QUANTITATIVE EASING AND THE UK STOCK MARKET: DOES THE BANK OF ENGLAND INFORMATION DISSEMINATION STRATEGY MATTER?

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We use intraday aggregate stock market data and an event-study framework to assess the UK's equity market reaction to the unexpected element of the Bank of England Monetary Policy Committee's (MPC) asset purchase announcements for the 2009–2017 period. We assess the reactions of equity returns and their volatility over various time frames, both preceding and following the MPC announcements. Our results show that the UK unconventional monetary policy shocks have a significant impact on domestic equity returns and volatilities. The strength of this impact depends on the Bank's information dissemination through inflation reports and the publication of the MPC's voting records. (JEL G14, E44, E52)

I. INTRODUCTION

In the wake of the 2007–2009 financial crisis, and during the recovery phase afterward, central banks globally have undertaken both conventional and unconventional measures to stabilize the economy and bolster growth. Since late 2008 and early 2009, the Federal Reserve (the Fed hereafter) and the Bank of England (the Bank hereafter), having already hit the zero lower bound, have embarked on large-scale purchases of long-term assets, commonly referred to as quantitative easing (QE hereafter), in order to provide monetary stimulus. The European Central Bank (ECB hereafter) followed by adopting an explicit QE program in January 2015. By the end of 2016, central bank assets in the United States and the United Kingdom amounted to almost 24% of their respective gross domestic products (GDPs hereafter)), while that of the ECB was almost 34% of Euro area's GDP. Large-scale asset purchases during this period

have been the main policy tool for major central banks globally, and the identification of their effectiveness has been a highly debatable topic for policymakers and practitioners alike.

This paper examines the impact of the Bank's QE on both stock market returns and their volatility in the United Kingdom. We consider the effects of the Bank's Monetary Policy Committee (hereafter, the MPC) announcements on financial markets, focusing on the implications of the MPC's communication framework. In particular, we examine the impact of the Bank's announcements on both stock market returns and volatility with special reference to the way in which the publication of inflation reports and MPC members' voting patterns intertwine with the MPC meeting schedule and policy decisions. Our sample period begins with the onset of QE in the UK in 2009 and ends in 2017, during which time the Bank's base policy rate was for the most part stable and constrained by the effective zero lower bound. During this period, the Bank implemented monetary policy by purchasing UK government

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ABBREVIATIONS

Bank: Bank of England
ECB: European Central Bank
Fed: Federal Reserve
FOMC: Federal Open Market Committee
GDP: Gross Domestic Product
MPC: Monetary Policy Committee
QE: Quantitative Easing
IV: Implied Volatility

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bonds worth a total of £435 billion.[1] To our knowledge, this is the first attempt to consider the implications of the Bank's asset purchase program for stock market volatility. Moreover, it is the first attempt to analyze the role of information releases (inflation reports and voting records) by the Bank in the context of QE policies.

The impact of central bank asset purchases on equity prices potentially runs through three key theoretical channels of transmission (e.g., Joyce et al. 2011; Neely 2015). Particularly, central bank announcements of asset purchases can increase equity prices through the portfolio balance channel by causing investors to rebalance their portfolios to include more equities, to the extent that the latter are better substitutes for bonds than money. An additional channel of transmission which leads to similar effects on equities is the liquidity channel, which posits that large-scale asset purchases can reduce liquidity premia in the markets, increasing, in turn, equity prices. The third key channel of transmission operates through the signaling effects of asset purchases on investors' expectations. According to this channel, the ultimate impact of MPC announcements hinges on the way information from the announcements influences investors' expectations regarding the future economic conditions and the path of interest rates. Against this background, worse- or better-than-expected news will exert different impact on equity prices pushing them at lower or higher levels respectively.

The Bank's asset purchases, if successfully implemented, are expected to lower long-term rates and improve the outlook for economic activity and, thus, feed through to higher equity prices. Better informed expectations about the Bank's future monetary policy stance are, therefore, important for the effectiveness of the Bank's QE program. To that end, we examine the implications of the Bank's communication, which holds a central role in managing investors' expectations, for the impact of QE announcements on equities. Indicative of the Bank's increased interest in shaping investors' expectations is also the adoption, since August 2013, of another unconventional measure of monetary policy, the forward guidance. This measure allows the market participants to have a more informed view on the MPC's reaction function, and it has already been implemented by the Fed postcrisis for the same reason since December 2008.

We gauge the financial market reactions to the Bank's MPC communication framework by analyzing how the proximity of the MPC announcement to the release of an inflation report and the pattern (unanimous versus dissenting votes) of the MPC members' voting records may affect the equity responses to the announcements. During the period from 2009 to July 2015, the Bank's MPC met every month to decide on its monetary policy. Between these MPC meetings, the Bank published the inflation report (when applicable) and the minutes from the previous meeting, which may have influenced the relative importance of MPC meetings announcements (Chortareas and Noikokyris 2014). As inflation reports are released quarterly, there were three MPC announcements in between every two inflation report releases. The third occurred less than a week before the release of the inflation report. The minutes of the MPC meetings, which include the voting records of the MPC members, were published approximately 2 weeks after the meetings (and 2 weeks before the next meeting).

To illustrate this information dissemination structure, we provide Figure 1, depicting the publication schedule of MPC meetings, their supporting minutes, and inflation reports over a 3-month period from November 2009 to February 2010. It is important to note that the timeline of the Bank's information dissemination activities was rather regular, and the publication schedule during this 3-month period is typical of the entire 2009–2015 period.

A voluminous literature on the relationship between QE policies and asset prices has evolved since the outbreak of the recent financial crisis and the adoption of QE policies by many central banks around the globe. The bulk of the evidence comes from the United States, and the effects of QE implemented by the Fed are typically estimated in an event-study context by capturing the cumulative change in the price of a financial asset over a short window bracketing QE-related announcements. The results from the existing evidence point to lower longer-term rates following QE announcements (e.g., D'Amico and King 2013; Gagnon et al. 2011; Krishnamurthy and Vissing-Jorgensen 2011; Meaning and Zhu 2011; Neely 2015; Swanson 2011). Further evidence is also derived from studies that examine the impact of the Fed's QE programs on a wider array of financial assets. For instance, Neely (2015) finds that the Fed's QE announcements

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1. The Bank undertakes the purchases of gilts and (to a much lesser extent) corporate bonds via its subsidiary, the Asset Purchase Facility.

