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**The Financial Market Impact of Unconventional Monetary Policies in the  
U.S., the U.K., the Eurozone, and Japan**

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The views expressed in this paper are those of the authors and not those of the Ministry of Finance or the Policy Research Institute.

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# The Financial Market Impact of Unconventional Monetary Policies in the U.S., the U.K., the Eurozone, and Japan<sup>1</sup>

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## Abstract

This paper investigates the impact of the unconventional policies implemented by the Federal Reserve, the Bank of England, the European Central Bank, and the Bank of Japan on the returns on a broad class of assets in a comprehensive and consistent manner.

Controlling for market expectations, we find that for most economies and periods, policies had the effect of lowering long-term government bond yields and the exchange rate of the home currency; for some economies and periods we also find an impact on corporate bond spreads, interbank loan spreads, and stock prices. We further find that policy announcements that were accompanied by forward guidance tended to have a more significant and greater impact on a broad range of assets than policy announcements without forward guidance.

**Key Words:** Unconventional monetary policies; Event study; Announcement.

**JEL Classification Numbers:** E58, G12, F31.

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# The Financial Market Impact of Unconventional Monetary Policies in the U.S., the U.K., the Eurozone, and Japan

## 1. Introduction

In response to the global financial crisis and subsequent recession, the Federal Reserve (FRB), the Bank of England (BOE), the European Central Bank (ECB), and the Bank of Japan (BOJ), in addition to conventional measures such as lowering target interest rates, implemented a range of unconventional monetary policies that include the expansion of the scope and scale of asset purchases as well as future policy commitments. Moreover, the BOJ had already pursued a policy of quantitative easing prior to the global financial crisis by setting a target level for current accounts at the Bank with the aim of overcoming deflation.

These policies have become the subject of a burgeoning literature examining the impact of such asset purchases and explicit policy commitments on asset prices and economic activity. This literature can be broadly divided into two strands: theoretical and empirical. As for the first strand, recent theoretical studies on optimal monetary policy close to the zero lower bound predict that unconventional policies affect asset returns and thereby the real economy either through the central bank's commitment to future low interest rates or through portfolio rebalancing by private agents. The commitment channel works if unconventional monetary policies affect economic actors' expectations regarding the future path of monetary policy (see, e.g., Krugman, 1998; Eggertsson and Woodford, 2003; Jung et al., 2005; Jeane and Svensson, 2007). More specifically, an increase in the monetary base today can have the effect of lowering interest rates in the future when the economy escapes from the liquidity trap and interest rates move away from the zero lower bound as long as no contraction of the monetary base in the future is expected, that is, if the central bank can commit itself to future monetary easing. Meanwhile, the portfolio rebalancing channel works if investors prefer assets with some specific maturity or risk (the preferred-habitat hypothesis) (see, e.g., Andrés et al., 2004; Bernanke and Reinhart, 2004, Vayanos and Vila, 2009). When the central bank purchases risky assets held by private sector agents, this reduces the amount of risk held by such agents, which may in turn purchase other risky or long-term assets, resulting in a decrease in the returns on these assets. Another area of focus in the theoretical literature is the role of financial frictions and the role that central banks can play during a financial crisis as financial intermediaries by purchasing risky assets in order to support economic activity (see, e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Gertler et al., 2012; Curdia and Woodford, 2011; Chang, and Velasco, 2012; Christiano and Ikeda, 2013). Finally, large-scale asset purchases may also strengthen bank net worth and increase banks' leverage, thus resulting in a rise in asset returns (Céspedes et al., 2012).

Accompanying the growing theoretical literature on the effects of unconventional policies on asset returns and economic activity is a growing body of empirical research. This includes studies on the effects of FRB announcements concerning asset purchases on asset returns by Hancock and Passmore (2011), Krishnamurthy and Vissing-Jorgensen (2011), Gagnon et al., (2011), Bauer and Rudebusch (2012), Neely (2012), Stroebel and Taylor (2012), Rosa (2012), and D'Amico and King (2013), as well as studies by Joyce et al. (2011) on the effect of announcements by the BOE regarding quantitative easing on asset returns and by Glick and Leduc (2012) on the effects of announcements by both the FRB and the BOE on asset returns. For the Eurozone, Kilponen et al. (2012) analyze the effects of ECB announcements on sovereign bond spreads, and for Japan, Baba et al. (2006) examine the effects of the zero interest rate policy implemented from 1999 and the subsequent quantitative easing policy implemented from 2001 on bank risk premiums in the money market, while Ueda (2012, 2013) examines the effects of the BOJ's quantitative easing and subsequent policies, including the quantitative and qualitative easing (QQE) implemented since April 2013, on the Tokyo Stock Price Index (TOPIX), 10-year Japanese government bond (JGB) yields, and the yen-dollar exchange rate. Finally, studies that, like the present one, examine the impact on asset prices of unconventional monetary policies in the U.S., the U.K., the Euro area, and Japan are those by Ait-Sahalia et al. (2012) and Rogers et al. (2014). The former examines the impact of policy announcements regarding monetary policy, liquidity support, fiscal easing, financial restructuring, and ad hoc bank bailouts and failures, on interbank credit and liquidity risk premiums, while the latter examines the effect of monetary policy announcements on bond yields, stock prices, and exchange rates. Most of these studies find that policy announcements have a negative effect on long-term interest rates on government bonds, mortgage rates, and the exchange rate of the home currency, although the statistical and economic significance differs across studies.<sup>4</sup>

While most of these empirical studies employ an event study approach using daily or intraday high-frequency data,<sup>5</sup> only a small number of them control for market expectations with regard to policy announcements, with notable exceptions being the studies by Joyce et al. (2011), Rosa (2012), Glick and Leduc (2012), and Rogers et al. (2014). In the context of conventional monetary policy, it is well known that empirical analysis without controlling for market expectations may underestimate the quantitative impact of policies (see, e.g., Cochrane

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<sup>4</sup> While most of the studies find statistically and economically significant impacts, some do not. Stroebel and Taylor (2012), for example, estimate the impact of the FRB's mortgage-backed securities purchase program and do not find statistically significant or only quantitatively small effects of the program once prepayments and default risks are controlled for.

<sup>5</sup> An example of studies that employ a different approach is that by Hamilton and Wu (2012), who use a model of risk-averse arbitrageurs to examine the effects of the maturity structure of publicly held debt on the term structure of interest rates.

and Piazzesi, 2002). This means that, as suggested by Rosa (2012) and Glick and Leduc (2012), it is likely that the impact of unconventional policies will also be underestimated unless market expectations are controlled for. Thus, in order to control for market expectations, Joyce et al. (2011) use survey information to measure the expected amount of BOE asset purchases under quantitative easing (QE) in their analysis, while Wright (2012), Glick and Leduc (2012), and Rogers et al. (2014) use changes in the yields on government bond futures to gauge the surprise component of unconventional policies. Another shortcoming of the literature is that, in our view, there are still too few studies that examine the impact of the policies pursued by the BOJ, despite the fact that these potentially provide a great opportunity to understand what type of unconventional policies have a significant impact on asset returns, given that the BOJ has pursued a variety of unconventional policies – such as purchases of risky assets, large-scale asset purchases, and forward guidance – since the early 2000s. Moreover, there are also surprisingly few studies on the FRB’s credit easing policy, which it implemented as a response to the credit crisis from December 2007, even though it provides a good opportunity to examine the role of central bank policy during a financial crisis (e.g., Gertler and Karadi, 2011).

The present study contributes to the literature in a number of ways. The first is that we expand the scope of analysis. Specifically, we analyze the effects of unconventional monetary policies adopted by the four major central banks, i.e., the BOJ, the FRB, the ECB, and the BOE in the wake of the global financial crisis, as well as the BOJ’s quantitative easing adopted in 2001 when Japan’s banking sector was unstable. Moreover, we cover all types of unconventional policy, not just large-scale asset purchases as is the case in many previous studies. The range of asset classes and returns covered in our analysis is also broad, including long-term and short-term interest rates on government bonds, corporate bond yields, short-term interbank loan rates, stock price indices for all sectors, stock price indices for the banking sector, and exchange rates. The second way in which our study contributes to the literature is that we estimate the impact of unconventional policies with and without controlling for market expectations. Specifically, we control for market expectations by extracting the expected component from government bond futures prices and identifying the surprise component of policy announcements as the change in government bond futures prices around policy announcements. Finally, the third contribution is that we classify the FRB’s and the BOJ’s policies into those that explicitly state the conditions under which the current policy would continue (“forward guidance”) and those without forward guidance and examine the difference in the effects of these two types of announcements.

We employ a standard event study approach using daily data to analyze the change in interest rates, stock price indices, and exchange rates from the day before the announcement to the day of the announcement (and the three days after the announcement). Daily data enable us

to identify monetary policy shocks, given that monetary policy is unlikely to be determined in response to changes in asset returns on the same day, so that the likelihood that our results are contaminated by reverse causality running from asset returns to changes in monetary policy is minimal.

Controlling for market expectations, we find that for most economies and periods, policies had the effect of lowering long-term government bond yields and the exchange rate of the home currency; for some economies and periods we also find an impact on corporate bond spreads, interbank loan spreads, and stock prices. A notable exception to the impact on exchange rates is the FRB's credit easing policy, which caused the U.S. dollar to significantly appreciate, possibly reflecting the policy's contribution to restoring confidence in U.S. financial assets that had been lost in the financial market turmoil. In fact, the credit easing policy decreased U.S. corporate bond spreads. Another set of policies that do not fit the general pattern is the BOJ's comprehensive monetary easing (CE) and QQE policies, which had a substantial prolonged effect on stock prices. We further find that policy announcements that were accompanied by forward guidance tended to have a more significant and greater impact on a broad range of assets than those without forward guidance.

The remainder of the paper is organized as follows. Section 2 provides a description of our dataset and methodology, while Section 3 reports the estimation results. Section 4 concludes.

## **2. Methodology and Data**

### *2.1 Unconventional monetary policies*

To examine the effects of unconventional monetary policies on asset returns, we begin by identifying unconventional policies. Following International Monetary Fund (2013), we broadly define unconventional policies as policies that a central bank adopts beyond the conventional short-term interest rate targeting either to restore the functioning of financial markets and intermediation or to provide further monetary policy accommodation at the zero interest rate bound. Both the nature and content of unconventional policies differ across central banks and periods, ranging from setting a target for the quantity of current account balances at the central bank to various asset purchase programs and liquidity provision programs. In some cases, the central bank explicitly announced the conditions under which it would continue with such policies. Bank of Japan (2009) classifies unconventional monetary policies into the following six categories: (1) announcements on future policies; (2) the enhancement of liquidity provision; (3) the expansion of the central bank's balance sheet; (4) increases in reserves; (5) the expansion of the class of assets purchased; and (6) liquidity support to individual financial institutions. Below, we provide a brief sketch of the policies actually taken by the major central banks.

The BOJ set targets for current account balances at the Bank during its QE policy (March 2001 to March 2006). Further, in the wake of the global financial crisis, the BOJ first adopted unconventional measures such as expanding the corporate debt it accepted as collateral and then announced its CE in October 2010 consisting of (1) lowering the policy interest rate to around 0 to 0.1%, (2) clarifying the time horizon of the virtually zero interest rate policy on the basis of the “understanding of medium- to long-term price stability,” and (3) establishing the Asset Purchase Program. In addition, on April 4, 2013, the BOJ announced a new policy package, QQE, under which it would double the monetary base as well as the amount of JGBs and exchange-traded funds on its balance sheet in two years, and more than double the average remaining maturity of JGB purchases.

The FRB, starting in December 2007, launched various credit and liquidity programs under its “credit easing policy” in response to the credit crisis, including the provision of loans accepting high-grade securities as collateral and of loans to financial institutions other than depository institutions, purchases of commercial paper, and auctions of collateralized loans with terms of 28 to 84 days to depository institutions (the Term Auction Facility). Subsequently, the FRB implemented a series of purchases of longer-term securities – including Treasuries, GSE debt, and Agency MBSs – commonly referred to as QE 1, which lasted from November 2008 to March 2010, QE2 (from August 2010 to June 2011), and QE3 (from September 2012).

Meanwhile, the ECB launched a series of “enhanced credit support” measures including longer-term refinancing operations (LTROs), special term refinancing operations (STRO), the expansion of the range of assets eligible as collateral, and the purchase of covered bonds. It also announced the Securities Markets Program in May 2010. Moreover, in September 2012, in order to tackle the sovereign debt crisis in the Eurozone, the ECB announced the introduction of Outright Monetary Transactions (OMT) to purchase bonds issued by Eurozone member states.

Finally, the BOE also introduced QE in March 2009, launching a large-scale asset purchase program.

## *2.2 Events*

We adopt an event study approach by identifying monetary policy announcements as events. To obtain unbiased and efficient estimates of the effects of unconventional policy measures on asset returns, we need to carefully choose the events. Although we basically rely on central bank announcements and events identified in preceding event studies on unconventional monetary policies, we exclude the agreement of swap lines between the FRB and the other central banks because the use of swap lines is likely to inject dollars in the foreign exchange market and have different effects on exchange rates from the other unconventional policy measures. We also exclude central bank announcements that were released on the same day

when governments intervened in foreign exchange markets, as far as information on intervention days is available. Table 1 provides a list of unconventional policy events that we use for each central bank. The remainder of this subsection provides a detailed description of these policy events.

First, for the BOJ, we basically use the policy announcements identified by Ueda (2012) for the period from April 1999 to March 2010. While we use most of the announcements selected by Ueda (2012), we add two announcements and drop three in this period.<sup>6</sup> Specifically, the policy announcements we add are that on the increase in the target of current account balances at the BOJ (September 18, 2001) and that on operations to facilitate corporate financing (February 19, 2009), while we drop the announcement on the currency swap agreement (September 18, 2008), that on the exit from quantitative easing (March 9, 2006), and that on the clarification of the BOJ's understanding of price stability (December 18, 2009). We further add 15 announcements made between May 2010 and April 2013.<sup>7</sup> Thus, overall we pick 13 events before the global financial crisis and 22 after the eruption of the global crisis, consisting of the BOJ's announcements on (1) the target of current account balances at the BOJ, (2) new asset purchase or loan programs, (3) increases in the amount of Japanese government bonds (JGBs) and other assets to be purchased, and (4) the expansion of the range of assets eligible for collateral in operations. We divide policies in the wake of the crisis into those before the introduction of CE in October 2010 and those after the introduction of CE, including QQE. Finally, we exclude May 20, 2003, October 10, 2003 and August 4, 2011 from the policy dates because on these days the Ministry of Finance intervened in the foreign exchange markets. Note that in the empirical analysis in Section 3, we use two alternative specifications for the period since the introduction of CE: one including the policy announcement on Monday, March 14, 2011 and the other excluding it, because that announcement was released just after the Tohoku Earthquake and the Fukushima Daiichi nuclear disaster, which occurred on Friday, March 11, 2011 and significantly affected financial markets at the beginning of the following week.<sup>8</sup>

Second, for the FRB, we first pick six events regarding its credit easing policies before QE1 by referring to Federal Open Market Committee (FOMC) statements. Next, for QE1 and QE2, we follow Krishnamurthy et al. (2011) and identify five and four events, respectively,

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<sup>6</sup> In addition, we change the date of the announcement on growth promoting measures from May 17, 2010 to May 21, 2010 based on information from the BOJ's web site.

