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THE EFFECT OF QUANTITATIVE EASING ANNOUNCEMENTS ON STOCK RETURNS

Master's Thesis in Accounting and Finance
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TABLE OF CONTENTS **page**

LIST OF FIGURES AND TABLES

FIGURES

TABLES

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ABSTRACT

When interest rates approach zero, conventional monetary policy may cease to be effective and central banks may adopt the use of unconventional monetary policies, such as quantitative easing. The popularity of QE has increased particularly in the wake of the financial crisis that began in 2007. QE and the effect it has on financial markets has been a regularly discussed topic in financial journalism in the recent years. News articles have often claimed that QE has an inflationary effect on stock prices but has this actually been the case?

This thesis studies the stock market reaction to quantitative easing announcements made by central banks. The reaction is examined for local all shares indices, and large cap and small cap indices to find out whether the stock prices of companies with different levels of market capitalization react differently.

A variety of parametric and nonparametric event study tests are employed to see if the reaction is significant, positive, and do the prices of small cap stocks react differently relative to large cap stocks. The results from the parametric and nonparametric event study tests show that the local stock indices do indeed show a positive and significant reaction to the announcements. Moreover, the reaction is pronounced in the case of small cap stocks.

KEYWORDS: quantitative easing, unconventional monetary policy, event study, abnormal returns, market efficiency, stock index

1. INTRODUCTION

According to Abel et al. (2014), central bank announcements and actions are closely monitored by the media, participants in the financial markets, and the general public, because monetary policy and the resulting changes in the money supply affect the economy significantly through changes in the price level, nominal exchange rate, real GDP, real interest rate, and the unemployment rate.

When interest rates approach zero conventional monetary policy may not be effective anymore and central banks may adopt the use of unconventional monetary policies. Joyce et al. (2012) state that the most high-profile form of unconventional monetary policy has been Quantitative Easing (QE). In QE, a central bank purchases government securities from the banking sector and/or the financial market with the objective that the money received by the sellers of these securities would spill over into lending into the broader economy which would help drive asset prices up and remove deflationary forces. The popularity of Quantitative Easing has increased particularly in the wake of the financial crisis that began in 2007.

The history of Quantitative Easing dates back to March 19, 2001 when the Bank of Japan announced a new policy of "Quantitative Easing" where the BoJ increased its current account target far beyond the level of commercial bank required reserves and raised the ceiling on BoJ purchases of Japanese Government Bonds. This policy was in place for nearly 5 years until it was formally lifted on March 9, 2006. (Kobayashi et al., 2006). To this date there has been a total of 17 announcements by central banks of Japan, England, the United States, the Euro-area and Sweden, where they have announced to the public that they are examining the implementation of a Quantitative easing programme, will begin a QE programme, expand the size of the asset purchases in the QE programme or continue the QE programme longer than previously announced. A stock market reaction of some kind can be expected from such an announcement in the announcement country or area but has this actually been the case?

This study uses event study methodology, which statistically tests whether the announcements of these quantitative easing programs lead to significant positive abnormal returns in the short-term. The stock market reaction of small cap companies are compared with that of large cap companies to see whether they react differently to QE announcements.

1.2. Previous Main Studies

A number of studies have examined the effects of changes in monetary policy and economic news announcements on stock market returns. However, comprehensive event studies that examine the reaction of stock prices to quantitative easing announcements at the aggregate index level are scarce.

Bernanke and Kuttner (2004) examine the reaction of the stock market on changes in monetary policy and the economic sources of that reaction. In the event study portion of their study, they employ simple regressions that measured the change in stock return on the raw change in federal funds rate target, both expected and unexpected. They do not estimate the normal (or expected return) of the stock market, but simply focus on the change in stock return on the days when the changes in the federal funds rate target were announced. They show a relatively strong and consistent stock market response to unexpected monetary policy actions. They report that an unanticipated 25-basis-point cut in the federal funds leads to an expected one percent increase in broad stock indices. They suggest that the effects of unexpected monetary policy actions on expected excess returns explain the largest part of the change in stock prices.

Bredin et al. (2009) investigate the stock market response to international monetary policy changes in the UK and Germany. They conduct an event study to examine the impact of expected and unexpected changes in the UK and Euro/German area policy rates on the UK and German aggregate and sectoral equity returns. They follow the event study methodology adopted by Bernanke and Kuttner (2005). They show that the UK monetary policy suprises have a significant negative influence on both aggregate and industry level returns in both countries. They also point out that the Euro/German area monetary policy surprises do not influence either Germany or UK significantly.

Thorbecke (1997) employ vector autoregression and an event study to examine how stock return data respond to monetary policy shocks. The event study consists of an ordinary least squares regression where the percentage change in Dow Jones Industrial Average and Dow Jones Composite Average is regressed against the amount in percentage points by which the federal funds rate changed. Thorbecke also employs the Arbitrage Pricing Theory multifactor model by Ross (1976) to measure the ex-ante expected excess return by a beta-weighted vector of risk premia. Thorbecke demonstrate that monetary policy has a significant effect on ex-ante and ex-post stock returns and that monetary shocks have larger effects on small firms than large firms.

Wang and Mayes (2012) research the impact of domestic monetary policy rate announcements on the stock markets in New Zealand, Australia, the United Kingdom and the euro area, focusing on the unanticipated component of the announcements using event-study methods. They follow the Bernanke and Kuttner (2004) event-study approach. Similar to previous studies, they find that monetary policy surprises cause significant negative stock price reactions.

There is a substantial amount of research conducted on the recent QE programs. Gagnon et al. (2011) show that large-scale asset purchase announcements reduced U.S. long-term yields. Joyce et al. (2011) report that Bank of England's Quantitative Easing program had similar bond yield effects to those reported by Gagnon et al. (2011) for the U.S. program. Hamilton and Wu (2011) use a term structure model to indirectly calculate the effects of the Fed's 2008-2009 QE programs. Their estimates imply that at the zero lower bound, a maturity swap where the Fed would sell off all of its Treasury holdings of less than one-year maturity and use the proceeds to retire Treasury debt from the long-end, would have the same effect as buying $400 billion in long-term maturities with newly created reserves, and could reduce the 10-year rate by 13 basis points without raising short-term yields. Neely (2012) examines the effect of the Fed's 2008-2009 QE program on international bond yields and exchange rates, and show that the effects are consistent with long-run purchasing power parity and a simple portfolio balance model. Glick and Leduc (2012) examine the large-scale asset purchase announcements by the Federal Reserve and the Bank of England and the impact on global financial and commodity markets. They present evidence that the announcements led to lower long-term interest rates and depreciations of the U.S. dollar and the British pound on announcement days, while commodity prices generally declined. Equity prices showed mixed reactions to the announcements depending on the country in question.

1.3. Purpose of the Study

The purpose of this study is to examine all of the quantitative easing programs that have been employed around the world in the past and to see whether the QE announcements related to them have had a statistically significant impact on stock returns in the short-term. Moreover, the purpose of this study is also to find whether these announcements lead to short-term positive abnormal and cumulative abnormal returns. Thorbecke (1997) states that monetary policy influences a company's access to credit and when a central bank employs a quantitative easing program the money supply and consequently the company's access to credit are expected to increase. Smaller companies are most likely worse collaterized and more vulnerable to binding credit constraints than large companies, therefore the stock returns of the smaller company should be impacted more significantly when a central bank announces a QE program. This is examined by seeing whether the abnormal returns and their significance differ between large and small market capitalization companies.

1.4. Contribution

Previous literature on QE programs is mostly limited to studies investigating the impact of QE announcements on interest rates and exchange rates. Glick and Leduc (2012) examine the large-scale asset purchase announcements by the Federal Reserve and the Bank of England and the impact on global financial and commodity markets including equity markets, however, the equity markets are not examined comprehensively or in great detail. They limit their investigation on the impact of the QE announcements by the Fed and the BoE on S&P 500, S&P/TSX composite, Xetra Dax, Nikkei 225, and FT All shares. They simply see if the announcement day return is significantly larger than the average return during the period from January 2004 to July 2011. This thesis extends the study by Glick and Leduc (2012) in several ways. First, all of the QE announcements made by central banks around the world are included. Second, the reaction is examined for companies of different levels of market capitalization by including local all share, large cap, and small cap indices. Third, a variety of parametric and nonparametric tests are employed to test if there is a statistically significant impact and to improve the statistical robustness of the results.

1.5. Assumptions and Limitations

This study, like most studies in the field of finance, need to include some assumptions for being able to test whether abnormal returns are present or not. One key assumption is that the normal or expected return model employed in this study produces reliable estimations of the indices' returns. The use of such a normal return model involves the joint hypothesis problem that is present in most finance studies. Even if significant abnormal returns or cumulative abnormal returns are found surrounding the quantitative easing announcements, it may not necessarily mean that the markets are inefficient. As Campbell et al. (1997) state:

> *"If efficiency is rejected, this could be because the market is truly inefficient or because and incorrect equilibrium model has been assumed. This joint hypothesis problem means that market efficiency as such can never be rejected".*

Additionally, it is assumed that there are no other significant events affecting the index returns during the test window. It is always possible that there some global or local event during the test window that causes a reaction in one or all of the indices tested in this study.

Another issue can be that some of the quantitative easing announcements may have already been expected by the market and therefore may not lead to a significant reaction in the index returns or may lead to a reaction of a different sign than if the announcement was not expected. For example, on 22nd of October, 2015, Mario Draghi, the president of the European Central Bank, said that the central bank is ready to adjust the size, composition and duration of its QE programme and that policymakers' measures would need to be re-examined at their December 3 vote. Investors interpreted this as a signal to buy, which lead to a sharp increase in the prices of European assets. (Financial Times, 2015). On December 3rd, 2015, when the ECB extended the duration of the QE programme and to included municipal bonds in addition to standard government debt, the investors were not impressed as they were expecting more monthly bond purchases. The Eurofirst 300 index suffered its worst day since August 24, and pushed the S&P 500 down into negative territory for the year 2015 again. (Financial Times, 2015)

International stock market integration can impact the results. For example, a quantitative easing announcements by the FED can and most likely do impact the returns of stock indices around the world. The returns of the MSCI World Index ex USA are used in estimating the U.S. stock index normal returns. This can pose an issue, because if the MSCI index would react to the Fed announcement, it would impact the abnormal returns of the U.S. stock index. If the MSCI index reacted similarly as the local U.S. stock index to the announcement, the abnormal return of the U.S. index could be insignificant even if it did clearly react to the announcement.

The fact that there has only been 17 quantitative easing announcements of this particular type can be an issue in terms of the statistical robustness of the results. Naturally, if there were more announcements, the robustness of any statistical inferences drawn from the results would be improved. Additionally, different event study methodologies have different inherent weaknesses. This will be dealt with by employing several different types of event study tests.

2. LITERATURE REVIEW & HYPOTHESIS

This section includes an overview of the literature related to the topics of this study followed by the development of the hypotheses.

2.1. Market Efficiency

One of the key theoretical aspects related to studying the effect of quantitative easing announcements on stock returns is the efficiency of the stock markets. According to Fama (1970), market efficiency causes current stock prices to always incorporate and reflect all relevant information. This famous concept is known as the efficient market hypothesis. If this hypothesis was true, the current stock prices would be correct and all relevant new information would lead to an immediate price reaction. When central banks employ quantitative easing, they do this with the objective that the money received by the sellers of the securities involved in the QE would spill into lending into the broader economy which in turn would drive asset prices up and remove deflationary pressure. The QE announcements contain relevant information that should impact the economy as a whole, including the companies operating in that country or area. Thus the stock prices in that economy should react immediately to such announcements.

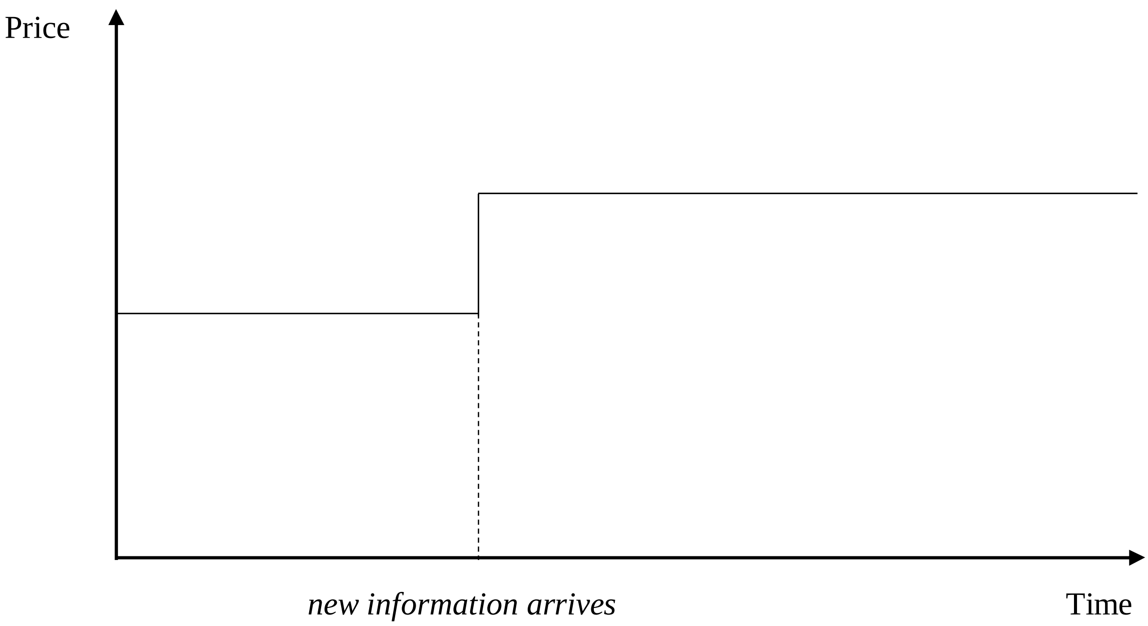

Figure 1. Market efficiency and positive news

2.1.1. The Three Forms of Market Efficiency

Fama (1970) divides market efficiency into three common forms. The weak-form efficiency is the least rigorous form of EMH and is concerned with historical information about the share prices. According to it, there are no patterns to stock prices and thus must move randomly. Kendall (1953) introduced the theory of stock prices following a random walk in his study where he studied stock and commodity prices and found no patterns in the prices. If markets are weak-form efficient, excess returns cannot be earned consistently using investment strategies based on historical share prices. This would imply that technical analysis is not useful in the long run. In the semi-strong-form efficiency, share prices reflect all relevant publicly available information in an unbiased way. Share prices should adjust quickly to reflect any new relevant information. This would imply that neither fundamental analysis nor technical analysis can be used to produce excess returns consistently in the long run. In the strong-form of market efficiency, share prices reflect all relevant public and private information. According to it, no one, including insiders, can earn excess returns.

Several researchers have studied the efficient market hypothesis and the three forms of it. Academics disagree on the validity of the efficient market hypothesis. There are numerous proponents and opponents of the theory. In support of the weak-form, Fama (1965) found that the serial correlation coefficients for a sample of 30 Dow Jones Industrial stocks were significant, but too small to cover transaction costs of trading. Similar studies have mostly found similar results across other countries and time periods. In contrast, Jegadeesh and Titman (1993) provide evidence against the weak-form market efficiency in the form of a trading strategy based on short-run momentum that yield a compounded excess return of 12.01% per year on average. In support of the semi-strong-form, Fama et al. (1969) show that stock prices display no abnormal performance following stock splits. In contrast, Bernard and Thomas (1989) provide direct evidence against the semi-strong-form in their study of quarterly earnings surprises. Larger positive (negative) earnings surprises lead to higher positive (negative) abnormal returns and the upward (downward) drift in the stock price continues for months after the earnings announcement. Jaffe (1974) and Rozeff and Zaman (1988) argue against the strong-form by providing evidence of insider trades being profitable.

According to Keane (1983), different forms of market efficiency are inclusive of each other in the following way. If the market is efficient on the strong-form level it is also efficient on the semi-strong and weak-form levels, and if the market is efficient on the semi-strong level it is also efficient on the weak-form level. The following figure illustrates these relationships.