FIGURE 1

Timeline of MPC Information Dissemination Actions
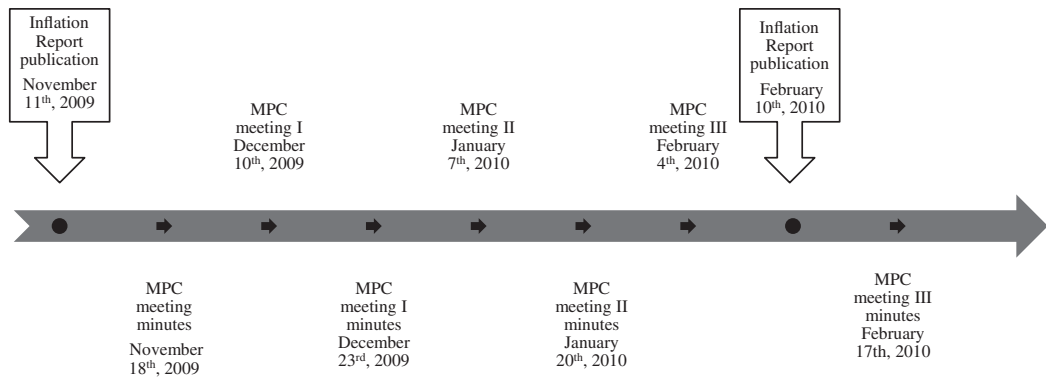
Notes: This figure plots the publication schedule of the Bank's information dissemination activities (MPC meetings, their supporting minutes, and inflation reports) over a 3-month period from November 2009 to February 2010.

lower global long-term interest rates as well as the price of the dollar, whereas Meaning and Zhu (2011) find that large-scale asset purchases by the Fed bolster equity prices and lower the market's implied volatility (IV hereafter).

Much of the extant literature on the effects of the Bank's asset purchases also uses the event-study framework and documents significant reductions in government gilt yields in the wake of QE announcements (e.g., Breedon, Chadha, and Waters 2012; Joyce et al. 2011; Joyce, McLaren, and Young 2012; Joyce and Tong 2012). The evidence from the Bank's first QE program, however, is inconclusive in terms of the equity market's responses to QE announcements. Breedon, Chadha, and Waters (2012) find that the Bank's bond purchase operations over the 2009–2010 period did not result in significant responses in the equity market. Joyce et al. (2011) consider the same period and show that equities exhibited small and positive responses that are not uniform across the six QE announcements in their sample. In contrast to Breedon, Chadha, and Waters (2012), however, Joyce et al. (2011) consider the days that asset purchases were announced as opposed to the days of actual purchases.

The empirical framework in this paper captures the association of intraday equity returns with the news component of the QE announcement. Following academic convention, we derive the news component of the monetary policy announcement using economists' survey data (Cahill et al. 2013; Joyce et al. 2011; McLaren, Banerjee, and Latto 2014). Existing evidence on

equity reactions to QE news from MPC meetings indicates a weak, if any, relationship. Using data until 2014, Rogers, Scotti, and Wright (2014) conduct a multicountry study, finding that United Kingdom equities exhibit a positive reaction to the Bank's expansionary market-based QE policy shocks in the first 15 minutes of the announcements. This reaction, however, is smaller than that reported for the United States and the Eurozone. Rosa (2012), who derives QE policy shocks from *Financial Times* articles, finds that until June 2011, equity returns are not associated with QE news in the first 25 minutes following the MPC decision announcement. Both studies rely exclusively on short intraday windows to gauge the reaction of the equity markets, and they do not examine whether the Bank's communication framework influences the magnitude of the pass-through of QE news into UK equities.

The relationship between monetary policy and stock market volatility has also seen some attention in the literature (Bomfim 2003; Konrad 2009; Lobo 2000). Identifying this relationship can reveal the impact of QE on the level of market participants' uncertainty, allowing a more involved assessment of the way QE is transmitted to the real economy. Gospodinov and Jamali (2012) produce related evidence using daily data in event time and find that both the historical and implied volatility of U.S. equity returns respond significantly to the Fed's monetary policy shocks. In studies for the United States and the Euro area, monetary policy shocks also emerge as a significant determinant of other financial assets' intraday realized volatility, including exchange

rates and bond yields (Andersson 2010; Chuliá, Martens, and Dijk 2010). Jubinski and Tomljanovich (2013) also find that U.S. equities' realized volatility is sensitive to the publication of the minutes of the Federal Open Market Committee (FOMC hereafter) meetings. Surprisingly, however, there is no study, to our knowledge, considering the implications of QE for stock market volatility in the United Kingdom, while scant evidence exists for the United States during the recent period of unconventional monetary policy.

In this paper, we use an event-study framework, seeking to identify equities' response to QE news over a narrow and a wider intraday window. We assert that an evaluation of the differences in equities' reaction to MPC announcements over these two time-frames can reveal equity investors' capacity to incorporate the economic news from MPC meetings. The notion of a narrow event window has the appealing property that the reaction estimates are not contaminated by other news arriving on the same day and influencing equity prices. Measuring the reaction of an asset in narrow event windows, however, might yield erroneous estimates capturing over- or underreactions. Embedded in this assumption is the acknowledgment that the initial reaction might fail to incorporate any subsequent upward or downward adjustments in the price of the asset (Thornton 2014; Foerster and Cao 2013). The case for possible over- or underreactions is reinforced by the complexity that the relatively novel policy of large-scale asset purchases presents for investors, that might require some additional time to fully price QE news, as well as by the sample period which is characterized by high turbulence and disruptions in the financial markets (Gagnon et al. 2011; Joyce et al. 2011; Meaning and Zhu 2011; Neely 2015).

The remainder of the paper is organized as follows. Section II considers the effects of QE surprises on equity returns, as well as the implications of the MPC communication framework for their transmission. Section III shifts focus to the response of stock market returns' implied and realized volatility to the MPC's QE announcements and information dissemination by the Bank. Finally, Section IV concludes.

II.   THE BANK'S ASSET PURCHASE NEWS AND EQUITY RETURNS

A. The Benchmark Event-Study Empirical Setup

We measure the effects of the Bank's MPC meeting announcements on UK equity returns during the period of QE spanning from 2009 to 2017 using an event-study framework. This framework allows capturing equities' reaction to the unexpected elements of the Bank's announcements over a short window bracketing the announcement. We begin by developing descriptive statistics to examine the equities' market behavior on announcement days. Figure 2 shows the mean cumulative 5-minute returns on the FTSE-100 index from the market open of the MPC announcement day to the market close of the same day. We consider mean returns from 95 MPC announcement days that take place during the period under examination.

The 5-minute average cumulative stock returns indicate an upward trend in stock prices on the Thursdays of MPC announcement days, particularly in the hours following the announcement. Nevertheless, by the end of announcement days, stock prices drop to their level before the announcement. Most point-wise means of cumulative returns are not statistically different from zero, while most of the statistically significant results (at the 10% level of significance) can be seen in the hour following the announcement. In sharp contrast, the cumulative mean returns on all other Thursdays, which do not coincide with MPC announcement days, show—on average—slightly negative equity returns.[2] The increase in equity prices during the hours leading up to the MPC announcement, however, points to the possibility of a preannouncement drift similar to that reported in the U.S. equity market by Lucca and Moench (2015) for the Fed's policy announcements. Moreover, the significant variability in stock prices during the hours following the announcement motivates the use of a wider window to evaluate the announcement's effect.