<sup>7</sup> Ueda (2013) extends the period analyzed in Ueda (2012) to April 2013. However, Ueda (2013) does not include in his analysis of monthly data the six announcements from June 2011 to December 2012 that we include for this period. On the other hand, Ueda (2013) includes two political events in his analysis of daily data that we do not include, namely, the dissolution of the Upper House on November 16, 2012, and the Liberal Democratic Party's victory on December 16, 2012.

<sup>8</sup> The earthquake occurred at 2:46 pm, just before the closure of the Tokyo Stock Exchange (3:00 pm), meaning that the impact of the earthquake on financial markets was largely felt on the next business day, March 14.



consisting of suggestions of possible future purchases and firm statements of planned purchases.<sup>9</sup> Analyzing intraday movements in Treasury yields and trading volumes for each of the QE1 and QE2 events, Krishnamurthy et al. (2011) show that these events triggered significant movements in Treasury yields and trading volume and that the announcements generally appear to be the main piece of news coming out on the event days. Finally, for QE3, we use two events in which the FOMC announced that the FRB would purchase MBSs (September 13, 2012) and Treasury bonds (December 12, 2012).

Third, for the ECB, we refer to Kilponen et al., (2012), who classify the ECB's policy decisions from March 2007 to December 2011 into (1) 12 decisions on interest rates, (2) 18 decisions on liquidity support, (3) two decisions on covered bond purchase programs, and (4) one decision on the Securities Markets Program. We drop some of their events and add some events as follows. First, we omit all of the interest rate decisions because they represent conventional monetary policy. Second, among the liquidity support decisions, we choose the following five events: the introduction of LTROs with a maturity of three months for an amount of 40 billion euros (August 22, 2007), the expansion of the maturity of LTROs to six months (March 28, 2008), one year (May 7, 2009), and three years (December 8, 2011), and the introduction of the STRO (September 29, 2008). Third, among the covered bond purchase programs, we choose one (October 6, 2011). Fourth, as for the Securities Markets Program, we choose the same event (May 10, 2010) as Kilponen et al. (2012). Finally, we add the following two events: the expansion of the list of assets eligible as collateral for operations (October 15, 2008) and the introduction of OMT (September 6, 2012).

Finally, for the BOE, we choose six events consisting of indications or firm statements of asset purchases in 2009–10 following Joyce et al. (2011), and add three policy announcements on increases in the amount of asset purchases after 2010 (October 6, 2011, and February 9 and July 5, 2012).

### *2.3 Data*

We analyze the responses of the returns on various financial assets such as long-term and short-term government bonds, corporate bonds, short-term interbank loans, and stock price indexes, as well as of the exchange rates of the Japanese yen (JPY), the U.S. dollar (USD), pound sterling (GBP), and the euro (EUR). We also examine the responses of the Korean won (KRW) to the BOJ's policies and the Brazilian real (BRL) to the FRB's policies.

The start date of our observation period for all financial assets depends on the economy in

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<sup>9</sup> Krishnamurthy et al. (2011) use five events that represent the start or an increase of asset purchases for QE1, while Gagnon et al. (2011) and Neely (2012) use an additional three events that represent slower or reduced asset purchases as well as the five buy events. Neely (2012) shows that the three events involving slower or reduced asset purchases did not have a strong or consistent effect on U.S. bond yields.

question, while the end date is April 30, 2013 for all economies. Specifically, for Japan, given that the BOJ started its QE policy in March 2001, we choose January 1, 2001 as the start date for observations on financial assets with the exception of the KRW/JPY rate, for which data are available only from November 24, 2003, so that we set that day as the start date for observations on the KRW/JPY rate. For all other economies, we set January 1, 2007 as the start date.

The data source for asset returns is Bloomberg. Bloomberg compiles daily data at the closing time of the market in each economy except for the London Interbank Offered Rates (LIBORs) and the exchange rates. As for the LIBOR rates, Bloomberg records the data by midday London time (Greenwich Mean Time, GMT). As for the exchange rates, Bloomberg records data at 17:00 U.S. Eastern Standard Time (EST) and at 20:00 Japan Standard Time (JST), the latter of which corresponds to either 6:00 or 7:00 EST. We combine these data to minimize the interval used to measure changes in asset returns.

Specifically, for government bond yields and corporate bond yields, we use the change from the closing time on day  $t-1$  to that on  $t$ , where  $t$  denotes the day of a policy announcement. For LIBOR rates, we use the change from midday GMT on day  $t-1$  to midday GMT on day  $t$  in the case of Japan, while we use the change from midday GMT on day  $t$  to midday GMT on day  $t+1$  in the cases of the U.S., the U.K., and the Eurozone. As for changes in exchange rates, we examine the effects of BOJ policy announcements using the change in the JPY against the other currencies from 17:00 EST of day  $t-1$  to 20:00 JST of day  $t$ , while for policy announcements by the other central banks we use the change in the home currency against the other currencies from 20:00 JST (i.e., 6:00 or 7:00 EST) on day  $t$  to 17:00 EST on day  $t$ .

Some recent studies rely on high-frequency intraday data rather than daily data to conduct event study analyses (Rosa, 2012; Rogers et al., 2014). Intraday data can in principle extract the effects of policy shocks more accurately than daily data as long as market participants understand the policy announcements and the policy shock is incorporated in asset returns within the intraday window set by researchers. Although this is likely for conventional policies, it may take a considerable amount of time for a policy shock to be properly reflected in asset returns due to the novelty of unconventional policies. In addition, when market functioning is impaired, as was the case in many countries during the severe global financial crisis of late 2008 and early 2009, an intraday window may not be appropriate. On the other hand, a window that is too long may be contaminated by pieces of news other than monetary policy announcements. Considering such a trade-off, we set a one-day window. One-day windows are unlikely to be contaminated by other pieces of news. Krishnamurthy and Vissing-Jorgensen (2011), for example, using intraday trading volume data on U.S. 10-year Treasury bonds, show that the announcement of large-scale asset purchases in the U.S. were the main news items on the days

such announcements were made.<sup>10</sup> To take account of the fact that other news or government actions may have influenced asset returns, we deliberately omit announcements on these days as mentioned above (specifically, we excluded the days of foreign exchange market interventions and the Tohoku Earthquake in Japan).

Table 2 shows the changes in the asset returns on each of the event days. Table 2 indicates that some of the announcements of unconventional policies resulted in a lowering of returns and a depreciation of the home currency while others did not. Not surprisingly, negative shocks – i.e., announcements that are less expansionary than expected – are often associated with an increase in long-term government bond yields. We examine the impact of policy announcements and their surprise component on asset returns more rigorously below.

## *2.4 Methodology*

### *2.4.1 The surprise component of monetary policy announcements*

We analyze the change in asset returns from the day before the announcement to the day of the announcement (and the three days after the announcement) as detailed in the previous subsection. If announcements were anticipated beforehand, however, a simple comparison of the asset returns before the announcement to the day of the announcement may result in underestimation of the policy impact. To overcome this bias, it is desirable to distinguish the surprise component of announcements from the anticipated component and to measure the effect of the former on changes in asset returns. That being said, it is difficult in practice to correctly identify the surprise component. Therefore, given that the measurement of the surprise component may not be accurate, we estimate the effects of policy announcements both with and without controlling for the expectations of market participants.

One way to measure the expectations of market participants is to rely on surveys. Joyce et al. (2011) use repeat survey data from the Reuters poll of economists to measure the expected amount of asset purchases by the BOE under its QE policy. However, such surveys are not available for all the economies that we examine. Another way to measure expectations is for researchers to read newspaper articles and judge whether actual policy measures were more expansionary or restrictive than prior articles expected. Rosa (2012) applies this methodology to the FRB's and BOE's quantitative easing policies. This methodology is based on the researcher's judgment and potentially suffers from misclassification. Perhaps more importantly, this methodology only measures the direction of surprises and does not capture their magnitude. Yet another way to measure the surprise component is to utilize asset prices. Central banks undertook unconventional policies by expanding the size and scope of asset purchases in a

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<sup>10</sup> Krishnamurthy and Vissing-Jorgensen (2011) set a two-day window to examine the impacts of the FRB's QE1 announcements.

situation where policy rates were almost zero. Such policies are likely to change expected future short-term interest rates and to reduce uncertainty about them, resulting in lower term premiums. This means that it is possible to use changes in yields or prices of long-term government bond futures in order to quantify monetary policy surprises. Employing this approach to examine the effects of large-scale asset purchases in the U.S., Wright (2012), Glick and Leduc (2012), and Rogers et al. (2014) use intraday interest rate futures and utilize as the surprise component the first principal component of the changes in yields on two-, five-, ten-, and 30-year U.S. bond futures. However, it may take a considerable amount of time for a policy shock to be properly reflected in yields on bond futures. We therefore use the changes in daily prices of 10-year government bond futures traded on the Tokyo Stock Exchange, the Chicago Board of Trade, and the New York Stock Exchange Liffe, respectively, in the cases of Japan, the U.S and the U.K. In the case of the Eurozone, we use the changes in daily prices of 10-year German government bond futures traded on the Eurex Exchange. These data are obtained from Bloomberg. We standardize the surprise components by dividing them by their standard deviation for each economy and period.<sup>11</sup>

The surprise component for each event is reported in Table 1. A positive (negative) surprise component indicates that the announcement was more (less) expansionary than expected. Interestingly, about half of the policy announcements we examine (37 of 66 announcements in total) represented a positive surprise (expansionary shock), while the remaining half of the announcements represented a negative surprise (they were less expansionary than expected). Comparing our estimates of the surprise components for the FRB and the BOE with those of Glick and Leduc (2012) for policy announcements covered in both studies, we find that they are very similar. The correlation coefficients between our estimates and theirs are 0.927 and 0.929 respectively for the FRB's eight announcements from November 2008 to November 2010 and for the BOE's five announcements from February 2009 to November 2009.<sup>12</sup> This suggests that our measure of the surprise components performs reasonably well.

#### 2.4.2 Specifications

Our methodology is based on an event study approach that examines the changes of asset returns from the day before the announcement to the day of the announcement and the three days after the announcement. To take into consideration the possibility that changes in asset returns are affected by their past movements, however, we estimate equations that are similar to

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<sup>11</sup> A detailed description of how we divide the observation period into subperiods is provided in Section 2.4.2.

<sup>12</sup> Regarding announcements by the FRB, Glick and Leduc (2012) include Bernanke's speeches on August 27, 2010 and October 15, 2010, while we do not.

those estimated by Ito (2003, 2004) and Watanabe and Yabu (2013), who examine the effects of government intervention on exchange rates. Specifically, in the case of interest rates and stock price indexes, we estimate the following equation:

$$\Delta r_t = \phi_0 + \phi_1 \Delta r_{t-1} + \phi_2 (r_{t-1} - r_{t-1}^T) + \sum_{s=0}^3 \phi_{3s} QE_{t-s} + \varepsilon_t \quad (1),$$

where  $\Delta r_t$  is the change in interest rates or the log difference in stock price indexes.

Following Ito (2003, 2004) and Watanabe and Yabu (2013), we include  $\Delta r_{t-1}$  to capture the bandwagon effect, and  $r_{t-1} - r_{t-1}^T$  to capture the mean reversion effect, where  $\Delta r_{t-1}$  is the change in interest rates or the log difference in stock price indexes as of  $t-1$ ,  $r_{t-1}$  represents interest rates or the logarithm of stock price indexes as of  $t-1$ , and  $r_{t-1}^T$  is the moving average over the past 250 business days of interest rates or the logarithm of the moving average over the past 250 business days of stock price indexes. We expect  $\phi_1$  and  $\phi_2$  to be positive and negative, respectively. In the case of exchange rates, we estimate the following equation:

$$\Delta s_{ijt} = \phi_0 + \phi_1 \Delta s_{ijt-1} + \phi_2 (s_{ijt-1} - s_{ijt-1}^T) + \sum_{s=0}^3 \phi_{3is} QE_{it-s} + \sum_{s=0}^3 \phi_{3js} QE_{jt-s} + \varepsilon_{ijt} \quad (2),$$

where  $\Delta s_{ijt}$  is the log difference in the exchange rate of currency  $i$  (home currency) against currency  $j$ , and  $s_{ijt-1}$  is the logarithm of the exchange rate as of the previous day (at 20:00 JST for the exchange rates of the JPY against the other currencies and at 17:00 EST for the other exchange rates), and  $s_{ijt-1}^T$  is the log of the moving average over the past 250 business days (as of the same hour as  $s_{ijt-1}$ ). As in the case of interest rates and stock indexes, we expect  $\phi_1$  and  $\phi_2$  to be positive and negative, respectively.

The variable we are most interested in is QE. In the case of interest rates and stock price indexes, we consider policy announcements, denoted by QE, by the central bank of the economy where the asset is traded, while in the case of exchange rates, we consider QE by central banks  $i$  (home) and  $j$  (foreign). In both cases, we use two alternative variables to

represent QE. The first variable simply is a dummy that takes one on the day when the central bank announces unconventional policies, while the second variable to represent QE is the surprise component shown in Table 1. If pre-announcement asset returns incorporate the expected component of the announcement (e.g., the expected size of asset purchases) conditional on the information available at that time, then the relationship between the change in asset returns on the announcement day and the surprise component of the announcement should be the same as that between the pre-announcement asset returns and the expected component.

$\phi_{30}$  captures this relationship when we use the surprise component to represent QE. If unconventional policies are expansionary, QE is expected to take a negative coefficient for interest rates, a positive coefficient for stock indexes, and a negative coefficient for the home currency (indicating a depreciation).

In addition to QE for the announcement days, we add QE for the three days after the announcement to take into consideration the possibility that it may take time until market participants have fully digested the significance of policies that are unprecedented. Such a long time window, however, may be contaminated by news other than monetary policy announcements. We therefore mainly focus on the impact on the announcement day, captured by

$\phi_{30}$  and  $\phi_{310}$ , although we also report the results for the test of the hypothesis that  $\sum_{s=0}^3 \phi_{3s}$  (or  $\sum_{s=0}^3 \phi_{3is}$ ) is zero in order to examine whether policy announcements had a permanent effect on the

level of interest rates, the logarithm of stock indexes, and the logarithm of foreign exchange rates.

