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Bachelor Thesis

The ECB's Unconventional Monetary Policy: Spillovers to the Financial Markets of Non-euro Area European Countries

Authors:

Jekaterina Gornostajeva
Alivija Kovaļova

Supervisor:

Ágnes Lublóy

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Abstract

This paper studies how the financial markets of non-euro area European countries were surprised by the announcements of unconventional monetary policy of the European Central Bank (ECB). The data sample covers years from 2007 until 2016, analyzing how bond yields, equity indices, and exchange rates reacted to two types of the ECB's policy announcements. To the first type belong those announcements which were the most unexpected by the market, while to the second type – those which not only surprised the market but were also able to change market expectations about future monetary policy stance. The results suggest that equity indices of all sample countries and bond yields of advanced economies were affected mostly by the announcements of the first type. Exchange rates, in turn, reacted to announcements that caused changes in expectations.

Keywords: The European Central Bank, surprise factors, event study, non-euro area European financial markets

Contents

1. Introduction

In response to the global financial crisis of 2008 and the Euro-area's sovereign debt crisis of 2010, the Governing council of the European Central Bank (ECB) cut the European key interest rates, which allowed to use a series of unconventional monetary policy tools. In particular, the first prompt actions took place on October 15, 2008, when the 3-month Euribor/overnight indexed swap spread reached a high of 198 basis points, signaling that the subprime crisis substantially intensified counterparty risk. On this day, the ECB announced the start of the fixed-rate full-allotment tender (FRTFA) for refinancing operations of all maturities, the idea of which was to supply commercial banks with unlimited funding in order to enhance liquidity at the European money market (Fawley and Neely, 2013). In addition, the maturity of regular 3-month long-term refinancing operations (LTROs) was extended to six months, twelve months and, finally, three years' horizon, in March 2008, May 2009, and December 2011, correspondingly (Fratzscher, M., Duca, M.L., & Straub, R., 2016).

However, the implementation of the liquidity-providing operations was not enough to calm markets and reduce the exposure to counterparty risk. Thus, in July 2009 the ECB employed another tool of non-standard monetary policy called the asset purchase programme (APP), which implies that the ECB buys private or public securities from the open market, mostly from commercial banks, and by doing so it lowers the yields and increases the securities' prices. Precisely, four programmes - covered bond purchase programme of the first and the second round (CBPP1, CBPP2), outright monetary transactions (OMTs), and securities markets programme (SMP) – tried to heighten the European banks' refinancing channels and address severe tensions in the most suffering financial market segments. The programmes were carried out until 2012 (Fawley and Neely, 2013).

Even though the overall 'health' of the European economy started to gradually recover after the crises, in 2014 the Eurozone faced another challenge - a prolonged period of low inflation. Starting from the end of 2013 the euro area inflation rate has been fluctuating between 1% and -1% (Trading Economics, 2016). One might argue that low or even negative inflation (deflation) enhances the purchasing power of consumers, however, it is not the case. Quite the contrary, as was noted by the ECB Executive Board member Peter Praet (2016) in the periods of low inflation/deflation people tend to postpone their consumption and investment decisions because they expect that prices will fall further, as well as real debt

burdens upsurge, curtailing the spending power of businesses and individuals who make loans. Furthermore, deflation undermines the efficacy of monetary policy, as real interest rate might no longer be verifiable by central banks. The abovementioned factors, in turn, could result in high unemployment and economic stagnation in the long run (The Economist, 2015a).

Thus, in order to address the deflation risks, in October 2014 the ECB restarted its non-standard monetary policy measures, but at this time it pursues the goal of achieving the euro area inflation rate close to 2% at least over the medium term. The currently undertaken measures include targeted long-term refinancing operations (TLTROs), which are aimed to ameliorate bank lending to private sector, and expanded asset purchase programmes (EAPP) that consists of covered bond (CBPP3), asset-backed securities (ABSPP), public sector (PSPP), and corporate sector (CSPP) purchase programs (ECB, 2016a).

Due to the fact that the domestic impact of the ECB's unconventional monetary policy has been already substantially studied, the authors focus their research on examining the influence of the ECB's measures beyond the euro area, precisely, the spillovers to non-euro area European countries, which include: Hungary, Poland, Romania, the Czech Republic, Croatia, Bulgaria, Sweden, Denmark, Norway, and Switzerland. The motivation for choosing these countries is discussed in the methodology section (3.4) of the present paper.

The research is limited to investigation of financial spillovers rather than macroeconomic ones because the effect produced on financial markets is quick: investors rebalance their portfolios immediately in response to the unexpected decisions of the ECB, thereby initiating an immediate impact on asset prices. Macroeconomic spillovers, in turn, will appear only after a significant time interval, as real wages, prices, and output react slowly, and it is hard to capture the changes initiated exactly by the ECB's policies.

The research questions are formulated as follows:

(1) Are there spillover effects from the ECB's unconventional monetary policy on the financial markets of non-euro area European countries?

(2) Which asset classes of non-euro area European countries are affected the most by the spillovers from the ECB's unconventional monetary policy?

In particular, the authors intend to examine how bond yields, equity indices, and local currencies' exchange rates vis-à-vis the euro reacted to the ECB's policy announcements

which were completely or partially unexpected. Due to the fact that most announcements tend to be foreseen at least in part prior official releases, the preceding researchers of this field such as Gürkaynak, R.S., Sack, B., and Swanson, E., T. (2005) and Rogers, J. H., Chiara, S., and Wright, J. H. (2014) argued that only unexpected part/surprise components of announcements are supposed to reveal true effect on asset prices.

It should be highlighted that there are quite a few researchers that investigated financial spillovers from the ECB's non-standard monetary policies, for example, Falagiarda, M., McQuade, P., and Tirpák, M (2015), Fratzscher et al. (2016), and Georgiadis and Gräb (2016). Moreover, these studies are relatively new, and they access either actual or announcement impact of the ECB's measures on asset prices. None of the papers tests, however, the influence from the surprise components of the ECB's decisions. Thus, the authors of the present paper are the first who estimate how the financial markets of non-euro area European countries were surprised by the announcements of the ECB. Additionally, as the present study covers the period from 2007 to 2016, the spillovers generated from the latest decisions of 2016 are accessed as well.

The authors expect that their research will be useful for policymakers of non-euro area European countries because if they are aware of impact and magnitude of the spillovers from the ECB's policies, they are able to more efficiently adjust their domestic monetary policy and alleviate the effect from destabilizing spillovers. Furthermore, the research should be relevant for the ECB as well. Mario Draghi (2016) pointed out that due to the fact that non-euro area European economies can pursue their independent monetary policies, they tend to obstruct the ECB from the effective implementation of non-standard measures. That is why the ECB responds to it by intensification of their policies. This implies that the ECB aggressively increases the amount of asset purchases and conducts refinancing operations more frequently than expected. Thus, Mario Draghi (2016) highlighted that the ECB must monitor what effects it generates beyond the euro area, and how other economies react to them. Additionally, the research can be useful for investors – if they know how the sample countries react to the ECB's announcements, they may use this knowledge when evaluating investment opportunities.

The paper is structured as follows. First, the authors review the existing literature on the topic (Section 2). Next, in Section 3 the applied methodology is described. Section 4

reviews the results on the most surprising ECB events, as well as reports the findings of event study and regression analyses. Sections 5 and 6 discuss the obtained results and draw conclusions.

2. *Literature review*

2.1 Spillovers from the ECB's unconventional monetary policies on non-euro area European countries

While a significant number of researchers investigate the ECB's unconventional monetary policy impact on the European financial market, there is quite a few studies that focus on spillover effects from such policies on the markets of non-euro area European countries (Falagiarda et al., 2015, Fratzscher et al., 2016, Georgiadis and Gräb, 2016, Ciarlone and Colabella, 2016, and Bluwstein and Canova, 2016). Not only are these countries closely linked to the euro area through economic and financial linkages, but also these economies are able to pursue its independent monetary policy since they are not subordinate to the ECB (Mario Draghi, 2016). However, Rey (2015) argued that nowadays this is under the question whether the effect of these independent policies is still efficient because of the strengthening globalization. The well-known Trilemma hypothesis states that it is impossible for a country to carry out three policies – exchange rate stability, national monetary policy autonomy, and capital mobility – at the same time. This trilemma has been recently transformed into dilemma, suggesting that a country could employ independent monetary policy only if it manages its capital account (Rey, 2015). Therefore, non-euro area European countries, which are open to free capital movement and implement their own monetary policy, are the countries that are subject to spillovers from the ECB's unconventional monetary policy in the first place.

Before the discussion of existing literature on the topic one should consider that the previous researchers, except Bluwstein and Canova (2016), obtained their results through event study analysis, the main feature of which is the presence of event dummies as explanatory variables in a regression model (i.e. event dummy takes value 1 on days of the ECB's announcements and 0 otherwise). Moreover, the previous researchers were able to separately assess the influence from each unconventional monetary policy. The list of such policies is provided in Appendix B.

The present paper stands out from the previous researches done since it suggests new measures of the ECB's announcements – surprise factors, which are discussed in detail in Section 3.1.

2.1.1 Equity indices

Falagiarda et al. (2015), who limited its research to investigation of spillovers from the ECB's policies on four emerging markets – the Czech Republic, Hungary, Poland, and Romania – found that the announcements of all ECB's non-standard monetary policy measures (key interest rate cuts, LTROs, APPs, etc.), undertaken from January 2007 till January 2015, did not influence equity indices of these countries. They argued that the possible reasoning might lie in the fact that their equity markets are less developed than their debt markets.

The main conclusions of Falagiarda et al. (2015) contradict with the findings of Bluwstein and Canova (2016). The research paper of Bluwstein and Canova (2016), however, stands out from other researches as the authors developed a novel methodology that allowed to assess not only presence and magnitude of spillover effects from actual implementation of the ECB's policy (2007-2013), but their persistence as well. Their sample consisted of nine non-euro area European countries: Bulgaria, the Czech Republic, Hungary, Poland, Romania, Denmark, Norway, Sweden, and Switzerland. They discovered that stock prices at first increased for all countries, with the exception of Norway; however, the rise was soon replaced by the decline that was present for approximately eight weeks, for all countries except Denmark. They also found that the effect produced on emerging markets was more persistent than in advanced economies.

At this point it is important to clarify that due to the fact that each open market operation or asset purchase programme has different specifications and is directed towards a certain market segment, most researchers assume that spillovers might vary across programme type and, thus, try to estimate the effect from each non-standard monetary policy tool separately. Their findings are discussed below.

Falagiarda et al. (2015) found that spillovers initiated by the announcements of long-term refinancing operations (LTROs) were weak: only Hungarian equity index ascended in response to them. Fratzscher et al. (2016), in turn, concluded that equity indices of Bulgaria, Hungary, Poland, and the Czech Republic were unimpaired.