The Bank's announcements are to some extent anticipated by the market, as they have been subject to intense scrutiny, both during the period of conventional monetary policy, and during the recent years when unconventional monetary policies have been pursued. Disentangling the stock market's reaction to MPC announcements requires identification of the unexpected element of the announcements because equity markets do not react to anticipated pieces of information. The unexpected element of MPC announcements (i.e., the surprises, denoted as S) can be found in the difference between the actual amount

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2. The only two MPC meeting announcements that did not take place on a Thursday occurred on Monday May 10, 2010 and Monday May 11, 2015 due to the general elections.

FIGURE 2

Cumulative Stock Returns on FTSE 100 Stock Price Index
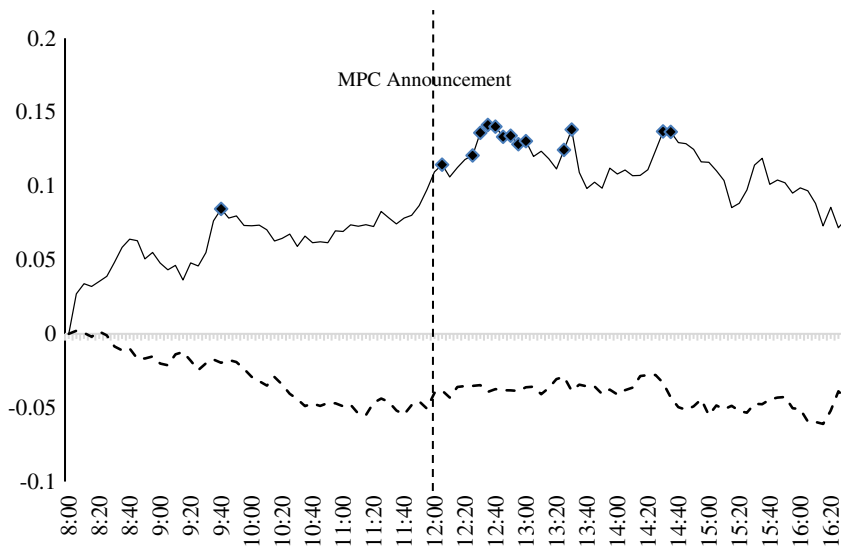
Notes: The vertical dashed line indicates the time of the MPC announcement. The solid line depicts the average cumulative 5-minute returns on the 95 Thursdays of MPC announcement days from September 2009 to December 2017. The dashed line depicts the average cumulative 5-minute returns on all other 338 Thursdays in our sample, excluding the ones that have an MPC announcement. 90% confidence intervals from Newey-West standard errors are constructed for each point-wise mean of cumulative returns, and only points marked with ◆ are statistically different from zero.

of asset purchases announced by the Bank (*A*) and that expected by the market before the announcement (*E*). The market's expectations regarding asset purchases are taken to be the average of the forecasts by economists appearing in Bloomberg's survey. This survey has also been used by Melvin et al. (2010) to infer market expectations regarding the Bank's monetary policy decisions before QE.

Figure 3 shows the Bank's unexpected asset purchases on MPC announcement days. Although economists' forecasts are cast during the week before the MPC meeting, Bloomberg economists' forecasts match the Bank's announcements 73 out of 95 times. For most of the remaining announcements, the divergence was less than £10 billion, and all surprises, except for three, are negative in sign. Negative surprises could be considered as bad news for equity markets, as they suggest that the Bank purchased fewer assets than the market expected. The only MPC meetings when the unexpected asset purchases were of significant magnitude and of positive sign were those on October 6, 2011 and August 4, 2016 when the Bank announced £56.25 and £29.09 billion asset purchases more than what was expected, respectively.

We capture equities' reaction using two intra-day windows. Both windows begin 10 minutes before the announcement, that is, at 11:50 a.m. The narrower window finishes 1 hour after the MPC announcement at 1 p.m., whereas the wider window ranges to the closing of the trading day. Recent papers have examined the effects of unconventional monetary policy by measuring equities' responses to the unexpected element of announcements only over a short intraday window surrounding the announcement (e.g., Joyce and Tong 2012; Rogers, Scotti, and Wright 2014).

We measure the response of equities to news about the Bank's asset purchases using the following empirical specification:

$$(1) \qquad r_t = a + \beta^{MP} S_t + \epsilon_t,$$

where r_t stands for the (log) returns on the FTSE-100 index, calculated over the two alternative event windows described above. Specifically, equity returns for the narrow window are $r_{t, [-10m, +60m]} = \ln P_{t, 13:00} - \ln P_{t, 11:50}$ and for the wider window are $r_{t, [-10m, close]} = \ln P_{t, c} - \ln P_{t, 11:50}$, where $P_{t, hh:mm}$ denotes the equity price on trading day t at the time specified at the subscript, or at the close of day $P_{t, c}$. S_t represents the unexpected element