To take into account the possibility that the variance of the error term changes over time, we estimate the following GARCH (1,1) model for the error term:

$$\varepsilon_t = v_t \sqrt{h_t}, \text{ with } v_t \sim N(0,1), \quad h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}, \quad \alpha_0 > 0, \quad \alpha_1, \alpha_2 \geq 0 \quad (3).$$

Allowing for changes in the variance of the error term is important since monetary policies are likely to affect the volatility of asset returns. Ueda (2013), for example, points out that the volatility of 10-year JGB yields has increased significantly since the BOJ's announcement of the QQE policy. While using the GARCH model allows for great flexibility in the stochastic process of the error term, doing so means that we cannot estimate the effect of each QE announcement (or its surprise component), that is, we cannot add each QE announcement (or its surprise component) separately in (1), which would yield an extremely large standard error for the coefficient on each QE. We therefore examine the average effect of the QE announcements of each central bank. In the case of the BOJ and the FRB, however, the

policies were conducted for different purposes and employed different tools depending on the period each policy was implemented. We therefore divide our observation period for the BOJ and the FRB into several subperiods and examine the average effect of the QE announcements for each subperiod. Specifically, to examine the effect of the BOJ's unconventional policies, we choose the following three subperiods: (1) the period of QE before the global financial crisis from January 1, 2001 to December 31, 2006; (2) the period of unconventional policies prior to CE from January 1, 2007 to September 30, 2010; and (3) the period of CE and subsequent unconventional policies including QQE from October 1, 2010 to April 30, 2013. To examine the impact of the FRB's unconventional policies, we choose the following four subperiods: (1) the period of credit easing from January 1, 2007 to October 31, 2008; (2) the QE1 period from November 1, 2008 to June 30, 2010; (3) the QE2 period from July 1, 2010 to December 31, 2011; and (4) the QE3 period from January 1, 2012 to April 30, 2013. The situation regarding financial market stability differed in each of the periods. U.S. financial markets were most seriously impaired when the credit easing policy was conducted and became more stable as the FRB implemented QE1 to QE3. Similarly, the BOJ's quantitative easing policy from 2001 to 2006 was implemented when Japanese banks were burdened with huge non-performing loans, while the BOJ's subsequent policies were implemented when – except for the latter half of 2008 and the first half of 2009 – Japanese financial markets were relatively stable.

On the other hand, since the purpose of the BOE's and the ECB's unconventional policies did not substantially change over time, we do not divide the observation period for these central banks into subperiods but use the entire period from January 1, 2007 to April 30, 2013.

### 3. Results

#### 3.1 Baseline results for unconventional monetary policies

Tables 3 to 6 summarize the estimates of  $\phi_{3s}$  or  $\phi_{3is}$  for the announcement day ( $\phi_{30}$  or  $\phi_{3i0}$  in the first column), the post-announcement days ( $\sum_{s=1}^3 \phi_{3s}$  or  $\sum_{s=1}^3 \phi_{3is}$  in the second column), and the sum of the announcement and post-announcement days ( $\sum_{s=0}^3 \phi_{3s}$  or  $\sum_{s=0}^3 \phi_{3is}$ ) in the third column) for Japan, the U.S., the Eurozone, and the U.K.

The estimates of  $\phi_1$  and  $\phi_2$  are omitted from the tables to save space, but can be summarized as follows. Using a significance level of 10%, we find that  $\phi_1$  is positive and significant as expected in 46 of the 277 cases in total, insignificant in 186 cases, and negative

and significant in 45 cases. On the other hand,  $\phi_2$  is negative and significant as expected in 71 cases, insignificant in 169 cases, and positive and significant in 37 cases.

Next, let us look at the results presented in the tables. Specifically, in the subsections below, we first look at the results for  $\phi_{3s}$  or  $\phi_{3is}$  for Japan, the U.S., the Eurozone, and the U.K. one by one and then consider them as a whole. Moreover, we compare our results with those obtained in preceding event study analyses that cover at least part of the asset classes and periods we examine. In the discussion below, when we talk of a “positive surprise,” “positive shock,” or “expansionary shock,” we mean that a policy (announcement) was more expansionary than expected, while a “negative surprise” or “negative shock” is a policy (announcement) that is less expansionary than expected.

### Japan

Table 3(a) shows the results for Japan for the three different subperiods using the surprise component as the variable for QE. We first focus on  $\phi_{30}$  and  $\phi_{3i0}$ , which show the financial market responses on the day of policy announcements, and find that they differ substantially across the three periods. In the period before the global financial crisis (i.e., from January 2001 to December 2006), the surprise component of announcements did not have a significant impact, with the only exception being the negative impact on 5-year Japanese government bond (JGB) yields. In the next period (from January 2007 to September 2010), positive surprises had a significant negative impact on short- to long-term interest rates, i.e., 3-month to 10-year JGB yields and the 3-month yen LIBOR rate. Although positive surprises had a significant positive impact on the spread between 3-month yen LIBOR rates and 3-month JGB yields, this reflects the larger negative impact on the latter. During the CE/QQE period (from October 2010 to April 2013), expansionary shocks had a negative impact not only on long-term interest rates but also on the exchange rate of the JPY. Specifically, when we exclude the effect of the Tohoku Earthquake (March 14, 2011), expansionary shocks had a negative impact on 5-year to 10-year JGB yields, the 3-month yen LIBOR rate, the term spread (i.e., the spread between 10- and 1-year JGB yields), and the exchange rates of the JPY against the USD, EURO, GBP, and KRW. The only unexpected result is the significantly positive impact on the spread between 5-year BBB corporate bond yields and 5-year JGB yields.

When we look at  $\sum_{s=0}^3 \phi_{3s}$  (or  $\sum_{s=0}^3 \phi_{3is}$ ), we find that policy announcements had a prolonged impact on interest rates, stock price indexes, and exchange rates only for the CE/QQE



period. Specifically, excluding the March 14, 2011 event, we find that an expansionary shock had a long-term negative impact on the term spread (i.e., the spread between 10- and 1-year JGB yields) and the exchange rates of the JPY against the USD, EURO, and GBP, while they had a long-term positive impact on the TOPIX and on the TOPIX Banks (i.e., the stock price index for the banking sector).

Next, Table 3(b) shows the results for Japan when we use the announcement day dummy for QE. While the results for some of the interest rates, stock price indexes, and exchange rates are similar to those in Table 3(a), for others they are either not significant or in the opposite direction. Specifically, in the period before the global financial crisis, 5-year to 10-year JGB yields significantly increased in response to policy announcements. Given that Japan's banking sector was unstable during this period, the positive response of long-term interest rates may be interpreted as indicating that policy announcements had the effect of stabilizing the banking sector, as reflected in the positive response of the TOPIX and the positive and larger response of the TOPIX Banks. Furthermore, during the CE/QQE period, the exchange rate of the JPY did not show any significant response except against the USD. One possible reason for the difference between the two sets of estimation results is that policy announcements were less expansionary than expected, as is shown by the fact that the surprise component in Table 1 in a number of cases takes a negative value.

There are no preceding studies to which our results for the BOJ can be directly compared in terms of the asset classes and period(s) covered.<sup>13</sup> The studies that probably come closest are those by Ueda (2012, 2013), although neither study controls for market expectations. Ueda (2012) analyzes the permanent effects – rather than the one-day effects – of each of the BOJ's announcements on the TOPIX, 10-year JGB yields, and the USD/JPY rate using daily data from March 18, 1999 to March 28, 2011. He finds that while some of the BOJ's announcements had a significant and permanent impact on asset returns, a majority of them had no significant impact or the coefficient had the wrong sign.<sup>14</sup> Extending the observation period for his daily data analysis to the end of April 2013, Ueda (2013) obtains similar results.<sup>15</sup> Our results for the

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<sup>13</sup> A study that covers relatively similar ground is that by Rogers et al. (2014). However, they analyze the BOJ's policies for the entire period from January 2007 to June 2013 and for two sub-periods that differ considerably from ours, namely the crisis period of 2008 and 2009 and the remaining non-crisis period, which makes comparison with our results difficult.

<sup>14</sup> Ueda (2012, Table 7) examines 24 announcements of the BOJ including one on the zero-interest rate policy on April 13, 1999. Among the other 23 announcements he examines, six had a significant and positive impact on the TOPIX, three had a significant and negative impact on 10-year JGB yields, and three had a significant and negative impact on the USD/JPY rate.

<sup>15</sup> Using four dummies representing major events during the Abenomics period, Ueda (2013) finds that the announcement of QQE on April 4, 2013 had a significant permanent impact with the right sign on the TOPIX, 10-year JGB yields, and the USD/JPY rate, and the dissolution of the Upper House on November 16, 2012 had a significant negative impact on 10-year JGB yields, while the other dummies, including the announcement of the 2-percent inflation target on January 22, 2013, had no significant permanent effect

announcement day dummy also show that the permanent effects are generally weak: they are significant for the USD/JPY rate for the period of the global financial crisis (January 1, 2007 to September 30, 2010) and the CE/QQE period (October 2010 to April 2013), but insignificant for the TOPIX or 10-year JGB yields for either of the periods. It should be noted, however, that the estimates of the permanent effects may be contaminated by news other than monetary policy announcements.

### The United States

Table 4(a) shows the results for the U.S. when we use the surprise component as the QE variable. Focusing on the market responses on the announcement days ( $\phi_{30}$  and  $\phi_{3i0}$ ), we find that positive surprises during the credit easing and QE1 periods had a significant impact on financial markets, while during the QE2 and QE3 periods the impact was limited or no impact can be discerned. Specifically, positive surprises during the credit easing period had a significant negative impact on short- to long-term interest rates. i.e., 3-month to 5-year U.S. Treasury yields and 5-year BBB-rated corporate bond yields. They also reduced the corporate bond spread as measured by the spread between 5-year BBB-rated corporate bond yields and 5-year U.S. Treasury yields. Somewhat surprisingly, positive surprises during the credit easing policy had a negative impact on the S&P 500 and the S&P 500 Banks on the announcement day, although they had a positive impact on the post-announcement days. On the other hand, positive surprises led to a significant appreciation of the USD against the EURO and the GBP on the announcement day and did not lead to a significant depreciation on the post-announcement days. These results suggest that the credit easing policy may have contributed to restoring confidence in U.S. financial assets.

Turning to the QE1 period, we find that positive surprises had a significant negative impact on 1-year to 10-year U.S. Treasury yields, 5-year BBB-rated corporate bond yields, the 3-month USD LIBOR rate, the term spread (i.e., the spread between 10- and 1-year U.S. Treasury yields), and the exchange rate of the USD against the EURO and the GBP. As for positive surprises during QE2, we find no significant financial market impact, while for QE3 we find a significant positive impact only on the S&P 500 and the S&P 500 Banks.

Moreover, looking at  $\sum_{s=0}^3 \phi_{3s}$  (or  $\sum_{s=0}^3 \phi_{3is}$ ), we find that a positive surprise during the credit easing period had a prolonged positive impact on the S&P 500 Banks, which presumably reflects that the credit easing policy helped to restore confidence in the U.S. banking system. As for QE1, positive surprises had a prolonged impact on long-term interest rates (5- to 10-year

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on asset returns.

U.S. Treasury yields) and the exchange rate of the USD against the EURO.

Next, Table 4(b) shows the results for the U.S. when we use the announcement day dummy for QE. While the results for QE1 and QE3 are similar to those in Table 4(a), those for the credit easing policy and QE2 show some notable differences. In the case of the credit easing policy, the announcement day dummy has a significantly positive impact on 5-year U.S. Treasury yields, 5-year corporate bond yields, and the S&P 500 Banks. The difference between the results when using the announcement dummy and the surprise components again seems to be due to negative values for the surprise component. In the case of QE2, the announcement dummy has a negative coefficient for 5- and 10-year U.S. Treasury yields and the S&P 500, although the coefficients are significant only at the 10% level.

As far as we are aware, there are no preceding studies on the impact of the credit easing policy on asset returns. As for event-studies on QE1, Gagnon et al. (2011) and Neely (2012) find that QE1 announcements reduced 10-year U.S. Treasury yields. Neely (2012), moreover, finds that they also reduced the exchange rate of the USD. Although these studies do not control for market expectations, our results for QE1 are consistent with theirs. Further, our finding that QE1 had a more significant impact on the 10-year U.S. Treasury rate and corporate bond rates than QE2 is in line with the results obtained by Krishnamurthy and Vissing-Jorgensen (2011), although they also do not control for market expectations. Glick and Leduc (2012), on the other hand, find a significant and somewhat larger impact of QE2 on the 10-year U.S. Treasury rate than of QE1 after controlling for market expectations. The difference in the results likely is due to differences in the regression specification and in the announcements that are included in the analysis.<sup>16,17</sup>

### The Eurozone

Table 5(a) shows the results for the Eurozone when we use the surprise component as the QE variable. Positive surprises had a significant negative impact on 1- to 5-year German government bond yields, 5-year BBB-rated corporate bond yields, and the 3-month euro LIBOR rate. Although positive surprises had a significant positive effect on the corporate bond spread

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<sup>16</sup> To examine how differences in the specification affect the estimation results, we also estimated the impact of QE1 and QE2 announcements without assuming GARCH(1,1) errors and found that QE2 announcements have a significant negative impact on 5- and 10-year U.S. Treasury yields, the 3-month USD LIBOR rate, the term spread between 10- and 1-year U.S. Treasury yields, and the exchange rate of the USD against the JPY. However, even in this specification, we found that QE1 announcements had a significant impact on a broader range of assets, including 5-year BBB corporate bonds and the exchange rate of the USD against the EURO and the GBP. We obtained similar results when assuming no bandwagon or mean reversion effects.

<sup>17</sup> Rosa (2012), using an intraday dataset that covers the period from May 1999 to June 2011, finds that the surprise components of the QE announcements had a significant impact on 5-year U.S. Treasury yields, the S&P 500, and the exchange rate of the USD against major currencies. However, since his observation period includes both QE1 and part of QE2, his results cannot be directly compared with ours.

(i.e., the spread between 5-year BBB-rated corporate bond yields and 5-year German Bund yields), this reflects the larger negative impact on the latter. On the other hand, the result for stock prices are inconsistent with expectations: both the STOXX Europe 600 and the EURO STOXX Banks showed a negative response to a positive shock. One possible interpretation is that announcements that were more expansionary than expected may have been interpreted as signaling that the ECB thought that economic conditions were worse than market participants realized.

Looking at  $\sum_{s=0}^3 \phi_{3s}$  (or  $\sum_{s=0}^3 \phi_{3is}$ ), we find that expansionary shocks had a prolonged impact on the exchange rate of the EURO against the JPY and the USD as well as on the corporate bond spread and the two stock price indexes.