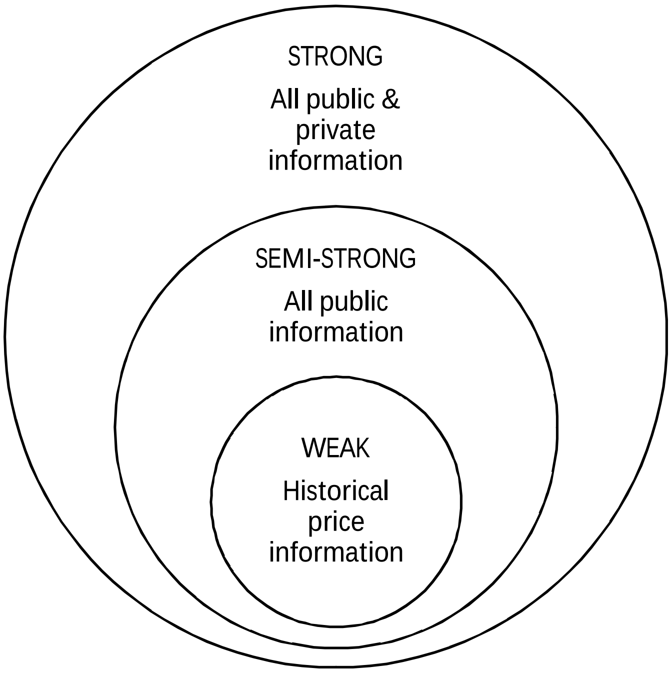

Figure 2. The three forms of market efficiency and their relation to each other

The most important form of efficiency for this study is the semi-strong form as quantitative easing announcements are public and do not contain any past asset price information. The issue of interest is that do the stock markets react to these announcements and whether the reaction is immediate or not. This study employs a variety of event study tests to examine the abnormal returns and cumulative abnormal returns surrounding the announcements. It can be interpreted as a sign of market inefficiency if the cumulative abnormal returns are significant and drift upwards for a several days or weeks after the announcements.

2.2. The Small Cap Anomaly

According to Thorbecke (1997), monetary policy influences firms’ access to credit and when a central bank employs a quantitative easing program the money supply and consequently firms’ access to credit are expected to increase. Small companies are most likely worse collaterized and thus less immune from binding credit constraints than large companies, therefore the small firms’ stock returns should be impacted more significantly when a central bank announces a QE program. This study investigates whether the reaction of small cap stock returns is actually any different from large cap stock returns, and if it is, is the reaction more positive for small caps.

The literature concerned with anomalies identifies firm size as one of the factors that explain stock returns. Firm size is measured by the market value of the firm's stock. Banz (1981) was the first researcher to observe the size effect in his study where he examined the relationship between the total market value of the firm's stock and the return of the firm's stock. He found a significant inverse relationship between firm size and stock returns and observed that firm size is a significant factor in explaining stock returns.

After this researchers have argued whether size truly is a significant factor in explaining stock returns or not. The findings of Banz (1981) were met with skepticism by Lo & MacKinlay (1990) and Black (1992) who argued that studies of firms sorted on size result in empirical artifacts, data snooping is present and such tests were not motivated by any theory linking size to returns. Berk (1995) defends Banz's findings by arguing that empirical observation of the size effect should be recognized even if no underlying theory is offered to explain the phenomena. Additionally, Berk links the size effect to the prior classical financial theory of stock returns being related to risk. Fama & French (1992) present evidence of size being an important factor for explaining returns over long horizons. Horowitz et al. (2000) observe that there is substantial support among practitioners and researchers that size is an important factor in explaining stock returns in the long-run.

2.3. Central Banks and Monetary Policies

Abel et al. (2014) define monetary policy as the government's decisions about how much money to supply to the economy. It is one of the two principal tools available to central banks for affecting macroeconomic behavior. The changes in money supply affects nominal variables such as the nominal exchange rate and the price level, furthermore, in the short run monetary policy affects real variables such as the unemployment rate, the real interest rate, and the real GDP. As monetary policy has such significant economic effects, the announcements and actions of central banks are closely monitored by the financial market participants, media, and the general public. Central banks can affect the money supply by conducting open-market operations, changing reserve requirements, engaging in discount window lending, and changing the reserve deposit rate.

Open market operations are used by central banks as the primary means of implementing their monetary policy. They are the most direct way for a central bank to change the money supply. An open market operation is an activity where a central bank buys or sells government bonds on the open market with the objective of affecting the money supply. For example, if a central bank wishes to increase the money in the economy, they buy securities from private investors in the bond market. As the central bank pays for the securities, the increase in the economy's money supply is significantly larger than the original purchase amount because of the process of multiple expansion of loans and deposits, in which fractional reserve banking increases the economy's loans and deposits. This process will stop only when the reserves of the banking system equal the reserve requirement. Reserve requirement is the minimum fraction of each type of deposit that banks must hold as reserves. If a central bank has the objective of increasing the money supply they can decrease the reserve requirement. By doing so they force banks to hold less reserves which increases the money multiplier and the money supply. Discount window lending occurs when a central bank lends reserves to banks. Discount window lending increases the monetary base and money supply. Reserve deposit rate is the interest rate that a central bank pays on banks' reserve deposits at the central bank. If a central bank aims for an increase in the money supply, they reduce the interest rate they pay on reserves which encourages banks to hold less in reserves and leads to a increase in the money multiplier and the money supply.

2.3.1. Unconventional Monetary Policies: Quantitative Easing

According to Keynes (1936), monetary policy ceases to be an effective instrument to combat economic contraction in a situation where interest rates have fallen so low that further expansion of the money supply cannot drive them lower. Particularly since the 2007 financial crisis, interest rates close to the zero lower bound have become a common occurrence in many economies around the world and consequently many central banks have adopted the use of unconventional monetary policies. According to Joyce et al. (2012), the most high-profile type of unconventional monetary policy has been Quantitative Easing (QE). In Quantitative Easing, a central bank purchases government securities from the banking sector and/or the financial market with the objective that the money received by the sellers of these securities would spill over into lending into the broader economy which in turn would help drive asset prices up and remove deflationary forces. As of today, countries or areas including Japan, the U.S., United Kingdom, the Euro-area, and Sweden have engaged in one or several rounds of Quantitative Easing.

According to Joyce et al. (2011), the immediate effect of monetary policy purchases of securities is that the balance sheet of the central bank expands and the amount of central bank money increases. When the central bank purchases a bond from a bank, there is a direct growth in the monetary base as the bond is added to the assets side of the central bank's balance sheet and the central bank credits the seller bank's current account at the central bank with electronic central bank money. This initial effect can be referred to as the impact phase. However, Newby and Orjasniemi (2015) state that such a growth in central bank money or liquidity in the banking system does not automatically mean an increase in the amount of held by households and non-financial corporations. The increased liquidity flows into the real economy only if banks increase their lending to these households and non-financial corporations. Thus, the [central bank] cannot directly stimulate loan markets and increase aggregate demand or supply with asset purchases. This second phase is called the adjustment phase, and it takes longer to yield results than the impact phase. In addition, there are several factors that influence the transmission that are independent of central bank measures, such as the structures of the economy and the accumulation of private sector debt.

Quantitative Easing programmes are transmitted to the real economy and prices via various transmission channels. These transmission channels are discussed in the next section.

2.3.2. The Transmission Channels of Non-Conventional Central Bank Policies

There are several channels through which non-conventional central bank policies, such as large-scale asset purchase programmes may affect long-term interest rates, financial markets and economies in general.

According to Glick and Leduc (2012), the first channel through which central bank large-scale asset purchases may affect long-term interest rates is portfolio balance effects that effectively cause a reduction in the overall supply of longer-term securities available to investors. This reduction in the stock of long-term securities held by the private sector drive up the price of these securities, lower the term premium required by the investors, and consequently lower long-term interest rates.

The second channel is through policy signaling effects. Asset purchase announcements may signal about the central bank's perception of the economic conditions and about how it will most likely react to future developments. If an announcement signals that conditions are worse than they originally perceived or heightens concerns related to risk, the demand for Treasuries by the investors may increase, lowering their yields. Large-scale asset purchases can also signal that short-term risk free interest rates would stay low. Such an expectation will lower long-term rates.

The third channel is through liquidity effects. Central bank large-scale asset purchases can improve market functioning during times of distress through actively encouraging trading. This can lead to increases in asset prices due to lower illiquidity premia.

Bank of England (2012) also mention that Quantitative Easing may also have a stimulatory impact through its broader effects on expectations. If the economic outlook improves as a result of Quantitative Easing, it may directly boost consumer confidence, and consequently people's willingness to spend. Some of this improvement in confidence can also lead to higher asset prices, especially by reducing risk premiums.

Krishnamurthy and Vissing-Jorgensen (2011) point out several other transmission channels of asset purchases, such as lowering of mortgage prepayment risk if the asset purchases involve mortgage-backed securities, the lowering of corporate default risk, and the raising of inflation expectations.

2.4. International Stock Market Integration

International stock market co-movement and integration is a relevant issue for this study as this study examines the local stock index reaction to the local central bank's quantitative easing announcement using the appropriate world index as a benchmark. If the quantitative easing announcement of the Fed leads to a reaction in the foreign indices, and consequently in the world index, this can dilute the impact we see in the local indices with respect to the abnormal returns employed in this study.

Numerous researchers have investigated if and how stock markets around the world co-move. According to Berben and Jansen (2005), the Japanese stock market is generally weakly correlated with the stock markets of other developed countries. Rua and Nunes (2009) study the international co-movement of stock returns by employing wavelet analysis that allows one to assess the time- and frequency-varying co-movement within an unified framework. They describe how the degree of co-movement of the German market with the US and UK markets has not been stable. In fact, the co-movement has been characterized by a gradual but steady increase at the lower frequencies and by a sudden increase for the other frequencies after then end of the nineties. Nikkinen et al. (2006) examine the integration between global stock markets with respect to the U.S. macroeconomic news announcements. They show that the developed Asian countries, the emerging Asian countries, the G7 countries and the European countries other than G7 countries are closely integrated with respect to U.S. macroeconomic news announcements. However, they find that Latin American and Transition economies are not affected by these news. Wongswan (2009) documents and provides evidence of a large and significant response of 15 foreign equity indices in Asia, Europe, and Latin America, on U.S. monetary policy announcement surprises. The announcement surprises affect the foreign equity indices through their discount rate component. Wongswan's findings suggest that U.S. monetary policy can be a risk factor in equity markets around the world. Hausman and Wongswan (2011) study the impact of U.S. monetary policy announcement surprises on global asset prices. They provide direct evidence that these announcement surprises affect global asset prices, and this effect varies greatly across countries depending on the country's exchange rate regime. Equity indices and interest rates in more flexible exchange rate regime respond less to U.S. monetary policy surprises, and vice-versa. Moreover, the percentage of each country's equity market capitalization owned by U.S. investors is strongly related to the cross-country variation in the foreign equity market response.

2.6. Development of Hypothesis

This study will test if the central bank quantitative easing announcements have a statistically significant impact on stock index returns in the short-term. Moreover, based on previous literature, this impact is expected to be positive and larger for companies with smaller market capitalization.

Abel et al. (2014) state that monetary policy and the resulting changes in the money supply affect the economy significantly through changes in the price level, nominal exchange rate, real GDP, real interest rate, and the unemployment rate, thus central bank announcements and actions are closely monitored by the participants in the financial markets, the media, and the general public. Additionally, according to Joyce et al. (2012), the Bank of Japan engaged in quantitative easing with the hope that the resulting boost in the level of cash reserves the banks held in the system would eventually spill over into lending into the broader economy, helping drive asset prices up.

H_1: QE announcements have a statistically significant impact on stock returns in the short-term

The changes in stock prices reflect investor's expectations of the future. Bank of England (2012) points out that Quantitative Easing may lead to higher asset prices due to its stimulatory impact on expectations, consumer confidence, and people's willingness to spend.

H_2: QE announcements lead to positive abnormal returns in the short-term

Thorbecke (1997) states that monetary policy shocks exert an important and statistically significant effect on small firm returns. Larger firms are most likely better collaterized and thus more immune from binding credit constraints. Thus the stronger effect of monetary shocks on small firms compared to large firms is consistent with the hypothesis that monetary policy works by influencing firms' access to credit. The money supply and consequently firms’ access to credit are expected to increase when a central bank implements a quantitative easing program, thus the reaction of small firms should be more heightened.

H_3: QE announcements lead to larger positive abnormal returns for companies with smaller market capitalization

3. EVENT STUDY METHODOLOGY

Economists have employed various event study methodologies to measure the effect of an event on the value of a firm since the 1930s when Dolley examined the effect of stock splits on the stock price (Campbell et al., 1996). Generally, significance tests can be grouped into two groups, parametric and nonparametric tests. Parametric tests assume that abnormal returns are normally distributed, whereas nonparametric tests do not rely on any assumptions concerning the distribution of the abnormal returns (Brown and Warner, 1980). A vast number of parametric event studies have been done since Dolley (1933). Myers and Bakay (1948), Baker (1956, 1957, 1958), and Ashley (1962) improved the methodology by removing general stock price movements and separating out confounding events. Ball and Brown (1968) considered the information content of earnings and Fama, Fisher, Jensen and Roll (1969) investigated the effects of stock splits after removing the effects of simultaneous increases in dividends. Patell (1976) introduced the Patell Test that is immune to the way in which abnormal returns are distributed across the event window. Campbell and Wasley (1993), Maynes and Rumsey (1993), Cowan and Sergeant (1996), and Kolari and Pynnönen (2010) showed that the Patell Test is prone to cross-sectional correlation and event-induced volatility. Boehmer, Musumeci and Poulsen (1991) presented the Standardized Cross-Sectional Test which accounts for event-induced volatility and serial correlation but is still prone to cross-sectional correlation. Kolari and Pynnönen (2010) introduced the Adjusted Patell Test and the Adjusted Standardized Cross-Sectional Test which are immune to cross-sectional correlation.

Generally nonparametric tests tend to be more powerful than parametric tests due to the normal distribution assumption of parametric tests. Wilcoxon (1945) presented the Wilcoxon Signed-rank Test which considers both the sign and magnitude of ARs are important. Cowan (1992) introduced the Sign Test and the Generalized Sign Test which compares the share of positive abnormal returns close to an event to the proportion from a normal period. The tests account for skewness in security returns but perform poorly for longer event windows. Corrado and Zivney (1992) presented the Corrado Rank Test which has proven robust against event induced volatility and cross-correlation. Kolari and Pynnönen (2011) presented the Generalized Rank Test which accounts for cross-correlation of returns, returns serial correlation, and event induced volatility. The test is one of the most powerful tests for both shorter and longer cumulative abnormal return windows.

According to Campbell et al. (1996), an event study consists of seven steps which are discussed next.

3.1. Event Definition

The first task in conducting an event study is defining the event of interest and identifying the event window, which is the period over which the security prices of the firms of interest involved in the event will be examined.
In this study the events of interest are the quantitative easing announcements of central banks where they announce the quantitative easing policy to the public for the first time and / or announce the continuation of the said policy. Up to this day there has been 17 of such quantitative easing announcements:

Central Bank	*Date of QE announcement*
Bank of Japan	19.3.2001
	5.10.2010
	4.8.2011
	19.9.2012
	4.4.2013
	31.10.2014
The Federal Reserve	25.11.2008
	3.11.2010
	13.9.2012
	12.12.2012
Bank of England	5.3.2009
	7.5.2009
	6.8.2009
	5.11.2009
European Central Bank	22.1.2015
	3.12.2015
Bank of Sweden	12.2.2015

The central banks will be referred to as BoJ, FED, BoE, ECB and BoS from now on. After the event of interest and the event dates have been identified, the next step is to define the event window, which is the period of time surrounding the event date when the effect of the event is examined. The event window is set up on the basis of the number of trading days preceding and following the event date to account for any possible leakage of information prior to the event date and to allow for some additional time for the event to reach and affect the stock market. This study will follow Filbien and Fabien (2009) who state that an event window with 5 days prior to ECB meeting (from t_{-5} to t_0) helps to capture any information about ECB communication revealed in that period. The post-event window (or the test window) is extended to t_{+30} to examine whether the market processes the quantitative easing announcement and stock prices change instantly, as it should according to the efficient market hypothesis, or the market processes the announcement and the stock prices change slowly in contrast with the EMH. By setting the event window from 5 days prior and 30 days after the event date, it allows for leakage, forecast and post-announcement effect to have an impact on the stock indices.