FIGURE 3

Unexpected Asset Purchases on Bank's Announcements. (A) Actual (actual) versus Forecast Size of
APP (expected) and (B) Monetary Policy Surprises (S)
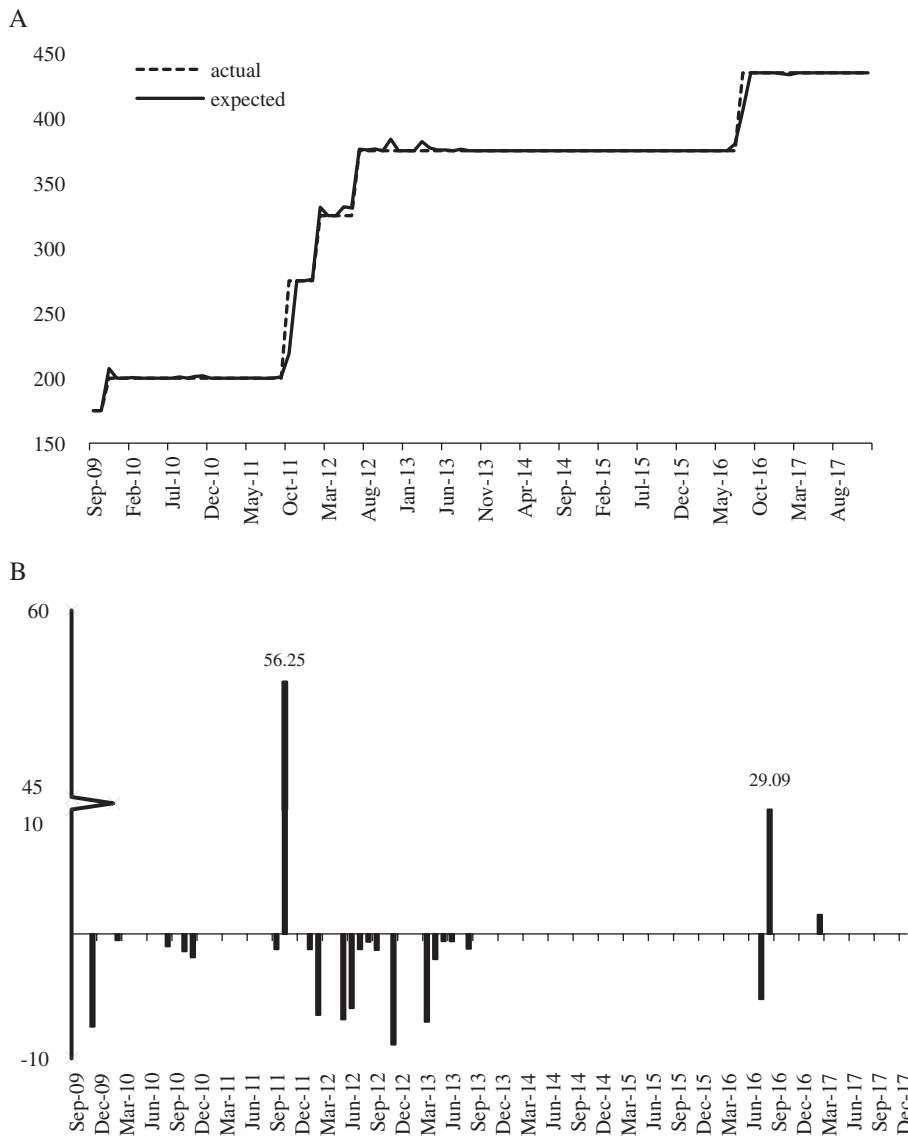
Notes: The dashed line in Panel A of this figure reports the actual size of the Bank's asset purchase program (APP) as announced at each of the 95 MPC meetings (actual), while the solid line depicts the average of the forecasts provided by economists taking part in Bloomberg's survey preceding the MPC meeting (expected). Monetary surprises (S) in Panel B show the difference between the actual minus the expected size of the Bank's asset purchase program.

of the MPC's QE announcement on the 95 announcement days, t. The coefficient estimate β^{MP} captures the equity market's reaction to unexpected asset purchases by the Bank.

We begin our estimations from September 2009, when the Bloomberg survey data become available, and we consider the period until December 2017. We report the M-estimators from the robust regression of Equation (1) in Table 1, showing that the magnitude of equities' reaction to news of the Bank's asset purchases depends on the length of the event window.

TABLE 1
QE Surprises and UK Equity Returns

	(1)	**(2)**	**(3)**	**(4)**
	$r_{t,\,[-10m,\,+60m]}$	$r_{t,\,[-10m,\,close]}$	$r_{t,\,[-10m,\,+60m]}$	$r_{t,\,[-10m,\,close]}$
c	0.001 (−0.02)	0.027 (0.45)	0.007 (0.33)	−0.001 (−0.01)
S_t	−0.004 (−1.10)	0.023*** (2.61)	—	—
$I^1 \times S_t$	—	—	0.032 (1.59)	−0.007 (−0.11)
$I^2 \times S_t$	—	—	0.011 (0.46)	0.183** (2.47)
$I^3 \times S_t$	—	—	−0.058** (−2.46)	−0.080 (−1.08)
$I^{una} \times S_t$	—	—	0.063** (2.26)	0.144* (1.65)
$I^{AP} \times S_t$	—	—	−0.015 (−0.62)	−0.152** (−2.06)
$R^2(\%)$	1.24	3.68	10.04	13.97
Obs.	95	95	71	71

Notes: In columns (1) and (2), we report results from the estimation of Equation (1). Two different event windows for the calculation of stock returns are employed: both start 10 minutes before the MPC announcement and the narrow one ends 1 hour after the announcement ($r_{t,\,[-10m,\,+60m]}$), while the wider one extends up to the closing of the trading day ($r_{t,\,[-10m,\,close]}$). S_t denotes the unexpected element of the MPC's QE announcement, which is calculated as the difference between the actual asset purchases by the Bank and the mean of Bloomberg economists' forecasts about the Bank's asset purchases: $S_t = A_t - E_t$. In columns (1) and (2), we examine 95 MPC announcements starting from September 2009 until December 2017, while in columns (3) and (4) our sample includes 71 MPC announcements until July 2015. In columns (3) and (4) we report the results from Equation (2), where I^1, I^2 and I^3 are 0–1 dummy variables taking the value of 1 on the 24 MPC meetings immediately following the release of an inflation report (I^1), the 24-second MPC meeting days following the release of an inflation report (I^2), and the 23 MPC meetings immediately preceding the release of an inflation report (I^3). I^{UNA} is a 0–1 dummy variable taking the value of 1 on the 43 MPC meeting days directly following releases of MPC meetings' minutes indicating unanimity in the decision of the previous MPC meeting. I^{AP} is a 0–1 dummy variable taking the value of 1 on the four MPC meetings when there is an increase in the size of the program. The *Obs.* row shows the number of observations in each equation.

*Significant at 90%; **significant at 95%; ***significant at 99%.

Specifically, we find that when the event window spans up to the end of the day, the reaction estimate is positive and statistically significant, whereas during the first hour after the announcement, news regarding asset purchases does not influence equity prices. Although the reaction estimate is of small magnitude, it is positive suggesting that negative surprises—asset purchases that are less than expected—lead to lower equity prices. In particular, if the Bank's actual asset purchases are smaller by £1 billion from what Bloomberg-participating economists expected, equities drop by 0.023%.

The difference in equities' reaction to QE news between the narrow and the event window may signify the difficulties investors face incorporating in a timely fashion the news from MPC meetings. A more involved assessment of the effects of MPC announcements over these two event windows, however, would require capturing meeting-specific effects that may be driving the reaction or the lack of it. For instance, the lack of significant reactions, particularly during the first hour of the announcement, may result from systematically opposite responses to QE news originating from different MPC announcements. In the following section, we consider in more detail the possibility of nonlinearities in the impact of monetary policy shocks on equity prices.

B. The MPC's Communication Framework and Its Implications

This section formally examines the role of the MPC's communication framework in the way news of the Bank's asset purchases impacts the UK equity market. To that end, we employ an empirical specification developed by Chortareas and Noikokyris (2014). We partition the MPC meetings in three categories based on their proximity to the inflation report release, and we consider equities' response to news regarding asset purchases on the first, second, and third MPC meetings following the release of the inflation report. We now only consider the period from September 2009 to August 2015, because since August 2015, the Bank has been releasing the minutes of the MPC meetings simultaneously with the meetings' policy announcement and the inflation report (when applicable). We construct 0–1 dummy variables taking the value of 1 on the 24 (24/23) first (second/third) MPC meetings following the release of an inflation report, which we denote as I^1 (I^2/I^3). The third MPC meeting following the inflation report release actually occurs less than a week before the release of the next inflation report.