Table 5(b) shows the results for the Eurozone when we use the announcement day dummy as the QE variable. We find that the results for long-term interest rates and stock price indexes are the opposite to those in Table 5(a). In particular, the positive coefficients for the announcement day dummy for 5- and 10-year German government bond yields are not consistent with those in Table 5(a). A likely reason is that the surprise component takes a negative value for a number of ECB announcements. In addition, the ECB's aim to lower sovereign spreads in the euro area may have led to a reversal of the flight to quality (i.e., a reversal of capital flows into German government bonds), thereby resulting in an increase in German Bund yields.<sup>18</sup>

Kilponen et al. (2012) examine the impact of the ECB's policies on 10-year government bond yields in seven countries, including Germany. They find that while the ECB's liquidity support and covered bond purchase programs generally did not affect government bond yields in general, the announcement of the ECB's Securities Markets Program did have a significant negative impact on bond yields in most of the seven countries they examined. However, their results for 10-year German government bond yields are more or less consistent with ours. Specifically, they show that the ECB's liquidity support had a positive and marginally significant effect and the Securities Markets Program had a significant positive effect on the announcement day, although the latter had a negative effect on the following day.

### *The United Kingdom*

Table 6(a) shows the results for the U.K. when we use the surprise component as the QE

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<sup>18</sup> Rogers et al. (2014), using intraday changes in cash-market spreads between yields on Italian 10-year government bonds and their German counterpart as a measure of ECB policy surprises, similarly find that policy surprises have a positive impact on 10-year German government bond yields and interpret this result in the manner above. They further find that a positive shock significantly raised the German stock price index, the DAX.

variable. Looking at the market response on announcement days ( $\phi_{30}$  and  $\phi_{3i0}$ ), we find that positive surprises had a significant negative impact on 1- to 5-year gilt yields, 5-year corporate bond yields, the short-term interbank loan spread (i.e., the spread between 1-year GBP LIBOR rates and 1-year gilt yields), and the exchange rate of the GBP against the JPY. On the other hand, positive surprises had a significant positive impact on the term spread (i.e., the spread between 10- and 1-year gilt yields), reflecting the negative impact on the latter.

Looking at  $\sum_{s=0}^3 \phi_{3s}$  (or  $\sum_{s=0}^3 \phi_{3is}$ ), we find that positive shocks had a prolonged impact on 5-year corporate bond yields and the short-term interbank loan spread.

Next, Table 6(b) shows the results for the U.K. when we use the announcement day dummy as the QE variable. The results are similar to those in Table 6(a).

Using a survey-based surprise measure for the BOE's QE policy from February 2009 to February 2010, Joyce et al. (2011) show that the surprise measure was negatively correlated with the average change in gilt yields across maturities from 5 to 25 years. Further, this time without controlling for market expectations, they find that corporate bond yields fell markedly around announcements, and there were modest falls in the GBP while equity prices did not respond in a uniform way. Further, Rosa (2012), using intraday data for announcement days for the period from January 2009 to June 2011, and measuring the surprise component of BOE QE announcements based on articles in the Financial Times, found that a positive surprise was associated with a decline in 5- and 10-year gilt yields and a depreciation of the GBP, but did not have a significant impact on the FTSE 100.<sup>19</sup> Although the observation periods and how market expectations are controlled for in these two studies and ours differ, the results are broadly consistent.

### Summary

Summing up, we find quite similar results for most economies and periods regardless of whether we use the surprise component or the announcement day dummy as the QE variable. However, overall, the results when focusing on the surprise component are more in line with the expectation that a positive shock affects financial assets in a manner that is expansionary – that is, that it lowers interest rates, leads to higher stock prices, resulted in a depreciation of the home currency, etc. In this section, we therefore focus on the results when using the surprise

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<sup>19</sup> Another study of interest in this context is that by Rogers et al. (2014), which arrives at similar results as our study, although the exact asset classes differ somewhat from those examined here. Specifically, they find that a positive surprise by the BOE significantly lowered 2- to 30-year gilt yields and 5-year AA- and BB-rated corporate bond yields and caused GBP futures to fall, while the impact on the FTSE stock price index was marginally significant.

component.

Starting with the impact on government bond yields, we found that except in the case of the FRB's QE2 and QE3, a positive shock tended to have a significant negative impact on long-term government bond yields. As a result, the term premium as measured by the spread between 10-year and 1-year government bond yields tended to shrink, although the statistical significance of the decline in the term premium differs across the economies and periods.

Turning to the impact on exchange rates, we further found that a positive surprise tended to cause a significant depreciation of the home currency in the case of the BOJ's CE/QQE policies, the FED's QE1 policy, and the BOE's policies. A notable exception is the FRB's credit easing policy, which caused a significant appreciation of the USD. We interpreted this result as suggesting that the credit easing policy helped to restore confidence in U.S. financial assets, which had been lost in the midst of the financial market turmoil.

Next, looking at the effect of positive surprises on other assets, we find that such surprises tended to have only a limited impact in terms of shrinking risk premiums on corporate bonds and short-term interbank loans. An interesting exception is again the FRB's credit easing policy, which significantly reduced the risk premium on corporate bonds, which is consistent with our interpretation that the policy contributed to restoring confidence in U.S. financial assets. The other exception is the BOE's policies, which significantly reduced interbank loan spreads. We also find that surprises only have a limited positive impact on stock prices. One notable exception is the BOJ's CE/QQE policies, which we found had a prolonged positive impact on stock prices.

### *3.2 Results for forward guidance*

In the baseline specifications, we implicitly assumed that central banks' policy announcements all had the same impact within the period we set. Table 1, however, shows that the contents of announcements differed greatly, which means that their impact on financial markets also differed considerably. One of the major ways in which such announcements differed is in terms of whether the central bank explicitly announced the conditions under which the current or new policy would continue, which is often dubbed "forward guidance." The policy announcements by the FRB and the BOJ in Table 1 contain various instances of such forward guidance, and we will focus on the announcements of these two central banks in this subsection.<sup>20</sup>

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<sup>20</sup> Specifically, among the policy announcements listed in Table 1, the BOJ's announcements on March 19, 2001, October 5, 2010, February 14, 2012, January 22, 2013, and April 4, 2013 and the FRB's announcements on December 16, 2008, March 18, 2009, September 13, 2012, and December 12, 2012 included forward guidance. Although not included in our observation period, the ECB's announcement on July 4, 2013 and the BOE's announcement on August 7, 2013 also included forward guidance.

We therefore classify announcements by these two central banks into those including and not including forward guidance, and estimate the following equation for interest rates and stock price indexes:

$$\Delta r_t = \phi_0 + \phi_1 r_{t-1} + \phi_2 (r_{t-1} - r_{t-1}^T) + \sum_{s=0}^3 \phi_{3Ns} \text{NOFORWARD}_{t-s} + \sum_{s=0}^3 \phi_{3Fs} \text{FORWARD}_{t-s} + \varepsilon_t \quad (4),$$

where FORWARD and NOFORWARD respectively denote announcements with and without forward guidance. We estimate a similar equation for the exchange rates of the USD and JPY. We estimate (4) as above using both the announcement day dummy and the surprise component of announcements, but report only the results for the latter. The results for the announcement day dummy are similar to, but somewhat weaker than, those for the surprise component. For the analysis of the FRB's announcements we exclude the announcements for the credit easing policy, because in the previous subsection the effects of the credit easing policy turned out to be quite different from the subsequent QE policies. For the analysis of the BOJ's announcements, we exclude the announcement on March 14, 2011 to exclude the effects of the Tohoku Earthquake.

Table 7(a) shows the estimated coefficients on NOFORWARD and FORWARD for the FRB. Focusing on the impact on the announcement day ( $\phi_{30}$  and  $\phi_{3i0}$ ), we find that while NOFORWARD, i.e., announcements without any forward guidance, had a significant negative impact on BBB-rated corporate bond yields and the term spread (the spread between 10-year and 1-year U.S. Treasury yields), and led to a significant depreciation of the USD against the EURO and the GBP, it had a significant negative impact on the S&P 500 and S&P 500 Banks. On the other hand, FORWARD, i.e., announcements with forward guidance, had a significantly negative impact on 1-year and 10-year Treasury yields, the term spread, and the 3-month USD LIBOR rate, and led to a significant depreciation of the USD against EURO and the GBP. It also had a significant positive impact on the S&P 500 and the S&P 500 Banks.

Next, Table 7(b) shows the results for the BOJ. Focusing on the impact on the announcement day ( $\phi_{30}$  and  $\phi_{3i0}$ ), we find that both FORWARD and NOFORWARD had a significant impact on long term interest rates (1- to 10-year JGB yields), corporate bond yields, and the term spread (the spread between 10-year and 1-year JGB yields). Looking at the size of the impact on JGB yields, we find that the impact on 1- and 10-year JGB yields and the term spread between them is much larger for FORWARD than for NOFORWARD. Furthermore, only FORWARD also had a significant impact on the exchange rate of the JPY against the USD,

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Finally, another announcement also not included in our observation period is the BOJ Governor's statement on April 13, 1999, which referred to the conditions under which the zero-interest-rate policy would continue.

EURO, GBP, and KRW.

In sum, our analysis on the impact of forward guidance shows that policy announcements that were accompanied by forward guidance tended to have a more significant and greater impact on a broad range of assets than policy announcements without forward guidance.

#### **4. Conclusion**

In the wake of the global financial crisis, the FRB, BOE, ECB, and BOJ all implemented various unconventional monetary policies. Moreover, the BOJ already pursued quantitative easing prior to the global financial crisis during 2001-2006. This study investigated the responses of long-term interest rates, stock prices, and exchange rates to the unconventional monetary policies taken by the above four major central banks with and without controlling for market expectations.

Controlling for market expectations, we find that in most economies and periods, unconventional policies affected long-term government bonds and the exchange rate of the home currency in an expansionary manner; for some economies and periods we also find an impact on corporate bond spreads, interbank loan spreads, and stock prices. A notable exception is the FRB's credit easing policy, which caused the U.S. dollar to significantly appreciate. Together with the finding that the credit easing policy significantly decreased corporate bond spreads, we interpreted this result as suggesting that the policy helped to restore confidence in U.S. financial assets lost in the financial crisis. Another notable exception is the BOJ's comprehensive monetary easing (CE) and quantitative and qualitative easing (QQE) policies, which had a significant prolonged effect on stock prices. We further find that policy announcements that were accompanied by forward guidance tended to have a more significant and greater impact on a broad range of assets than those without forward guidance.

Our findings on the response of financial markets to unconventional policies have important policy implications. While the ultimate goal of monetary policy is to ensure that economic activity and prices remain stable, monetary policy is unlikely to affect economic activity if it does not have an impact on asset returns. Furthermore, if investors are rational, asset prices should reflect future economic activity and inflation. Based on these considerations, we interpret our results as suggesting that even when the policy rate is close to the zero lower bound central banks have the ability to affect economic activity, primarily through the effect that unconventional policies have on long-term interest rates and exchange rates. In addition, our results regarding the FRB's credit easing policy suggest that central banks can play the role of financial intermediary and restore confidence in domestic financial assets when financial markets are in turmoil.



Unconventional monetary policies comprise a considerable range of measures, which are likely to affect asset prices and hence the economy in different ways. In addition to examining the impact of unconventional monetary policies overall, this study picked out one specific element, forward guidance, to investigate whether the specific content of unconventional policy measures mattered for their effectiveness. The results showed that, unsurprisingly, this is indeed the case. This means that there remains considerable scope for examining the specific impact that other elements of unconventional monetary policy have. In addition, a possible reason why we found that the BOJ's CE/QQE policies had a significant impact on a broad range of assets including stock prices may be that these policies consisted of a combination of large-scale asset purchases and forward guidance. This suggests that in order to fully understand the impact of unconventional monetary policy, it is necessary to understand not only the effect of individual policy instruments but also if and how they interact. These are important issues left for future research.

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Table 1: Unconventional monetary policies announced by each central bank

BOJ		
Date	Announcement	Surprise
3/19/2001	Begins the quantitative easing policy. Increases the target for current account balances at the Bank of Japan (BOJ) to around ¥5 trillion. States that it will continue with the new procedures for money market operations until the rate of change in the CPI (excluding fresh food, on a nationwide basis) stably registers zero percent or an increase year on year.	-0.094
8/14/2001	Increases the target for current account balances at the BOJ to around ¥6 trillion. Increases the amount of outright purchases of long-term government bonds by ¥2.4 trillion per year to ¥7.2 trillion per year.	0.745
9/18/2001	Increases the target for current account balances at the BOJ to above ¥6 trillion.	-0.218
12/19/2001	Increases the target for current account balances at the BOJ to around ¥10 trillion to ¥15 trillion. Increases the amount of outright purchases of long-term government bonds by ¥2.4 trillion per year to ¥9.6 trillion per year.	-0.031
2/28/2002	Increases the amount of outright purchases of long-term government bonds by ¥2.4 trillion per year to ¥12 trillion per year.	0.223
9/18/2002	Explores possible policy measures to enhance financial institutions' efforts to reduce their shareholdings.	-6.189
10/30/2002	Increases the target for current account balances at the BOJ to around ¥15 to ¥20 trillion. Increases the amount of outright purchases of long-term government bonds by ¥2.4 trillion per year to ¥14.4 trillion per year. Extends the maturities for bills purchased in bill purchasing operations from six months or less to a year or less.	-0.154
3/25/2003	Increases the target for current account balances at the BOJ to around ¥17 trillion to ¥22 trillion from April 1.	0.947
4/8/2003	Examines possible purchases of asset-backed securities (ABS).	0.336
4/30/2003	Increases the target for current account balances at the BOJ to around ¥22 trillion to ¥27 trillion.	0.091
5/20/2003	Increases the target for current account balances at the BOJ to around ¥27 trillion to ¥30 trillion.	0.076
10/10/2003	Increases the target for current account balances at the BOJ to around ¥27 trillion to ¥32 trillion.	-0.290
1/20/2004	Increases the target for current account balances at the BOJ to around ¥30 trillion to ¥35 trillion.	-1.384
12/2/2008	Expands the range of corporate debt eligible as collateral and introduces new operations utilizing corporate debt.	0.924
12/19/2008	Increases the amount of outright purchases of long-term government bonds by ¥2.4 trillion per year to ¥16.8 trillion per year. Adds 30-year bonds, floating-rate bonds, and inflation-indexed bonds to the list of JGBs accepted in outright purchases.	0.779
2/3/2009	Resumes the purchase of stocks held by financial institutions.	-0.696
2/19/2009	Expands the special funds-supplying operations to facilitate corporate financing. Introduces outright purchases of corporate bonds.	0.029
3/18/2009	Increases the amount of outright purchases of JGBs by ¥4.8 trillion to ¥21.6 trillion per year.	0.784
12/1/2009	Introduces a three-month fixed-rate funds-supplying operation against pooled collateral.	2.099
3/17/2010	Increases the amount of loans to be provided through the fixed-rate funds-supplying operation against pooled collateral by ¥10 trillion to approximately ¥20 trillion.	-0.348
5/21/2010	Publishes the preliminary framework for the Fund-Provisioning Measure to Facilitate Strengthening of the Foundations for Economic Growth.	0.431
8/30/2010	Introduces a six-month term in the fixed-rate funds-supplying operation against pooled collateral.	-0.283
10/5/2010	States it will encourage the uncollateralized overnight call rate to remain at around 0 to 0.1%. Establishes the Asset Purchase Program to purchase various financial assets such as government securities, commercial paper, corporate bonds, ETFs, and J-REITs, and to conduct fixed-rate funds-supplying operations against pooled collateral. States it will maintain the virtually zero interest rate policy until it judges, on the basis of the "understanding of medium- to long-term price stability," that price stability is in sight.	0.952
3/14/2011	Increases the total size of the Asset Purchase Program by about ¥5 trillion to about ¥40 trillion.	3.203
6/14/2011	Establishes a new line of credit for equity investments and asset-based lending to enhance the fund-provisioning measure to support strengthening the foundations for economic growth.	-0.749
8/4/2011	Increases the total size of the Asset Purchase Program by about ¥10 trillion to about ¥50 trillion.	-0.014
10/27/2011	Increases the total size of the Asset Purchase Program by about ¥5 trillion to about ¥55 trillion.	-0.610
2/14/2012	Increases the total size of the Asset Purchase Program by about ¥10 trillion to about ¥65 trillion. Announces that the BOJ judges "the price stability goal in the medium to long term" to be within a positive range of 2 percent or lower in terms of the year-on-year rate of change in the CPI and, more specifically, sets a goal of 1 percent for the time being.	0.828
3/13/2012	Increases the total amount of loans available through the Growth-Supporting Funding Facility by ¥2 trillion to ¥5.5 trillion.	0.087
4/27/2012	Increases the total size of the Asset Purchase Program by about ¥5 trillion to about ¥70 trillion.	1.172
9/19/2012	Increases the total size of the Asset Purchase Program by about ¥10 trillion to about ¥80 trillion.	-0.346
10/30/2012	Increases the total size of the Asset Purchase Program by about ¥11 trillion to about ¥91 trillion. Establishes the framework for the Fund-Provisioning Measure to Stimulate Bank Lending.	0.774
12/20/2012	Increases the total size of the Asset Purchase Program by about ¥10 trillion to about ¥101 trillion.	0.561
1/22/2013	Introduces the price stability target and the "open-ended asset purchasing method." States that under the price stability target, it will pursue monetary easing and aim to achieve this target at the earliest possible time. Specifically, the BOJ states that it will pursue aggressive monetary easing with the aim of achieving the price stability target through a virtually zero interest rate policy and purchases of financial assets as long as it judges it appropriate to continue with each policy measure.	0.172
4/4/2013	Introduces Quantitative and Qualitative Monetary Easing with the aim of doubling the monetary base and the amount of JGBs and ETFs on its balance sheet in two years. Moreover, states it would aim to more than double the average remaining maturity of JGB purchases. Further states the aim of achieving the price stability target of 2 percent in terms of the year-on-year rate of change in the CPI at the earliest possible time, with a time horizon of about two years. States that it will continue with QQE as long as necessary in order to achieve the 2 percent price stability target in a stable manner.	2.556