3.2. Selection Criteria

After identification of the event of interest, in most event studies the next step is to determine the selection criteria used to determine which firms are to be included in the study, or which indices in the case of this paper.

3.3. Normal, Abnormal and Cumulative Abnormal Returns

To determine the impact of the event in question we must have a measure of the abnormal return. Firstly, return is simply calculated as the natural logarithm of today's index value divided by yesterday's index value. For each index and date we have:

(1)
$$R_{it} = ln\left(\frac{index\ value_{i,t}}{index\ value_{i,t-1}}\right)$$

where $R_{i,t}$ is the return for time period t.

The normal return is the return that would be expected if the event did not occur. There are several models available to calculate the normal return of a given security. The models can be grouped into two categories, statistical and economic. Statistical models do not depend on any economical arguments and contain statistical assumptions regarding the behavior of asset returns. Economic models rely on assumptions regarding investor behavior, but in practice some statistical assumptions are necessary. In the case of the statistical models, an assumption is conventionally made that asset returns are jointly multivariate normal and independently and identically distributed through time. According to Campbell et al. (1996), inferences from using the normal returns models are robust to deviations from the assumption. The two classical statistical models to calculate the normal return are the constant-mean-return model and the market model. The constant-mean-return model is perhaps the least complex as it assumes that the normal return of any given security is simply its average return in the past. For any security we have:

(2) $$R_{i,t} = \mu_i$$

where $R_{i,t}$ is the return for security i on day t and μ_i is the average return of security i in the past.

The market model is a regression-based statistical model which relates the return of a security to the return of the market portfolio. This model's linear specification follows from the assumption of joint normality of asset returns. For any security we have:

(3) $$R_{it} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}$$

$$E[\varepsilon_{i,t}] = 0 \quad Var[\varepsilon_{i,t}] = \sigma^2_{\varepsilon_i}$$

where $R_{i,t}$ is the return for security i on day t, α_i is the intercept term, β_i is the beta coefficient that measures the sensitivity of the security's returns to market returns, $R_{m,t}$ is the market return on day t and $\varepsilon_{i,t}$ is the error term.

As this study concerns entire indices instead of individual securities, the security is replaced with the appropriate local index and the market portfolio is replaced with the appropriate world index. The methodology used to define the normal (or expected) return of the indices of relevant countries and areas is motivated by previous studies of the time series variability of stock returns, such as Edmans et al. (2007). The normal return is defined by the following formula:

(4) $$R_{i,t} = \alpha_i + \beta 1_i R_{i,t-1} + \beta 2_i R_{m,t-1} + \beta 3_i R_{m,t} + \beta 4_i R_{m,t+1} + \varepsilon_{i,t}$$

where $R_{i,t}$ is the return on the stock market index for country (or area) i on day t measured in local currency and $R_{m,t}$ is the return on the MSCI World Index (and its various versions employed in this study) on day t.

Several authors have shown that first-order serial correlation is present in time series measuring stock returns. For example, Brock et al. (1992) found positive first-order serial correlation at the 1% significance level in their full sample of Dow Jones Industrial Average index daily returns from 1897 to 1986. $R_{i,t-1}$ is included to account for this phenomenon. Return on local indices are correlated across countries and regions to some extent, thus the return on the appropriate global MSCI World Index is used to estimate the normal return for each index. Indices of some countries or regions may be lagging or leading the world index, therefore the model also includes $R_{m,t-1}$ and $R_{m,t+1}$.

Next the abnormal return can be calculated. The abnormal return is the actual return of the day minus the expected or normal return of that day. For each index and date we have:

(5) $$AR_{i,t} = R_{i,t} - ER_{i,t}$$

where $AR_{i,t}$, $R_{i,t}$ and $ER_{i,t}$ are the abnormal, actual and normal returns for time period t. The average abnormal return (AAR) is simply the sum of the abnormal return for each index divided by the number of indices.

In addition to abnormal returns, this study examines cumulative abnormal returns. Cumulative abnormal return is defined as the sum of abnormal returns from time period t1 to t2. For each index and time interval we have:

(6) $$CAR_{i,t1,t2} = \sum_{t=t1+1}^{t2} AR_{i,t}$$

where $CAR_{i,t1,t2}$ is the cumulative abnormal return of index i from day t1 to t2 and $AR_{i,t}$ is the abnormal return for index i on day t. The cumulative average abnormal return (CAAR) is simply the sum of the abnormal return for each index divided by the number of indices.

3.4. Estimation Procedure

Once the normal return model has been chosen, the parameters of the model must be estimated using the estimation window. Usually, the time period prior to the event window is used for the estimation window to prevent the event from influencing the normal return model parameter estimates. The length of the estimation window depends on the researcher. It should not be so short that the estimated parameters become inefficient due to lack of observations and it should not be so long that fundamental market and firm changes cause bias in the parameters. Mackinlay (1997) states that when the estimation period is sufficiently long, the conditional variance approaches the disturbance variance and thus eliminates the additional variance due to the sampling error in α and β, which otherwise could lead to problems with serial correlation. According to Bartholdy et al. (2007), the standard estimation period is 200 to 250, thus 250 days are used in this study (if the required data is available). In the case of the U.S. estimation period, the daily data for the Wilshire 5000 that is used as a proxy for the entire U.S. stock market, is only available for 240 days prior to the first event date, thus a 240-day estimation period is used for studying the U.S. quantitative easing announcements.

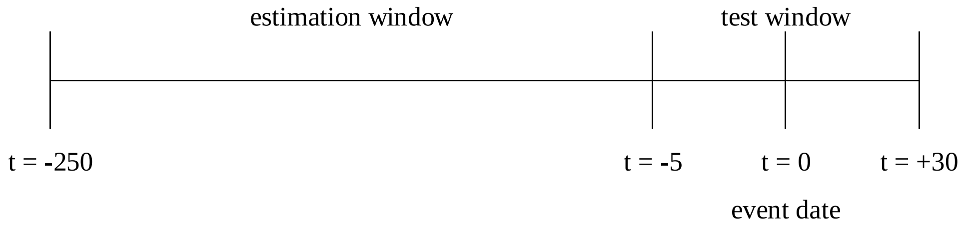

Figure 3. Estimation and test window

This figure is a graphical representation of the estimation window specified above and the test window that was specified in section 3.1.

This study has a single estimation period for the quantitative easing announcements of the BoS, the ECB, the BoE, and the FED, while the BoJ's QE announcements have two estimation periods. The BoS and ECB have both made only one QE announcement, thus naturally they only have single estimation periods. The BoE made their four QE announcements within the year 2009, consequently only one 250-trading day estimation period must be used to prevent the events from influencing the normal return model parameter estimates. The time between each of the FED's three QE announcements was less than two years, thus a single estimation period is deemed sufficient and should yield similar results to three separate estimation periods. The BoJ released their first QE announcement in 2001, the second one more than 9 years later in 2010, and the remaining four once a year, thus a pre-2001 announcement estimation period and a pre-2010 announcement estimation period are deemed appropriate for the purposes of this study.

3.5. Testing Procedure

As has been mentioned earlier in the literature review section of this study, both parametric and nonparametric tests can and should be used to investigate the reaction of security returns to an event and to test the abnormal returns caused by the event. Both types of tests have different types of advantages and weaknesses, thus they complement each other and increase the reliability and statistical robustness of the results.

3.5.1. Parametric Tests

All of the following parametric tests test the hypotheses of whether abnormal returns and/or cumulative abnormal returns equal zero for each index separately and/or together.

$$H_0: AR_{i,t} = 0$$

$$H_0: CAR_{i,t1,t2} = 0$$

Traditional T Test

There is a wide variety of parametric tests that have been employed in the numerous event studies done in the past. The simplest parametric test is the traditional T test. Several studies such as Masulis (1980), Brown and Warner (1985), Corrado and Zivney (1992), Beneish and Gardner (1995) and many others have used the following test statistics, assuming abnormal returns are independent across securities.

To test the abnormal returns of each index together, we have:

(7)
$$t\ statistic_{it} = \frac{\sum AR_{i,t}}{\sqrt{\sum \sigma_i^2}}$$

where $AR_{i,t}$ is the abnormal return for index i on day t and σ^2_i is the variance of estimation period residuals of index i.

The cumulative abnormal return is simply the sum of the abnormal returns from day t1 to t2:

(8)
$$CAR_{i,t1,t2} = \sum_{t=t1+1}^{t2} AR_{i,t}$$

where $CAR_{i,t1,t2}$ is the cumulative abnormal return of index i from day t1 to t2 and $AR_{i,t}$ is the abnormal return for index i on day t.

To examine whether the event had effect on cumulative abnormal returns of each index during the test window, the following test statistic can be used:

(9)
$$t\ statistic_{i,t} = \frac{\sum CAR_{i,t1,t2}}{\sqrt{(K+1)\sum \sigma_i^2}}$$

where $CAR_{i,t1,t2}$ is the cumulative abnormal return for index i from day t1 to t2, K is the number of days in the cumulative abnormal returns (for example, on test window day 1 K equals 1) and σ^2i is the variance of estimation period residuals of index i.

The advantage of the traditional T test is that it is simple to execute but it is somewhat weak because it implicitly assumes that security residuals are uncorrelated and that event-induced variance is insignificant, thus additional parametric tests must be conducted.

Standardized-residual Test

According to Boehmer et al. (1991), the standardized-residual test, also known as the Patell test, was introduced by Patell (1976). It is similar to the traditional T test in the sense that it assumes that event-induced variance is insignificant and that security residuals are uncorrelated. In contrast to the traditional test, the residuals are standardized before forming portfolios for two reasons. Firstly, it adjusts for the event-period residual is an out-of-sample prediction and thus will have a higher standard deviation than estimation-period residuals. Secondly, when event-period residuals are standardized before forming portfolios, heteroscedastic event-day residuals are allowed and securities with large variances are prevented from dominating the test.

The standardized residuals are estimated with the following formula:

(10)
$$SR_{i,t} = \frac{AR_{i,t}}{\sigma^*_{i,t}}$$

where $AR_{i,t}$ is the abnormal return for index i on day t and $\sigma^*_{i,t}$ is the standard deviation of the estimation period residuals of index i adjusted to reflect the forecast error.

As the event-window residuals (or abnormal returns) are out-of-sample predictions, Patell adjusts the standard deviation by the forecast error:

(11)
$$\sigma^{*2}_{i,t} = \sigma_i^2\left(1 + \frac{1}{T_i} + \frac{\left(R_{m,t} - \mu_{R_m}\right)^2}{\sum_{t=T_0}^{T_1}\left(R_{m,t} - \mu_{R_m}\right)^2}\right)$$

with T_i as the number of days in the estimation period of index i, $R_{m,t}$ as the market return on test day t, and μ_{Rm} as the mean of the market returns in the estimation window. $SR_{i,t}$ is distributed as a t-distribution with T_i - 2 degrees of freedom under the Null.

The test statistic can be estimated with the following formula:

(12)
$$t\ statistic_{i,t} = \frac{\sum SR_{i,t}}{\sqrt{\#\ of\ sample\ indices}}$$

where $SR_{i,t}$ is the standardized residual for index i on day t.

The cumulative standardized residual (or cumulative standardized abnormal return) is simply the sum of the standardized residuals from day t1 to t2:

(13)
$$CSR_{i,t1,t2} = \sum_{t=t1+1}^{t2} SR_{i,t}$$

where $CSR_{i,t1,t2}$ is the cumulative standardized residual (or cumulative abnormal return) of index i from day t1 to t2 and $SR_{i,t}$ is the standardized residual (or abnormal return) for index i on day t.

To examine whether the event had effect on cumulative abnormal returns of each index during the test window, the following test statistic can be used:

(14)
$$t\ statistic_{i,t} = \frac{\sum CSR_{i,t1,t2}}{\sqrt{(K+1)\ \#\ of\ sample\ indices}}$$

where $CSR_{i,t1,t2}$ is the cumulative standardized residual for index i from day t1 to t2 and K is the number of days used in calculating the cumulative abnormal returns (for example, on test window day 1 K equals 1).

Many researchers have improved upon the Standardized Residual Test. Kolari and Pynnönen (2010) introduced the Adjusted Patell Test and the Adjusted Standardized Cross-Sectional Test which are both immune to cross-sectional correlation. However, the Standardized Residual Test is deemed sufficient for this study as cross-sectional correlation is not an issue. The tests of each index together consist of 15 indices for 15 different events with test windows that do not overlap each other, thus cross-sectional correlation does not occur.

According to Brown and Warner (1980), parametric T tests contain a strong assumption of security return normality. If this assumption is not met, then the sampling distribution of test statistics assumed for the hypothesis tests could differ from the actual distribution possibly resulting in false inferences. Therefore, a number of nonparametric tests are employed to overcome this issue.

3.5.2. Nonparametric Tests

Prior research related to event studies have employed a wide variety of nonparametric tests. The Sign Test, Generalized Sign Test, and Corrado Rank Test are deemed appropriate for the purposes of this study. These tests and additionally, the Generalized Rank Test, are described next.

Sign Test

The first and the simplest nonparametric employed in this study is the sign test. Brown and Warner (1980) state that in the sign test, the null hypothesis is that the proportion of sample securities having positive measures of abnormal performance is equal to 0.5.
The test statistic is derived using the following formula:

(15)
$$t\ statistic_i = \sqrt{N}\left(\frac{p_i - 0.5}{\sqrt{0.5\,(1-0.5)}}\right)$$

where N is the number of days in the test window and p is the proportion of positive abnormal returns for index i in the test window.

If the proportion of positive cumulative abnormal returns in the test window is greater than 0.5 at a statistically significant level, the event has had a positive effect on the index returns.

Boehmer et al. (1991) argue that the problem with this approach is the assumption of 50% of security returns being negative, while in fact, as Fama (1976) and Brown and Warner (1980) show they are skewed to the right. Next, the generalized sign test is employed to address this issue.

Generalized Sign Test

Cowan et al. (1990) and Sanger and Peterson (1990) allow the null hypothesis to be different from 0.5. This modification of the sign test is called the generalized sign test and compares the event period proportion of positive returns to the proportion of the estimation period, thus the test takes possible asymmetric return distribution under the null hypothesis into account.

The test statistic is derived using the following formula:

(16)

$$t\ statistic_i = \sqrt{N}\left(\frac{p_{test\ i} - p_{est\ i}}{\sqrt{p_{est\ i}\,(1 - p_{est\ i})}}\right)$$

where N is the number of days in the test window, $p_{test\ i}$ is the proportion of positive abnormal returns in the test window for index i and $p_{est\ i}$ is the proportion of positive abnormal returns in the estimation period for index i.

If the proportion of positive cumulative abnormal returns in the test window is greater than the proportion of positive abnormal returns in the estimation period at a statistically significant level, the event has had a positive effect on the index returns.

Cowan (1992) show that the generalized sign test is well specified for event windows of one to eleven days based on simulation results for portfolios of actual NYSE-AMEX and NASDAQ stocks, and that the test is correctly specified both when the variance increases and in the absence of a variance increase, and is more powerful than the cross-sectional parametric test proposed by Brown and Warner (1985).

Corrado Rank Test

Corrado (1989) propose another nonparametric test, the rank test, and suggest that it is more powerful in detecting abnormal stock price changes than standard parametric tests. According to Cowan (1992), the rank test procedure treats the estimation period and the event period (or the test window) as a single time series, and a rank to each daily return for each index is assigned.