Furthermore, we investigate the marginal reaction of equities to the Bank's unexpected asset purchases on announcement days directly

following the release of the MPC meetings' minutes revealing a unanimous vote of the MPC members in the previous MPC meeting. Until July 2015, the minutes of the MPC meetings—and MPC members' voting decisions—were not released with the announcement, but instead were released approximately 2 weeks later. Therefore, this release occurred approximately 2 weeks before the next MPC meeting, and we set I^{UNA} to be a 0–1 dummy variable taking the value of 1 on the 43 MPC meeting days immediately following news of unanimity in the previous MPC meeting decision.[3] Finally, I^{AP} is a 0–1 dummy variable taking the value of 1 for the four MPC meetings when the Bank expanded the size of its asset purchases program during that period.[4] We measure the additional impact on these four announcement days to account for the possibility of a differential reaction on days when actual changes in the size of the Bank's QE program are announced.

Thus, we estimate the following regression:

$$(2) \quad r_t = a + \beta_1 I^1 S_t + \beta_2 I^2 S_t + \beta_3 I^3 S_t$$
$$+ \beta_{una} I^{una} S_t + \beta_{AP} I^{AP} S_t + \epsilon_t,$$

and we report the results for stock returns calculated over both the narrow and the wider window in Table 1. We begin by considering the results from the narrow window during the first hour after the announcement. Our results point to meeting-specific effects of unexpected asset purchases on equity prices. During the first hour, the timing of the inflation report and the timing of the news about MPC members' voting appear to be the determinative factors in the relationship between equities and QE surprises.

In particular, we find that on MPC meetings occurring in the week before the release of the inflation report, smaller-than-expected asset purchases lead to higher equity prices (i.e., the reaction estimate to the interactive term $I^3 S_t$ is negative and statistically significant). This result is at odds with what should intuitively be expected. The proximity of the MPC announcement to the inflation report release, however, might explain this result. To the extent that the Bank's MPC announcements reveal MPC members' private views on future economic conditions, smaller-than-expected asset purchases

less than a week before the inflation report might be perceived as revealing private information about better-than-expected news from the forthcoming inflation report release. This result would seem to suggest that these MPC announcements take on the role of a predictor of the inflation report.

Conversely, on MPC meeting days following news of a unanimous decision in the previous committee meeting, we document a pronounced response of stock prices to news regarding asset purchases (the estimated coefficient β_{una} is positive and statistically significant). The sign of the reaction estimate is in line with theoretical predictions and consistent with that observed during the conventional monetary policy period from 1994 to 2008 (Chortareas and Noikokyris 2014). Considering the individualistic nature of the MPC's decision-making process (Blinder and Wyplosz 2005; Ehrmann and Fratzscher 2007), the dissenting votes and the discussions explaining them constitute an integral part of investors' information set. Thus, the absence of opposing views limits the information available to investors regarding future monetary policy. Hence, in the MPC meeting just 2 weeks later, any news about asset purchases weighs heavily in the equities price discovery process during the first hour following the announcement.

When we consider the wider event window, we find that UK equities respond only to news about the Bank's asset purchases originating from the second MPC meeting following the release of an inflation report. In particular, we find that the reaction estimate to the interactive term $I^2 S_t$ in Equation (2) is positive and statistically significant, suggesting that equity prices drop following news about smaller-than-expected asset purchases.[5] Therefore, equities respond in a manner intuitively expected only with regard to MPC announcement news that is unaccompanied by fresh inflation report news or when no inflation report is due in the following week. The absence of any significant response on any other MPC meeting day (both β_1 and β_3 coefficient estimates are statistically insignificant) indicates the dominance of the inflation report over the news content of MPC meetings immediately following

3. From the 43 MPC announcements 13(15/15) correspond to $I^1(I^2/I^3)$ announcements.

4. From the four MPC announcements 0(2/2) correspond to $I^1(I^2/I^3)$ announcements.

5. The only announcement with positive surprises occurs on the second MPC meeting following the release of the inflation report, and it also coincides with one of the four meetings in which a change in the size of the asset purchase program was announced. Thus, the marginal reaction estimate to the interactive term $I^{AP} \times S_t$ captures the reaction of equities to positive surprises.

or preceding these releases. There is also some evidence of more pronounced equities' response to MPC meeting news following the release of minutes indicating a unanimous decision in the previous committee meeting which, however, is only marginally significant at the 10% level.

The way in which the Bank's communication intertwines with the MPC meeting schedule, therefore, appears to influence the manner in which news regarding asset purchases influence equities in both event windows. This influence, however, is not homogeneous for both event windows. During the first hour, equities respond only to QE news from MPC meetings occurring in the week before the inflation report and following news of unanimity in the previous decision. In fact, equities' reaction to QE news from these MPC meetings is to the opposite direction and, hence, our results from Equation (1), which does not account for meeting-specific effects, do not show a statistically significant relationship. Allowing more time for processing the economic news from MPC announcements renders the pattern observed during the first hour an over-reaction, as this reaction dissipates when equity returns are measured over the wider window. Instead, for the wider window we only find statistically significant results, with a sign expected by theory, on MPC meetings occurring further in time from inflation report releases. This impact does not occur during the first hour from an MPC announcement possibly reflecting investors' difficulty in incorporating in a timely fashion the news emanating from the announcements.

C. Preannouncement Drift

In Figure 2, we show that, although statistically insignificant, equities display an upward drift in the hours before announcement. To formally examine whether there is a preannouncement drift in the UK stock market, we investigate whether stock returns are systematically larger during the hours leading up to the MPC announcements using the following empirical specification developed by Lucca and Moench (2015). Specifically, we estimate the following equation:

$$(3) \qquad r_t = a + \beta I_t^{pre-MPC} + \epsilon_t.$$

In this equation, r_t represents the returns on the FTSE-100 index calculated over the period from the beginning of the trading day t at 8:00 a.m. until 11:55 a.m. of the same day $(r_{t, [08:00, 11:55]} = \ln P_{t, 11:55} - \ln P_{t, 08:00})$. $I^{pre-MPC}$ is the preannouncement dummy variable taking a value of 1 if an MPC decision announcement is released at 12:00 p.m. of day t, and zero otherwise. We examine the robustness of our results also by considering stock returns from 12 p.m. on day $t-1$ to 11:55 a.m. on day t $(r_{t, [12:00, 11:55]} = \ln P_{t, 11:55} - \ln P_{t-1, 12:00})$.