Equity indices of advanced economies, in turn, showed more substantial responses to the LTROs: Fratzscher et al. (2016)[1] discovered that 6-month and 12-month LTROs caused a rise of 2.62% in their equity prices, while 3-year LTROs initiated even larger increase of 2.97%.

Announcements related to the arrangement of currency swap lines generated the opposite effect on equity prices: Falagiarda et al. (2015) concluded that the Czech and Polish equity indices fell in response to such announcements.

Ciarlone and Colabella (2016) focused on investigation of spillovers generated purely by the ECB's asset purchase programmes. The authors assessed the impact of both terminated and currently undertaken programmes. The countries of their interest were Bulgaria, Croatia, the Czech Republic, Hungary, Poland, and Romania. The obtained results suggested that the APP announcements caused a rise in equity returns, however, the researchers who assessed the influence of each asset purchase programme separately, revealed that the responses substantially differed across programme types.

Falagiarda et al. (2015) found that the SMP announcements generated strong negative spillovers on equity indices of the Czech Republic, Hungary, Poland, and Romania. Fratzscher et al. (2016), in turn, did not find any spillovers to emerging markets' equity returns. Georgiadis and Gräb (2016)[2] obtained that equity indices of non-euro area EU countries, which were represented by both emerging and advanced economies, increased by 1.32%. It seems that only emerging markets contributed to the increase due to the fact that Georgiadis and Gräb (2016), and Fratzscher et al. (2016) estimated that in advanced economies equity indices fell by 1.85-1.95% in response to the SMP announcements. The authors argued that the negative effect took place due to the fact that the SMP announcements managed to alleviate tension in certain European financial market segments and initiated equity outflows from other countries into the euro area.

Fratzscher et al. (2016) discovered that the announcements of the OMT programme caused a rise of 1.08% in equity indices across emerging markets, while for the advanced economies an increase in equity prices added up to 2.55%. The results obtained are consistent

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[1] The sample of advanced economies included the countries relevant for the present research – Sweden, Denmark, Norway, and Switzerland.

[2] The sample on non-euro area EU countries included the Czech Republic, Croatia, Hungary, Poland, Romania, Denmark, Sweden, and Great Britain.

with the findings of Georgiadis and Gräb (2016), who revealed that non-euro area EU equity prices went up by 2.84%, while in advanced economies equity returns increased by 3.38%. The general conclusion from these estimations is evident – in contrast to the SMP, the announcements of the OMT generated positive spillovers to all non-euro area European countries, which was in line with the aim of the ECB.

Falagiarda et al. (2015), and Georgiadis and Gräb (2016) were the ones that assessed the spillover effects from currently undertaken Expanded Asset Purchase Programme (EAPP). Falagiarda et al. (2015) did not find any influence on equity indices of the Czech Republic, Hungary, Poland, and Romania, while Georgiadis and Gräb (2016) discovered that equity indices of non-euro area EU countries went up by 3.10%, but for advanced economies the estimated effect was even larger – 3.94%. One might conclude that equity indices of advanced economies were more affected by the EAPP than the indices of emerging markets. The increase in equity returns was stimulated by enhancing expectations around the PSPP announcement issued on January 22, 2015. Prior the official release of that decision, the ECB was gradually insinuating to the market that in addition to the ABSPP and the CBPP3, it might initiate new measures that will entail purchases of government bonds in secondary markets.

To sum up, the ECB's unconventional monetary policy, in general, lowered the returns of equity indices, however, spillover effects considerably varied across programme types: while announcements of the LTROs and the OMT enlarged the returns, announcements of the SMP and currency swap arrangements initiated a negative impact on them. The equity indices of advanced economies were more heavily affected by the ECB's non-standard monetary policies than the indices of emerging markets.

2.1.2 Long-term sovereign bond yields

Falagiarda et al. (2015) found that the aggregate measure of the ECB's non-standard monetary policy measures (key interest rate cuts, LTROs, APPs, etc.) lowered 10-year sovereign bond yields of the Czech Republic, Poland and Romania. Hungary's bond yield was unimpaired; the authors explained it by the fact that Hungary's financial assets are perceived to be the riskiest among those four countries, and investors might have been unwilling to include Hungarian assets in their portfolios due to their low credit rating.

Considering the impact of each ECB's unconventional monetary tool separately, Fratzscher et al. (2016) found that long-term bond yields of Bulgaria, Hungary, Poland, and the Czech Republic were unimpaired by the LTROs. Similarly, Falagiarda et al. (2015) found that only the Czech bond yield fell in response to the LTROs' announcements.

Fratzscher et al. (2016) evaluated spillover effects generated on bond yields of advanced economies as well. Unlike emerging markets, advanced economies were influenced by the LTROs: a decline of 8 basis points in the yields was observed in response to 6-month and 12-month LTROs.

Considering the announcements related to currency swap arrangements between the ECB and other central banks, Falagiarda et al. (2015) found that these announcements are associated with a drop in long-term bond yields of the Czech Republic, Poland, and Romania.

Further, the authors of the present paper proceed with the discussion of 10-year sovereign bond yields' reaction to different asset purchase programmes.

Falagiarda et al. (2015) ascertained that the announcements of the CBPPs left bond yields of emerging markets unchanged, however, in response to the SMP announcements the yields declined. Surprisingly, Fratzscher et al. (2016) estimated no impact on emerging markets' yields from the SMP announcements. The same conclusion was drawn by Fratzscher et al. (2016) regarding the yields of advanced economies; however, Georgiadis and Gräb (2016) were the ones who estimated that the SMP announcements caused a decrease of 9 basis points in the yields of advanced economies.

 Considering the impact of the OMT announcements, Georgiadis and Gräb (2016) found an increase of 6 basis points in bond yields of non-euro area EU countries, which include both developing and developed economies. However, it might be concluded that only advanced economies contributed to the increase, as Georgiadis and Gräb (2016), and Fratzscher et al. (2016) discovered that bond yields of advanced economies went up by 10-11 basis points in response to the OMT, while Fratzscher et al. (2016) found no influence on the yields of emerging markets.

Considering the Expanded Asset Purchase Programme, Falagiarda et al. (2016) concluded that no spillovers are generated from the announcements of this programme, however, Georgiadis and Gräb (2016) did discover that in non-euro are EU economies bond

yields dropped by 16 basis points, but in advanced economies the decline added up to 5 basis points in response to the EAPP.

   To conclude, the results of different researches contradict to a considerable extent. For instance, while the results of Falagiarda et al. (2015) suggested that the yields of emerging markets fell in response to announcements of different programmes, Fratzscher et al. (2015) did not find any evidence that spillover effects from any programme was at place. Thus, it is hard to arrive to general conclusion.

2.1.3 Exchange rates

Bluwstein and Canova (2016) found that although their sample included countries of both fixed and floating exchange rates regimes, all local currencies were affected similarly – they appreciated vis-à-vis the euro. The exchange rate regime did not play an important role.

The main results of Falagiarda et al. (2015), in turn, suggested that the announcements of all ECB's non-standard monetary policy measures left floating exchange rates of emerging markets unimpaired.

Regarding the impact of each ECB's non-standard monetary tool separately, Falagiarda et al. (2015) concluded that the Czech koruna appreciated in response to the announcements of the LTROs, while the Hungarian forint and the Romanian leu depreciated. The results to some extent contradict with the findings of Fratzscher et al. (2016) who found that local currencies of emerging markets (namely, Bulgaria, the Czech Republic, Hungary, and Poland) on average appreciated by 0.79% versus the euro in response to 6-month and 12-month LTROs. The announcements of 3-year LTROs left the exchanges rates of these countries unimpaired. The local currencies of advanced economies, in turn, were affected mostly by 3-year LTROs: Fratzscher et al. (2016) estimated that their currencies appreciated by 0.73%.

The announcements of currency swap lines initiated weak spillovers: Falagiarda et al. (2015) found that only the Polish zloty appreciated in response to these announcements.

The results of Ciarlone and Colabella (2016) suggested that the announcements of all asset purchase programmes caused appreciation of local currencies of non-euro area European emerging markets. The conclusions did not differ a lot if one examined spillover effects from each programme separately. Falagiarda et al. (2015), Georgiadis and Gräb (2016), and Fratzscher et al. (2016) affirmed that the SMP announcements led to appreciation

of local currencies against the euro. In particular, Fratzscher et al. (2016) found that domestic currencies of emerging markets appreciated by 0.42% versus the euro, while currencies of advanced economies – by 0.76%. Georgiadis and Gräb (2016) discovered that domestic currencies of non-euro area EU countries appreciated by 0.68%.

The responses of exchange rates to the OMT announcements are contradicting. Georgiadis and Gräb (2016) did not find any impact from them on exchange rates. Fratzscher et al. (2016), in turn, estimated that domestic currencies of emerging markets appreciated versus the euro by 0.95%; in contrast, the currencies of advanced economies depreciated versus the euro by 0.45%.

Finally, Georgiadis and Gräb (2016) found that the strongest spillovers were initiated by the Expanded Asset Purchase Programme. They obtained that local currencies of non-euro area EU economies appreciated by 1.80%, while in advanced economies the effect was even more pronounced – 5.73%. Unexpectedly, Falagiarda et al. (2016) did not find any significant impact of these programme on exchange rates.

To sum up, the ECB's unconventional monetary policy in general caused appreciation of local currencies versus the euro, irrespective of country group (advanced versus developing economies) and exchange rate regime (fixed versus floating). However, it was found that local currencies depreciated in response to the announcements of currency swap arrangements and the OMT.

3. Methodology

Methodology of the present research paper consists of three main steps: (1) estimation of the ECB's unconventional monetary policy surprise factors; (2) event study analysis in a form of empirical distribution method in order to assess the magnitude of the asset price changes around the days of the ECB's announcements; and (3) time series regression analysis to find the impact of those surprise factors on non-euro area European financial markets. The second and third steps of the methodology highly depend on the surprise factors obtained in the first step.

3.1. Surprise factors

The present research aims to identify the influence of surprise factors of the ECB's unconventional monetary policy announcements on 10-year sovereign bond yields, equity

indices, and exchange rates for the period from January 2007 till December 2016. The term 'surprise factor' could be defined as an unexpected component of an announced monetary policy decision. The authors of the present paper would like to stress that they are the first who utilize monetary policy surprise factors to assess the impact of the ECB's non-standard monetary policy.