The rank statistic for testing on a single day (H0 : AAR = 0) is given by:

(17)

$$t\ statistic_{rank,t} = \frac{\frac{1}{N}\sum_{I=1}^{N}\left(K_{i,t} - \bar{K}\right)}{S(K)}$$

where N is the number of indices involved, $K_{i,t}$ is the rank of index i's abnormal return on day t, $\overline{K}$ is the average rank, and the standard deviation S(K) is computed as:

(18)

$$S(K) = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left[\sum_{i=1}^{N}(K_{it} - \bar{K})/N\right]^2}$$

Next, the methodology of Campbell and Wasley (1993) is followed to define the rank test considering the sum of the mean excess rank for the event window as follows (H_0: CAAR = 0):

(19)

$$t\ statistic_{rank} = \frac{\sum AK_t}{\sqrt{(K+1)\ S(K)^2}}$$

where K is the number of days in the cumulative abnormal returns.

Cowan (1992) suggest that the rank test is more sensitive to an extreme return, and thus rejects the null hypothesis too often when there is an increase in event window variance. The rank test generally provides more power than the sign test in detecting abnormal returns, however this is only when the event window is very short. As the number of days in the event window increase, the power of the rank test decreases rapidly. Cowan concludes that the rank test performs better than the generalized sign test under ideal conditions, however, the generalized test will be a better choice when the return variance increases on the event date. To overcome these weaknesses, the Generalized Rank Test by Kolari and Pynnönen (2010) is performed.

Generalized Rank Test

Kolari and Pynnönen (2010) argue that the Generalized Rank test outperforms previous rank tests of CARs and is robust to event-induced volatility and abnormal return serial correlation. Moreover, the test has superior empirical power relative to parametric tests by Patell (1976) and Boehmer et al. (1991).

As usual, the standardized abnormal returns are estimated with the following formula:

(20)
$$SAR_{i,t} = \frac{AR_{i,t}}{\sigma_{i,t}}$$

where $AR_{i,t}$ is the abnormal return for index i on day t and σ_{it} is the standard deviation of the estimation period residuals of index i.

The cumulative standardized abnormal return is simply the sum of the standardized abnormal returns from day t1 to t2:

(21)
$$CAR_{i,\tau} = \sum_{t=t1+1}^{t1+\tau} AR_{i,t}$$

where $CAR_{i\tau}$ is the cumulative abnormal return of index i during time period τ and $AR_{i,t}$ is the abnormal return of index i on day t.

The standardized cumulative abnormal returns are estimated with the following formula:

(22)
$$SCAR_{i,\tau} = \frac{CAR_{i,\tau}}{\sigma_{CAR_{i,\tau}}}$$

where $CAR_{i,\tau}$ is the cumulative abnormal return for index i during time period τ and $\sigma_{CARi,\tau}$ is the standard deviation of the residuals in the cumulative abnormal returns of index i. Boehmer et al. (1991) re-standardize the SCARs with the cross-sectional standard deviation to account for possible event-induced volatility. The event days of this study are not clustered, thus cross-sectional correlation does not occur and this step is not deemed necessary.

SCARi t1,t2 is a a zeromean and unit variance random variable, therefore we use SCARi t1,t2 as one abnormal return and define generalized abnormal returns as follows:

$$GSAR_{i,t} = \begin{cases} SCAR_{i,\tau} \; for \; t_1 + 1 \leq t \leq t_1 + \tau \\ SAR_{i,t} \; for \; t = T_0 + 1, \dots, t_1, t_1 + \tau + 1, \dots, T_2 \end{cases}$$

The CAR-period is considered to be one point in time in which the abnormal return (GSAR) equals the CAR defined earlier, and for other points in time GSAR equals the usual standardized abnormal return.

The time indexing is redefined so that the entire CAR-period of length τ is squeezed into one observation with time index t = 0, hereafter referred to as the cumulative event day. As the standardized cumulative abnormal return is considered as one observation, we have $L_1 + 1$ observations in the testing procedure, oh which the first L_1 are the estimation period abnormal returns and the last one is the cumulative return. We define:

(23)
$$U_{i,t} = \frac{Rank(GSAR_{i,t})}{T + 1} - \frac{1}{2}$$

where $U_{i,t}$ is the demeaned standardized abnormal rank of the generalized abnormal returns for the set of time indexes including the estimation period for $t = T_0 + 1,\dots,T_1$ and the cumulative abnormal return for t = 0, with $T_0 + 1$ and T_1, the first and last observation in the estimation period, and $T = L_1 = T_1 – T_0 + 1$ is the total number of observations, with $L_1 = T_1 – T_0$ estimation period returns and the one cumulative abnormal return.

Given that U_{i0} is the standardized abnormal rank of the cumulative abnormal return, under the null hypothesis of no mean effect we have:

$$E(U_{i0}) = 0$$

for all indices (i = 1,…,n).

Next, a single t-ratio can be used to test either cumulative or single day abnormal returns against the hypothesis of no mean event effect. The t-statistic is defined as follows:

(24)
$$t_{grank} = Z\left(\frac{T-2}{T-1-Z^2}\right)^{\frac{1}{2}}$$

where

(25)
$$Z = \frac{\overline{U}_0}{S_{\overline{U}}}$$

with

(26)
$$S_{\overline{U}} = \sqrt{\frac{1}{T}\sum_{t\in\tau}\frac{n_t}{n}\overline{U}_t^2}$$
$$\overline{U}_t = \frac{1}{n_t}\sum_{i=1}^{n_t} U_{it}$$

where n_t is the number of valid generalized standardized abnormal returns ($GSAR_{it}$) available at time point t, $t \in \tau = \{T_0 + 1, \ldots, T_1, 0\}$, $T = T_1 - T_0 + 1$ is the number of observations ($T - 1$ estimation period observations and the one event observation), and $\overline{U}_0$ is the mean $\overline{U}_t$ for $t = 0$ (the cumulative abnormal return).

3.6. Empirical Results

Once the formulation of the econometric design is complete, the empirical results are presented. These empirical results include summary statistics, regression results, abnormal returns and cumulative abnormal returns, and the event study test results.

3.7. Interpretation and Conclusions

Finally, the empirical results from the previous section are interpreted and conclusions are drawn. Ideally the results will lead to insights concerning the mechanisms by which the quantitative easing announcements affect index returns.

4. DATA

This study focuses on entire stock indices instead of a group of individual firms to see whether the quantitative easing announcements have a market-wide effect. The daily data of market wide indices that are fairly accurate representations of the entire markets for the given countries or areas are used to examine the effect on the entire stock market along with representative large-cap and small-cap indices for the same country or area to see whether firms of different levels of market capitalization react differently. If available, a world index that excludes the country or area in question is used to investigate the performance of these indices during the estimation and event windows. If no such index is available, like in the case of Sweden, the broad world index is used. In 2012, the stock market capitalization of Sweden accounted for approximately 1 percent of the global stock market capitalization (theGlobalEconomy.com & Witkowski, W., 2015), thus the inclusion of it in the world index when examining the Bank of Sweden QE announcement is not likely to have a significant effect on the results. Table 1 displays the indices used in this study.

Table 1
The appropriate world indices, and the three types of local indices used in this study

Area	World index	All-shares index	Large cap index	Small cap index
Japan	MSCI World ex. Japan	TOPIX	TOPIX 500	TOPIX Small
U.S.	MSCI World ex. USA	Wilson 5000	S&P 500	Russell 2000
U.K.	MSCI World ex. UK	FTSE All-Share	FTSE 100	FTSE SmallCap
Eurozone	MSCI World ex. EMU	EURO STOXX TMI	EURO STOXX Large	EURO STOXX Small
Sweden	MSCI World	OMX Stockholm	OMX Stockholm 60	OMX Stockholm Small Cap

As of August, 2015 the MSCI World Index captures large and mid cap representation across 23 developed markets countries. It has 1643 constituents and covers approximately 85% of the free float-adjusted market capitalization in each country (MSCI, 2015). The MSCI World Index is used as a common benchmark for world of global stock funds, and thus it, and its various different versions excluding chosen countries or areas, can be deemed appropriate for the purposes of this study as well.

Additionally, the quantitative easing announcements, and the press releases or statements related to them were gathered from the websites of each of the central bank that has made the announcements examined in this study.

4.1. The Issues with Using Daily Data

According to Brown and Warner (1985), the use of daily data in event studies involves the following potentially important problems related to this study:

Non-normality

The daily return and the daily excess return for individual stocks exhibit substantial departures from normality that are not observed with monthly data. However, Blattberg and Gonedes (1974) and Hagerman (1978) suggest that there is some evidence that the distribution of the cross-sectional daily mean return converges to normal as the number of securities increase, thus as this paper focuses on daily returns and daily excess returns of entire indices, the severity of this problem diminishes.

Variance estimation

The estimation of the sample mean excess return variance is important for tests of statistical significance for both daily and monthly data. Beaver (1968) and Patell and Wolfson (1979) propose that the variance of stock returns increases for the days around the event such as earnings announcements.

5. EMPIRICAL RESULTS

This section describes empirical results of this study including the presentation and interpretation summary statistics, regressions results, abnormal returns, and the results from the parametric and nonparametric tests.

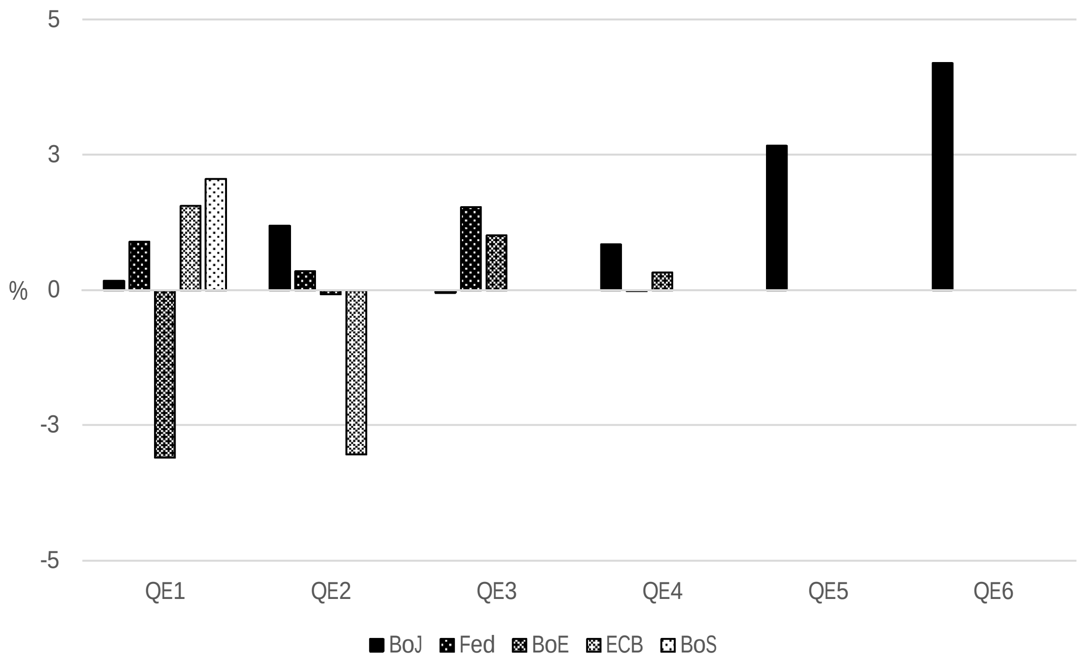

Figure 4. The daily returns of the local all-shares indices on the QE announcement days

5.1. Summary Statistics

Figure 5 shows how the relevant local stock indices performed on average in the 5 trading days before and 30 trading days after the 17 central bank QE announcements in the Japan, U.S., England, Europe, and Sweden. It is evident that the relevant local all shares indices, large-cap indices, and small-cap indices provided higher returns than the comparable world indices especially during the time period from one day prior to three days after the QE announcement. The local stock indices of the relevant countries or areas seem to have had returns of roughly 0,4 to 1% in excess of the world indices during the t-1 to t+3 time period.

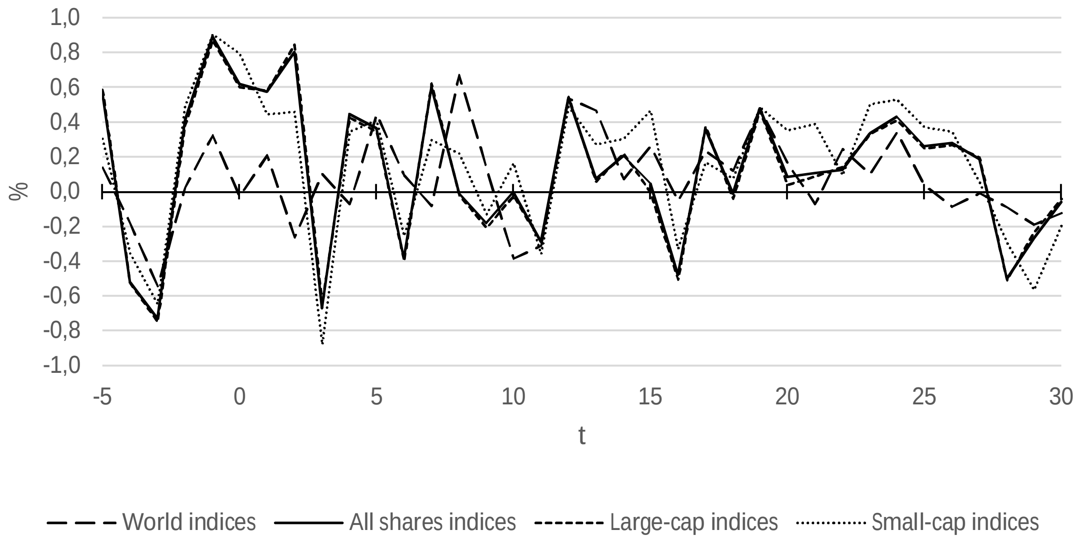

Figure 5. Daily average returns surrounding the QE announcements

This figure presents the daily average returns of the local stock indices from 5 days before the announcement to 30 days after it. T = 0 is the QE announcement date. All shares indices, Large-cap indices, and Small-cap indices show the average daily return of the local market-wide indices, large-cap indices, and small-cap indices of Japan, U.S., U.K., euro area and Sweden surrounding the 17 QE announcements. World indices shows the average return of the MSCI World Indices used in this study surrounding the QE announcements.

Figure 6 shows how the relevant local stock indices performed in cumulative terms during the time period starting from 5 days before the announcement to 30 days after the announcement. The figure clearly shows how the that the relevant local all shares indices, large-cap indices, and small-cap indices provided higher cumulative returns than the comparable world indices from 5 days prior to the QE announcements to 30 days after the announcements. Particularly, the small-cap indices seemed to have reacted most significantly to the announcements. During this t-5 to t+30 time frame the relevant world indices on average have produced a cumulative raw return of approximately 2,1% while the relevant all shares indices, large-cap indices, and small-cap indices produced approximately 4,5%, 4,3% and 6,1%. Naturally, such raw returns cannot be the basis any of statistically robust inferences of the effect of QE announcements on stock returns, however, they are promising enough to warrant further investigation into the matter.