FRB		
Date	Announcement	Surprise
12/12/2007	Introduces the Term Auction Facility (TAF).	-1.233
3/11/2008	Introduces the Term Securities Lending Facility (TSLF).	-2.434
3/16/2008	Introduces the Primary Dealer Credit Facility (PDCF).	1.309
9/19/2008	Introduces the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF).	-5.172
10/7/2008	Introduces the Commercial Paper Funding Facility (CPFF).	-1.500
10/21/2008	Introduces the Money Market Investor Funding Facility (MMIFF).	2.778
11/25/2008	Introduces the Term Asset-Backed Securities Loan Facility (TALF) and the purchase of GSE debt and mortgage-backed securities.	2.805
12/1/2008	Chairman Bernanke mentions that the Fed could purchase long-term Treasuries.	2.431
12/16/2008	Announces that FOMC is evaluating the potential benefits of purchasing longer-term Treasury securities.	2.873
1/28/2009	Announces that it is ready to expand agency debt and MBS purchases, as well as to purchase long-term Treasuries.	-1.334
3/18/2009	Announces that it will purchase up to \$300 billion of longer-term Treasury securities over the next six months, an additional \$100 billion in agency debt, and an additional \$750 billion in agency MBS.	6.755
8/10/2010	Announces that it will keep constant the FRB's holdings of securities at their current level by reinvesting principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury securities. States that it will continue to roll over the FRB's holdings of Treasury securities as they mature.	0.901
9/21/2010	Announces that the FOMC is prepared to provide additional accommodation if needed.	1.860
11/3/2010	Announces that it will purchase a further \$600 billion of longer-term Treasury securities by the end of the second quarter of 2011.	0.089
9/21/2011	Announces that it will extend the average maturity of the FRB's holdings of securities (by purchasing, by the end of June 2012, \$400 billion of Treasury securities with remaining maturities of 6 years to 30 years and selling an equal amount of Treasury securities with remaining maturities of 3 years or less).	0.516
9/13/2012	Announces that it will purchase additional agency mortgage-backed securities at a pace of \$40 billion per month.	1.228
12/12/2012	Announces that it will purchase longer-term Treasury securities at a pace of \$45 billion per month after the program to extend the average maturity of the FRB's holdings of Treasury securities is completed at the end of the year.	-0.996

ECB		
Date	Announcement	Surprise
8/22/2007	Introduces long-term refinancing operations (LTROs) with a maturity of three months for an amount of €40 billion.	-0.999
3/28/2008	Introduces LTROs with a maturity of six months.	-0.085
9/29/2008	Introduces the special term refinancing operation (STRO).	3.612
10/15/2008	Expands the list of assets eligible as collateral in Eurosystem credit operations.	-0.022
5/7/2009	Introduces LTROs with a maturity of one year. Purchases covered bonds.	-2.353
5/10/2010	Introduces the Securities Markets Programme (SMP).	-2.890
10/6/2011	Introduces a new covered bond purchase programme (CBPP2).	-2.132
12/8/2011	Introduces LTROs with a maturity of 36 months.	1.845
9/6/2012	Terminates the SMP and introduces Outright Monetary Transactions (OMT) focusing on sovereign bonds with a maturity of between 1 and 3 years.	-2.154

BOE		
Date	Announcement	Surprise
2/11/2009	Governor King says that BOE will open its facility to make purchases later in the week.	3.126
3/5/2009	Introduces a programme of asset purchases of £75 billion.	3.718
5/7/2009	Increases the size of the asset purchase programme by £50 billion to £125 billion.	-0.897
8/6/2009	Increases the size of the asset purchase programme by £50 billion to £175 billion.	1.178
11/5/2009	Increases the size of the asset purchase programme by £25 billion to £200 billion.	-0.901
2/4/2010	Announces that further purchases would be made should the outlook warrant them.	0.227
10/6/2011	Increases the size of the asset purchase programme by £75 billion to £275 billion.	-1.095
2/9/2012	Increases the size of the purchase programme by £50 billion to £325 billion.	-0.779
7/5/2012	Increases the size of the asset purchase programme by £50 billion to £375 billion.	0.968

Table 2: Financial market movements on each announcement date

(a) BOJ

	Surprise	10-year JGBs	5-year JGBs	1-year JGBs	3-month JGBs	5-year BBB corporate bonds	3-month JPY LIBOR rate	Spread between 10-year and 1-year JGBs	Spread between 3-month JPY LIBOR rate and 3-month JGBs	Spread between 5-year BBB corporate bonds and 5-year JGBs
3/19/2001	-0.094	-0.001	0.004	-0.014 **	-0.017 **	-	-0.039 ***	0.013	-0.022 **	-
8/14/2001	0.745	-0.006	-0.026	-0.006	-0.009 *	-	-0.009 **	0.000	0.000	-
9/18/2001	-0.218	0.016	0.012	0.006	0.001	-	0.000	0.010	-0.001	-
12/19/2001	-0.031	0.010	0.005	-0.003	-0.002	-	0.001	0.013	0.003	-
2/28/2002	0.223	-0.015	-0.010	0.000	0.000	-	0.001	-0.015	0.001	-
9/18/2002	-6.189	0.177 ***	0.104 ***	0.002	0.000	-	-0.001	0.175 ***	-0.001	-
10/30/2002	-0.154	-0.005	0.001	-0.001	-0.004	-	-0.001	-0.004	0.003	-
3/25/2003	0.947	-0.029	-0.005	0.001	0.004	-	0.001	-0.030	-0.003	-
4/8/2003	0.336	0.002	0.002	-0.001	0.001	-	0.000	0.003	-0.001	-
4/30/2003	0.091	0.001	-0.006	-0.011 *	0.001	-	0.000	0.012	-0.001	-
1/20/2004	-1.384	0.051 *	0.030	0.001	0.000	-	0.003	0.050 *	0.003	-
12/2/2008	0.924	-0.049 *	-0.030	-0.004	-0.013 **	-0.053 *	0.005	-0.045 *	0.018 *	-0.023 **
12/19/2008	0.779	-0.036	-0.026	-0.049 ***	-0.117 ***	-0.016	-0.041 ***	0.013	0.076 ***	0.010
2/3/2009	-0.696	0.006	0.019	0.001	0.005	0.017	-0.004	0.005	-0.009	-0.002
2/19/2009	0.029	0.007	-0.006	0.000	0.002	-0.003	0.001	0.007	-0.001	0.003
3/18/2009	0.784	-0.001	-0.015	0.000	0.006	-0.014	-0.003	-0.001	-0.009	0.001
12/1/2009	2.099	-0.064 **	-0.079 **	-0.037 **	-0.030 **	-0.076 **	-0.005	-0.027	0.025 **	0.003
3/17/2010	-0.348	0.005	0.005	-0.002	0.000	0.013	-0.001	0.007	-0.001	0.008
5/21/2010	0.431	-0.020	-0.009	0.000	0.000	-0.010	0.000	-0.020	0.000	-0.001
8/30/2010	-0.283	0.020	0.004	0.000	0.000	0.002	0.000	0.020	0.000	-0.002
10/5/2010	0.952	-0.029	-0.026 *	-0.009 *	-0.006 **	-0.014	-0.009 ***	-0.020	-0.003 *	0.012
3/14/2011	3.203	-0.042 **	-0.072 ***	-0.017 **	-0.001 *	-0.144 ***	0.000	-0.025	0.001	-0.072 ***
6/14/2011	-0.749	0.010	0.010	0.000	0.000	0.009	0.000	0.010	0.000	-0.001
10/27/2011	-0.610	0.013	0.010	-0.002	0.000	0.014	0.000	0.015	0.000	0.004
2/14/2012	0.828	-0.016	-0.018	-0.002	0.000	-0.010	0.000	-0.014	0.000	0.008
3/13/2012	0.087	-0.003	0.000	0.001	0.000	0.004	0.000	-0.004	0.000	0.004
4/27/2012	1.172	-0.020	-0.016	-0.001	0.000	0.018	0.000	-0.019	0.000	0.034 **
9/19/2012	-0.346	0.004	-0.004	-0.004	0.000	-0.000	0.000	0.008	0.000	0.004
10/30/2012	0.774	-0.014	-0.008	0.000	0.000	0.008	0.000	-0.014	0.000	0.016
12/20/2012	0.561	0.000	-0.016	-0.001	0.000	-0.019	0.000	0.001	0.000	-0.003
1/22/2013	0.172	-0.008	0.000	0.001	0.000	0.020	0.000	-0.009	0.000	0.020 *
4/4/2013	2.556	-0.114 ***	-0.012	-0.001	0.006 **	-0.017	-0.003 **	-0.113 ***	-0.009 **	-0.005

	Surprise	TOPIX	TOPIX Banks	ΔUSD/JPY	ΔEURO/JPY	ΔGBP/JPY	ΔKRW/JPY
3/19/2001	-0.094	0.179	-0.143	0.579	0.100	0.455	-
8/14/2001	0.745	2.686 **	6.071 **	-0.318	-0.282	-0.333	-
9/18/2001	-0.218	1.656	-0.088	0.298	0.211	0.162	-
12/19/2001	-0.031	0.407	3.107 *	0.031	0.756 *	0.660	-
2/28/2002	0.223	0.655	1.315	0.388	0.414	0.603	-
9/18/2002	-6.189	-0.498	1.637	0.419	0.514	0.616	-
10/30/2002	-0.154	0.866	1.870	0.236	0.199	0.219	-
3/25/2003	0.947	-2.329 *	-1.546	0.857 *	0.234	0.715	-
4/8/2003	0.336	-0.987	-2.534	-0.083	0.133	0.094	-
4/30/2003	0.091	2.989 **	5.106 **	0.234	-0.181	0.139	-
1/20/2004	-1.384	0.351	-0.851	-0.344	-1.089 **	-1.167 **	-
12/2/2008	0.924	-4.999 **	-6.965 **	0.118	-0.145	0.704	-1.490
12/19/2008	0.779	-0.509	0.600	0.426	2.142 **	0.577	-1.640 *
2/3/2009	-0.696	-0.523	-0.645	-0.067	0.096	0.324	-1.047
2/19/2009	0.029	0.310	0.014	0.149	-0.915	-0.878	0.394
3/18/2009	0.784	0.528	1.885	0.020	-0.218	1.128	0.890
12/1/2009	2.099	2.099	2.447	-0.427	-0.906	-1.169 *	-0.925
3/17/2010	-0.348	0.990	0.655	-0.232	-0.393	-0.933	-0.712
5/21/2010	0.431	-2.077	-1.223	-0.256	-0.437	-0.211	0.950
8/30/2010	-0.283	1.163	0.075	0.718	1.156	0.615	0.786
10/5/2010	0.952	1.196	2.630 *	0.024	-0.594	-0.232	0.487
3/14/2011	3.203	-7.783 ***	-8.232 ***	-0.220	-0.701	-0.419	0.206
6/14/2011	-0.749	1.297	2.118	0.112	-0.017	-0.064	-0.068
10/27/2011	-0.610	2.161 **	3.925 **	0.461	-0.433	0.180	-1.489 **
2/14/2012	0.828	0.653	1.135	-0.502	-0.624	-0.452	-0.101
3/13/2012	0.087	0.006	0.605	-0.534	-0.249	-0.628	-0.314
4/27/2012	1.172	-0.722	-0.320	0.396	0.374	0.191	0.434
9/19/2012	-0.346	0.846	0.169	-0.139	0.195	0.089	-0.368
10/30/2012	0.774	-0.928	-0.717	0.477	0.097	0.240	-0.165
12/20/2012	0.561	-0.087	0.729	0.511	0.359	0.383	0.740
1/22/2013	0.172	-0.444	-0.708	1.009 ***	0.715	0.882 *	1.002
4/4/2013	2.556	2.669 **	4.907 **	-2.610 ***	-2.299 ***	-2.094 ***	-1.991 **

Note: \* indicates that the value falls in the 2.5-5 or 95-97.5 percentile. \*\* indicates that the value falls in the 0.5-2.5 or 97.5-99.5 percentile. \*\*\* indicates that the value falls in the 0-0.5 percentiles or 99.5-100 percentile.