The majority of the previous researchers (e.g., Gürkaynak et al., 2005; Bernanke and Kuttner, 2005), who investigated the influence of the Federal Reserve's monetary policy, claim that only surprise factors are able to capture a pure effect of monetary policy announcements on asset prices due to the following reasons. First, most of the ECB's announcements might be anticipated by the market to some extent since news regarding a possible decision are sometimes released in a gradual manner prior an official announcement. Thus, due to the efficient market hypothesis, some part of the ECB's decision could be already incorporated in asset prices on an announcement day. Second, the ECB not only announces its decisions, but explains them in detail at press conferences right after the announcements as well. This is done to ensure that market expectations across the term structure of interest rates are formed accurately, triggering the right investment decisions, which in turn, directly affect the real economy.

The authors of the present paper have followed the approach designed by Leon and Sebestyén (2012) to measure the surprises. Their approach is relatively new, as it was formed in the process of studying the disadvantages of the previous methods of monetary policy surprise identification. The calculation of monetary policy surprise factors is grounded on movements in money market rates, namely, 2-week and 1-month Eonia swap rates, and 3-month Euribor futures rates of the first five deliveries.

Eonia swap is an agreement between two parties according to which a fixed rate interest cash flow is exchanged for a variable rate cash flow. The variable rate is pegged to Eonia (Euro Overnight Index Average). In contrast, Eonia swap rate is related to the fixed rate of the swap, and it indicates the expected average level of Eonia over the swap maturity (Pérez-Quirós and Sicilia, 2002). The rates were primarily proposed for monetary policy surprise factor estimation by Pérez-Quirós and Sicilia (2002) who argued that Eonia swap rates, notably for the shortest maturities, are less liable to liquidity issues than Eonia rate.

3-month Euribor futures contract implies that an investor makes a loan or a deposit on a principal value of 1 million euros and can immobilize the borrowing or lending rate over future three months. The contract has four delivery months – March, June, September, and December. The contract of the first delivery expires on March 2017, etc. Leon and Sebestyén (2012) highlighted that the trading of 3-month Euribor futures contracts represent 99% of activity in euro-denominated short-term derivatives market. The futures are very liquid up to 18-month horizon, thus, the implied interest rate of contracts of the first five deliveries should provide the most credible market expectations regarding the future level of 3-month Euribor. The implied rate is computed as 100 minus a future's price.

Using the abovementioned rates, the authors have calculated daily changes in these rates on the days when the ECB announced its unconventional monetary policy decisions, namely, announcements of the ECB's key interest rate cuts, open market operations (FRTFA, LTROs of different maturities, TLTROs), asset purchase programmes, etc. To develop the list of the ECB's events (Appendix B) the authors have utilized the already composed list by Falagiarda et al. (2015), which covers period from January 2007 till January 2015. The authors have supplemented the list with the events occurred in 2015 and 2016, pursuing the same selection method as Falagiarda et al. (2015). The necessary information on the ECB's announcements has been collected from the ECB's website, where all press releases and monetary policy decisions are reported.

In order to measure surprise factors from 2-week and 1-month Eonia swap rates, and 3-month Euribor futures rates of the first five deliveries, the authors have applied principal component analysis (PCA) which allows to identify patterns in daily movements of these rates. Prior to the analysis, the input data matrix for the PCA has been constructed (119x7): the rows reflect one hundred and nineteen ECB's events, and the columns represent daily changes in the selected money market rates (seven columns in total) on the ECB's event dates. The daily changes in the rates have been normalized to have a unit variance in order not to allow the most volatile of them to prevail the analysis.

Principal component analysis transforms the original input matrix into a set of orthogonal (uncorrelated) vectors – in this case, seven factors/principal components with length corresponding to the number of the ECB's events. For further analysis the authors

have utilized only the first and the second principal components, which have been normalized to have a unit variance.

Leon and Sebestyén (2012) proved that the first principal component could be defined as the first surprise factor called the *level* factor, which is related to the surprise of the monetary policy decision itself. The *level* factor explains changes in the level of the money market yield curve on the days when the decisions of the ECB were announced. The largest *level* factors (in absolute terms) reflect the most unexpected decisions/shocks to the market and indicate how large a parallel shift of the EU money market yield curve was on that days.

The second principal component is defined as the second surprise factor called the *slope* factor, which reflects movements in the slope of the yield curve and shows whether the ECB with its announcements was able change expectations regarding the future monetary policy stance.

3.2 Event study based on empirical distribution method

After ranking the most surprising *level* and *slope* factors, and identifying the largest factors in absolute terms, the authors have applied event study analysis in a form of the empirical distribution method in order to examine the magnitude of the asset price changes around the ECB event dates.

The empirical distribution method was previously used by Neely (2015), and Glick and Leduc (2012). The main idea of the method is that by computing 1-day changes in bond yields, equity prices, and exchange rates for a sample period, the historical return distribution is computed, and then, the realized returns of these assets on event dates are compared to that distribution. Prior to the analysis execution, it is of utmost importance to determine the length of a sample period. The authors have decided to conduct the analysis for two time intervals, the first – from January 2008 to December 2012, the second – from January 2014 till December 2016. The choice of these intervals is motivated by the fact that in the first period the ECB took the most significant unconventional monetary policy measures that were aimed to address the adverse consequences caused by the global financial crisis of 2008 and the Euro-area's sovereign debt crisis of 2010, while in the second period the ECB intended to reduce the risks associated with a too prolonged period of low inflation.

The authors of the present paper have undertaken the following steps to produce the results of event study analysis based on empirical distribution method. First, 1-day asset price

changes on the event days have been computed. For equity indices and exchange rates changes in logarithms have been utilized (1):

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \tag{1}$$

Second, the authors have calculated historical 1-day price changes in respective asset classes. Third, these historical price movements have been used to estimate an empirical distribution of past returns for each country and for each asset class. Finally, the observed returns on the ECB announcement days have been compared to the historical distribution, and a corresponding percentile has been estimated in order to conclude whether the return was significantly large comparing to historical norms.
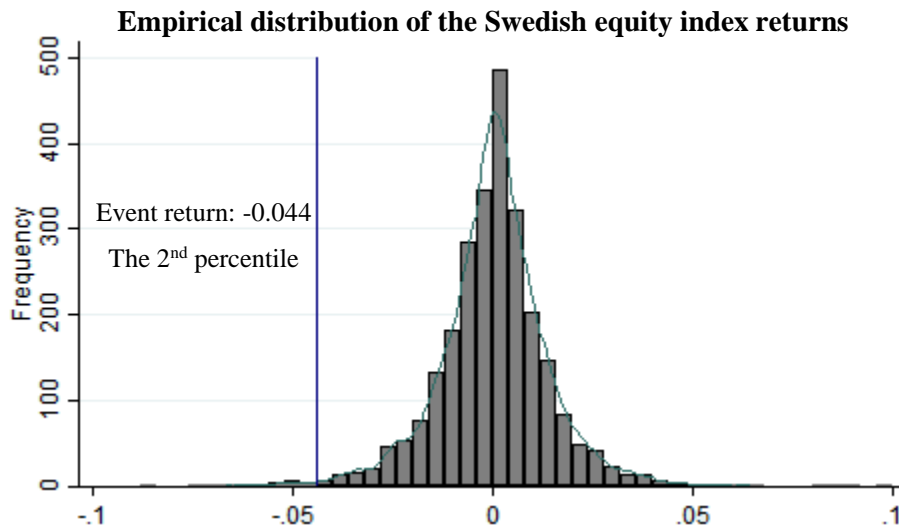
Figure 1. The histogram represents empirical distribution of the Swedish equity index returns. As an example, the return on the ECB's event date – August 4, 2011, – is used. The vertical line shows where in the distribution the return is. As it is located in the 2nd percentile, which is smaller than the 5th percentile, the return is considered significant comparing to historical norms.

3.3 Regression analysis

In the last step the authors have employed time-series regression analysis (2) to identify the average relationship between surprise factors and non-euro area European financial market returns. The dependent variables (ΔR_{it}) – 10-year sovereign bond yields, equity indices, and exchange rate (the euro vis-à-vis currencies of non-euro area European countries) have been regressed on *level* and *slope* monetary policy surprise factors. It is essential to distinguish the effects of *level* and *slope* factors because it allows to investigate what affected the returns on event dates the most – unexpected announcements themselves, or changed expectations regarding the future path of monetary policy. The regressions based

on OLS estimation have been conducted for each countries' asset returns separately for the period from January 2007 till December 2016. This approach was previously used by Neely (2015) and Gürkaynak et al. (2005). Leon and Sebestyén (2012) applied the same method to measure surprise factors' impact on interest rates changes, however, they highlighted that this approach is applicable for asset returns as well.

$$\Delta R_{it} = \beta_0 + \beta_1 level + \beta_2 slope + \varepsilon_{it} \qquad (2)$$

3.4 Data used in the research

The following countries have been added to the sample: the Czech Republic, Hungary, Poland, Romania, Bulgaria, Croatia, Norway, Sweden, Denmark, and Switzerland. The abovementioned sample of countries has been chosen on purpose: these economies have strong economic and financial links with the euro area, being their active trading partners and capital receivers. Moreover, one could note that the sample has been formed from both advanced and emerging market economies. The authors assume that it might be reasonable to confront the research results obtained for these two subgroups since degree of financial integration with the euro area is more pronounced for advanced economies than for developing ones. This implies that advanced economies might be subject to stronger spillovers (Bluwstein and Canova, 2016). Finally, countries with different exchange rate regimes have been included in the sample. Hungary, Poland, Romania, the Czech Republic, Sweden, and Norway have floating exchange rate regime vis-à-vis the euro. The Bulgarian lev, the Danish krone, and the Croatian kuna have a pegged float to the euro. The case with the Swiss franc is irregular – being pegged to the euro since 2011 – on January 15, 2015, the Swiss National Bank announced its decision to discontinue the Swiss franc fixed regime vis-à-vis the euro, as it was no longer be possible to cope with negative spillovers (strong appreciation of the Swiss franc) generated by the ECB's non-standard monetary policy measures (The Economist, 2015b).

For bond data the authors have used 10-year yields of sovereign bonds denominated in domestic currency, and for equity indices local stock market indices have been utilized. 2-week and 1-month Eonia swap rates, and 3-month Euribor futures contracts with delivery months on March 2017, June 2017, September 2017, December 2017, and March 2018 have been used to obtain surprise factors. The daily data has been retrieved from Thomson Reuters Datastream and Bloomberg on February 11, 2017 (Appendix A).

Prior the regression analysis the variables have been checked for stationarity by employing Dickey-Fuller test; the results suggest that time series, including *level* and *slope* factors, are stationary, and, thus, can be used in the regression model.

In addition, the authors have checked autocorrelation of the regressions' residuals and found that small (i.e. less than 0.10 in most cases) autocorrelation is present in some regressions. Therefore, the authors have tried to solve this problem by running OLS regressions with heteroscedasticity- and autocorrelation-consistent (HAC) errors.