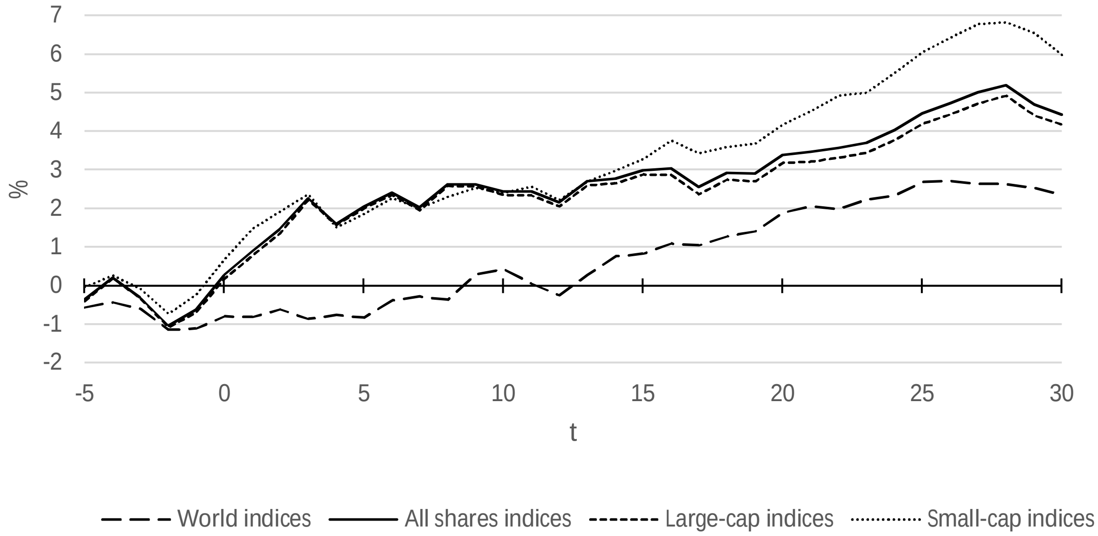

Figure 6. Cumulative average returns surrounding the QE announcements

This figure presents the daily cumulative average returns of the local stock indices from 5 days before the announcement to 30 days after it. T = 0 is the QE announcement date. All shares indices, Large-cap indices, and Small-cap indices show the cumulative average return of the local market-wide indices, large-cap indices, and small-cap indices of Japan, U.S., U.K., euro area and Sweden surrounding the 17 QE announcements. World indices shows the average return of the MSCI World Indices used in this study surrounding the QE announcements.

Table 2 shows the summary statistics of the relevant indices surrounding the Bank of Japan six QE announcements. The world index that excludes Japan had a mean returns ranging from -0,30% to +0,15% during the six test periods, while the local all-share index, the large cap index, and the small cap index had mean returns ranging from -0,32& to +0,48%, -0,33% to +0,49%, and -0,15% to +0,37%. There is evidence of the local indices reacting strongly to the QE announcements. The 6,13% maximum daily return of the local all-shares index during the test period far exceeded its 3,05% maximum daily return of the estimation period. The local large cap and small cap indices behaved similarly.

Table 2
Summary statistics of the relevant indices surrounding the Bank of Japan QE announcements
This table presents the mean, media, maximum, minimum, and standard deviation of the daily returns of the world index that excludes Japan (MSCI World ex. Japan), the local all-share index (TOPIX), large cap index (TOPIX 500), and small cap index (TOPIX Small) during the two normal return estimation periods, the six test periods and the six quantitative easing announcement days presented in percentage units.

Index		Estimation period 1	Estimation period 2	QE 1 Test period	QE 2 Test period	QE 3 Test period	QE 4 Test period	QE 5 Test period	QE 6 Test period
MSCI World ex. Japan	Mean	-0,07	0,03	0,01	0,06	-0,30	0,01	0,15	0,04
	Median	-0,02	0,07	0,13	0,08	-0,41	0,01	0,37	0,10
	Max	3,29	4,77	3,39	1,71	3,68	1,13	1,35	1,29
	Min	-4,64	-3,14	-3,60	-1,65	-5,56	-1,44	-1,75	-1,74
	SD	1,02	1,03	1,65	0,62	2,09	0,59	0,67	0,63
TOPIX	Mean	-0,12	-0,02	0,35	0,04	-0,32	0,02	0,48	0,29
	Median	-0,15	-0,01	0,11	-0,01	-0,33	0,07	0,15	0,18
	Max	3,05	3,51	6,13	2,26	2,15	1,69	3,28	4,19
	Min	-6,32	-3,54	-3,97	-2,08	-3,12	-2,02	-3,36	-2,48
	SD	1,24	1,11	1,90	0,98	1,30	0,93	1,45	1,18
TOPIX 500	Mean	-0,11	-0,02	0,34	0,04	-0,33	0,02	0,49	0,30
	Median	-0,12	-0,01	0,09	0,00	-0,37	0,04	0,14	0,21
	Max	3,03	3,57	6,31	2,26	2,11	1,75	3,28	4,28
	Min	-6,19	-3,59	-4,23	-2,10	-3,16	-2,14	-3,25	-2,50
	SD	1,25	1,13	1,97	0,98	1,31	0,96	1,48	1,21
TOPIX Small	Mean	-0,04	-0,04	0,39	-0,04	-0,15	0,06	0,37	0,20
	Median	-0,01	-0,02	0,32	-0,05	-0,02	0,10	0,31	0,19
	Max	2,89	2,81	3,91	2,24	2,61	1,20	3,19	3,29
	Min	-7,17	-3,00	-1,94	-2,77	-2,77	-1,35	-4,49	-2,24
	SD	1,05	0,99	1,07	0,97	1,26	0,74	1,48	0,91
Index				Event date	Event date	Event date	Event date	Event date	Event date
MSCI World ex. Japan	Return			0,83	1,68	-4,19	0,23	-0,13	1,29
TOPIX	Return			0,18	1,20	-0,05	0,85	2,67	4,19
TOPIX 500	Return			0,12	1,26	-0,06	0,87	2,68	4,28
TOPIX Small	Return			0,48	0,47	0,09	0,60	2,51	3,29

The local indices had lower returns on the first and second QE announcement days relative to the world index. This changed for the remaining four QE announcement days as the local indices had higher returns relative to the world index.

Table 3
Summary statistics of the relevant indices surrounding the Federal Reserve QE announcements
This table presents the mean, media, maximum, minimum, and standard deviation of the daily returns of the world index that excludes the U.S. (MSCI World ex. USA), the local all-share index (Wilson 5000), large cap index (S&P 500), and small cap index (Russell 2000) during the normal return estimation peri-od, the four test periods and the four quantitative easing announcement days presented in percentage units. *Mean** for *Event Dates* refer to that particular QE announcement day's return.

Index		Estimation period	QE 1 Test period	QE 2 Test period	QE 3 Test period	QE 4 Test period	QE 1 Event date	QE 2 Event date	QE 3 Event date	QE 4 Event date
MSCI World ex. USA	Mean*	-0,23	0,02	0,08	0,08	0,19	1,46	-0,21	0,11	0,37
	Median	1,87	-0,08	0,04	0,05	0,13				
	Max	6,54	5,29	1,60	1,60	1,72				
	Min	-7,57	-4,39	-1,43	-1,54	-0,65				
	SD	1,87	1,98	0,68	0,67	0,44				
Wilson 5000	Mean*	-0,22	0,01	0,14	0,01	0,19	0,89	0,35	1,54	-0,01
	Median	2,30	0,48	0,05	-0,02	0,10				
	Max	10,77	6,34	2,10	2,01	2,51				
	Min	-9,49	-9,63	-1,68	-1,66	-1,03				
	SD	2,30	3,42	0,81	0,71	0,67				
S&P 500	Mean*	-0,22	-0,01	0,13	0,01	0,18	0,65	0,37	1,62	0,04
	Median	2,33	0,44	0,07	-0,02	0,08				
	Max	10,96	6,27	2,14	2,02	2,51				
	Min	-9,47	-9,35	-1,63	-1,67	-1,11				
	SD	2,33	3,33	0,80	0,72	0,68				
Russell 2000	Mean*	-0,21	0,07	0,25	-0,03	0,26	1,45	0,32	1,29	-0,67
	Median	2,56	0,84	0,32	-0,13	0,11				
	Max	8,86	7,18	2,53	2,02	2,79				
	Min	-9,95	-12,61	-2,05	-1,94	-0,69				
	SD	2,56	4,23	1,05	0,78	0,74				

Table 3 presents the summary statistics of the relevant indices surrounding the four Federal Reserve QE announcements. There is indication of the local indices reacting to the QE announcements. All of the local indices had higher mean returns during the test periods compared to their estimation periods. Additionally, the all-shares and the small cap indices had lower minimum returns during the test periods relative to the minimum returns of the entire estimation periods. The local indices underperformed the world index on the first and fourth QE announcement days and outperformed during the second and third QE announcement days.

Table 4
Summary statistics of the relevant indices surrounding the Bank of England QE announcements
This table presents the mean, media, maximum, minimum, and standard deviation of the daily returns of the world index that excludes the U.K. (MSCI World ex. UK), the local all-share index (FTSE All-Share), large cap index (FTSE 100), and small cap index (FTSE Small Cap) during the normal return estimation period, the four test periods and the four quantitative easing announcement days presented in percentage units. *Mean** for *Event Dates* refer to that particular QE announcement day's return.

Index		Estimation period	QE 1 Test period	QE 2 Test period	QE 3 Test period	QE 4 Test period	QE 1 Event date	QE 2 Event date	QE 3 Event date	QE 4 Event date
MSCI World ex. UK	Mean*	-0,24	0,32	0,04	0,28	0,06	-3,20	-0,35	-0,13	1,12
	Median	2,09	0,52	0,12	0,29	0,11				
	Max	8,82	5,21	2,38	1,41	1,82				
	Min	-7,13	-4,55	-2,54	-2,43	-1,89				
	SD	2,09	2,08	1,17	0,76	0,86				
FTSE All-Share	Mean*	-0,19	0,21	0,03	0,39	-0,01	-3,09	-0,08	1,02	0,33
	Median	2,24	0,28	0,02	0,42	0,22				
	Max	8,81	4,53	2,36	1,92	2,30				
	Min	-8,71	-5,17	-2,78	-1,87	-3,22				
	SD	2,24	2,14	1,35	0,89	1,21				
FTSE 100	Mean*	-0,19	0,16	0,04	0,36	0,00	-3,23	0,05	0,93	0,35
	Median	2,34	0,22	0,06	0,42	0,18				
	Max	9,38	4,76	2,25	1,96	2,31				
	Min	-9,26	-5,48	-2,79	-1,83	-3,23				
	SD	2,34	2,24	1,35	0,89	1,22				
FTSE SmallCap	Mean*	-0,26	0,51	0,10	0,54	-0,17	-0,40	0,44	2,55	-0,27
	Median	1,34	0,64	0,32	0,63	-0,19				
	Max	3,05	3,77	3,30	2,55	1,43				
	Min	-6,15	-2,62	-4,19	-1,44	-2,68				
	SD	1,34	1,29	1,30	0,89	0,84				

Table 4 displays the summary statistics of the relevant indices surrounding the four Bank of England QE announcements. There is evidence of the local indices reacting to the QE announcements positively. The local small cap index had a higher maximum daily return of 3,77% during the test periods relative to the maximum daily return of 3,05% of the estimation period. All of the local indices had higher mean returns during the test periods relative to the estimation periods. The local indices had higher returns on the second and third QE announcement days compared with the world index. Additionally, the all-share and small cap indices had higher returns during the first QE announcement day.

Table 5
Summary statistics of the relevant indices surrounding the European Central Bank QE announcements
This table presents the mean, media, maximum, minimum, and standard deviation of the daily returns of the world index that excludes the EMU area (MSCI World ex. EMU), the local all-share index (EURO STOXX Total Market), large cap index (EURO STOXX Large), and small cap index (EURO STOXX Small) during the normal return estimation period, the two test periods and the two quantitative easing announcement days presented in percentage units. *Mean** for *Event Dates* refer to that particular QE announcement day's return.

Index		Estimation period	QE 1 Test period	QE 2 Test period	QE 1 Event date	QE 2 Event date
MSCI World ex. EMU	Mean*	0,03	0,11	-0,28	1,18	-1,34
	Median	0,60	0,55	-0,17		
	Max	2,15	1,18	1,47		
	Min	-1,93	-0,92	-2,32		
	SD	0,60	0,55	0,92		
EURO STOXX Total Market	Mean*	0,00	0,38	-0,31	1,55	-3,04
	Median	1,02	0,79	-0,26		
	Max	3,03	1,87	2,88		
	Min	-3,39	-1,39	-3,04		
	SD	1,02	0,79	1,38		
EURO STOXX Large	Mean*	0,00	0,38	-0,32	1,56	-3,39
	Median	1,07	0,82	-0,28		
	Max	3,31	2,04	3,07		
	Min	-3,53	-1,41	-3,39		
	SD	1,07	0,82	1,45		
EURO STOXX Small	Mean*	-0,01	0,32	-0,25	1,41	-2,14
	Median	0,97	0,79	-0,16		
	Max	3,29	1,97	2,67		
	Min	-2,84	-1,59	-2,17		
	SD	0,97	0,79	1,23		

Table 5 shows the summary statistics of the relevant indices surrounding the two European Central Bank QE announcements. It appears that the local indices reacted positively to the first QE announcement and negatively to the second one. All of the local indices had higher mean returns during the first test period compared to their estimation periods and the mean return of the world index during the first test period. Additionally, the local indices had higher daily returns on the first QE announcement day compared to the world index. The opposite was true during the second test period and the second QE announcement day.

Table 6
Summary statistics of the relevant indices surrounding the Bank of Sweden QE announcements
This table presents the mean, media, maximum, minimum, and standard deviation of the daily returns of the world index (MSCI World), the local all-share index (OMX Stockholm), large cap index (OMX Stockholm 60), and small cap index (OMX Stockholm Small Cap) during the normal return estimation period, the test period and the quantitative easing announcement day presented in percentage units. *Mean** for *Event Dates* refer to that particular QE announcement day's return.

Index		Estimation period	Test period	Event date
MSCI World	Mean*	0,05	0,07	0,89
	Median	0,62	0,53	
	Max	2,25	1,07	
	Min	-1,80	-1,43	
	SD	0,62	0,53	
OMX Stockholm	Mean*	0,08	0,12	2,06
	Median	0,87	0,80	
	Max	3,02	2,06	
	Min	-2,74	-1,55	
	SD	0,87	0,80	
OMX Stockholm 60	Mean*	0,08	0,13	2,09
	Median	0,90	0,81	
	Max	2,96	2,09	
	Min	-2,91	-1,51	
	SD	0,90	0,81	
OMX Stockholm Small Cap	Mean*	0,04	0,29	2,14
	Median	0,73	0,66	
	Max	2,67	2,14	
	Min	-4,16	-1,51	
	SD	0,73	0,66	

Table 6 reports the summary statistics of the relevant indices surrounding the Bank of Sweden QE announcement. The summary statistics suggest that the local indices reacted positively to the QE announcement. The local indices had higher mean during the test period relative to the estimation period and the test period of the world index. Furthermore, the local indices had higher daily returns on the QE announcement day compared with the world index.

5.2. Regression Results

Table 7 presents the regression results for the normal or expected return estimation that was defined in section 3.3. The regression model used in this study attempts to demonstrate the normal return of the local indices of interest. The normal return is the return that would be expected if the event of interest did not occur. These coefficients are presented and discussed because they are used in the estimation of the abnormal returns and, thus are the foundation of this study. Additionally, it may be of interest to many to see which indices show signs of first-order serial correlation, and which indices are leading or lagging the world index.

The constant term α_i is 0,00 and insignificant at 1%, 5% and 10% levels for each regression. The Japanese index regressions preceding the 2001 announcement have only one coefficient, $\beta_{2i}R_{m,t-1,}$ that is significant at the 1% level, which indicates that the Japanese indices are lagging the world index by one trading day. This is not surprising considering the fact that the Japanese Standard Time is 9 hours ahead of Coordinated Universal Time and 14 hours ahead of New York time. Similarly, the Japanese index regressions preceding the 2010 announcement result in $\beta_{2i}R_{m,t-1}$ being significant at the 1% level. However, unlike the pre-2001 regressions, these later regressions result in $\beta_{3i}R_{m,t}$ being significant. Additionally, the all share index and the large-cap index display some degree of first-order serial correlation as the coefficients, $\beta_{1i}R_{i,t-1}$, which are the previous day's return of the local indices under investigation, are significant at the 5% level. The U.S. regression produces even stronger results in terms of first-order serial correlation. In this case, the all share index and the large-cap index have the coefficients for $\beta_{1i}R_{i,t-1}$ significant at the 1% level. All of the U.S. index regressions result in the coefficients for the current and the following trading day's world index returns being significant at the 1% level. The U.S. all shares index has a coefficient of 0,91 for the current day's world index return, thus it clearly moves in close unison with the world index. The fact that the following day's world index return is significant at 1% for the U.S. indices indicates that the U.S. stock market may be leading the global stock indices. The U.K. regression results for all shares and large-cap indices show signs of first-order serial correlation. The coefficients of the previous and current trading day's world index returns are significant at the 1% level for local indices. The EURO and Sweden regressions produce very similar results to the U.K. results. The only significant difference is that the EURO STOXX large-cap index regression results in the previous day's world index return being significant only at the 5% level, and that all the Swedish index regressions result in the coefficient for the

Table 7
Regression results from normal or expected return estimation
This table presents results from the normal or expected return estimation model defined in section 3.3. where $R_{i,t}$ is the return on the local stock market index for country or area i on day t measured in local currency and $R_{m,t}$ is the return on the appropriate MSCI World Index on day t. Japan 1 refers to the estimation period preceding the 2001 announcement and Japan 2 refers to the estimation period preceding the 2010 announcement. ***, **, and * refer to significance at the 1%, 5%, and 10% level.