(b) FRB

	Surprise	10-year U.S. Treasuries	5-year U.S. Treasuries	1-year U.S. Treasuries	3-month U.S. Treasuries	5-year BBB corporate bonds	3-month USD LIBOR rate	Spread between 10- and 1-year U.S. Treasuries	Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries
12/12/2007	-1.233	0.120 *	0.155 *	0.000	-0.041	0.206 *	-0.067 *	0.120 *	-0.025	0.051
3/11/2008	-2.434	0.137 *	0.251 **	0.000	0.144 *	0.250 **	-0.018	0.137 *	-0.161 *	-0.001
3/17/2008	1.309	-0.162 **	-0.196 **	0.000	-0.164	-0.221 **	-0.037	-0.162 **	0.127	-0.025
9/19/2008	-5.172	0.267 ***	0.412 ***	0.488 ***	0.813 ***	0.415 ***	-0.013	-0.221 ***	-0.825 ***	0.003
10/7/2008	-1.500	0.050	0.016	-0.062	0.295 **	0.098	0.204 **	0.111	-0.091	0.082 *
10/21/2008	2.778	-0.103	-0.128	-0.083 *	-0.010	-0.216 **	-0.293 **	-0.020	-0.282 **	-0.088 **
11/25/2008	2.805	-0.216 **	-0.165 **	0.021	0.091 ***	-0.334 ***	-0.015	-0.236 ***	-0.106 **	-0.169 **
12/1/2008	2.431	-0.189 **	-0.200 **	-0.092 **	0.000	-0.284 **	-0.010	-0.097	-0.010	-0.084 *
12/16/2008	2.873	-0.257 **	-0.197 **	-0.025	-0.020	-0.197 **	-0.270 ***	-0.232 **	-0.250 ***	-0.000
1/28/2009	-1.334	0.139 *	0.127 *	0.020	0.046 **	0.149 *	-0.004	0.119 *	-0.050	0.022
3/18/2009	6.755	-0.474 ***	-0.406 ***	-0.127 **	-0.029	-0.365 ***	-0.061 *	-0.347 ***	-0.031	0.042 *
8/10/2010	0.901	-0.070	-0.075	-0.005	0.003	-0.083	-0.013 ***	-0.065	-0.017 *	-0.008
9/21/2010	1.860	-0.130 *	-0.112 *	0.000	0.000	-0.080	-0.000	-0.130 **	-0.000	0.032
11/3/2010	0.089	-0.016	-0.048	-0.003	0.005	-0.030	-0.000	-0.013	-0.005	0.019
9/21/2011	0.516	-0.081	-0.000	0.031 **	0.000	0.006	0.003	-0.112 *	0.003	0.006
9/13/2012	1.228	-0.035	-0.048	-0.005	-0.005	-0.063	-0.004	-0.029	0.002	-0.015
12/12/2012	-0.996	0.044	0.018	0.005	-0.005	-0.004	-0.002	0.039	0.004	-0.022

	Surprise	S&P 500	S&P 500 Banks	ΔJPY/USD	ΔEURO/USD	ΔGBP/USD	ΔBRL/USD
12/12/2007	-1.233	0.603	-2.396	-1.048 *	-0.061	-0.171	-0.781
3/11/2008	-2.434	3.646 **	9.654 **	-1.324 **	0.909 *	0.576	-0.832
3/17/2008	1.309	-0.900	-1.372	-1.022 *	0.273	0.325	0.481
9/19/2008	-5.172	3.947 **	9.807 **	0.074	-1.694 ***	-1.829 ***	-4.664 **
10/7/2008	-1.500	-5.911 **	-9.102 **	0.384	-0.118	-0.212	5.854 **
10/21/2008	2.778	-3.128 *	0.116	1.043 *	1.157 **	1.839 ***	5.463 **
11/25/2008	2.805	0.653	2.627	0.576	-1.737 **	-2.652 ***	-0.023
12/1/2008	2.431	-9.354 ***	-18.917 ***	0.663	0.325	1.016	0.818
12/16/2008	2.873	5.008 **	10.898 *	0.928	-2.640 ***	-2.259 **	-2.755 *
1/28/2009	-1.334	3.301 *	18.275 ***	-1.158 *	0.606	0.119	-3.296 **
3/18/2009	6.755	2.064	12.310 **	2.403 ***	-3.213 ***	-2.742 ***	-1.541
8/10/2010	0.901	-0.599	-0.806	0.677 *	-0.144	-0.665	0.315
9/21/2010	1.860	-0.257	-1.166	0.446	-1.015 *	-0.674	-1.326 *
11/3/2010	0.089	0.367	1.930	-0.358	-0.610	0.310	-0.153
9/21/2011	0.516	-2.983 **	-4.897 **	-0.183	0.668	1.053 **	5.242 ***
9/13/2012	1.228	1.618 *	2.957 **	0.296	-0.649	-0.316	-0.385
12/12/2012	-0.996	0.045	0.432	-0.482	-0.352	-0.043	-0.249

Note: See Table 2(a).

(c) ECB

	Surprise	10-year German Bunds	5-year German Bunds	1-year German Bunds	3-month German Bunds	5-year BBB corporate bonds	3-month EUR LIBOR rate	Spread between 10- and 1-year German Bunds	Spread between 3-month EUR LIBOR rate and 3-month German Bunds	Spread between 5-year BBB corporate bonds and 5-year German Bunds
8/22/2007	-0.999	0.065	0.120 **	0.124 **	0.041	0.060	0.059 ***	-0.059	0.018	-0.060 *
3/28/2008	-0.085	0.014	0.013	-0.007	0.023	0.009	-0.008	0.021	-0.031	-0.004
9/29/2008	3.612	-0.192 ***	-0.216 ***	-0.461 ***	-0.501 ***	-0.136 **	0.051 **	0.269 ***	0.552 ***	0.080 **
10/15/2008	-0.022	0.007	-0.035	0.091 **	0.027	0.248 ***	-0.094 ***	-0.084 *	-0.121 **	0.283 ***
5/7/2009	-2.353	0.140 **	0.114 **	-0.023	-0.022	0.042	-0.015	0.163 **	0.007	-0.072 **
5/10/2010	-2.890	0.158 ***	0.140 **	0.040	-0.029	0.063	0.000	0.118 **	0.029	-0.077 **
10/6/2011	-2.132	0.103 **	0.100 *	0.091 **	0.036	0.097 *	0.008	0.012	-0.028	-0.003
12/8/2011	1.845	-0.088 *	-0.064	-0.003	0.005	-0.056	-0.033 *	-0.085 *	-0.038	0.008
9/6/2012	-2.154	0.080 *	0.087	0.010	0.022	0.091 *	-0.001	0.070	-0.023	0.004

	Surprise	STOXX Europe 600	EURO STOXX Banks	ΔJPY/EURO	ΔUSD/EURO	ΔGBP/EURO
8/22/2007	-0.999	1.580	1.046	-0.642	-0.392	0.210
3/28/2008	-0.085	-0.264	0.134	0.870	0.070	0.032
9/29/2008	3.612	-5.437 **	-7.866 ***	1.341 *	-0.611	0.271
10/15/2008	-0.022	-6.483 ***	-6.625 ***	2.799 ***	1.266 **	0.421
5/7/2009	-2.353	-1.002	-1.166	-0.332	-0.502	1.373 ***
5/10/2010	-2.890	8.670 ***	17.763 ***	1.663 **	1.606 **	-0.587
10/6/2011	-2.132	3.123	3.943 *	-0.720	-0.642	0.745 *
12/8/2011	1.845	-2.380	-4.439 *	0.029	0.337	0.111
9/6/2012	-2.154	3.020 **	5.758 **	-0.655	-0.127	0.008

Note: See Table 2(a).



(d) BOE

	Surprise	10-year U.K. Gilts	5-year U.K. Gilts	1-year U.K. Gilts	5-year BBB corporate bonds	3-month GBP LIBOR rate	Spread between 10- and 1-year U.K. Gilts	Spread between 1-year GBP LIBOR rate and 1-year U.K. Gilts	Spread between 5-year BBB corporate bonds and 5-year U.K. Gilts
2/11/2009	3.126	-0.241 ***	-0.232 ***	-0.290 ***	-0.229 ***	-0.012	0.049	0.267 ***	0.003
3/5/2009	3.718	-0.285 ***	-0.205 ***	-0.038	-0.225 ***	-0.039 *	-0.247 ***	0.017	-0.020
5/7/2009	-0.897	0.073	0.026	0.006	0.006	-0.007	0.067	-0.008	-0.020
8/6/2009	1.178	-0.095 *	-0.069	-0.006	-0.084	-0.011	-0.089 *	-0.012	-0.015
11/5/2009	-0.901	0.062	0.040	-0.006	0.031	0.006	0.068	0.012	-0.009
2/4/2010	0.227	-0.018	-0.029	-0.031	-0.024	0.004	0.013	0.033	0.005
10/6/2011	-1.095	0.038	0.020	0.025	0.009	-0.001	0.013	-0.023	-0.011
2/9/2012	-0.779	0.034	-0.035	0.008	-0.044	0.000	0.026	-0.008	-0.009
7/5/2012	0.968	-0.068	-0.107 *	-0.031	-0.087 *	-0.009	-0.037	0.021	0.020

	Surprise	FTSE 350	FTSE 350 Banks	ΔJPY/GBP	ΔUSD/GBP	ΔEURO/GBP
2/11/2009	3.126	0.449	-2.717	-0.952	-0.383	-0.693 *
3/5/2009	3.718	-3.147 **	-7.712 **	1.678 **	0.304	0.080
5/7/2009	-0.897	-0.092	-0.278	1.023 *	0.882 *	1.373 ***
8/6/2009	1.178	0.980	5.136 **	1.221 *	1.126 **	0.868 **
11/5/2009	-0.901	0.342	-1.019	-0.916	-0.465	-0.242
2/4/2010	0.227	-2.177	-4.737 **	2.366 ***	0.570	-0.340
10/6/2011	-1.095	3.595 **	6.357 **	0.045	0.155	0.745 *
2/9/2012	-0.779	0.374	0.313	-0.513	0.145	0.201
7/5/2012	0.968	0.090	-0.409	0.062	0.418	-0.673

Note: See Table 2(a).

Table 3(a): Effects of the surprise component: BOJ

Quantitative easing before the global financial crisis  
(1/1/2001–12/31/2006)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ_surprise	-0.029	-0.007	-0.036
5-year JGBs	QE_BOJ_surprise	-0.017 **	0.007	-0.010
1-year JGBs	QE_BOJ_surprise	-0.000	0.000	0.000
3-month JGBs	QE_BOJ_surprise	0.000	-0.000 ***	-0.000
5-year BBB corporate bonds	QE_BOJ_surprise	-	-	-
3-month JPY LIBOR rate	QE_BOJ_surprise	0.000	0.001	0.001
Spread between 10- and 1-year JGBs	QE_BOJ_surprise	-0.028	-0.008	-0.036
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_surprise	0.000	0.000	0.000
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_surprise	-	-	-
TOPIX	QE_BOJ_surprise	0.066	0.006	0.073
TOPIX Banks	QE_BOJ_surprise	-0.044	0.401	0.357
$\Delta$ USD/JPY	QE_BOJ_surprise	-0.039	0.216	0.177
$\Delta$ EURO/JPY	QE_BOJ_surprise	-0.052	0.197	0.145
$\Delta$ GBP/JPY	QE_BOJ_surprise	-0.057	0.241	0.184
$\Delta$ KRW/JPY	QE_BOJ_surprise	0.193	-0.685	-0.492

Unconventional policies in response to the global financial crisis and prior to comprehensive monetary easing  
(1/1/2007–9/30/2010)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ_surprise	-0.030 *	0.016	-0.014
5-year JGBs	QE_BOJ_surprise	-0.034 **	0.002	-0.032
1-year JGBs	QE_BOJ_surprise	-0.015 ***	0.002	-0.013
3-month JGBs	QE_BOJ_surprise	-0.013 ***	0.001	-0.012
5-year BBB corporate bonds	QE_BOJ_surprise	-0.034	0.003	-0.031
3-month JPY LIBOR rate	QE_BOJ_surprise	-0.002 **	-0.002	-0.004
Spread between 10- and 1-year JGBs	QE_BOJ_surprise	-0.014	0.022	0.008
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_surprise	0.010 ***	-0.003	0.007
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_surprise	0.001	-0.002	-0.001
TOPIX	QE_BOJ_surprise	0.354	1.380	1.734
TOPIX Banks	QE_BOJ_surprise	-0.115	-0.154	-0.268
$\Delta$ USD/JPY	QE_BOJ_surprise	-0.147	-0.518	-0.665
$\Delta$ EURO/JPY	QE_BOJ_surprise	-0.307	-0.888	-1.195
$\Delta$ GBP/JPY	QE_BOJ_surprise	-0.309	-0.759	-1.068
$\Delta$ KRW/JPY	QE_BOJ_surprise	-0.244	-0.854	-1.098

Table 3(a): Effects of the surprise component: BOJ (continued)

Comprehensive monetary easing and subsequent unconventional policies  
(10/1/2010–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ_surprise	-0.021 ***	0.007	-0.014
5-year JGBs	QE_BOJ_surprise	-0.015 ***	0.005	-0.010 **
1-year JGBs	QE_BOJ_surprise	-0.002 ***	0.003	0.001
3-month JGBs	QE_BOJ_surprise	0.000	0.000	0.000
5-year BBB corporate bonds	QE_BOJ_surprise	-0.027 ***	0.013 *	-0.014 *
3-month JPY LIBOR rate	QE_BOJ_surprise	0.000	0.000	0.000
Spread between 10- and 1-year JGBs	QE_BOJ_surprise	-0.019 ***	-0.002	-0.021 **
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_surprise	0.000	0.000	0.000
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_surprise	-0.007 ***	-0.002	-0.009 **
TOPIX	QE_BOJ_surprise	-0.771 ***	0.707	-0.064
TOPIX Banks	QE_BOJ_surprise	-0.644 ***	0.460	-0.184
$\Delta$ USD/JPY	QE_BOJ_surprise	-0.378 ***	0.187	-0.191
$\Delta$ EURO/JPY	QE_BOJ_surprise	-0.528 ***	-0.651 ***	-1.179 ***
$\Delta$ GBP/JPY	QE_BOJ_surprise	-0.464 ***	-0.297 **	-0.761 ***
$\Delta$ KRW/JPY	QE_BOJ_surprise	-0.214 ***	-0.099	-0.313

Comprehensive monetary easing and subsequent unconventional policies  
(10/1/2010–4/30/2013, ex 3/14/2011)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ_surprise	-0.025 ***	0.011	-0.014
5-year JGBs	QE_BOJ_surprise	-0.014 ***	0.002	-0.011
1-year JGBs	QE_BOJ_surprise	-0.000	-0.000	-0.001
3-month JGBs	QE_BOJ_surprise	0.000	0.000	0.000
5-year BBB corporate bonds	QE_BOJ_surprise	-0.001	0.009	0.008
3-month JPY LIBOR rate	QE_BOJ_surprise	-0.000 ***	0.000	-0.000
Spread between 10- and 1-year JGBs	QE_BOJ_surprise	-0.026 ***	0.003	-0.023 **
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_surprise	0.000	0.000	0.000
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_surprise	0.004 **	0.002	0.006
TOPIX	QE_BOJ_surprise	-0.133	1.758 **	1.625 **
TOPIX Banks	QE_BOJ_surprise	0.152	1.846 **	1.997 **
$\Delta$ USD/JPY	QE_BOJ_surprise	-0.559 ***	-0.085	-0.644 **
$\Delta$ EURO/JPY	QE_BOJ_surprise	-0.508 ***	-0.382	-0.890 *
$\Delta$ GBP/JPY	QE_BOJ_surprise	-0.508 ***	-0.263	-0.772 *
$\Delta$ KRW/JPY	QE_BOJ_surprise	-0.253 ***	-0.076	-0.329

Notes: 1. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

2. The explanatory variables include the QE dummy, a variable to capture the bandwagon effect, and a variable to capture the mean reversion effect.