We report the results from the estimation of Equation (3) in Table 2, and we find no significant preannouncement effects in the UK stock market. Specifically, we find that the coefficient estimates β from Equation (3) for both preannouncement windows are statistically insignificant (columns (1) and (2) in Table 2), and that they remain so even after we trim the top and bottom 1% stock returns from our sample (columns (3) and (4) in Table 2). We only report a preannouncement drift for the shorter preannouncement window, which, however, is marginally significant at the 10% level. Lucca and Moench (2015) reach a similar result when they investigate the presence of a pre-MPC decision announcement

TABLE 2
PRE-MPC Announcement Returns

	(1)	(2)	(3)	(4)	(5)	(6)
			$r_{t, [08:00, 11:55]}$	$r_{t, [12:00, 11:55]}$		
	$r_{t, [08:00, 11:55]}$	$r_{t, [12:00, 11:55]}$	(excl. Top/bottom 1%)	(excl. Top/Bottom 1%)	$r_{t, [08:00, 11:55]}$	$r_{t, [12:00, 11:55]}$
c	−0.028** (−2.44)	0.012 (0.55)	−0.024** (−2.30)	0.021 (1.12)	0.07 (1.37)	0.123 (1.26)
$I^{pre-MPC}$	0.117* (1.79)	0.104 (0.99)	0.061 (1.28)	0.031 (0.32)	—	—
S_t	—	—	—	—	0.014* (1.86)	0.036** (2.48)
Obs.	2,097	2,097	2,057	2,057	95	95
MPC Ann.	95	95	90	93	95	95

Notes: In columns (1)–(4) we report the results from Equation (3). $I^{pre-MPC}$ is a dummy variable taking the value of 1 on the 95 preannouncement windows which are directly followed by MPC announcements and zero otherwise. In columns (5)–(6) we show the results from Equation (1), but now we use pre-MPC announcement equity returns. S_t is the unexpected element of the MPC's QE announcement. The *Obs.* row shows the number of observations in each equation, and the *MPC Ann.* row shows the number of MPC announcements. Huber-White standard errors for the estimates are reported in the parentheses.

*Significant at 90%; **significant at 95%; ***significant at 99%.

TABLE 3

QE Surprises and Daily Changes in Equity Volatility

	(1) ΔIV	(2) ΔRV	(3) $\beta^{IV} = \beta^{RV}$ [Sign.]	(4) ΔRV^G	(5) ΔRV^C
c	−0.660*** (−3.41)	1.11*** (3.04)	[.00]	−0.093 (−1.22)	0.854** (2.17)
$I^1 \times S_t$	0.130 (0.79)	0.100 (0.32)	[.98]	0.009 (0.14)	0.048 (0.14)
$I^2 \times S_t$	−0.149 (−0.73)	0.776** (2.02)	[.02]	−0.045 (−0.56)	0.757** (1.98)
$I^3 \times S_t$	0.028 (0.13)	0.444 (1.15)	[.35]	0.006 (0.08)	0.450 (1.08)
$I^{una} \times S_t$	−0.169 (−0.70)	−0.233 (−0.51)	[.95]	−0.008 (−0.08)	−0.325 (−0.66)
$I^{AP} \times S_t$	0.093 (0.46)	−0.732** (−1.99)	[.03]	−0.013 (−0.17)	−0.738* (−1.91)
R^2 (%)	7.53	7.69	—	8.29	6.28
Obs.	71	71	—	71	71

Notes: This table displays the results from the M-estimation of Equation (4). ΔIV is the daily change in IV taken by the FTSE-100 IV index. ΔRV denotes the daily change in realized volatility taken from the Oxford-Man Institute's "realized library" (Gerd et al. 2009). Column (3) reports the p value of an equality test of the estimates from regressions in columns (1) and (2). ΔRV^G and ΔRV^C stand for the daily change of the stock market's realized volatility obtained from Equations (5) and (6) from the main body of the text respectively. The *Obs*. row shows the number of observations in each equation.

*Significant at 90%; **significant at 95%; ***significant at 99%.

drift in UK stock returns for the period up to 2011.[6]

Next, we evaluate the extent to which the preannouncement drift is associated with news about the Bank's asset purchases. To that end, we regress pre-MPC equity returns on news regarding asset purchases on the 95 MPC meeting days. We report the results from this estimation in columns (5) and (6) of Table 2, and we find lower pre-MPC returns when smaller-than-expected asset purchases are announced at the MPC meeting. This result holds only for pre-MPC returns calculated over the wider window from 12 p.m. on day $t − 1$ to 11:55 a.m. on day t. When we use equity returns from the shorter preannouncement window including data only from the MPC meeting day, we also report a positive reaction estimate, but it is less pronounced and statistically significant only at the 10% level.

This result is surprising, according to Lucca and Moench (2015), because it shows ex ante equity returns being sensitive to QE news that is known only ex post to investors. Moreover, it might partly account for the weak response (in absolute terms) of equities to QE news, as it suggests that part of the impact of QE news is not captured by the event window employed in our empirical setup. A more involved examination of the determinants of pre-MPC returns would seek to identify the impact of other relevant news arriving during the pre-MPC announcement

period. In this manner, we would be in a position to assess whether the positive association between QE news and pre-MPC equity returns is due to news leaks or other reasons, but such an assessment would extend beyond the scope of this paper.

III. MPC ANNOUNCEMENTS AND STOCK MARKET VOLATILITY

A. Daily Implied and Realized Volatility Response to Bank Announcements

We use the event-study framework from the previous section, and we estimate the UK equity returns' volatility response—both historical and implied—to news about the Bank's asset purchases. We use the FTSE-100 IV index as a measure of *IV*. This index measures the interpolated 30-day expected volatility and is calculated using the prices of out-of-the-money traded options. We obtain data for the realized volatility of the FTSE-100 index (*RV*) from the Oxford-Man Institute's "realized library" (Gerd et al. 2009). This measure for realized variance is daily in frequency and is produced using high frequency data from that day only. Thus, we estimate:

$$(4) \quad \Delta V_t = a + \beta_1 I^1 S_t + \beta_2 I^2 S_t + \beta_3 I^3 S_t + \beta_{una} I^{una} S_t + \beta_{AP} I^{AP} S_t + \epsilon_t,$$

where ΔV_t represents the first difference of either implied (ΔIV_t) or realized volatility (ΔRV_t).

In column (1) of Table 3, we report the *M*-estimators for Equation (4) when the dependent variable represents changes in IV. We find

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6. Lucca and Moench (2015) indicate that they do not find significant preannouncement effects of the Bank's announcements, although they do not report this result in their paper.

that news regarding asset purchases from MPC announcements does not influence the level of expected volatility in the UK stock market (all five reaction estimates to the interactive terms are insignificant). This result differs from the findings of Gospodinov and Jamali (2012), who find that tightening monetary policy shocks lead to positive changes in IV in the United States over the 1994–2007 period.