	Slope coefficients, adjusted R-squared values and standard errors from regressions of the form $R_{i,t} = \alpha_i + \beta 1_i R_{i,t-1} + \beta 2_i R_{m,t-1} + \beta 3_i R_{m,t} + \beta 4_i R_{m,t+1} + \varepsilon_i$											
Independent variable	***Japan 1***		***Japan 2***		***U.S.***		***U.K.***		***EURO***		***Sweden***	
All Shares indices												
α_i	0,00		0,00		0,00		0,00		0,00		0,00	
$\beta_{1i} R_{i,t-1}$	0,08		-0,12	**	-0,54	***	-0,49	***	-0,26	***	-0,27	***
$\beta_{2i} R_{m,t-1}$	0,59	***	0,55	***	0,09		0,64	***	0,32	***	0,33	***
$\beta_{3i} R_{m,t}$	0,13	*	0,25	***	0,91	***	0,80	***	1,18	***	0,98	***
$\beta_{4i} R_{m,t+1}$	0,07		-0,10	*	0,48	***	-0,02		-0,07		-0,13	**
Adj. R-squared	0,25		0,30		0,65		0,74		0,52		0,55	
S.E. of Regression	0,01		0,01		0,01		0,01		0,01		0,01	
Large-cap indices												
α_i	0,00		0,00		0,00		0,00		0,00		0,00	
$\beta_{1i} R_{i,t-1}$	0,07		-0,13	**	-0,54	***	-0,51	***	-0,27	***	-0,29	***
$\beta_{2i} R_{m,t-1}$	0,59	***	0,56	***	0,07		0,66	***	0,29	**	0,32	***
$\beta_{3i} R_{m,t}$	0,13	*	0,26	***	0,91	***	0,83	***	1,24	***	1,02	***
$\beta_{3i} R_{m,t+1}$	0,07		-0,10	*	0,46	***	-0,03		-0,09		-0,13	**
Adj. R-squared	0,24		0,31		0,64		0,73		0,52		0,55	
S.E. of Regression	0,01		0,01		0,01		0,01		0,01		0,01	
Small-cap indices												
α_i	0,00		0,00		0,00		0,00		0,00		0,00	
$\beta_{1i} R_{i,t-1}$	0,08		0,00		-0,46	***	-0,01		-0,06		-0,05	
$\beta_{2i} R_{m,t-1}$	0,51	***	0,42	***	0,11		0,27	***	0,28	***	0,32	***
$\beta_{3i} R_{m,t}$	0,09		0,19	***	0,79	***	0,38	***	1,02	***	0,48	***
$\beta_{3i} R_{m,t+1}$	0,02		-0,09	*	0,70	***	0,02		-0,05		-0,12	*
Adj. R-squared	0,25		0,23		0,55		0,53		0,45		0,25	
S.E. of Regression	0,01		0,01		0,02		0,01		0,01		0,01	

following day's world index return being significant at 5% for the local all shares and large-cap indices and at 10% for the small cap index.

The Adjusted R-squareds range from 0,23 (Japan 2; Small cap) to 0,74 (UK; All shares), which indicate that the variation in the world index returns explain less of the variation in the Japanese index returns, and the more in the U.K. index returns. This is not a surprising result considering the fact that among these countries or areas investigated in this study, Japan is the most different in terms of geographical location, culture, etc., and the only non-western country or area, thus it is only natural that the Japanese market moves more independently from the world index.

The negatively lagged term for the local index, $R_{i,t-1}$, is included to account for first-order serial correlation. The inclusion of this term may lead to multicollinearity as the model includes a negatively lagged term for the world index return as well. Even though the world indices used in this study exclude the local index, except in the case of the Sweden regression, multicollinearity may still be an issue because most of the indices around the world are more or less integrated. Variance inflation factors of the regressions are examined to find out whether multicollinearity is present or not. Multicollinearity is not deemed to be an issue based on the VIF values that can be seen in table 8. Most of the VIF values are approximately 2 or less, except for the UK all shares and large cap regressions where the VIF values are approximately 2,5.

Table 8

Variance inflation factors for the normal return regressions

This table presents the variance inflation factors for the lagged local index return independent variable ($R_{i,t-1}$) for the regressions used in estimating the normal return for each index.

	All shares		Large cap		Small cap	
Regression	Uncentered VIF	Centered VIF	Uncentered VIF	Centered VIF	Uncentered VIF	Centered VIF
Japan 1	1,03	1,02	1,03	1,02	1,02	1,02
Japan 2	1,09	1,09	1,09	1,09	1,06	1,06
US	2,08	2,06	2,02	2,00	1,85	1,84
UK	2,53	2,51	2,50	2,49	1,65	1,59
EURO	2,04	2,04	2,00	2,00	1,82	1,82
Sweden	2,09	2,07	2,10	2,08	1,26	1,25

5.3. Abnormal Returns

Table 9 reports the abnormal returns on each of the quantitative easing announcement day for all shares, large cap, and small cap indices for each country or area where the announcement was made. Abnormal return is estimated as $AR_{i,t} = R_{i,t} - ER_{i,t}$, which is the difference between the actual return of the local index and the normal or expected return of the index. All of the six QE announcements by BoJ lead to positive abnormal returns for the three types of indices in Japan. The mean abnormal return across these six announcements ranged from +1,58 % for the small cap index to +1,95 % for the large cap index. The first three QE announcements by the Fed lead to positive abnormal returns for all of the index types, while the fourth announcement resulted in a negative abnormal return for all shares and small cap indices in the U.S. The mean abnormal return across these four announcements ranged from +0,75 % for the small cap index to +0,92 % for the other indices. In the U.K., the third QE announcement by the BoE lead to positive abnormal returns for all of the indices, while the opposite was true in the case of the fourth announcement. The mean abnormal return across the four announcements ranged from +0,16 % for the large cap index to +0,68 % for the small cap index. In the Eurozone, the first QE announcement day witnessed positive abnormal returns across all index types, while the second QE announcement day had negative abnormal returns. In Sweden, on the day of the BoS QE announcement, abnormal returns ranged from +1,08 % for the large index to +1,79 % for the small cap index. The mean abnormal return across all of the QE announcements for all of the countries and areas ranged from +1,41 % for the small cap indices to +1,57 % for the all shares and large cap indices.

Figure 7 and figure 8 show the daily average abnormal returns and cumulative average abnormal returns across all of the QE announcements for the all share, large cap, and small cap indices. All of the three types of indices have positive daily abnormal returns on t 0 to t +3. The cumulative average abnormal returns spike upwards on the event date and remain positive for all of the index types for the remainder of the test period, up to t +30. The CAARs for all shares and large cap indices are relatively stable after the event

Table 9
Abnormal returns on Quantitative Easing announcement days
This table presents the daily abnormal returns (%) on the quantitative easing announcement days for the local all shares, large cap, and small cap indices for each announcement country or area. Abnormal return is estimated as $AR_{i,t} = R_{i,t} - ER_{i,t}$. Additionally, the mean abnormal returns across the QE announcements and areas are reported to see 1) if the AR is different for the 1st announcemend relative to the subsequent announcements, and 2) if the different types of indices react differently on average.

	Quantitative Easing announcement						
Area and index	1st	2nd	3rd	4th	5th	6th	Mean
Japan							
All shares	1,37	1,09	0,96	0,99	3,46	3,67	1,92
Large cap	1,32	1,15	0,97	1,02	3,50	3,75	1,95
Small cap	1,46	0,49	1,03	0,71	2,96	2,84	1,58
U.S.							
All shares	2,74	0,25	0,73	-0,04	-	-	0,92
Large cap	2,56	0,26	0,84	0,02	-	-	0,92
Small cap	3,25	0,25	0,12	-0,61	-	-	0,75
U.K.							
All shares	-0,09	-0,04	1,13	-0,22	-	-	0,20
Large cap	-0,15	0,15	0,97	-0,32	-	-	0,16
Small cap	0,38	0,32	2,78	-0,75	-	-	0,68
EURO							
All shares	0,23	-1,16	-	-	-	-	-0,46
Large cap	0,21	-1,46	-	-	-	-	-0,63
Small cap	0,14	-0,46	-	-	-	-	-0,16
Sweden							
All shares	1,10	-	-	-	-	-	1,10
Large cap	1,08	-	-	-	-	-	1,08
Small cap	1,79	-	-	-	-	-	1,79
Mean							
All shares	1,07	0,04	0,94	0,25	3,46	3,67	1,57
Large cap	1,00	0,03	0,93	0,24	3,50	3,75	1,57
Small cap	1,41	0,15	1,31	-0,22	2,96	2,84	1,41

date and end up at +2,35 % for all shares and +1,90 % for large cap indices. The CAARs for small cap indices clearly drift upwards after the event date for the remainder of the test period and end up at +4,92 % on t +30. The upwards drifting of CAARs of the small cap indices indicate that the market may not be interpreting the information content of the QE announcements efficiently. If the markets were efficient, the CAARs should be approximately flat after the announcements.

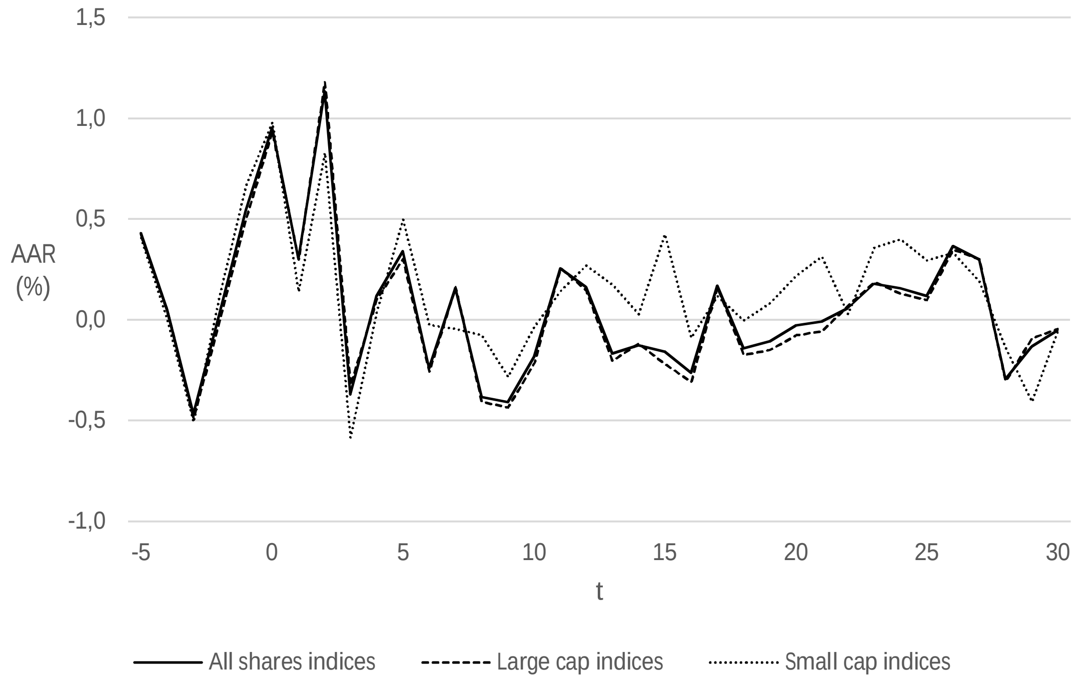

Figure 7. The average abnormal returns surrounding the QE announcements

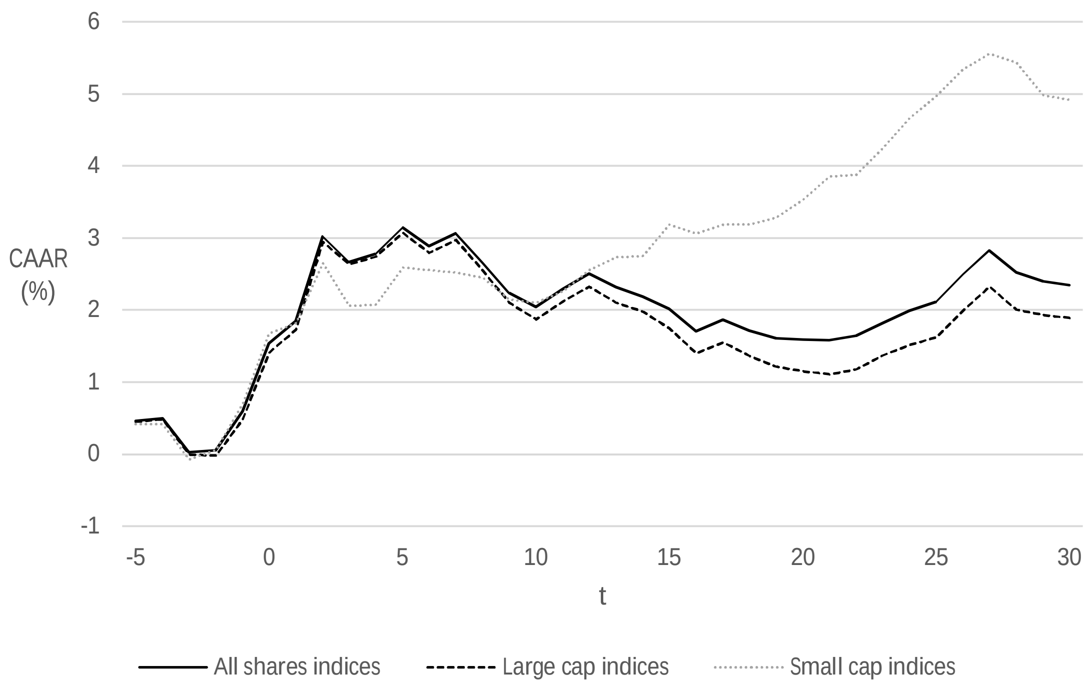

Figure 8. The cumulative average abnormal returns surrounding the QE announcements

5.4. Parametric Tests

Table 10 presents the Traditional T test results for the daily average abnormal returns. The all shares indices have statistically significant positive abnormal returns at the 1 to 5% level on five and one days prior to the announcement, on the announcement day, and on the second day after the announcement. The large cap indices react similarly. The small cap indices have significant positive abnormal returns at the 1% level on the day before the announcement, on the announcement day, and on the second day after the announcement. Additionally, a significant positive abnormal return on the 5% level is found on the fifth day after the announcement. The hypotheses of this study are that the QE announcements have a statistically significant impact on stock returns in the short-term, these announcements lead to positive abnormal returns in the short-term, and that these announcements lead to larger positive abnormal returns for companies with smaller market capitalization. These results confirm the first two hypotheses. There is also some evidence of the third hypothesis being true, at least on the event date when the small cap indices have a higher abnormal return.

Table 11 shows the Traditional T test results for the cumulative average abnormal returns. The CAARs of the all shares indices are positive and significant at the 1 to 5% level starting from the announcement date up to the fifteenth following day. Additionally, the CAARs of days t +26 to +28 are significant at the 5% level. The CAARs of the large cap indices are similar in terms of the sign of the CAAR and the significance of it except for the t +26 to +28 period. The CAARs of the small cap indices are positive and significant at the 1% level starting from the announcement date up to the end of the test period excluding the period from t +9 to +14 when they are significantly positive at the 5% level. These results confirm all of the hypotheses of this study. Additionally, the efficiency of the markets can be questioned as the CAARs keep drifting upwards and remain at a statistically significant level after the announcement date.