3. The observation period for the KRW is from November 24, 2003 to April 30, 2013.

Table 3(b): Effects of announcements: BOJ

Quantitative easing before the global financial crisis  
(1/1/2001–12/31/2006)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ	0.014 ***	-0.010	0.004
5-year JGBs	QE_BOJ	0.007 ***	-0.007	0.000
1-year JGBs	QE_BOJ	-0.002 *	-0.001	-0.003
3-month JGBs	QE_BOJ	0.000	-0.001 ***	-0.001
5-year BBB corporate bonds	QE_BOJ	-	-	-
3-month JPY LIBOR rate	QE_BOJ	-0.002 ***	-0.001	-0.003 ***
Spread between 10- and 1-year JGBs	QE_BOJ	0.017 ***	-0.007	0.010
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ	0.000	0.003 ***	0.003 ***
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ	-	-	-
TOPIX	QE_BOJ	0.605 *	0.569	1.174
TOPIX Banks	QE_BOJ	1.166 ***	1.706	2.872 **
$\Delta$ USD/JPY	QE_BOJ	0.172	-0.054	0.118
$\Delta$ EURO/JPY	QE_BOJ	0.021	-0.399 *	-0.378
$\Delta$ GBP/JPY	QE_BOJ	0.129	-0.119	0.010
$\Delta$ KRW/JPY	QE_BOJ	-0.268	0.948	0.680

Unconventional policies in response to the global financial crisis and prior to comprehensive monetary easing (1/1/2007–9/30/2010)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ	-0.016 ***	0.010	-0.006
5-year JGBs	QE_BOJ	-0.016 ***	0.003	-0.013
1-year JGBs	QE_BOJ	-0.003 ***	0.002	-0.001
3-month JGBs	QE_BOJ	-0.004 ***	0.002	-0.002
5-year BBB corporate bonds	QE_BOJ	-0.011 **	0.015	0.004
3-month JPY LIBOR rate	QE_BOJ	0.000	0.001	0.001
Spread between 10- and 1-year JGBs	QE_BOJ	-0.005	0.016	0.011
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ	0.003 ***	0.000	0.003
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ	0.001	0.006	0.007
TOPIX	QE_BOJ	0.320	0.037	0.357
TOPIX Banks	QE_BOJ	-0.064	-0.833	-0.897
$\Delta$ USD/JPY	QE_BOJ	-0.190	-0.663 **	-0.853 ***
$\Delta$ EURO/JPY	QE_BOJ	-0.154	-0.415	-0.569
$\Delta$ GBP/JPY	QE_BOJ	-0.335	-0.071	-0.406
$\Delta$ KRW/JPY	QE_BOJ	-0.407	-0.016	-0.423

Table 3(b): Effects of announcements: BOJ (continued)

Comprehensive monetary easing and subsequent unconventional policies  
(10/1/2010–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ	-0.012 ***	0.006	-0.006
5-year JGBs	QE_BOJ	-0.010 ***	0.008	-0.002
1-year JGBs	QE_BOJ	-0.002 **	0.002	0.000
3-month JGBs	QE_BOJ	cannot estimate		
5-year BBB corporate bonds	QE_BOJ	-0.006 *	0.013	0.007
3-month JPY LIBOR rate	QE_BOJ	cannot estimate		
Spread between 10- and 1-year JGBs	QE_BOJ	-0.011 ***	0.000	-0.011
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ	cannot estimate		
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ	0.004	0.003	0.007
TOPIX	QE_BOJ	-0.113	0.440	0.327
TOPIX Banks	QE_BOJ	0.393 *	0.275	0.668
$\Delta$ USD/JPY	QE_BOJ	-0.294 ***	-0.500 **	-0.794 ***
$\Delta$ EURO/JPY	QE_BOJ	-0.237 *	0.152	-0.085
$\Delta$ GBP/JPY	QE_BOJ	-0.166	-0.198	-0.364
$\Delta$ KRW/JPY	QE_BOJ	-0.145	-0.109	-0.254

Comprehensive monetary easing and subsequent unconventional policies  
(10/1/2010–4/30/2013, ex 3/14/2011)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year JGBs	QE_BOJ	-0.011 ***	0.005	-0.006
5-year JGBs	QE_BOJ	-0.005	0.007	0.002
1-year JGBs	QE_BOJ	-0.002	0.002	0.000
3-month JGBs	QE_BOJ	cannot estimate		
5-year BBB corporate bonds	QE_BOJ	0.007	0.014	0.021 **
3-month JPY LIBOR rate	QE_BOJ	cannot estimate		
Spread between 10- and 1-year JGBs	QE_BOJ	-0.010 ***	0.002	-0.008
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ	cannot estimate		
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ	0.008 **	0.003	0.011
TOPIX	QE_BOJ	0.335	0.515	0.850
TOPIX Banks	QE_BOJ	0.932 ***	0.441	1.373
$\Delta$ USD/JPY	QE_BOJ	-0.265 ***	-0.548 **	-0.813 ***
$\Delta$ EURO/JPY	QE_BOJ	cannot estimate		
$\Delta$ GBP/JPY	QE_BOJ	-0.163	-0.249	-0.412
$\Delta$ KRW/JPY	QE_BOJ	-0.132	0.019	-0.113

Notes: See Table 3(a).

Table 4(a): Effects of the surprise component: FRB

Credit easing (1/1/2007–10/31/2008)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB_surprise	-0.054	-0.014	-0.069
5-year U.S. Treasuries	QE_FRB_surprise	-0.080 *	0.009	-0.071
1-year U.S. Treasuries	QE_FRB_surprise	-0.029 ***	-0.001	-0.031
3-month U.S. Treasuries	QE_FRB_surprise	-0.074 *	0.070	-0.004
5-year BBB corporate bonds	QE_FRB_surprise	-0.094 **	0.020	-0.075
3-month USD LIBOR rate	QE_FRB_surprise	-0.001	0.058 ***	0.057
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_surprise	0.008	-0.017	-0.010
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_surprise	0.041	0.000	0.042
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_surprise	-0.016 ***	0.030 ***	0.014
S&P 500	QE_FRB_surprise	-0.876 *	1.527 ***	0.651
S&P 500 Banks	QE_FRB_surprise	-1.986 ***	4.745 ***	2.759 ***
$\Delta$ JPY/USD	QE_FRB_surprise	-0.127	0.403	0.275
$\Delta$ EURO/USD	QE_FRB_surprise	0.119 ***	0.130	0.248
$\Delta$ GBP/USD	QE_FRB_surprise	0.150 ***	-0.115	0.036
$\Delta$ BRL/USD	QE FRB surprise	0.329	-1.137 ***	-0.807

QE1 (11/1/2008–6/30/2010)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB_surprise	-0.075 ***	-0.010	-0.084 **
5-year U.S. Treasuries	QE_FRB_surprise	-0.064 **	0.000	-0.064 *
1-year U.S. Treasuries	QE_FRB_surprise	-0.018 ***	0.002	-0.016
3-month U.S. Treasuries	QE_FRB_surprise	-0.005	-0.005	-0.010
5-year BBB corporate bonds	QE_FRB_surprise	-0.064 ***	0.002	-0.062
3-month USD LIBOR rate	QE_FRB_surprise	-0.008 ***	0.005	-0.004
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_surprise	-0.058 ***	0.002	-0.055
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_surprise	-0.006	0.001	-0.005
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_surprise	0.008	-0.001	0.007
S&P 500	QE_FRB_surprise	0.161	0.500	0.661
S&P 500 Banks	QE_FRB_surprise	0.146	0.518	0.664
$\Delta$ JPY/USD	QE_FRB_surprise	-0.357	-0.163	-0.520
$\Delta$ EURO/USD	QE_FRB_surprise	-0.464 **	-0.127	-0.590 *
$\Delta$ GBP/USD	QE_FRB_surprise	-0.383 ***	0.045	-0.338
$\Delta$ BRL/USD	QE FRB surprise	-0.157	0.073	-0.083

Table 4(a): Effects of the surprise component: FRB (continued)

QE2 (7/1/2010–12/31/2011)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB_surprise	-0.074	-0.008	-0.082
5-year U.S. Treasuries	QE_FRB_surprise	-0.060	0.026	-0.035
1-year U.S. Treasuries	QE_FRB_surprise	0.002	0.002	0.003
3-month U.S. Treasuries	QE_FRB_surprise	0.002	0.004	0.006
5-year BBB corporate bonds	QE_FRB_surprise	-0.051	0.020	-0.032
3-month USD LIBOR rate	QE_FRB_surprise	0.000	0.000	0.000
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_surprise	-0.076	-0.012	-0.088
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_surprise	-0.003	-0.000	-0.003
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_surprise	0.012	0.010	0.021
S&P 500	QE_FRB_surprise	-0.328	-0.570	-0.898
S&P 500 Banks	QE_FRB_surprise	-0.870	-2.064	-2.934
$\Delta$ JPY/USD	QE_FRB_surprise	-0.269	-0.057	-0.326
$\Delta$ EURO/USD	QE_FRB_surprise	-0.366	-0.025	-0.391
$\Delta$ GBP/USD	QE_FRB_surprise	-0.279	-0.237	-0.516
$\Delta$ BRL/USD	QE_FRB_surprise	-0.421	0.239	-0.183

QE3 (1/1/2012–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB_surprise	-0.035	0.006	-0.030
5-year U.S. Treasuries	QE_FRB_surprise	-0.029	-0.015	-0.044
1-year U.S. Treasuries	QE_FRB_surprise	-0.005	0.017	0.012
3-month U.S. Treasuries	QE_FRB_surprise	-0.001	0.008	0.007
5-year BBB corporate bonds	QE_FRB_surprise	-0.028	-0.041	-0.069
3-month USD LIBOR rate	QE_FRB_surprise	0.001	-0.002	-0.001
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_surprise	-0.031	-0.010	-0.040
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_surprise	-0.002	-0.012	-0.013
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_surprise	-0.003	-0.031	-0.033
S&P 500	QE_FRB_surprise	0.845 *	0.354	1.199
S&P 500 Banks	QE_FRB_surprise	1.462 ***	-0.246	1.216
$\Delta$ JPY/USD	QE_FRB_surprise	-0.342	0.411	0.069
$\Delta$ EURO/USD	QE_FRB_surprise	-0.136	0.307	0.171
$\Delta$ GBP/USD	QE_FRB_surprise	-0.156	0.094	-0.062
$\Delta$ BRL/USD	QE_FRB_surprise	-0.237	-0.082	-0.319

Notes: 1. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

2. The explanatory variables include the QE dummy, a variable to capture the bandwagon effect, and a variable to capture the mean reversion effect.

Table 4(b): Effects of announcements: FRB

Credit easing (1/1/2007–10/31/2008)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB	0.031	0.035	0.066
5-year U.S. Treasuries	QE_FRB	0.074 ***	0.039	0.113
1-year U.S. Treasuries	QE_FRB	0.021	0.004	0.025
3-month U.S. Treasuries	QE_FRB	0.043	-0.378 ***	-0.335 **
5-year BBB corporate bonds	QE_FRB	0.071 ***	0.105	0.176
3-month USD LIBOR rate	QE_FRB	-0.026 **	0.027	0.001
Spread between 10- and 1-year U.S. Treasuries	QE_FRB	-0.022	0.046	0.024
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB	-0.089 *	0.328 ***	0.239 ***
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB	-0.007	0.026	0.019
S&P 500	QE_FRB	0.672	-1.004	-0.332
S&P 500 Banks	QE_FRB	2.399 ***	0.292	2.691
$\Delta$ JPY/USD	QE_FRB	0.462 *	0.473	0.935
$\Delta$ EURO/USD	QE_FRB	0.204	0.516	0.720 *
$\Delta$ GBP/USD	QE_FRB	0.149	0.527	0.676
$\Delta$ BRL/USD	QE_FRB	-0.179	1.729	1.550

QE1 (11/1/2008–6/30/2010)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB	-0.211 ***	-0.115	-0.326 ***
5-year U.S. Treasuries	QE_FRB	-0.173 ***	-0.065	-0.238 ***
1-year U.S. Treasuries	QE_FRB	-0.050 ***	-0.043	-0.093 **
3-month U.S. Treasuries	QE_FRB	0.002	-0.021	-0.019
5-year BBB corporate bonds	QE_FRB	-0.176 ***	0.007	-0.169
3-month USD LIBOR rate	QE_FRB	-0.047 ***	0.040	-0.007
Spread between 10- and 1-year U.S. Treasuries	QE_FRB	-0.161 ***	-0.008	-0.169 *
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB	-0.053 ***	0.016	-0.037
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB	0.015	-0.006	0.009
S&P 500	QE_FRB	1.177	-0.256	0.921
S&P 500 Banks	QE_FRB	1.794	0.497	2.291
$\Delta$ JPY/USD	QE_FRB	-0.815 ***	-0.561	-1.376
$\Delta$ EURO/USD	QE_FRB	-1.753 ***	-0.181	-1.934 **
$\Delta$ GBP/USD	QE_FRB	-1.261 ***	-0.037	-1.298
$\Delta$ BRL/USD	QE_FRB	-1.965 *	1.524	-0.441



Table 4(b): Effects of announcements: FRB (continued)

QE2 (7/1/2010–12/31/2011)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB	-0.079 *	-0.024	-0.103
5-year U.S. Treasuries	QE_FRB	-0.060 *	0.029	-0.031
1-year U.S. Treasuries	QE_FRB	0.004	0.001	0.005
3-month U.S. Treasuries	QE_FRB	0.003	0.002	0.005
5-year BBB corporate bonds	QE_FRB	-0.050	0.032	-0.018
3-month USD LIBOR rate	QE_FRB	0.000	0.000	0.000
Spread between 10- and 1-year U.S. Treasuries	QE_FRB	-0.083 **	-0.029	-0.112
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB	-0.004	0.001	-0.003
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB	0.005	0.028	0.033
S&P 500	QE_FRB	-0.704 *	-0.252	-0.956
S&P 500 Banks	QE_FRB	-1.033	-0.205	-1.238
$\Delta$ JPY/USD	QE_FRB	-0.191	0.174	-0.017
$\Delta$ EURO/USD	QE_FRB	-0.253	0.206	-0.047
$\Delta$ GBP/USD	QE_FRB	0.026	-0.247	-0.221
$\Delta$ BRL/USD	QE_FRB	0.048	0.267	0.315

QE3 (1/1/2012–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.S. Treasuries	QE_FRB	0.013	0.086	0.099
5-year U.S. Treasuries	QE_FRB	-0.005	0.077	0.072
1-year U.S. Treasuries	QE_FRB	-0.003	0.004	0.001
3-month U.S. Treasuries	QE_FRB	cannot estimate		
5-year BBB corporate bonds	QE_FRB	-0.024	0.050	0.026
3-month USD LIBOR rate	QE_FRB	-0.001	0.000	-0.001
Spread between 10- and 1-year U.S. Treasuries	QE_FRB	0.011	0.089	0.100
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB	0.003	0.005	0.008
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB	-0.016	-0.031	-0.047
S&P 500	QE_FRB	0.730 **	-0.194	0.536
S&P 500 Banks	QE_FRB	1.483 ***	0.473	1.956
$\Delta$ JPY/USD	QE_FRB	0.041	0.554	0.595
$\Delta$ EURO/USD	QE_FRB	-0.497	-0.453	-0.950
$\Delta$ GBP/USD	QE_FRB	-0.217	-0.117	-0.334
$\Delta$ BRL/USD	QE_FRB	-0.350	0.310	-0.040

Notes: See Table 4(a).