4. *Results*

In this section the results for surprise factors, event study, and regressions are reviewed. For the event study the authors have considered only the most significant events (events with the highest *level* and *slope* factors in absolute terms discussed in the section above), nevertheless, for regressions all events have been utilized. Each asset class of each country has been regressed separately.

4.1 Surprise factors

In this section the results for *level* and *slope* factors are considered. In Table 1 the factor loadings on Eonia swaps and Euribor future contracts are presented. The loadings show how much each factor explains the rates. The pattern in the loadings demonstrates why these two factors are considered as *level* and *slope*. It is seen from Table 1 that the first factor (F_1), which is the *level* factor, explains each rate by around 40%. This implies that an announcement causes the same changes in all seven rates, i.e. they increase/decrease by roughly the same number of percentage points. The loadings on the second factor (F_2) suggest that an announcement affects short-term rates more heavily than longer-term rates, thus, the second factor can be interpreted as the slope of money market yield curve.

The *level* factor explains around 65% of the variation in the rates on the events days, while the *slope* factor explains around 23%, summing up to 88%. The graphical representation of the factors can be seen in Figures 2 and 3. From the graphs one can capture that the ECB's unconventional monetary policies' announcements had surprise components from 2008 till 2012, but recent policies (2014 - 2016) did not have large surprise components in them. This might be the case due to the fact that the ECB tries to communicate better their policies with the market, thus, there is little or no surprise to the market when announcements

are made (Leon and Sebestyén, 2012).

	F_1	F_2
Eonia swaps		
2-Week	0.0978	0.7221
1-Month	0.1973	0.6577
Euribor futures		
1st delivery	0.3798	-0.0417
2nd delivery	0.4544	-0.0699
3rd delivery	0.4597	-0.0983
4th delivery	0.4498	-0.1225
5th delivery	0.4325	-0.1214
Explained variation (%)	65.43	23.18
Cumulative explained variation (%)	65.43	88.61

Table 1. Factor loadings obtained by principal component analysis. Made by the authors.

Event date	Level factor	Event type	Event date	Slope factor	Event type
29-Sep-08	-4.24	SWAP	4-Dec-08	-5.78	Policy rate cut
3-Mar-11	3.19	FRTFA, LTRO-3m	15-Jan-09	-4.14	Policy rate cut
4-Aug-11	-2.77	FRTFA, LTRO-3m, LTRO-6m	7-Jul-11	3.07	Policy rate rise
2-Apr-09	2.68	Policy rate cut	3-Nov-11	-2.76	Policy rate cut, CBBP2
26-Sep-08	-2.46	SWAP	3-Jul-08	2.45	Policy rate rise
6-Oct-11	2.40	CBPP2, LTRO-3m, LTRO-12m, FRTFA	6-Nov-08	-2.28	Policy rate cut
3-Dec-15	2.27	Policy rate cut	29-Jun-11	-2.27	SWAP

Table 2. Dates of the ECB's events, when *level* and *slope* factors were the largest in absolute terms. Explanations of the event types can be found in Appendix B.

Table 2 represents the largest *level* and *slope* factors. The most significant event for the *level* factor took place on September 29, 2008. This was the day when the Governing

Council decided to double their temporary reciprocal currency arrangements (swap lines) with the Federal Reserve. This was done to provide U.S. dollar liquidity for the Eurosystem counterparties at the time. Now this instrument is rarely in use. The next most surprising event was on March 3, 2011, when the ECB decided to continue to apply fixed rate tender procedures with full allotment (FRTFA) for main refinancing operations and to conduct 3-month LTROs as FRTFAs as well. This event is followed by the announcement on August 4, 2011, which is quite similar to the previous one, but adds 6-month LTROs. On April 2, 2009, the Governing Council meeting happened, when interest rates on the MROs, the marginal lending facility, and the deposit facility were decreased by 25 basis points. The next event was on September 26, 2008, when the ECB decided to provide U.S. dollar one-week funding. On October 6, 2011, the ECB announced the second round of the Covered Bond Purchase Programme (CBPP2). On December 3, 2015, the Governing Council decided to cut the rate for the deposit facility by 10 basis points (to -0.30%), while the MRO's and the marginal lending facility's rates remained unchanged. To sum up, the announcements of the LTROs, changes in key interest rates, and the CBPP2 caused substantial parallel shifts in the yield curve.
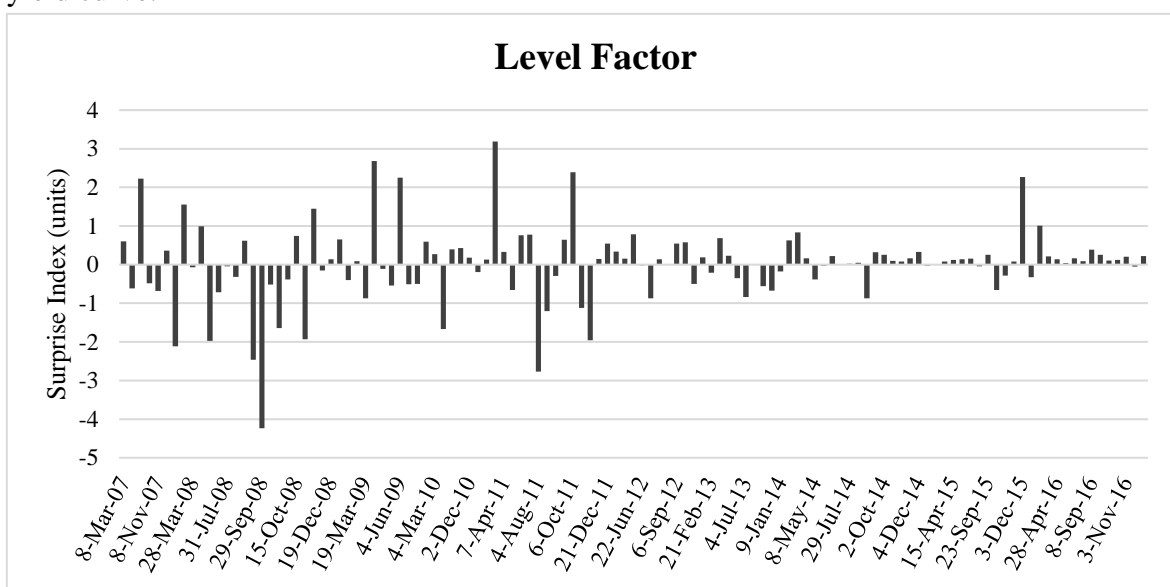
Figure 2. Graph for the *level* factor on the announcement days. Made by the authors.

Concerning the *slope* factor, the most surprising event happened on December 4, 2008, when the decision to cut the interest rates on the MROs, the marginal lending facility, and the deposit facility by 75 basis points was made. The similar decisions about changes in key interest rates were made on January 15, 2009, July 7, 2011, November 3, 2011, July 3,

2008, and November 6, 2008, the next five most surprising events. On November 3, 2011, besides the interest rates cut, technical details for the CBPP2 were also announced. The least most surprising event happened on June 29, 2011. It was the ECB decision to prolong U.S. dollar liquidity-providing operations. It is seen from the results that the ECB's decisions about changes in the interest rates had the most significant impact on the slope of the yield curve.
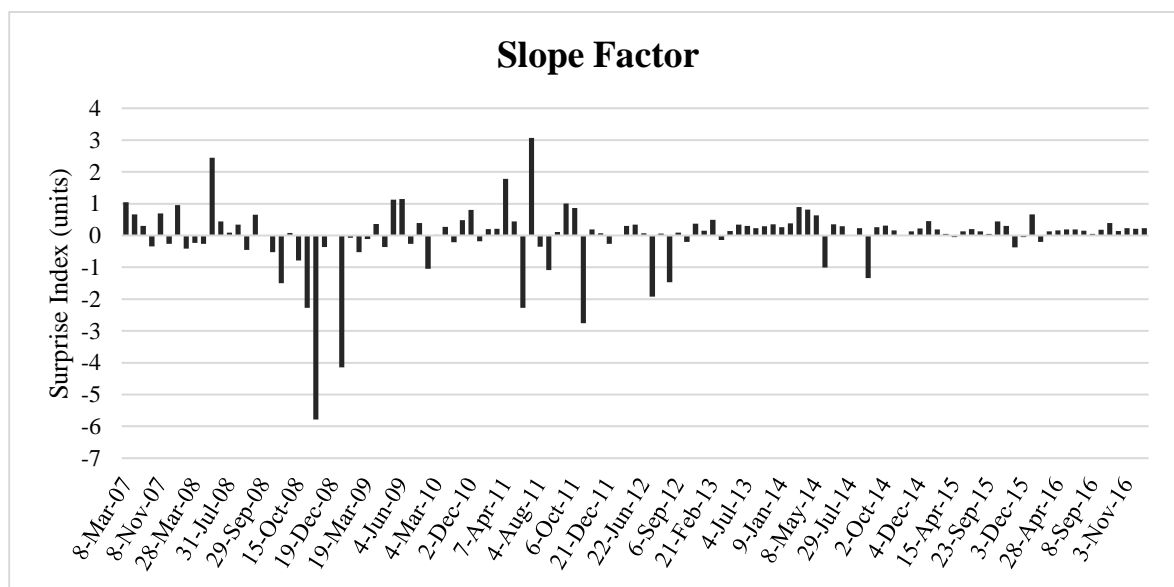
Figure 3. Graph for the *slope* factor on the announcement days. Made by the authors.

4.2 Equity indices

The detailed results for the event study on equity indices are presented in Appendix D. There is an event that influenced all countries in the study - April 2, 2009, when key interest rates' cut was announced. The magnitude of equity indices' changes in emerging markets (~5%) on average was slightly higher than in advanced economies (~4%). The event on November 6, 2008 (interest rates' cut), impacted negatively most of the countries. Significant results were obtained for Norway, Sweden, Denmark, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, and Switzerland (nine out of ten countries in the sample), however, the most pronounced influence was on two countries: Norway (-11%) and Hungary (-10%). However, not only *slope*, but also the *level* factor was comparatively large in absolute terms (slope: -2.28; level: -1.93). Thus, the equity indices on this day most probably reacted to the *level* factor.

The announcement on September 29, 2008, (the ECB decided to double swap lines with U.S. dollars) had a great impact on Norwegian, Danish, Swedish, Bulgarian, Czech, Hungarian, Polish, and Swiss equity indices. Eight countries out of ten were influenced. Only Romanian and Croatian equity indices did not show significant results for the day. Interestingly, Bulgaria was influenced positively by this event, while on the rest of the countries the event had a negative impact. There is an event that have clearly impacted only developing countries, and that is December 4, 2008 (interest rates' cut). Poland, the Czech Republic, Croatia, and Bulgaria were positively affected by the announcement (equity indices rose by 2.2 – 2.8%). On this day the largest *slope* factor of -5.78 was observed, equity indices of four emerging markets increased in response to the announcement of the policy rates' cuts. However, one should notice that on this day a relatively high *level* factor of 1.45 was observed, moreover, it was positive. Thus, it could again be the case that the indices reacted to the *level* factor, not *slope*.