Table 10
Traditional T test results for daily abnormal returns
This table presents the daily average abnormal returns and t-statistics for the test period from t-5 to t+30 surrounding the quantitative easing announcement days across all countries and announcements involved in this study. The t-statistics are calculated as described in section 3.5.1. formula 7. S1 refers to significant abnormal return of either direction across all of the QE announcements, while S2 refers to positive abnormal returns across the QE announcements. ***, **, and * refer to significance at the 1%, 5% and 10% level.

	All shares				Large cap				Small cap			
t	AAR (%)	t-stat.	S1	S2	AAR (%)	t-stat.	S1	S2	AAR (%)	t-stat.	S1	S2
-5	0,43	1,67	*	**	0,42	1,58		*	0,41	1,53		*
-4	0,05	0,20			0,05	0,18			0,00	0,01		
-3	-0,47	-1,80	*		-0,49	-1,83	*		-0,51	-1,88	*	
-2	0,03	0,13			0,00	-0,01			0,12	0,46		
-1	0,54	2,10	**	**	0,50	1,89	*	**	0,67	2,49	**	***
0	0,95	3,68	***	***	0,93	3,50	***	***	0,98	3,66	***	***
1	0,30	1,17			0,30	1,13			0,14	0,52		
2	1,14	4,39	***	***	1,18	4,44	***	***	0,83	3,09	***	***
3	-0,37	-1,43			-0,32	-1,21			-0,58	-2,17	**	
4	0,12	0,46			0,11	0,39			0,04	0,14		
5	0,34	1,32		*	0,30	1,14			0,50	1,87	*	**
6	-0,24	-0,92			-0,26	-0,96			-0,02	-0,08		
7	0,16	0,60			0,16	0,61			-0,04	-0,16		
8	-0,38	-1,47			-0,40	-1,51			-0,07	-0,27		
9	-0,41	-1,57			-0,43	-1,63			-0,28	-1,05		
10	-0,18	-0,70			-0,21	-0,80			-0,03	-0,12		
11	0,26	0,99			0,26	0,98			0,14	0,54		
12	0,16	0,63			0,15	0,56			0,27	1,01		
13	-0,17	-0,64			-0,20	-0,75			0,18	0,66		
14	-0,12	-0,48			-0,11	-0,43			0,03	0,12		
15	-0,16	-0,61			-0,22	-0,81			0,43	1,59		*
16	-0,26	-1,01			-0,30	-1,14			-0,09	-0,32		
17	0,17	0,66			0,17	0,62			0,12	0,45		
18	-0,14	-0,54			-0,17	-0,64			0,00	0,00		
19	-0,11	-0,41			-0,15	-0,56			0,09	0,32		
20	-0,03	-0,10			-0,07	-0,28			0,22	0,82		
21	-0,01	-0,03			-0,05	-0,21			0,32	1,18		
22	0,06	0,23			0,07	0,27			0,03	0,11		
23	0,18	0,69			0,19	0,71			0,36	1,35		*
24	0,16	0,61			0,13	0,50			0,40	1,50		*
25	0,12	0,47			0,10	0,37			0,30	1,10		
26	0,37	1,42		*	0,35	1,32		*	0,34	1,25		
27	0,30	1,16			0,30	1,14			0,19	0,72		
28	-0,29	-1,13			-0,30	-1,14			-0,14	-0,51		
29	-0,13	-0,50			-0,09	-0,34			-0,40	-1,51		
30	-0,05	-0,20			-0,04	-0,16			-0,06	-0,21		

Table 11
Traditional T test results for cumulative abnormal returns
This table presents the cumulative average abnormal returns and t-statistics for the test period from t-5 to t+30 surrounding the quantitative easing announcement days across all countries and announcements involved in this study. The t-statistics are calculated as described in section 3.5.1. formula 9. S1 refers to significant cumulative abnormal returns of either direction across all of the QE announcements, while S2 refers to positive cumulative abnormal returns across the QE announcements. ***, **, and * refer to significance at the 1%, 5% and 10% level.

	All shares				Large cap				Small cap			
t	CAAR (%)	t-stat.	S1	S2	CAAR (%)	t-stat.	S1	S2	CAAR (%)	t-stat.	S1	S2
-5	0,46	1,26			0,45	1,20			0,43	1,12		
-4	0,50	1,13			0,49	1,07			0,42	0,91		
-3	0,03	0,06			0,00	0,00			-0,07	-0,13		
-2	0,05	0,09			-0,02	-0,03			0,06	0,11		
-1	0,60	0,95			0,49	0,76			0,71	1,08		
0	1,54	2,25	**	**	1,42	2,01	**	**	1,68	2,37	**	***
1	1,86	2,54	**	***	1,73	2,30	**	**	1,82	2,40	**	***
2	3,03	3,90	***	***	2,95	3,70	***	***	2,66	3,31	***	***
3	2,67	3,26	***	***	2,64	3,13	***	***	2,06	2,43	**	***
4	2,78	3,25	***	***	2,74	3,11	***	***	2,08	2,34	**	***
5	3,15	3,52	***	***	3,08	3,33	***	***	2,59	2,79	***	***
6	2,89	3,10	***	***	2,80	2,91	***	***	2,56	2,65	***	***
7	3,07	3,17	***	***	2,98	2,99	***	***	2,52	2,51	**	***
8	2,66	2,66	***	***	2,55	2,47	**	***	2,45	2,36	**	***
9	2,25	2,17	**	**	2,11	1,98	**	**	2,16	2,01	**	**
10	2,04	1,92	*	**	1,88	1,71	*	**	2,11	1,91	*	**
11	2,29	2,09	**	**	2,13	1,88	*	**	2,27	1,99	**	**
12	2,51	2,23	**	**	2,33	2,01	**	**	2,57	2,19	**	**
13	2,32	2,01	**	**	2,11	1,77	*	**	2,74	2,28	**	**
14	2,19	1,85	*	**	1,99	1,63		*	2,75	2,24	**	**
15	2,02	1,66	*	**	1,76	1,41		*	3,20	2,54	**	***
16	1,71	1,38		*	1,40	1,10			3,07	2,38	**	***
17	1,87	1,48		*	1,56	1,19			3,20	2,43	**	***
18	1,72	1,33		*	1,37	1,03			3,20	2,38	**	***
19	1,61	1,22			1,22	0,90			3,29	2,41	**	***
20	1,59	1,18			1,16	0,84			3,54	2,54	**	***
21	1,59	1,16			1,11	0,79			3,86	2,72	***	***
22	1,64	1,18			1,18	0,83			3,89	2,69	***	***
23	1,82	1,29		*	1,38	0,94			4,26	2,90	***	***
24	1,99	1,38		*	1,52	1,03			4,67	3,13	***	***
25	2,11	1,45		*	1,63	1,08			4,98	3,28	***	***
26	2,50	1,68	*	**	2,00	1,31		*	5,35	3,47	***	***
27	2,83	1,88	*	**	2,33	1,50		*	5,57	3,56	***	***
28	2,52	1,65	*	**	2,01	1,28			5,44	3,43	***	***
29	2,40	1,55		*	1,94	1,21			4,99	3,10	***	***
30	2,35	1,49		*	1,90	1,17			4,92	3,02	***	***

The results from the Standardized Residual tests are very similar to those of the Traditional T tests. Table 12 presents the Standardized Residual test results for the daily average abnormal returns and shows how the three types of indices show similar reactions to the QE announcements. The all shares, large cap and small cap indices all show significantly positive standardized residuals at the 1% level on the announcement day and two days after that. Moreover, the indices display a significant positive reaction at the 5% level on the 26th trading day after the announcement. The first two hypotheses of this study are clearly confirmed. There is indication of the third hypothesis holding as the standardized residual and its t-statistic of the small cap indices is larger than those of the other indices.

Table 13 displays the Standardized Residual test results for the cumulative average abnormal returns. The cumulative standardized residuals of the large cap indices are positive and significant at the 5% level for two days starting from the announcement day. Then the CSRs are significantly positive at the 1% level up to the eigth trading day after the announcement, followed by 5% significance for the following 4 days. The CSRs of the all shares indices show similar behavior, however they are significant and positive at the 5% level on t +26 to +28. The CSRs of the small cap indices show an extremely strong reaction to the announcements as they are positive and significant at the 1% level from the announcement day to the end of the 30-trading day test period. These results confirm all of the three hypotheses of this study, all of the types of indices in this study react significantly and positively to the announcements, and the small cap indices reaction is stronger and lasts for longer. Furthermore, market efficiency can be questioned on the basis of these results as well.

Table 12
Standardized residual test results for daily abnormal returns
This table presents the daily standardized residuals and t-statistics for the test period from t-5 to t+30 surrounding the quantitative easing announcement days across all countries and announcements involved in this study. The t-statistics are calculated as described in section 3.5.1. formula 7. S1 refers to significant standardized residuals of either direction across all of the QE announcements, while S2 refers to significant positive standardized residuals across the QE announcements. ***, **, and * refer to significance at the 1%, 5% and 10% level.

	All shares				Large cap				Small cap			
t	SR	t-stat.	S1	S2	SR	t-stat.	S1	S2	SR	t-stat.	S1	S2
-5	4,26	1,03			3,96	0,96			4,40	1,07		
-4	1,85	0,45			1,73	0,42			1,93	0,47		
-3	-2,82	-0,68			-3,04	-0,74			-2,70	-0,66		
-2	1,29	0,31			0,81	0,20			4,10	0,99		
-1	5,45	1,32		*	4,81	1,17			6,75	1,64		*
0	13,57	3,29	***	***	13,05	3,17	***	***	15,37	3,73	***	***
1	4,59	1,11			4,58	1,11			0,00	0,00		
2	18,16	4,41	***	***	18,51	4,49	***	***	13,74	3,33	***	***
3	-5,40	-1,31			-4,70	-1,14			-5,89	-1,43		
4	2,11	0,51			1,68	0,41			1,14	0,28		
5	5,12	1,24			4,64	1,13			6,21	1,51		*
6	-4,16	-1,01			-4,39	-1,06			-1,38	-0,33		
7	2,16	0,52			2,17	0,53			-0,25	-0,06		
8	-5,45	-1,32			-5,67	-1,38			-1,16	-0,28		
9	-5,85	-1,42			-6,14	-1,49			-2,02	-0,49		
10	-1,72	-0,42			-2,12	-0,52			0,47	0,11		
11	4,17	1,01			4,05	0,98			4,17	1,01		
12	0,96	0,23			0,78	0,19			2,24	0,54		
13	-4,77	-1,16			-5,15	-1,25			0,83	0,20		
14	-3,09	-0,75			-2,72	-0,66			-2,03	-0,49		
15	-2,51	-0,61			-3,23	-0,78			5,82	1,41		*
16	-3,78	-0,92			-4,19	-1,02			-1,42	-0,34		
17	2,35	0,57			2,35	0,57			1,17	0,28		
18	-1,78	-0,43			-2,13	-0,52			1,44	0,35		
19	0,00	0,00			-0,76	-0,18			4,36	1,06		
20	-0,76	-0,18			-1,39	-0,34			4,03	0,98		
21	0,13	0,03			-0,56	-0,14			6,22	1,51		*
22	1,73	0,42			1,97	0,48			2,25	0,54		
23	3,35	0,81			3,45	0,84			6,56	1,59		*
24	2,93	0,71			2,60	0,63			5,91	1,43		*
25	2,13	0,52			1,76	0,43			5,52	1,34		*
26	7,33	1,78	*	**	7,00	1,70	*	**	7,74	1,88	*	**
27	4,91	1,19			4,81	1,17			3,69	0,89		
28	-5,14	-1,25			-5,12	-1,24			-1,83	-0,44		
29	-1,42	-0,34			-0,61	-0,15			-7,59	-1,84	*	
30	-0,59	-0,14			-0,31	-0,08			-0,43	-0,10		

Table 13
Standardized residual test results for cumulative abnormal returns
This table presents the cumulative standardized residuals and t-statistics for the test period from t-5 to t+30 surrounding the quantitative easing announcement days across all countries and announcements involved in this study. The t-statistics are calculated as described in section 3.5.1. formula 9. S1 refers to significant cumulative standardized residuals of either direction across all of the QE announcements, while S2 refers to significant positive standardized residuals across the QE announcements. ***, **, and * refer to significance at the 1%, 5% and 10% level.

	All shares				Large cap				Small cap			
t	CSR	t-stat.	S1	S2	CSR	t-stat.	S1	S2	CSR	t-stat.	S1	S2
-5	4,26	0,73			3,96	0,68			4,40	0,75		
-4	6,10	0,85			5,69	0,80			6,33	0,89		
-3	3,29	0,40			2,65	0,32			3,62	0,44		
-2	4,58	0,50			3,46	0,38			7,72	0,84		
-1	10,03	0,99			8,28	0,82			14,47	1,43		*
0	23,60	2,16	**	**	21,33	1,96	*	**	29,85	2,74	***	***
1	28,19	2,42	**	***	25,91	2,22	**	**	29,85	2,56	**	***
2	46,35	3,75	***	***	44,42	3,59	***	***	43,59	3,52	***	***
3	40,95	3,14	***	***	39,72	3,05	***	***	37,69	2,89	***	***
4	43,06	3,15	***	***	41,41	3,03	***	***	38,84	2,84	***	***
5	48,18	3,37	***	***	46,05	3,22	***	***	45,05	3,15	***	***
6	44,02	2,96	***	***	41,66	2,80	***	***	43,67	2,94	***	***
7	46,17	2,99	***	***	43,83	2,84	***	***	43,42	2,81	***	***
8	40,72	2,55	**	***	38,16	2,39	**	***	42,27	2,65	***	***
9	34,87	2,11	**	**	32,01	1,94	*	**	40,25	2,44	**	***
10	33,15	1,95	*	**	29,89	1,76	*	**	40,72	2,40	**	***
11	37,32	2,13	**	**	33,94	1,94	*	**	44,88	2,57	**	***
12	38,28	2,13	**	**	34,72	1,93	*	**	47,12	2,62	***	***
13	33,51	1,82	*	**	29,57	1,60		*	47,95	2,60	***	***
14	30,42	1,61		*	26,86	1,42		*	45,92	2,43	**	***
15	27,92	1,44		*	23,62	1,22			51,74	2,68	***	***
16	24,14	1,22			19,44	0,98			50,32	2,54	**	***
17	26,49	1,31		*	21,79	1,08			51,49	2,55	**	***
18	24,71	1,20			19,66	0,95			52,93	2,57	**	***
19	24,71	1,18			18,90	0,90			57,29	2,72	***	***
20	23,95	1,12			17,51	0,82			61,31	2,86	***	***
21	24,08	1,10			16,95	0,78			67,53	3,10	***	***
22	25,81	1,16			18,92	0,85			69,78	3,14	***	***
23	29,16	1,29		*	22,37	0,99			76,34	3,38	***	***
24	32,09	1,40		*	24,97	1,09			82,25	3,58	***	***
25	34,22	1,47		*	26,74	1,15			87,77	3,76	***	***
26	41,55	1,75	*	**	33,74	1,42		*	95,50	4,03	***	***
27	46,46	1,93	*	**	38,55	1,60		*	99,19	4,13	***	***
28	41,33	1,69	*	**	33,42	1,37		*	97,36	3,99	***	***
29	39,91	1,61		*	32,81	1,33		*	89,77	3,63	***	***
30	39,32	1,57		*	32,50	1,30		*	89,34	3,56	***	***

5.5. Nonparametric Tests

Table 14 presents the Sign test and Generalized Sign test results for each of the QE announcement for the three types of indices. The Sign test results show a significant positive reaction at the 1% level for the BoJ's QE announcements 1, 4, 5, and 6 for all of the index types. The Generalized Sign test results show a significant positive reaction at the 1% level for announcements 1 and 6 for all shares and large indices, while the reaction is significantly positive for announcements 1, 4, 5, and 6 for the small cap index. The Sign test results for the Fed's QE announcements show a significantly positive reaction at the 1 to 5% level for the large cap index for QE announcements 1 to 3, while the first and second are significant for all shares and small cap indices. Based on the Generalized Sign test, the Fed QE announcements did not have a statistically significant positive impact on the indices. The Sign test results for the BoE QE announcements show a significant positive reaction at the 1% level by the all shares and large cap indices for the third announcement, while announcements 1 to 3 are significant for the small cap index. The Generalized Sign test shows a significant reaction at the 1% level by the all shares indices for all of the four announcements, while the large cap index reacted at the same level to the second and third announcements, and the small cap index to the first three announcements. Both of the tests show a significant reaction at the 1% level by all of the three types of indices to the first ECB QE announcement and the BoS announcement. The second ECB announcement lead to a positive reaction in the small cap index based on both tests. When all of these QE announcements are examined together, both of the tests show a significantly positive reaction by the all shares, large cap, and small cap indices at the 1% level. These results support the first two hypotheses of this study. There is some indication that the reaction of the small cap indices has been stronger or more positive.