Table 5(a): Effects of the surprise component: ECB

Unconventional policies (1/1/2007–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year German Bunds	QE_ECB_surprise	-0.052	-0.002	-0.054
5-year German Bunds	QE_ECB_surprise	-0.051 **	-0.001	-0.052
1-year German Bunds	QE_ECB_surprise	-0.015 ***	0.000	-0.014
3-month German Bunds	QE_ECB_surprise	0.003	0.003	0.006
5-year BBB corporate bonds	QE_ECB_surprise	-0.032 **	0.009	-0.024
3-month EUR LIBOR rate	QE_ECB_surprise	-0.003 ***	0.001	-0.002
Spread between 10- and 1-year German Bunds	QE_ECB_surprise	-0.007 *	0.003	-0.004
Spread between 3-month EUR LIBOR rate and 3-month German Bunds	QE_ECB_surprise	-0.004	0.000	-0.004
Spread between 5-year BBB corporate bonds and 5-year German Bunds	QE_ECB_surprise	0.024 ***	0.005	0.030 *
STOXX Europe 600	QE_ECB_surprise	-1.268 ***	-0.497	-1.765 **
EURO STOXX Banks	QE_ECB_surprise	-2.511 ***	-0.854	-3.365 ***
$\Delta$ JPY/EURO	QE_ECB_surprise	-0.199	-0.224	-0.423 *
$\Delta$ USD/EURO	QE_ECB_surprise	-0.008	-0.519 ***	-0.527 ***
$\Delta$ GBP/EURO	QE_ECB_surprise	-0.063	-0.230	-0.293

Notes: See Table 4(a).

Table 5(b): Effects of announcements: ECB

Unconventional policies (1/1/2007–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year German Bunds	QE_ECB	0.045 ***	-0.004	0.041
5-year German Bunds	QE_ECB	0.057 ***	-0.016	0.041
1-year German Bunds	QE_ECB	0.015	0.001	0.016
3-month German Bunds	QE_ECB	-0.003	-0.013	-0.016
5-year BBB corporate bonds	QE_ECB	0.054 ***	0.000	0.054
3-month EUR LIBOR rate	QE_ECB	-0.004 ***	0.000	-0.004
Spread between 10- and 1-year German Bunds	QE_ECB	0.042 ***	-0.012	0.030
Spread between 3-month EUR LIBOR rate and 3-month German Bunds	QE_ECB	0.009	0.000	0.009
Spread between 5-year BBB corporate bonds and 5-year German Bunds	QE_ECB	-0.039 ***	0.014	-0.025
STOXX Europe 600	QE_ECB	1.281 ***	1.154	2.435
EURO STOXX Banks	QE_ECB	2.091	2.160	4.251 *
$\Delta$ JPY/EURO	QE_ECB	0.041	-0.412	-0.371
$\Delta$ USD/EURO	QE_ECB	0.017	0.117	0.134
$\Delta$ GBP/EURO	QE_ECB	0.213	0.002	0.215

Notes: See Table 4(a).

Table 6(a): Effects of the surprise component: BOE

Quantitative easing (1/1/2007–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.K. Gilts	QE_BOE_surprise	-0.074	-0.032	-0.106
5-year U.K. Gilts	QE_BOE_surprise	-0.058 ***	-0.007	-0.065
1-year U.K. Gilts	QE_BOE_surprise	-0.031 ***	0.009	-0.023
5-year BBB corporate bonds	QE_BOE_surprise	-0.055 ***	-0.001	-0.056 *
3-month GBP LIBOR rate	QE_BOE_surprise	-0.001	0.001	0.000
Spread between 10- and 1-year U.K. Gilts	QE_BOE_surprise	0.025 **	-0.017	0.008
Spread between 1-year GBP LIBOR rate and 1-year U.K. Gilts	QE_BOE_surprise	-0.034 ***	-0.046 **	-0.080 ***
Spread between 5-year BBB corporate bonds and 5-year U.K. Gilts	QE_BOE_surprise	0.000	0.006	0.006
FTSE 350	QE_BOE_surprise	-0.388	-0.266	-0.654
FTSE 350 Banks	QE_BOE_surprise	-0.329	-0.636	-0.966
$\Delta$ JPY/GBP	QE_BOE_surprise	-0.255 *	0.217	-0.038
$\Delta$ USD/GBP	QE_BOE_surprise	-0.154	-0.302	-0.456
$\Delta$ EURO/GBP	QE_BOE_surprise	0.108	-0.186	-0.078

Notes: See Table 4(a).

Table 6(b): Effects of announcements: BOE

Quantitative easing (1/1/2007–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3s}$	$\sum_{s=0}^3 \phi_{3s}$
10-year U.K. Gilts	QE_BOE	-0.033 **	-0.020	-0.053
5-year U.K. Gilts	QE_BOE	-0.053 ***	-0.028	-0.081
1-year U.K. Gilts	QE_BOE	-0.009	-0.005	-0.014
5-year BBB corporate bonds	QE_BOE	-0.058 ***	-0.031	-0.089 **
3-month GBP LIBOR rate	QE_BOE	0.000	-0.002	-0.002
Spread between 10- and 1-year U.K. Gilts	QE_BOE	-0.017	0.004	-0.013
Spread between 1-year GBP LIBOR rate and 1-year U.K. Gilts	QE_BOE	0.004	0.002	0.006
Spread between 5-year BBB corporate bonds and 5-year U.K. Gilts	QE_BOE	-0.006	-0.005	-0.011
FTSE 350	QE_BOE	-0.127	-0.021	-0.148
FTSE 350 Banks	QE_BOE	-0.283	-0.087	-0.370
$\Delta$ JPY/GBP	QE_BOE	-0.304 **	-0.508	-0.812 *
$\Delta$ USD/GBP	QE_BOE	-0.333 *	-0.476	-0.809 **
$\Delta$ EURO/GBP	QE_BOE	-0.084	0.206	0.122

Notes: See Table 4(a).

Table 7(a): Effects of the surprise component with and without forward guidance: FRB

Surprise component without forward guidance  
(11/1/2008–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3Ns}$	$\sum_{s=0}^3 \phi_{3Ns}$
10-year U.S. Treasuries	QE_FRB_noforward	-0.069	-0.043	-0.112
5-year U.S. Treasuries	QE_FRB_noforward	-0.060	-0.026	-0.086
1-year U.S. Treasuries	QE_FRB_noforward	0.001	-0.000	0.001
3-month U.S. Treasuries	QE_FRB_noforward	0.000	-0.003	-0.003
5-year BBB corporate bonds	QE_FRB_noforward	-0.066 **	0.000	-0.066
3-month USD LIBOR rate	QE_FRB_noforward	0.000	0.000	0.000
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_noforward	-0.060 ***	-0.014	-0.074
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_noforward	-0.002	0.002	0.000
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_noforward	0.010	0.005	0.015
S&P 500	QE_FRB_noforward	-0.647 *	0.014	-0.634
S&P 500 Banks	QE_FRB_noforward	-1.550 ***	-1.099	-2.649
$\Delta$ JPY/USD	QE_FRB_noforward	-0.278	-0.002	-0.280
$\Delta$ EURO/USD	QE_FRB_noforward	-0.306 **	0.081	-0.226
$\Delta$ GBP/USD	QE_FRB_noforward	-0.230 ***	-0.037	-0.267
$\Delta$ BRL/USD	QE_FRB_noforward	-0.056	0.400	0.345

Surprise component with forward guidance  
(11/1/2008–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3Fs}$	$\sum_{s=0}^3 \phi_{3Fs}$
10-year U.S. Treasuries	QE_FRB_forward	-0.059 **	0.004	-0.054
5-year U.S. Treasuries	QE_FRB_forward	-0.050	0.007	-0.043
1-year U.S. Treasuries	QE_FRB_forward	-0.014 ***	0.006	-0.009
3-month U.S. Treasuries	QE_FRB_forward	-0.004	0.002	-0.002
5-year BBB corporate bonds	QE_FRB_forward	-0.043	-0.006	-0.048
3-month USD LIBOR rate	QE_FRB_forward	-0.006 ***	0.003 ***	-0.003 **
Spread between 10- and 1-year U.S. Treasuries	QE_FRB_forward	-0.045 ***	0.005	-0.040
Spread between 3-month USD LIBOR rate and 3-month U.S. Treasuries	QE_FRB_forward	-0.005	-0.004	-0.009
Spread between 5-year BBB corporate bonds and 5-year U.S. Treasuries	QE_FRB_forward	0.002	-0.021 ***	-0.019 *
S&P 500	QE_FRB_forward	0.510 *	0.099	0.609
S&P 500 Banks	QE_FRB_forward	2.181 ***	-0.812	1.369
$\Delta$ JPY/USD	QE_FRB_forward	-0.300	-0.006	-0.306
$\Delta$ EURO/USD	QE_FRB_forward	-0.391 ***	-0.074	-0.465
$\Delta$ GBP/USD	QE_FRB_forward	-0.323 *	0.048	-0.275
$\Delta$ BRL/USD	QE_FRB_forward	-0.227	-0.010	-0.238

Notes: See Table 4(a).

Table 7(b): Effects of the surprise component with and without forward guidance: BOJ

Surprise component without forward guidance  
(1/1/2001–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3Ns}$	$\sum_{s=0}^3 \phi_{3Ns}$
10-year JGBs	QE_BOJ_noforward	-0.027 ***	-0.001	-0.028 **
5-year JGBs	QE_BOJ_noforward	-0.018 ***	0.006	-0.011 **
1-year JGBs	QE_BOJ_noforward	-0.002 ***	0.000	-0.002
3-month JGBs	QE_BOJ_noforward	cannot estimate		
5-year BBB corporate bonds	QE_BOJ_noforward	-0.024 ***	0.007	-0.017
3-month JPY LIBOR rate	QE_BOJ_noforward	cannot estimate		
Spread between 10- and 1-year JGBs	QE_BOJ_noforward	-0.024 ***	-0.001	-0.025 ***
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_noforward	cannot estimate		
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_noforward	0.003	-0.002	0.001
TOPIX	QE_BOJ_noforward	-0.033	0.294	0.260
TOPIX Banks	QE_BOJ_noforward	-0.248	-0.261	-0.509
$\Delta$ USD/JPY	QE_BOJ_noforward	-0.010	0.158	0.147
$\Delta$ EURO/JPY	QE_BOJ_noforward	-0.049	0.144 **	0.094
$\Delta$ GBP/JPY	QE_BOJ_noforward	-0.054	0.213	0.159
$\Delta$ KRW/JPY	QE_BOJ_noforward	0.166	-0.564	-0.398

Surprise component with forward guidance  
(1/1/2001–4/30/2013)

Dependent variable	Explanatory variable	$\phi_{30}$	$\sum_{s=1}^3 \phi_{3Fs}$	$\sum_{s=0}^3 \phi_{3Fs}$
10-year JGBs	QE_BOJ_forward	-0.048 ***	0.013	-0.034
5-year JGBs	QE_BOJ_forward	-0.017 ***	-0.005	-0.022 ***
1-year JGBs	QE_BOJ_forward	-0.010 ***	-0.002	-0.012
3-month JGBs	QE_BOJ_forward	cannot estimate		
5-year BBB corporate bonds	QE_BOJ_forward	-0.018 ***	0.003	-0.015
3-month JPY LIBOR rate	QE_BOJ_forward	cannot estimate		
Spread between 10- and 1-year JGBs	QE_BOJ_forward	-0.047 ***	0.004	-0.043
Spread between 3-month JPY LIBOR rate and 3-month JGBs	QE_BOJ_forward	cannot estimate		
Spread between 5-year BBB corporate bonds and 5-year JGBs	QE_BOJ_forward	0.003	0.005	0.008
TOPIX	QE_BOJ_forward	1.356	2.972 **	4.328
TOPIX Banks	QE_BOJ_forward	2.706	3.301	6.006 *
$\Delta$ USD/JPY	QE_BOJ_forward	-1.202 ***	-0.272	-1.474
$\Delta$ EURO/JPY	QE_BOJ_forward	-1.162 *	-0.369	-1.531
$\Delta$ GBP/JPY	QE_BOJ_forward	-1.021 ***	-0.348	-1.369
$\Delta$ KRW/JPY	QE_BOJ_forward	-0.640 ***	0.396	-0.244

Notes 1. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% level, respectively.

- The explanatory variables include the QE dummy, a variable to capture the bandwagon effect, and a variable to capture the mean reversion effect.
- The observation period for the KRW is from November 24, 2003 to April 30, 2013.
- The observation period for 5-year BBB corporate bond yields and the spread between 5-year BBB corporate bond yields and 5-year JGB yields is from January 15, 2004 to April 30, 2013.