The *level* factor is relevant for equity indices of the Czech Republic, Poland, Sweden, Norway, Denmark, and Switzerland. The *slope* factor, in turn, is important for Romanian, and Swedish equities. In Table 4 the results of regressions are presented for equity indices. The interpretation is the following: a unit increase (decrease) in the *level* factor is associated with an increase (decrease) of 0.7044 percentage points in proportional growth of the Czech equity index. This implies that if a day before the announcement equity index's growth rate was 5%, after a unit increase in the *level* factor on the announcement day, the index will grow at 5.7044%.

Country	Value	Level factor	Slope factor
Czech Republic	Coef.	**0.007044 ****	0.0017932
	p-value	**(0.006)**	(0.378)
Poland	Coef.	**0.006385 ****	0.0016926
	p-value	**(0.002)**	(0.319)
Hungary	Coef.	0.0045641	0.006258
	p-value	(0.122)	(0.051)
Croatia	Coef.	0.0022313	0.000268
	p-value	(0.298)	(0.895)
Bulgaria	Coef.	0.00209	0.0025392
	p-value	(0.286)	(0.318)

Romania	Coef.	0.0036176	**0.0047016 ***
	p-value	(0.18)	**(0.033)**
Denmark	Coef.	**0.0054043 ***	0.0017812
	p-value	**(0.028)**	(0.316)
Sweden	Coef.	**0.0062913 ***	**0.0042011 ***
	p-value	**(0.022)**	**(0.021)**
Norway	Coef.	**0.009898 ***	0.004046
	p-value	**(0.007)**	(0.149)
Switzerland	Coef.	**0.005392 ***	0.0022043
	p-value	**(0.009)**	(0.114)

Table 4. Regression analysis results for equity indices. * coefficient significant at 5%; ** coefficient significant at 1%; *** coefficient significant at 0.1%.

4.3 Long-term sovereign bond yields

The detailed results for event study on long-term sovereign bond yields are presented in Appendix E. The announcement on April 2, 2009 (interest rates' cut), surprised the markets in Sweden, Norway, Romania, Bulgaria, Denmark, and Hungary. The yields went up for all the countries, but Hungary. The event on September 29, 2008, when swap lines with the Federal Reserve were doubled, is significant for Sweden, Norway, Denmark, Poland, and the Czech Republic. The decrease in yields on this day is substantial comparing to historical norms. On December 4, 2008 (interest rates' cut), bond yields of the Czech Republic, Hungary, and Poland went down, while in Bulgaria they went up. One more announcement influenced most of the countries in the sample – December 3, 2015, when the deposit facility rate was cut by 10 basis points. Norwegian, Swedish, Danish, Swiss, and Polish bond yields were impacted positively.

Country	Value	Level factor	Slope factor
Czech Republic	Coef.	0.008974	0.01077
	p-value	(0.077)	(0.098)
Poland	Coef.	0.0317	-0.0028648
	p-value	(0.082)	(0.749)
Hungary	Coef.	-0.0136007	0.006823
	p-value	(0.493)	(0.734)
Bulgaria	Coef.	0.0202592	-0.0043238
	p-value	(0.20)	(0.853)
Denmark	Coef.	**0.029996 *****	0.0039615
	p-value	**(0.000)**	(0.526)
Sweden	Coef.	**0.022404 *****	**0.014266 ****
	p-value	**(0.000)**	**(0.002)**
Norway	Coef.	**0.023918 *****	**0.0109976 ***
	p-value	**(0.000)**	**(0.043)**
Switzerland	Coef.	**0.014048 *****	0.0031583
	p-value	**(0.000)**	(0.255)

Table 5. Regression analysis results for long term sovereign bond yields. * coefficient significant at 5%; ** coefficient significant at 1%; *** coefficient significant at 0.1%.

The results of regressions are presented in Table 5. The interpretation is the following: for Sweden one unit increase (decrease) in the *level* factor is associated with 2.24 basis points rise (decline) in long-term bond yields. Concerning the regressions results, *level* and *slope* factors appeared to be relevant only for advanced economies: Sweden, Norway, Denmark, and Switzerland.

4.4 Exchange rates

The detailed results for the event study on exchange rates are presented in Appendix F. One event had a pronounced impact on Romania, the Czech Republic, Denmark, Hungary, and Poland – November 6, 2008 (interest rates' cut). The announcement caused depreciation of local currencies against the euro. The other two relevant events happened on April 2, 2009, and January 15, 2009 (interest rates' cuts on both announcement days). The announcement on April 2, 2009, significantly influenced Bulgaria, the Czech Republic, Hungary, and Poland. It caused depreciation of the euro and appreciation of local currencies. The event on January 15, 2009, made local currencies of the Czech Republic, Hungary, and Poland to depreciate, while the Swedish krona appreciated.

Regarding the regression results, the *slope* factor appeared to be significant for Polish, Bulgarian, and Norwegian currencies, while the *level* factor only for the Swiss franc. The interpretation of coefficients is as follows: a unit rise (decline) in the *slope* factor is associated with an increase (decrease) of 0.00243 percentage points in proportional growth of BGN/EUR exchange rate. Table 6 presents regressions results for exchange rates of the sample countries. The currencies of Poland and Norway appreciate in response to the rise in the *slope* factor, but the Bulgarian lev – depreciate. The Swiss franc is the only currency that react to level surprise, depreciating in response to the rise in the *level* factor.

Country	Value	Level factor	Slope factor
Czech Republic	Coef.	-0.0008066	-0.0006797
	p-value	(0.234)	(0.228)
Poland	Coef.	-0.0014009	**-0.0019541 ****
	p-value	(0.184)	**(0.007)**
Hungary	Coef.	-0.0009131	-0.0014224
	p-value	(0.371)	(0.078)
Croatia	Coef.	0.0000532	-0.0000502
	p-value	(0.65)	(0.681)
Bulgaria	Coef.	-0.000009	**0.0000243 ****
	p-value	(0.486)	**(0.009)**
Romania	Coef.	-0.0003689	-0.0003191
	p-value	(0.235)	(0.192)
Denmark	Coef.	0.0000147	-0.000003
	p-value	(0.276)	(0.856)
Sweden	Coef.	0.0007458	-0.0004727
	p-value	(0.223)	(0.517)
Norway	Coef.	0.000246	**-0.0011188 ***
	p-value	(0.626)	**(0.046)**
Switzerland	Coef.	**0.001715 *****	0.0005162
	p-value	**(0.000)**	(0.118)

Table 6. Regression analysis results for exchange rates. * coefficient significant at 5%; ** coefficient significant at 1%; *** coefficient significant at 0.1%.

4.5 Robustness check

Event study by itself assumes that markets are generally informationally efficient. Thus, the real impact occurs when market participants form their expectations about an announcement, but not when the implementation of the policy/programme starts. Choosing

an appropriate event window is very important so as not to take too narrow window, which might not capture the potential delay in market participants' reaction, and too long window, when extraneous information can cause some noise in the results (Falagiarda et al., 2015). Moreover, as this research studies how the financial markets of non-euro area European countries are affected by the decisions of the ECB, assets of these countries may react slower because announcements do not affect the countries directly. In order to identify whether it is the case or not, the authors have checked the robustness of their results for 2-day event window. All in all, the results stay the same, however, the authors have found quite a few additional significant results for the returns of the sample countries, what proves that the reaction might happen slower (Appendices I, J, and K).

The authors have performed a robustness check for regressions as well. The authors have controlled for overlapping announcements of the Federal Reserve (Fed). It is needed to make sure that changes in the EU money market yield curve were caused by the ECB's announcements not the Fed's. The U.S. is one of the world's major economies that influences not only its domestic market but also the rest of the world, including Europe. Moreover, it was proven by Rogers et al. (2014) that the Fed's announcements spillover to the EU financial markets. The issue is controlled by excluding the overlapping announcements of the Federal Reserve with the ECB's announcements. This method is proposed by Hausman and Wongswan (2006). To develop the list of the Fed events (Appendix G) the authors have utilized the already composed list by Rogers et al. (2014), however, its list has been supplemented by the events occurred in 2015 and 2016. The necessary information has been collected from the Federal Reserve website, where all press releases and monetary policy decisions are reported. Due to time zone difference, the Fed's announcements that happened one day before the ECB's events are considered as overlapping. Overall, twelve events have been excluded from the regressions. The robustness check shows similar results as the main study does, however, the impact of the *slope* factor became important for the Czech bond yield. The results of robustness check are provided in Appendix G.

5. *Discussion of results*

Before proceeding with the discussion of the results, the authors would like to remind that announcements that had large *level* factor were those which were the most unexpected by the market. The *level* factor indicates how large a parallel shift of the yield curve was on

the ECB's event dates. Announcements with large *slope* factor were those which not only surprised the market but were also able to change expectations of market participants about future monetary policy stance. The *slope* factor reflects movements in the slope of the EU money market yield curve. An increase in the *slope* factor implies that the yield curve became steeper, while a decrease means that the yield curve became flatter.

5.1 Equity indices

It was revealed that equity indices of the sample countries did not react at all to four events, namely, announcements of policy rates' rises (July 3, 2008; July 7, 2011), extension of the currency swap line with the Federal Reserve (June, 29, 2011), and technical modalities of the CBPP2 with policy rates' cut (November 3, 2011). It is interestingly to note that all these events have one feature in common – on these days the largest *slope* factors were recorded. As it was revealed by regression analysis in most countries equity indices do not react to *slope* factors; instead, they do respond significantly to *level* factors: if the *level* factor increases, equity indices tend to ascend as well, and vice versa.

November 6, 2008, and December 4, 2008, were the events with both large *level* and *slope* factors. From the results discussed in the previous section it can be concluded that on November 6 and December 4, 2008, the responses of equity indices were triggered by the changes in the *level* rather than the *slope* factor. The equity prices' reaction is in line with the conclusion of the regression analysis: on November 6, 2008, equity indices of almost all countries declined, when the *level* factor decreased by -1.93 units, while on December 4, 2008, the equity prices of emerging markets rose in response to the increase of 1.43 in the *level* factor.

The last event with the large *slope* factor to discuss is January 15, 2009. On this day equity indices of two emerging markets (Bulgaria and Hungary) fell, as the policy rates' cut was announced. In contrast to the abovementioned events, no large *level* factor was recorded in addition to large *slope* factor of -4.14. However, in contrast to the majority of the sample countries, the regression analysis shows that Hungary's equity index significantly reacts to the *slope* factor.