We find, however, that the occurrence of the announcement itself leads to lower levels of expected volatility over the next 30 days (the intercept is negative and statistically significant). Gospodinov and Jamali (2012) reach a similar result, which suggests that the mere occurrence of an MPC announcement leads to more synchronized expectations about future monetary policy. Ehrmann and Sondermann (2012) also find that certain macroeconomic announcements enhance the precision of expectations lowering the level of UK interest rates' conditional volatility, after controlling for the actual news contained in these announcements.

We also estimate Equation (4) for realized volatility, and in contrast to the results for IV, we find a statistically significant positive intercept, which indicates significant positive changes in realized volatility on MPC meeting days (column (2) of Table 3). To test the differences in the response of implied and realized volatility to news regarding asset purchases, we employ a system of seemingly unrelated regressions similar to that developed by Gospodinov and Jamali (2012). The difference between the intercept estimates from these two regressions is statistically significant, as we show in column (3) of Table 3. The positive and statistically significant intercept in the realized volatility equation is consistent with Chuliá, Martens, and Dijk (2010), who find that the occurrence of adverse news from FOMC announcements not only leads to positive changes in intraday realized volatility but also is more important than the news itself. This finding also holds for the Bank's announcements during the QE period under examination.

Moreover, we find that news of smaller-than-expected asset purchases on the second MPC meeting days following an inflation report release helps investors coordinate their beliefs, as it leads to lower levels of realized volatility (the coefficient estimate β_2 is positive and statistically significant). This result holds unless an increase in the size of the Bank's asset purchase program is announced on that particular MPC decision day. In this case, the negative and

statistically significant marginal reaction estimate β_{AP} completely offsets the positive reaction estimate β_2.

We also use two alternative proxies for realized volatility to assess the robustness of this result. The first is the forward-looking measure for the (annualized) realized variance of Gospodinov, Gavala, and Jiang (2006), which is also used in Gospodinov and Jamali (2012). Based on this specification, the stock market's realized volatility on day t (RV^G) is constructed as follows using the 22-day-ahead squared stock returns:

$$(5) \qquad RV_t^G = \sqrt{\frac{1}{22} \sum_{i=t+1}^{22} r_i^2 \times \sqrt{252}},$$

where $r_i = \ln P_{t,c} - \ln P_{t-1,c}$. The second measure for realized volatility is that constructed in the spirit of Chuliá, Martens, and Dijk (2010) as follows:

$$(6) \qquad RV_t^C = \sqrt{\sum_k^u \left(r_{t,k} \right)^2 \times \sqrt{252}}.$$

$r_{t,k} = \ln P_{t,k} - \ln P_{t,k-5m}$ now stands for the 5-minute returns on the FTSE-100 index on day t.[7] u corresponds to the number of all 5-minute intervals on trading day t. The first 5-minute interval following the MPC announcement is excluded from the calculation of the realized volatility on MPC announcement days.

We report the results from the estimation of Equation (4) for both dependent variables ΔRV^G and ΔRV^C in columns (4) and (5) of Table 3, respectively. Our results suggest that the realized volatility, when calculated from Equation (5) using 22-day-ahead daily returns, does not respond to QE surprises, as all the reaction estimates are statistically insignificant. However, when the realized volatility of stock returns on MPC announcement days is calculated from Equation (6), using intraday data from that day only, our results are similar to those obtained when the data for realized volatility of Gerd et al. (2009) are used. The absence of a significant response when the volatility measure is constructed by excluding data from the MPC announcement day suggests that the impact of the MPC announcement is short-lived and traced only on the announcement day.

Therefore, QE news from the second MPC announcement following the inflation report

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7. $k - (k - 5\,\mathrm{m})$ is the 5-minute interval, that is, if $k = 3$:35 p.m. then $k - 5\,\mathrm{m} = 3$:30 p.m.

releases takes on the dual role that is ascribed to public information by Morris and Shin (2002). First, these announcements contain fundamental information. As we have shown in the previous section, equity prices respond to news emanating from them in a theoretically sound manner. Second, these announcements constitute a focal point helping investors coordinate their beliefs, as news about smaller-than-expected asset purchases results in lower realized volatility. A possible reason why news from these announcements carries significant weight for investors might be that they occur further away in time from inflation report releases than the other MPC announcements. This announcement follows the previous inflation report release by almost 2 months, whereas the next is more than a month ahead.

B. Intraday Volatility and the Bank's Announcements

Finally, in this section, we measure the impact of the Bank's MPC announcements on intraday measures of the UK equity returns volatility using the regression from Equation (4). We use two measures of intraday volatility to gauge the impact of MPC announcements on UK equity returns' volatility in the hour bracketing the announcement. The first measure is obtained from Equation (6) but instead of calculating the daily realized volatility, we now calculate equities' realized volatility for the period beginning 10 minutes before the announcement up to 1 hour following the announcement.

The second measure is the change in volatility ratios ($\Delta VOLR$) for equity returns used by Andersson (2010). We define a volatility ratio as the ratio of the volatility of intraday returns on MPC decision dates t to the average volatility on all other 236 Thursdays τ, excluding MPC announcements, for the same time frame. This specification defines the volatility of equity returns as the absolute value of the log price change. That is, on a day i the volatility of equity returns from 12 p.m. to 1 p.m. is given by $abs[r_{i,[0,+1h]}] = abs[\ln(P_{i,13:00}) - (P_{i,12:00})]$, while for the period from 11:30 a.m. to 12 p.m. it is $abs[r_{i,[-30m,0]}] = abs[\ln(P_{i,12:00}) - (P_{i,11:30})]$. So, if $t = 1, 2, \ldots, 71$ corresponds to the days of monetary policy decisions, and $\tau = 1, 2, \ldots, 236$ stands for the same weekdays but when no MPC announcement has taken place, then the change

in volatility ratio is given as follows:

(7)

$$\Delta VOLR_{t,[-30m,+1h]} = \frac{abs\left[r_{t,[0,+1h]}\right]}{\frac{1}{\tau}\sum_{\tau=1}^{236} abs\left[r_{\tau,[0,+1h]}\right]} - \frac{abs\left[r_{t,[-30m,0]}\right]}{\frac{1}{\tau}\sum_{\tau=1}^{236} abs\left[r_{\tau,[-30m,0]}\right]}.$$

We now regress these two intraday measures of the volatility of UK equity returns on the same independent variables as in Equation (4), except that we now use the absolute value of the surprise ($abs[S_t]$). Results from the M estimation of these regressions are reported in Table 4. Again, we find statistically significant results only for those MPC meetings directly preceding the publication of an inflation report and following news of unanimity in the previous MPC decision. Our results show that news about asset purchases increases equity returns' volatility for the MPC meetings preceding the inflation report release by a week (the reaction estimate to the interactive term $I^3 \times abs[S_t]$ is positive and statistically significant). Considering that these MPC meetings might be perceived as bearing news about the forthcoming inflation report, this speculation appears to increase volatility, as investors adjust their portfolios to reflect the expected news.