Table 15 reports the Corrado Rank test results for the daily average abnormal returns and the cumulative average abnormal returns. In the case of daily AARs there is little evidence of a significant positive reaction to the announcements by the local stock indices. A single significant AAR at the 5% level can be seen on t +2 for large cap indices. At the 10% level, all of the indices show a significant reaction on the announcement day.

Table 14
Sign test and Generalized Sign test results for daily cumulative abnormal returns
This table displays the results from the Sign tests and Generalized Sign tests during the test period of t-5 to t+30 surrounding the quantitative easing announcement days for the local stock indices of each QE announcement country. "Combined" shows the results from examining all of the QE announcements together. ***, **, and * refer to statistically significant positive cumulative abnormal returns at the 1%, 5% and 10% level.

	All shares		Large cap		Small cap	
Area	Sign test	Generalized Sign test	Sign test	Generalized Sign test	Sign test	Generalized Sign test
Japan						
QE announcement 1	***	***	***	***	***	***
QE announcement 2						
QE announcement 3						
QE announcement 4	***		***		***	***
QE announcement 5	***		***		***	***
QE announcement 6	***	***	***	***	***	***
U.S.						
QE announcement 1	***		***		***	
QE announcement 2	***		***		**	
QE announcement 3			**			
QE announcement 4						
U.K.						
QE announcement 1		***		*	***	***
QE announcement 2	*	***	*	***	***	***
QE announcement 3	***	***	***	***	***	***
QE announcement 4		***		*		
EURO						
QE announcement 1	***	***	***	***	***	***
QE announcement 2					***	***
Sweden						
QE announcement 1	***	***	***	***	***	***
Combined	***	***	***	***	***	***

The cumulative average abnormal returns tell a different story. The CAARs of the large cap indices show a significantly positive reaction at the 5% level on the second and third day after the announcements. The CAARs of the small cap indices show a significant positive reaction starting from the announcement day at the 10% level. The level decreases to the 5% level on the second day after the announcements, and then increases back to 10%. Interestingly, the CAARs become significantly positive at the 5% level on the 23rd day after the announcement and remain there until the end of the test period. The corrado rank test results for CAARs support all of the three hypotheses of this study. Moreover, in the case of the small cap indices, there is some indication of the markets not being efficient.

Table 15
Corrado Rank test results for daily average abnormal returns and cumulative average abnormal returns
This table presents the Corrado Rank test results for the daily average abnormal returns and cumulative average abnormal returns for the test period from t-5 to t+30 surrounding the quantitative easing announcement days across all countries and announcements involved in this study. S1 refers to significant abnormal return or cumulative abnormal return of either direction across all of the QE announcements, while S2 refers to positive abnormal returns or cumulative abnormal returns across the QE announcements. ***, **, and * refer to significance at the 1%, 5% and 10% level.

	All shares				Large cap				Small cap			
	AR		CAR		AR		CAR		AR		CAR	
t	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
-5												
-4												
-3												
-2												
-1												
0		*		*		*				*		*
1				*								*
2		*	*	**	**	**	*	**			*	**
3				*			*	**				*
4				*				*				*
5				*				*				*
6				*								*
7				*								*
8												*
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10												
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26											**	**
27											**	**
28											**	**
29											*	**
30											*	**

6. CONCLUSION

Motivated by the current popularity of the unconventional monetary policies, namely quantitative easing, this study examines whether quantitative easing announcements lead to a stock market reaction or not. A number of researchers have shown how changes in monetary policy and economic news announcements have had a significant impact on stock market returns, however, no comprehensive study about the effect of quantitative easing announcements has been done yet. This paper aims to fill this gap by studying if these announcements lead to a significant stock market reaction, whether the reaction is positive and whether small cap stocks react differently or not. Additionally, market efficiency is investigated.

This study employs a variety of event study tests to increase the robustness of the results. The parametric tests used include the Traditional T test and the Standardized Residual test. Parametric tests assume that abnormal returns are normally distributed. To overcome this limitation, three different nonparametric tests, the Sign test, the Generalized Sign test, and the Corrado Rank test, are utilized. Both parametric tests show a significant positive stock market reaction surrounding the announcement days, and the reaction is pronounced for small cap stocks. The results from the nonparametric tests confirm these results. The results from the Sign test and the Generalized Sign test show how the all shares, large cap, and small cap indices react significantly and positively to the announcements. The results from the Corrado Rank test show a stronger and longer significant positive reaction for the small cap indices. The market appears to be incorporating the information content of the QE announcements efficiently when it comes to the index-wide all shares indices and the large cap indices. However, the Traditional T test, the Standardized Residual test, and the Corrado Rank test results for the small cap indices cast doubt on market efficiency. The CAARs keep drifting upwards and remain statistically significant starting from the announcement date up to the end of the test period at 30 trading days after the announcement.

Further research can be conducted on this topic by including announcements where the central bank announces that it is investigating the possibility of beginning or extending the time, size, or composition of the quantitative easing programme. This would include surprise announcements and deal with the problem that some of the announcements in this study may have already been expected by the public, and thus been already incorporated into the prices before the actual announcement was given. Moreover, this study examines the local stock market reaction to the announcements. The stock markets are integrated globally to some extent, and therefore the global stock market reaction could be examined instead of only focusing on the local stock markets. Furthermore, more event study tests could be employed, such as the Generalized Rank Test (Kolari and Pynnönen, 2010). Additionally, research could be done on whether different industries react to these announcements differently.

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APPENDICES

APPENDIX 1. Excerpts from the Quantitative Easing announcements

Bank of Japan

March 19, 2001

3. In light of this, the Bank has come to a conclusion that the economic conditions warrant monetary easing as drastic as is unlikely to be taken under ordinary circumstances. Accordingly, the Bank decided at its Monetary Policy Meeting of today to take the following policy actions.
   a) Change in the operating target for money market operations
      The main operating target for money market operations be changed from the current uncollateralized overnight call rate to the outstanding balance of the current accounts at the Bank of Japan. Under the new procedures, the Bank provides ample liquidity, and the uncollateralized overnight call rate will be determined in the market at a certain level below the ceiling set by the Lombard-type lending facility.
   b) CPI guideline for the duration of the new procedures
      The new procedures for money market operations continue to be in place until the consumer price index (excluding perishables, on a nationwide statistics) registers stably a zero percent or an increase year on year.
   c) Increase in the current-account balance at the Bank of Japan and declines in interest rates
      For the time being, the balance outstanding at the Bank's current accounts be increased to around 5 trillion yen, or 1 trillion yen increase from the average outstanding of 4 trillion yen in February 2001 (see Attachment). As a consequence, it is anticipated that the uncollateralized overnight call rate will significantly decline from the current target level of 0.15 percent and stay close to zero percent under normal circumstances.
   d) Increase in outright purchase of long-term government bonds
      The Bank will increase the amount of its outright purchase of long-term government bonds from the current 400 billion yen per month, in case it considers that increase to be necessary for providing liquidity smoothly. The outright purchase is, on the other hand, subject to the limitation that the outstanding amount of long-term government bonds effectively held

by the Bank, i.e., after taking account of the government bond sales under gensaki repurchase agreements, be kept below the outstanding balance of banknotes issued.

Board of Governors of the Federal Reserve System

November 25, 2008

The Federal Reserve announced on Tuesday that it will initiate a program to purchase the direct obligations of housing-related government-sponsored enterprises (GSEs)--Fannie Mae, Freddie Mac, and the Federal Home Loan Banks--and mortgage-backed securities (MBS) backed by Fannie Mae, Freddie Mac, and Ginnie Mae. Spreads of rates on GSE debt and on GSE-guaranteed mortgages have widened appreciably of late. This action is being taken to reduce the cost and increase the availability of credit for the purchase of houses, which in turn should support housing markets and foster improved conditions in financial markets more generally.

Purchases of up to $100 billion in GSE direct obligations under the program will be conducted with the Federal Reserve's primary dealers through a series of competitive auctions and will begin next week. Purchases of up to $500 billion in MBS will be conducted by asset managers selected via a competitive process with a goal of beginning these purchases before year-end. Purchases of both direct obligations and MBS are expected to take place over several quarters. Further information regarding the operational details of this program will be provided after consultation with market participants.

Bank of England

5 March 2009

The Bank of England’s Monetary Policy Committee today voted to reduce the official Bank Rate paid on commercial bank reserves by 0.5 percentage points to 0.5%, and to undertake a programme of asset purchases of £75 billion financed by the issuance of central bank reserves.

Bank of England

7 May 2009

The Bank of England's Monetary Policy Committee today voted to maintain the official Bank Rate paid on commercial bank reserves at 0.5%. The Committee also voted to continue with its programme of asset purchases financed by the issuance of central bank reserves and to increase its size by £50 billion to a total of £125 billion.

Bank of England

6 August 2009

The Bank of England's Monetary Policy Committee today voted to maintain the official Bank Rate paid on commercial bank reserves at 0.5%. The Committee also voted to continue with its programme of asset purchases financed by the issuance of central bank reserves and to increase its size by £50 billion to £175 billion.

Bank of England

5 November 2009

The Bank of England's Monetary Policy Committee today voted to maintain the official Bank Rate paid on commercial bank reserves at 0.5%. The Committee also voted to continue with its programme of asset purchases financed by the issuance of central bank reserves and to increase its size by £25 billion to £200 billion.

Bank of Japan

October 5, 2010

The Bank will examine establishing, as a temporary measure, a program on its balance sheet to purchase various financial assets, such as government securities, commercial paper (CP), corporate bonds, exchange-traded funds (ETFs), and Japan real estate investment trusts (J-REITs) and to conduct the fixed-rate funds-supplying operation

Board of Governors of the Federal Reserve System

November 3, 2010

To promote a stronger pace of economic recovery and to help ensure that inflation, over time, is at levels consistent with its mandate, the Committee decided today to expand its holdings of securities. The Committee will maintain its existing policy of reinvesting principal payments from its securities holdings. In addition, the Committee intends to purchase a further $600 billion of longer-term Treasury securities by the end of the second quarter of 2011, a pace of about $75 billion per month. The Committee will regularly review the pace of its securities purchases and the overall size of the asset-purchase program in light of incoming information and will adjust the program as needed to best foster maximum employment and price stability.

Bank of Japan

August 4, 2011

At the Monetary Policy Meeting held today, the Policy Board of the Bank of Japan decided, by a unanimous vote to enhance monetary easing by increasing the total size of the Asset Purchase Program by about 10 trillion yen2 from about 40 trillion yen to about 50 trillion yen.

Board of Governors of the Federal Reserve System

September 13, 2012

To support a stronger economic recovery and to help ensure that inflation, over time, is at the rate most consistent with its dual mandate, the Committee agreed today to increase policy accommodation by purchasing additional agency mortgage-backed securities at a pace of $40 billion per month. The Committee also will continue through the end of the year its program to extend the average maturity of its holdings of securities as announced in June, and it is maintaining its existing policy of reinvesting principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities. These actions, which together will increase the Committee’s holdings of longer-term securities by about $85 billion each month through the end of the year, should put downward pressure on longer-term interest rates, support mortgage markets, and help to make broader financial conditions more accommodative.

Bank of Japan

September 19, 2012

The Bank decided to increase the total size of the Program by about 10 trillion yen, from about 70 trillion yen to about 80 trillion yen. The increase in the size of the Program corresponds with the size of additional purchases of treasury discount bills (T-Bills) by about 5 trillion yen and Japanese government bonds (JGBs) by about 5 trillion yen.

The increased purchases under the Program will be completed by around end-2013. Specifically, additional purchases of T-Bills and JGBs will be completed by around end-June 2013 and around end-2013, respectively. Through these measures, the amount outstanding of the Program will be about 65 trillion yen by around end-2012, about 75 trillion yen by around end-June 2013, and about 80 trillion yen by around end-2013.

Board of Governors of the Federal Reserve System

December 12, 2012

To support a stronger economic recovery and to help ensure that inflation, over time, is at the rate most consistent with its dual mandate, the Committee will continue purchasing additional agency mortgage-backed securities at a pace of $40 billion per month. The Committee also will purchase longer-term Treasury securities after its program to extend the average maturity of its holdings of Treasury securities is completed at the end of the year, initially at a pace of $45 billion per month. The Committee is maintaining its existing policy of reinvesting principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities and, in January, will resume rolling over maturing Treasury securities at auction. Taken together, these actions should maintain downward pressure on longer-term interest rates, support mortgage markets, and help to make broader financial conditions more accommodative.

Bank of Japan

April 4, 2013

The introduction of the "quantitative and qualitative monetary easing". The Bank will achieve the price stability target of 2 percent in terms of the year-on-year rate of change in the consumer price index (CPI) at the earliest possible time, with a time horizon of about two years. In order to do so, it will enter a new phase of monetary easing both in terms of quantity and quality. It will double the monetary base and the amounts outstanding of Japanese government bonds (JGBs) as well as exchange-traded funds (ETFs) in two years, and more than double the average remaining maturity of JGB purchases.

Bank of Japan

October 31, 2014

At the Monetary Policy Meeting held today, the Policy Board of the Bank of Japan decided upon the following measures.

(1) Accelerating the pace of increase in the monetary base by a 5-4 majority vote

(2) Increasing asset purchases and extending the average remaining maturity of Japanese government bond (JGB) purchases by a 5-4 majority vote

European Central Bank

22 January 2015

The Governing Council of the European Central Bank (ECB) today announced an expanded asset purchase programme. Aimed at fulfilling the ECB's price stability mandate, this programme will see the ECB add the purchase of sovereign bonds to its existing private sector asset purchase programmes in order to address the risks of a too prolonged period of low inflation.

Sveriges Riksbank

28/10/2015

Overall, the Executive Board's assessment is that monetary policy needs to be more expansionary in order to underpin the positive development in the Swedish economy and safeguard the robustness of the upturn in inflation. The Executive Board has therefore decided to extend the government bond purchasing programme by an additional SEK 65 billion so that purchases will amount to SEK 200 billion in total by the end of June 2016. The repo rate is left unchanged at −0.35 per cent but an initial raise in the rate will be deferred by approximately six months compared with the previous assessment.

European Central Bank

3 December 2015

Second, as regards **non-standard monetary policy measures**, we decided to extend the asset purchase programme (APP). The monthly purchases of €60 billion under the APP are now intended to run until the end of March 2017, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its aim of achieving inflation rates below, but close to, 2% over the medium term.

Third, we decided to **reinvest the principal payments** on the securities purchased under the APP as they mature, for as long as necessary. This will contribute both to favourable liquidity conditions and to an appropriate monetary policy stance. The technical details will be communicated in due time.

Fourth, we decided to include, in the public sector purchase programme, **euro-denominated marketable debt instruments issued by regional and local governments located in the euro area** in the list of assets that are eligible for regular purchases by the respective national central banks.