The possible explanation why equity indices react more to the *level* factor than to the *slope* is that a parallel shift in the money market yield curve strongly affects only future

discount rate of equity prices, their cash flows themselves remain unaffected. Thus, cash flows of equity prices are revalued at new discount rate (Wongswan, 2009).

On each announcement day when high *level* factors were observed, there were equity indices' responses in several countries. In particular, on April 2, 2009, when the ECB cut its key policy rates, equity indices of all countries increased in response to positive *level* factor of 2.68. One more event related to the ECB policy rates' cut, December 3, 2015, had large *level* factor of 2.27. However, this time equity prices of only two advanced economies (Sweden and Switzerland) were affected; moreover, they declined in response to positive *level* factor, which is not in line with the regression analysis. One should take into consideration that this is the only event with large *level* factor that belongs to the second-round of the ECB's unconventional monetary policy; all other events which happened in the period from 2014 to 2016 have small surprise factors. Thus, the reaction of equity indices on this day is left unexplained, and further investigation is needed. No country-specific announcements occurred in Sweden and Switzerland around December 3, 2015.

The event study results obtained for two announcements related to the ECB's currency swap arrangements with other central banks (September 26 and 29, 2008) are in line with the regression analysis results: on September 26 and 29, 2009, equity indices fell in response to large negative *level* factors. On September 26, 2009, only Bulgaria and Norway were affected, while on September 29, 2009, eight out of ten countries experienced substantial change in equity prices. However, one should take into consideration that on September 29, 2009, ten central banks, including the central banks of Norway, Sweden, Denmark, and Switzerland took coordinated actions and announced the expansion of swap facilities with the Federal Reserve as well. Therefore, this might explain why on this day the magnitude of response in advanced economies (6.3%) was larger on average by 2 percentage points than in emerging markets (4.2%).

Weaker equity prices' reaction was observed in response to the announcements of the LTROs which were conducted as fixed-rate full-allotment tenders (March 3, 2011; August 4, 2011), and the announcement of the CBPP2 (October 6, 2011). No significant equity price changes occurred on March 3, 2011. However, on August 4, 2011, equity indices of three advanced economies, Norway, Sweden, and Switzerland, declined in response to negative *level* factor of 2.77. At the same time the Polish equity index decreased as well. Finally, on

October 6, 2011, positive *level* factor of 2.4 caused equity indices of the Czech Republic and Switzerland to increase.

The most important conclusion that can be drawn from the event study analysis performed on equity indices is that in most cases the responses of equity indices vary not across event types or country groups (advanced economies versus emerging markets), but across announcement types. Equity indices tend to react significantly in response to the ECB's announcements with large *level* factors, while hardly any impact is recorded for the announcements with large *slope* factors. Moreover, the sign of the *level* factor, which represents the direction of money market yield curve's parallel shift, is important: if there is an upward shift in the yield curve on the ECB announcement day (positive *level* factor), equity indices tend to increase, and vice versa.

The findings of the present research are not in line with conclusions of the previous researchers, namely, Falagiarda et al. (2015), Fratzscher et al. (2016), Georgiadis and Gräb (2016), who argued that equity indices responses vary across event/programme types. The present research proves that, for example, two announcements of policy rates' cut might trigger different responses, and it is the surprise factor that explains why the responses varied.

5.2 Long-term sovereign bond yields

The discussion of the results for 10-year sovereign bond yields is divided into two parts. The first part is dedicated to the yields of advanced economies, while the second part – to the yields of emerging markets. This is done on purpose because the yields' responses substantially varied across country groups.

The results of the regression analysis suggest that even though long-term bond yields of all advanced economies are significantly influenced by both surprise factors, the magnitude of change in yields in response to the *level* factor is two times larger than in response to the *slope* factor. Thus, it could be concluded that the yields of advanced economies are more affected by the ECB's announcements with large *level* factor. The intuition behind this is similar to equity indices – a parallel shift in the yield curve has more substantial impact on a price of a bond as its cash flows are revalued at a new rate, which was affected by an announcement.

The regression results are consistent with event study findings: from Appendix E, it is clearly seen that substantial changes in yields of advanced economies are concentrated

around the *level*-factor events. In particular, on December 3, 2015 (policy rates' cut), 10-year sovereign bond yields of all advanced economies experienced a rise of 11-12 basis points in response to the large positive *level* factor. The Norwegian yield also reacted to the announcements on September 26 and 29, 2008 (expansion of swap lines), and on April 2, 2009 (policy rates' cut): the first two event caused a decrease in the yield in response to negative *level* factor, while the third event initiated a rise in the yield in response to positive *level* factor. Swedish and Danish yields were also significantly affected by the announcement related to the LTROs on March 3, 2011: the yield ascended in response to increase in the *level* factor. The Swiss yield, in turn, fell by 8.5 basis points on November 6, 2011 (policy rates' cut), when both large negative surprise factors were observed.

Overall, the event study findings are in line with regression results: advanced economies react to the *level* factor events to a considerable extent, and react just a little to the *slope* factor events; event type does not play a crucial role. Moreover, as was found by regression analysis and proved by event study: an increase (decrease) in the *level* factor causes long-term bond yields to rise (decline).

Regarding emerging markets, the regression analysis suggests that the yields of these countries were left unimpaired by the monetary policy surprise factors. These findings do contradict with the conclusion drawn by Falagiarda et al. (2015), who found that the yields of the Czech Republic, Poland, and Romania, declined in response the ECB's non-standard monetary policy. However, the findings are consistent to some extent with the conclusion of Fratzscher et al. (2016), who found that long-term bond yields of emerging markets were totally unaffected by the announcements of the LTROs and asset purchase programmes.

The event study analysis also suggests that it is unclear to which surprise factors the yields respond the most. However, it is clearly seen that significant changes in yields of developing countries are concentrated around the ECB's announcements that are related to policy rates' cuts (November 6, 2011; December 4, 2008; January 15, 2009; April 4, 2009, and December 3, 2015). September 29, 2008 (currency swap lines) is only one event which does not belong to event group of policy rates' cuts, but significantly lowered the yields of the Czech Republic (-9.5 bp) and Poland (-66 bp). Falagiarda et al. (2015) also found that the announcement related to currency swap line arrangements caused Czech, Polish, and Romanian yields to decline.

To sum up, for emerging markets the following conclusion could be drawn: the responses of the yields vary across event types, nevertheless, substantial movements are recorded around policy rates' cuts.

5.3 Exchange rates

The regression analysis shows that for exchange rates of Poland, Bulgaria, and Norway the effect of the *slope* factor is more relevant than the impact of the *level* factor, except the exchange rate of Switzerland. It is interesting to note that these countries represent both different country groups (advanced economies versus emerging markets) and different exchange rate regimes. The possible explanation why countries' exchange rates react more to the *slope* factor is that the slope of the yield curve reflects probabilities of downturns/peaks in an economy. As exchange rates are highly dependent on macroeconomic fundamentals, like inflation, etc., it explains why they mostly react to the *slope* surprise factor (Chen & Tsang, 2009).

However, the event study analysis shows that this time it is hard to identify patterns in exchange rates responses. The floating exchange rates of emerging markets responded significantly to only three announcements (November 11, 2008; January 15, 2009; April 4, 2009), moreover, all these announcements are related to policy rates' cuts. Two of the events - November 6, 2008, and January 15, 2009, - had large slope factors, and the exchange rates reaction on these days was consistent with the findings of the regression analysis: the Czech koruna, the Hungarian forint, and the Polish zloty depreciated, as the *slope* factor decreased by 2.28 and 4.14 units, respectively. However, the event on April 2, 2009, as well as on November 6, 2008, was accompanied by large *level* factors. Therefore, it is wise to conclude that emerging markets that have floating exchange rate regime vis-à-vis the euro on average respond to the announcements of policy rates' cuts, while a type of surprise factor plays a secondary role. These findings contradict to the results of Falagiarda et al. (2015), who obtained that the ECB's announcements left floating exchange rates of emerging markets unimpaired.

In contrast, the emerging markets, the currencies of which have a pegged float to the euro, were affected by various types of events. For example, exchange rate of the Croatian kuna to the euro was significantly influenced by announcements of currency swap line's

extension (September 29, 2008), 3-month LTROs with the FRTFA (August 4, 2011), and policy rates' cut (December 4, 2008).

For exchange rate of the Bulgarian lev to the euro, the regression results suggest that a rise in the *slope* factor causes the Bulgarian lev to depreciate versus the euro. The event study analysis, in turn, shows that the exchange rate was unaffected by all seven announcements with large *slope* factors. However, it was influenced by two events with large *level* factors (December 4, 2009, and December 3, 2015).

In the sample two advanced economies which have floating exchange rates vis-à-vis the euro are present (Norway and Sweden). The event study analysis suggests that the exchange rate of the Norwegian krone to the euro was substantially influenced by only one event with large *slope* factor – December 4, 2008 (policy rates' cut). The estimated effect is in line with the regression's conclusion: a decline in the *slope* factor leaded to the depreciation of the Norwegian krone. The events with large *level* factors left the exchange rate unimpaired.

The exchange rate of the Swedish krona to the euro was affected by two events with large *slope* factors (January 15, 2009; June 29, 2011). However, this time decreases in *slope* factors on both days led to appreciation of the Swedish krona.

Considering advanced economies, the currencies of which have a pegged float to the euro, the exchange rate of the Danish krone to the euro was affected only by two announcements: September 29, 2009, - the event with large level factor; November 6, 2008, - the event with large slope factor. As regression results suggest that the exchange rate was unaffected by the surprise factors, no strong conclusions could be made.

Finally, referring to the event study analysis, the Swiss franc depreciated in response to three announcements - March 3, 2011, June 29, 2011, and July 7, 2011. One should note that all three events happened in 2011, the year when the Swiss National Bank introduced exchange rate peg (The Economist, 2015). The regression analysis suggests that an increase in the *level* factor is associated with the depreciation of the Swiss franc, and vice versa. This dependence is observed only on March 3, 2011.

To conclude, the authors of the present paper have discovered that responses of exchange rates varied across different exchange rate regimes and country groups. On the one hand, this contradicts with the findings of Bluwstein and Canova (2016), who claimed that

local currencies of all non-euro area European countries were influenced similarly. On the other hand, the results support the other conclusion made by them: float does not preserve the countries from the ECB's non-standard monetary policy spillovers.

5.4 Limitations

There exist some limitations for this research. Firstly, 1-day window which is utilized in the event study analysis might be long as other events on a day can happen that may influence asset prices. Nevertheless, as international spillovers are assessed, which might have longer transmission lag, the authors consider that 1-day event window is justifiably used. Moreover, the authors have done the robustness check for 2-day event window and found no significant deviations from the main results.

