatility

Pre-FOMC Announcement Days			Other Days		
Mean	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**
20.85	9.34	97	20.38	8.72	3125

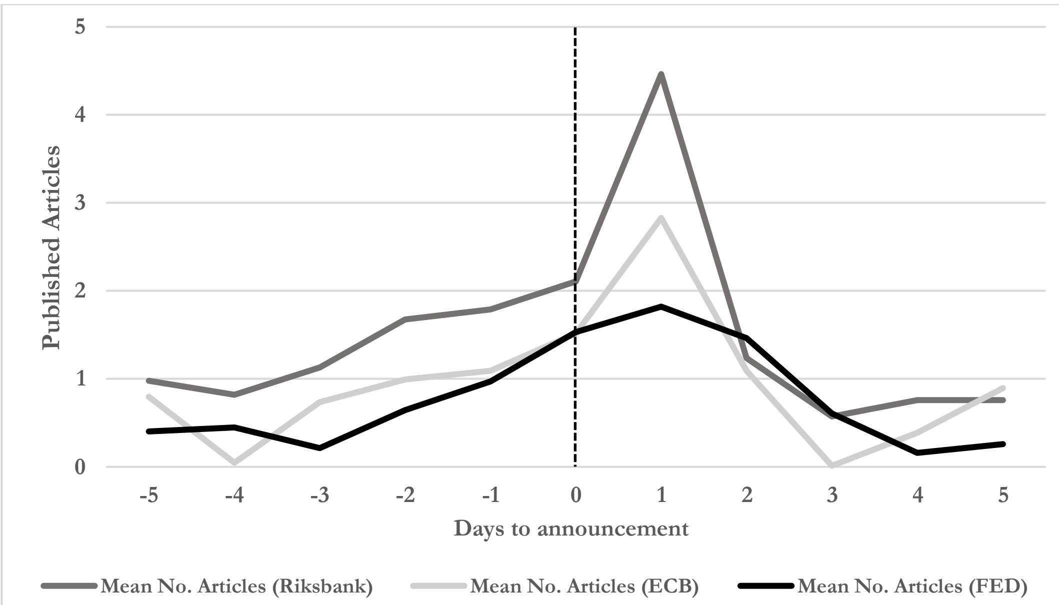
Liquidity

Pre-FOMC Announcement Days			Other Days		
Mean	**SD**	**Obs.**	**Mean**	**SD**	**Obs.**
0.759	0.985	79	1.330	5.143	2606

Table A2 reports levels of implied volatility and liquidity on pre-announcement days and for all other days. Volatility is measured as the level of the SIX Volatility Index and the sample period is from May 7 2004 to February 28 2017. Liquidity is measured as the trading volume on the XACT OMXS30 ETF relative to its 21 day average and the sample period is from March 16 2006 to February 28 2017.

Graph A4

News Articles Around Monetary Policy Announcement Days



Graph A4 shows the mean number of articles published in the Swedish business newspaper "Dagens Industri" in days before, under and after monetary policy announcements are made by each central bank. The sample period is between January 1 1999 to February 28 2017. The dotted vertical line marks the day (0) on which monetary policy announcement are made.

Table A3
Sensitivity Analysis

(1.1) FOMC	Excl. Top/Bottom 1%	Excl. Top/Bottom 5%
Dummy	**0.403**	**0.266**
	[0.098]***	[0.082]***
Constant	**0.011**	**0.022**
	[0.019]	[0.016]
Dummy t-stat.	4.12	3.24
No. Obs.	4469	4104

(1.2) Riksbank	Excl. Top/Bottom 1%	Excl. Top/Bottom 5%
Dummy	**0.192**	**0.181**
	[0.115]*	[0.099]*
Constant	**0.018**	**0.026**
	[0.019]	[0.016]
Dummy t-stat.	1.67	1.83
No. Obs.	4469	4104

(1.3) ECB	Excl. Top/Bottom 1%	Excl. Top/Bottom 5%
Dummy	**-0.004**	**-0.066**
	[0.103]	[0.077]
Constant	**0.023**	**0.034**
	[0.019]	[0.016]
Dummy t-stat.	0.04	-0.85
No. Obs.	4469	4104

Table A3 reports the results from the main regression model for the FOMC, Riksbank and ECB pre-announcement days with dropped extreme values. The left column excludes top/bottom 1% and the right column excludes top/bottom 5% of observed daily cum-dividend excess returns on the OMXSB. Robust standard errors are shown within brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A4

Bootstrapped Standard Errors

Model	Bootstrap Std. Err.	Empirical Std. Err.
(1.1) FOMC	0.10822	0.10818
(1.1) FOMC Sub-Sample	0.13886	0.13614
(1.2) Riksbank	0.12562	0.12744

Table A4 reports the empirically estimated and bootstrapped standard errors for the dummy variable coefficients in our main regression models. (1) FOMC and (2) Riksbank sample periods are from January 1 1999 to February 28 2017, (1) FOMC Sub-Sample period is from October 1 2011 to February 28 2017.

Table A5

Tests for Heteroscedasticity

Model	White	Prob. >	B-P/C-W	Prob. >
(1.1) FOMC	2.08	0.1496	5.70	0.0169
(1.2) Riksbank	0.66	0.4159	1.82	0.1773
(1.3) ECB	2.99	0.0837	8.22	0.0042
Alternative Model	792.69	0.0000	467.62	0.0000

Table A5 reports the results for White and The Breusch-Pagan/Cook-Weisberg Tests for heteroscedasticity for our three dummy variable main regression model and alternative regression model including volatility and liquidity variables. The numbers reported in the Prob. > columns are the probabilities of rejecting the null hypothesis that the error terms are homoscedastic.

Table A6

Breusch-Godfrey Test for Serial Correlation

	(1.1) FOMC		(1.2) Riksbank		(1.3) ECB		Alternative Model	
Lag	**BG-stat**	**Prob. >**	**BG-stat**	**Prob. >**	**BG-stat**	**Prob. >**	**BG-stat**	**Prob. >**
1	1.030	0.3102	1.206	0.2721	1.152	0.2832	0.229	0.6322
2	2.626	0.2691	2.866	0.2386	2.784	0.2486	0.382	0.8260
3	5.130	0.1625	5.398	0.1449	5.313	0.1503	3.169	0.3663
4	10.019	0.0401	10.629	0.0311	10.287	0.0359	17.619	0.0015
5	10.019	0.0747	10.636	0.0591	10.290	0.0674	17.835	0.0032

Table A6 reports the results from the Breusch-Godfrey Test for Autocorrelation in error terms. The test is performed for up to five lags for our three dummy variable main regression models and for our alternative regression model including liquidity and volatility variables.