TABLE 4
QE Surprises and Intraday Volatility

	(1) ΔRV^C	(2) $\Delta VOLR$
c	2.86*** (17.81)	−0.159 (−1.55)
$I^1 \times abs[S_t]$	0.100 (0.73)	0.076 (0.88)
$I^2 \times abs[S_t]$	0.063 (0.37)	0.154 (1.43)
$I^3 \times abs[S_t]$	0.408** (2.40)	0.346*** (3.19)
$I^{una} \times abs[S_t]$	−0.453** (−2.26)	−0.250** (−1.96)
$I^{AP} \times abs[S_t]$	0.105 (0.62)	−0.084 (−0.78)
R^2 (%)	11.59	15.24
Obs.	71	71

Notes: The results from the M-estimation of Equation (4). ΔRV^C is the realized volatility of equities from 10 minutes before the announcement until 1 hour after the announcement calculated from Equation (6). $\Delta VOLR$ is the volatility ratio, calculated by Equation (7), showing the difference between the volatility ratio for FTSE-100 index returns for the hour following the MPC announcement and the volatility ratio for the 30 minutes before it. $abs[S_t]$ is the absolute value of the unexpected element of MPC announcements. The *Obs.* row shows the number of observations in each equation.

*Significant at 90%; **significant at 95%; ***significant at 99%.

In addition, we report a negative marginal reaction of equities to QE news from the MPC announcements that follows the publication of minutes revealing unanimity in the previous MPC decision (the reaction estimate to the interactive term $I^{una} \times abs[S_t]$ is negative and statistically significant). This result shows that QE news from these MPC meeting days leads to lower volatility. This news possibly enhances the coordination of expectations in the stock market, as investors replace private views on future monetary policy with the public information from the MPC meeting (Morris and Shin 2002). The relatively reduced information set of investors arising from the absence of dissenting votes makes them underweight private information and place more emphasis on the public information from the MPC meeting.

IV. CONCLUDING REMARKS

This paper considers the effects of the UK's QE program on equity prices and on their volatility. We use an event-study framework and intraday data to characterize UK equity prices' reactions to the Bank's QE announcements. The key contributions of the paper include identifying the relatively unexplored effects of unconventional monetary policy on stock price volatility, and the association of the magnitude of the pass-through of QE news into UK equities with the MPC communication framework. To capture the latter effect, we focus on two key aspects of the MPC's communication framework, that is, the publication of inflation reports and the voting records of the MPC members.

Our results point to a statistically significant relationship between QE surprises and equity returns on the days of MPC meeting announcements, which is nonetheless of small magnitude. Although our evidence reiterates prior findings regarding the statistically significant impact of QE announcements on intraday UK equity prices (e.g., Rogers, Scotti, and Wright 2014), we also estimate the time dimension of this impact. Particularly, we find that news from MPC announcements affects equity returns only when the latter are measured over a period starting 10 minutes before the announcement and finishing at the end of the trading day. Moreover, we find a significant relationship between QE surprises and preannouncement returns, which might partly account for the less pronounced impact of QE announcements on equities.

TABLE 5
Summary of Equities' Reaction

	Panel A		Panel B	
	Narrow Window [−10 m, +60 m]		**Wide Window [−10 m, close]**	
	Returns	**Realized Volatility**	**Returns**	**Realized Volatility**
I^1	None	None	None	None
I^2	None	None	Positive	Positive
I^3	Negative	Positive	None	None
I^{una}	Positive	Negative	None	None
I^{AP}	None	None	Negative	Negative

Notes: In the column Returns in Panels A and B of this table, we report the sign ("positive"/"negative") of the reaction estimates from Equation (2) when equity returns are measured both over the narrow and the wider event windows described in the main body of the text, respectively. In the column *Realized Volatility* of Panel A, we report the sign of the reactions of the two measures of intraday volatility, obtained from Equations (6) and (7) as described in the main body of the text, to QE news from MPC announcements presented in Table 4. In the column *Realized Volatility* of Panel B, we report the sign of the reaction estimates from Equation (4) where daily realized volatility is measured using intraday data from the MPC announcement day (measures are obtained either by Oxford-Man Institute's realized library or from Equation (6)). "None" suggests that there is no statistically significant relationship.

Additionally, we provide a comprehensive analysis of the role of the Bank's communication policy in the magnitude of the impact of QE announcements on equity returns and their volatility. Specifically, we explore the extent to which equity markets' reactions to QE news from MPC meetings depend on the meeting's proximity to an inflation report release and to information about unanimity in the previous MPC meeting. In Table 5 we provide a summary of the results from our estimations for both the narrow and the wider windows for comparison reasons.

During the first hour following the MPC meeting announcements, equities react significantly and in a manner intuitively expected only in connection with those MPC meeting announcements following news about a unanimous decision in the previous MPC meeting. QE news from these MPC meeting announcements also appears to reduce stock price volatility. When we consider the impact of QE news from MPC meeting announcements preceding the inflation report release by a week, however, the results reveal a different pattern. This QE news appears to increase volatility in the equity markets during the hour following the announcement, and the reaction by the equity market is perplexing. Smaller-than-expected asset purchases are now

perceived as positive news, leading to slightly higher equity prices, as perhaps they are perceived to be predictors of the news included in the forthcoming inflation report.

Although equities are sensitive to news from MPC meetings attracting media attention (e.g., unanimous decisions and imminent inflation report releases) during the first hour following an announcement, when we consider a wider window a different picture emerges (see Panel B in Table 5). Equity returns and their volatility appear to respond significantly, both in magnitude and statistically, only to QE surprises emanating from the second MPC meetings following release of an inflation report. These MPC meetings occur almost 2 months after the previous inflation report release and at least a month from the new inflation report, reinforcing the view that the inflation report is the dominant channel of the Bank's information dissemination process.

The results of this study have policy implications, as they allow a preliminary evaluation of the changes in the MPC meeting schedule that were effective beginning in August 2015. Under the new schedule, the policy decisions of MPC meetings and their minutes are released simultaneously. The inflation reports are also released on the same day with the MPC policy decision. Moreover, the second MPC meetings following the release of the inflation report have been discontinued. In particular, the Bank dropped the four meetings taking place further in time from the release of an inflation report release, which is when our results indicate the highest sensitivity of equities to QE news. Finally, the fact that the MPC meetings, their minutes, and the inflation reports are all published simultaneously reduces the possibility for overreactions similar to those that we have identified in this study for the 2009–2015 period.

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