Secondly, the sample countries carry out their own unconventional policies. Nonetheless, monetary policy announcements of most of the sample countries do not coincide with the ECB's events, a few announcements of central banks of Sweden, Denmark, and the Czech Republic overlap with the ECB's announcements. Because events of the ECB and these countries coincide, it might be the case that parallel shifts or changes in the slope of the EU money market yield curve were caused by Swedish, Danish, or Czech central banks' events rather than the ECB's. However, there are no researches that prove that the mentioned countries' announcements somehow affect the EU money market yield curve, thus, the authors have not excluded the overlapping events from time series.

Thirdly, the same issue concerns overlapping announcements of the Federal Reserve and the ECB – the Fed's announcements that coincide with the ECB's could influence the EU money market yield curve. It is proven by some researchers such as Rogers et al. (2014), and Buitron and Vesperoni (2015) that announcements of the Fed spillover to the EU financial market. Thus, the authors have conducted robustness check of the main results by excluding the overlapping announcements of the Federal Reserve with the ECB announcements (Appendix G). The obtained results suggest that the main results of the present research are valid.

Fourthly, control variables could be used to see clearer relationship between assets prices and surprise factors. For example, a dummy variable to control exchange rate regimes, and a variable of financial market's size could be utilized for the purpose.

6. Conclusion

The topic of spillovers from the ECB's unconventional monetary policy has been studied by Falagiarda et al. (2015), Fratzscher et al. (2016), and Georgiadis and Gräb (2016). However, the present research is the first one where monetary policy surprise factors have been utilized to assess spillover effects from the ECB's unconventional monetary policy to financial markets of non-euro area European countries. The following research questions were set:

(1)   Are there spillover effects from the ECB's unconventional monetary policy on the financial markets of non-euro area European countries?

(2)   Which asset classes of non-euro area European countries are affected the most by the spillovers from the ECB's unconventional monetary policy?

To answer the research questions, the authors classified the ECB's announcements into two types. The first type - those which were the most unexpected by the market - and the second – those which not only surprised the market but also were able to change market expectations about future monetary policy stance. The answer to the first research question is that there exist spillover effects from the ECB's non-standard monetary policy on financial markets of the sample countries, nevertheless, for each asset class the impact from a particular announcement type was important. Thus, the answer to the second research question is the following. Equity indices of non-euro area European countries were affected the most. The indices of seven out of ten countries were impacted. Equity indices tend to increase (decrease) in response to the most unexpected announcements that caused upward (downward) parallel shift in the EU money market yield curve.

The second the most affected assets were bond yields of advanced economies, while no considerable impact was found on bond yields of developing countries. The advanced economies' yields were sensitive to the announcements of the first type. Finally, the results suggest that the least influenced asset class was exchange rates, which mostly reacted to announcements that caused changes in expectations.

The present research might be helpful to both local and EU policymakers. Being aware of spillover effects, the policymakers from both sides could correspondingly adjust their monetary policies to alleviate negative side effects. Investors can also benefit from the

research: by knowing which assets in which countries are affected by spillovers, they could structure their portfolio in a better way.

Regarding further research, it could be focused on the assessment of transmission channels through which spillovers from the ECB's unconventional monetary policy influence non-euro area European countries. The understanding of how the policies are transmitted is essential to correctly implement them and achieve eligible results. Moreover, it can be researched whether internal monetary policies of non-euro area European countries influence the EU financial market as it is essential for the ECB to know the effect from their side to be able to effectively conduct its monetary policy.

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8. *Appendices*

Appendix A. Data sources

Data	Period	Source	Comments
10-year sovereign bond yields	01.01.2007 – 30.12.2016	Thomson Reuters Datastream	10-year daily sovereign bond yields. Data coverage varied across countries.
Equity indices	01.01.2007 – 30.12.2016	Thomson Reuters Datastream	Equity indices of countries under study: Poland (WIG), Hungary (BUX), Croatia (CROBEX), the Czech Republic (PX), Bulgaria (SOFIX), Romania (BET-L), Sweden (OMXS30), Denmark (OMXC20), Norway (FTSE), and Switzerland (SMI).
Bilateral exchange rates	01.01.2007 – 30.12.2016	Thomson Reuters Datastream	All exchanges rates are taken as the euro vis-à-vis currencies of the countries under study.
3-month Euribor futures contracts of the first five deliveries	01.01.2007 – 30.12.2016	Thomson Reuters Datastream	3-month Euribor futures contracts delivery months on March 2017, June 2017, September 2017, December 2017, and March 2018.
2-week and 1-month Eonia swap rates	01.01.2007 – 30.12.2016	Bloomberg	

Table 1. List of data and its sources used in the research. The data was retrieved from Thomson Reuters Datastream and Bloomberg on February 11, 2017.

Appendix B. Event list

Date	Event group
08.03.2007	RISE
06.06.2007	RISE
22.08.2007	LTRO-3m
06.09.2007	LTRO-3m
08.11.2007	LTRO-3m
10.01.2008	SWAP
07.02.2008	LTRO-3m
11.03.2008	SWAP
28.03.2008	LTRO-6m
02.05.2008	SWAP
03.07.2008	RISE
30.07.2008	RISE, SWAP
31.07.2008	LTRO-3m
04.09.2008	LTRO-6m
18.09.2008	SWAP
26.09.2008	SWAP
29.09.2008	SWAP
07.10.2008	SWAP, LTRO-6m
08.10.2008	CUT, FRTFA
13.10.2008	SWAP
15.10.2008	LTRO, SWAP, COLL
06.11.2008	CUT
04.12.2008	CUT
18.12.2008	FRTFA
19.12.2008	SWAP
15.01.2009	CUT
03.02.2009	SWAP
05.03.2009	CUT, FRTFA, LTRO
19.03.2009	SWAP
02.04.2009	CUT
06.04.2009	SWAP
07.05.2009	CUT, LTRO-12m, CBPP1
04.06.2009	CBPP1
25.06.2009	SWAP
24.09.2009	SWAP
03.12.2009	FRTFA, LTRO
04.03.2010	FRTFA, LTRO
10.05.2010	SMP, SWAP, FRTFA, LTRO-3m, LTRO-6m
10.06.2010	FRTFA, LTRO-3m

Date	Event group
02.09.2010	FRTFA, LTRO-3m
02.12.2010	FRTFA, LTRO-3m
17.12.2010	SWAP
21.12.2010	SWAP
03.03.2011	FRTFA, LTRO-3m
07.04.2011	RISE
09.06.2011	SWAP
29.06.2011	SWAP
07.07.2011	RISE
04.08.2011	FRTFA, LTRO-3m, LTRO-6m
08.08.2011	SMP
25.08.2011	SWAP
15.09.2011	SWAP
06.10.2011	CBPP2, LTRO-3m, LTRO-12m, FRTFA
03.11.2011	CUT, CBBP2
30.11.2011	SWAP
08.12.2011	CUT, COLL, LTRO-3y
21.12.2011	LTRO-3y
09.02.2012	COLL
28.02.2012	LTRO-3y
06.06.2012	FRTFA, LTRO-3m
22.06.2012	COLL
05.07.2012	CUT
26.07.2012	OMT
02.08.2012	OMT
06.09.2012	OMT, COLL
12.09.2012	SWAP
06.12.2012	FRTFA, LTRO-3m
13.12.2012	SWAP
21.02.2013	SMP
07.03.2013	Unchanged
22.03.2013	COLL
02.05.2013	CUT, FRTFA, LTRO-3m
04.07.2013	Unchanged
16.09.2013	SWAP
31.10.2013	SWAP

Date	Event group
07.11.2013	CUT, FRTFA, LTRO-3m
09.01.2014	Unchanged
06.02.2014	Unchanged
06.03.2014	Unchanged
03.04.2014	Unchanged
08.05.2014	Unchanged
05.06.2014	CUT, FRTFA, LTRO-3m, TLTRO, ABSPP
17.06.2014	SWAP
03.07.2014	TLTRO
29.07.2014	TLTRO
07.08.2014	Unchanged
04.09.2014	RISE, CBPP3, ABSPP
18.09.2014	TLTRO
02.10.2014	CBPP3, ABSPP
06.11.2014	ECB Meeting
17.11.2014	PSPP
26.11.2014	PSPP
04.12.2014	PSPP
22.01.2015	PSPP, TLTRO
10.02.2015	TLTRO
05.03.2015	Unchanged
15.04.2015	Unchanged
03.06.2015	Unchanged
16.07.2015	Unchanged
03.09.2015	Unchanged
23.09.2015	ABSPP
22.10.2015	Unchanged
09.11.2015	PSPP
26.11.2015	SWAP
03.12.2015	CUT
21.01.2016	Unchanged
10.03.2016	CSPP, TLTRO
21.04.2016	CSPP
28.04.2016	TLTRO
03.05.2016	TLTRO
02.06.2016	CSPP, TLTRO
21.07.2016	Unchanged
08.09.2016	Unchanged
27.09.2016	SWAP
20.10.2016	Unchanged
31.10.2016	TLTRO
03.11.2016	COLL, FWG
08.12.2016	PSPP
15.12.2016	ABSPP

Table 2. Event list utilized in this research.
The ECB's events with large *level* surprise factors are marked in **bold**, the event with large *slope* factors – in **bold** and *italic*.

For the convenience purposes the authors divided the events/announcements into event groups. The description of the groups is as follows:

- RISE – the group represents the announcements of ECB key interest rates' increases.
- CUT – the group represents the announcements of ECB key interest rates' cuts.
- Unchanged – the group represents the days when the ECB on its regular meetings announced that key interest rates as well as the future monetary policy stance will remain unchanged.
- LTRO - the group summarizes the announcements related to long-term refinancing operations. The authors set up subgroups – LTRO-3m, LTRO-6m, LTRO-12m, LTRO-3y – in order to (1) mark out on which dates the ECB decision was associated with the LTRO of a particular maturity and (2) highlight when the ECB decided to extend maturities of LTROs. The group LTRO implies that the ECB decisions on that dates where related to all LTROs irrespective of maturity.
- TLTRO – the group includes the announcements related to targeted long-term refinancing operations, the maturity of which is 4 years.
- COLL – the group includes announcements when the ECB made some amendments in the list of assets valid as collaterals for refinancing operations.
- SWAP – the group represents the days when the ECB announced its intention to arrange currency swap lines with other central banks to be able to provide foreign currency funding to Eurosystem counterparties.
- FRTFA – the group represents the days when the ECB announced that refinancing operations will be conducted at fixed rate and will cover the whole sum that a commercial bank requires.
- CBBP1, SMP, CBBP2, OMT, ABSPP, CBBP3, PSPP, CSPP- the groups represent the days when the ECB announced its decisions to implement a particular asset purchase programme as well as the days when some technical features of the programmes were announced. Moreover, the groups OMT and PSPP include important speeches of Mario Draghi, in which, prior the official programme announcements, they intended to signal to markets that some measures which will include government bond purchases might be undertaken in the nearest futures.

Appendix C. Description of the ECB's unconventional monetary policies

Reviewing the ECB's undertaken unconventional monetary policies might help to understand better why they are implemented and what results from these policies could be expected. Before the description, the authors would like to note that these policies are divided into two periods – from 2008 to 2012, and 2014 onwards. The main target of the policies used from 2008 to 2012 was to rehabilitate the European Union (EU) economies from negative consequences of the subprime crisis, providing liquidity to the real economy. The target of the policies of the second period is to achieve inflation below but close to 2%, as there exists a prolonged period of low inflation in the EU countries. Such an inflation is needed to achieve economic growth and job creation (ECB, 2016a).

At first, the authors would like to mention that in order to implement unconventional monetary policies, the ECB lowered its key interest rates on the main refinancing operations, deposit facility, and marginal lending facility (ECB, 2013). The main refinancing operations (MRO) provide liquidity to the banking system with a normal maturity of a week. The deposit facility is used by banks to put overnight deposits in the Eurosystem, and the marginal lending facility is used when banks are given overnight credit from the Eurosystem (ECB, 2017a).

There are two features that have been introduced during unconventional monetary policies. First, it is fixed rate tender with full allotment (FRTFA). It means that the ECB gives a credit to a bank at the MRO rate and covers the whole sum that the bank asks for. Second, the list of collaterals that are approved by the ECB has been extended. This allowed banks to refinance a larger share of their balance sheet with the Eurosystem.

Unconventional monetary policies in the first period

Currency swap agreements - The ECB makes currency swap arrangements with other central banks (mostly with the Federal Reserve) to be able to conduct fixed rate tenders with full allotment (FRTFA) in U.S. dollars. The FRTFA are aimed at improving impaired money markets in foreign currencies. It has been essential after the collapse of Lehman Brothers but later the need in swap agreements has fallen (ECB, 2016b).

Long-term Refinancing Operations (LTRO) - This is the instrument that the ECB has always used as a monetary policy tool. These are liquidity-providing reverse transactions with longer maturities than main refinancing operations. The LTROs are conducted regularly on a tender basis and are given against a reasonable collateral. The standard maturity for the operations is three months, however, to fight the crisis, the ECB decided to increase the maturities of the operations up to 36 months, but this time it did not happen regularly. The aim was to provide additional long-term refinancing to the market. The first six-month LTRO was announced on March 28, 2008. There was a standard tender procedure with a variable rate, and the LTRO had a present amount of EUR 50

billion. Moreover, later in 2008 the ECB decided to introduce fixed rate tender procedure with full allotment for the LTROs. Further, 12-month and 36-month LTROs were announced in May 2009, and December 2011, respectively (ECB, 2011a).

Covered-Bond Purchase Programme (CBPP) - The first purchase programme for covered bonds was announced on May 7, 2009. The programme started in July, 2009, and ended in June, 2010 (ECB, 2009). The programme included euro-denominated bonds in amount of EUR 60 billion. These covered bonds had to satisfy several conditions: issue volume about EUR 500 million and minimum rating of AA given by a reliable institution (Fitch, Moody's, and S&P). Both primary and secondary markets were included in the CBPP. The aim of the programme was to support a specific financial market segment that had been severely affected by the financial crisis of 2008.

Securities Markets Programme (SMP) - On May 10, 2010, the Governing Council of the ECB decided to launch the Securities Market Programme. The programme was terminated in September, 2012. Through this programme the ECB bought eligible marketable debt instruments in the primary and secondary markets (denominated in the euro). The purchased securities were intended to be hold until they matured. The programme was designed to repair monetary policy transmission mechanisms (ECB, 2010).

Second Covered Bond Purchase Programme (CBPP2) - The second covered bond purchase programme was launched in November, 2011, and ended in October, 2012. The covered euro-denominated bonds were purchased in amount of EUR 40 billion. The criteria for eligible bonds also changed: issue volume should be around EUR 300 million, minimum rating of BBB- (or equivalent), and, in addition to that, maximum residual maturity was limited to 10.5 years. The aim of the second CBPP was to provide funding opportunities to credit institutions and encourage them to expand lending to the real economy (ECB, 2011b).

Outright Monetary Transactions (OMT) – Even though the programme was not officially included in the list of asset purchase programmes, the authors consider it as one of them since under this programme, the ECB purchased euro-denominated sovereign bonds in unlimited amounts in the secondary markets. The programme started right after the SMP in September, 2012, to maintain the appropriate functioning of monetary policy transmission mechanisms (ECB, 2012).

Unconventional monetary policies in the second period

Targeted Longer-term Refinancing Operations (TLTRO) – This policy is similar to the LTRO with one main difference – financing to credit institutions is given for periods up to four years. The first TLTRO was announced on June 5, 2014, and the second TLTRO – on March 10, 2016. The aim of the TLTROs is to improve bank lending to the euro area non-financial private sector, excluding loans to households for house purchases (ECB, 2017b).

Third Covered Bond Purchase Programme (CBPP3) - The third covered bond purchase programme has started in October 2014 and is still undertaken. There are no upper and lower limits for the maturities of covered bonds. The same criterion applies for the credit rating of bonds as in the CBPP2. The programme aims to improve financing conditions in the euro area, facilitate credit provision to the real economy, and generate positive spillovers to other countries (ECB, 2016a).

Asset-Backed Securities Purchase Programme (ABSPP) - This programme has started on November 21, 2014, to offer banks additional way of financing. The ECB purchases banks' newly issued securities and as a collateral requires a diversified pool of financial assets. The issuer of the asset-backed securities (ABS) should be in good financial health and have a regular presence in the ABS markets (ECB, 2015; ECB, 2016a).

Public Sector Purchase Programme (PSPP) - In March 2015 the ECB has started to buy public sector securities, which include nominal and inflation-linked central government bonds, and bonds issued by recognized agencies, local governments, and multilateral development banks which are located in the euro area. The aim of the PSPP is to ensure price stability in the euro area (ECB, 2016a; ECB, 2016c).

Corporate Sector Purchase Programme (CSPP) - This programme is the latest one. It has started on June 8, 2016. Under this programme, the Eurosystem purchases corporate bonds which should meet certain criteria, such as being denominated in the euro, having a rating of BBB- (or equivalent), etc. The programme has been established to provide credit to the real economy and help to achieve the inflation target of 2% (ECB, 2016a; ECB, 2016d).

Appendix D. Equity indices results and returns on dates with the largest surprise factors

	Event group	Fac-tor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Croatia	Czech Republic	Hungary	Poland
Events with the largest level factors												
26-09-08	SWAP	-2.46	**-0.055**** **(0.0178)**	-0.019 (0.107)	-0.024 (0.054)	-0.019 (0.063)	-0.025 (0.08)	**-0.034**** **(0.027)**	-0.008 (0.20)	-0.021 (0.081)	0.0142 (0.831)	0.002 (0.562)
29-09-08	SWAP	-4.24	**-0.093***** **(0.004)**	**-0.059***** **(0.005)**	**-0.054**** **(0.006)**	**-0.047**** **(0.007)**	-0.02 (0.105)	**0.036**** **(0.985)**	-0.018 (0.077)	**-0.055**** **(0.012)**	**-0.036**** **(0.025)**	**-0.043**** **(0.012)**
02-04-09	CUT	2.68	**0.05**** **(0.989)**	**0.049**** **(0.992)**	**0.033**** **(0.978)**	**0.032**** **(0.985)**	**0.056**** **(0.992)**	**0.029**** **(0.976)**	**0.055**** **(0.994)**	**0.061**** **(0.994)**	**0.052**** **(0.989)**	**0.058**** **(0.998)**
03-03-11	FRTFA LTRO	3.19	0.008 (0.704)	0.006 (0.702)	0.007 (0.752)	0.001 (0.557)	0.015 (0.852)	0 (0.493)	0.007 (0.796)	0.007 (0.716)	0.009 (0.748)	0.015 (0.896)
04-08-11	FRTFA LTRO-3m	-2.77	**-0.043*** **(0.031)**	**-0.044**** **(0.016)**	-0.021 (0.071)	**-0.037**** **(0.016)**	-0.014 (0.154)	-0.003 (0.379)	-0.006 (0.25)	-0.022 (0.071)	-0.023 (0.096)	**-0.039**** **(0.013)**
06-10-11	CBPP2 FRTFA LTRO-3/12m	2.40	0.025 (0.911)	0.023 (0.926)	-0.001 (0.45)	**0.024**** **(0.975)**	0.016 (0.863)	0.00003 (0.55)	0.002 (0.609)	**0.041**** **(0.986)**	0.015 (0.841)	0.011 (0.837)
03-12-15	CUT	2.27	-0.017 (0.055)	**-0.021*** **(0.042)**	-0.018 (0.063)	**-0.018*** **(0.038)**	0.004 (0.755)	-0.002 (0.358)	0.002 (0.719)	-0.008 (0.146)	0.0003 (0.50)	-0.007 (0.182)
Events with the largest slope factors												
03-07-08	RISE	2.45	**-0.037**** **(0.039)**	0.002 (0.588)	-0.021 (0.073)	0.00004 (0.505)	-0.018 (0.127)	-0.021 (0.058)	-0.011 (0.154)	-0.021 (0.082)	-0.0062 (0.327)	-0.008 (0.226)
06-11-08	CUT	-2.28	**-0.11***** **(0.001)**	**-0.065***** **(0.002)**	**-0.066***** **(0.002)**	**-0.042**** **(0.012)**	0.009 (0.771)	**-0.034**** **(0.028)**	**-0.052**** **(0.012)**	**-0.042**** **(0.018)**	**-0.101***** **(0.002)**	**-0.038**** **(0.015)**
04-12-08	CUT	-5.78	-0.02 (0.119)	-0.005 (0.331)	0.003 (0.617)	0.008 (0.79)	-0.002 (0.424)	**0.022*** **(0.958)**	**0.029**** **(0.975)**	**0.028*** **(0.962)**	0.019 (0.877)	**0.025*** **(0.965)**
15-01-09	CUT	-4.14	0.025 (0.913)	-0.0037 (0.365)	0.011 (0.815)	0.0007 (0.536)	-0.003 (0.37)	**-0.04**** **(0.018)**	0.011 (0.868)	-0.009 (0.239)	**-0.0316*** **(0.038)**	-0.012 (0.152)
29-06-11	SWAP	-2.27	0.026 (0.926)	0.025 (0.942)	0.02 (0.912)	0.016 (0.936)	0.004 (0.623)	0.017 (0.941)	0.004 (0.706)	0.0188 (0.912)	0.004 (0.636)	0.01 (0.824)
07-07-11	RISE	3.07	0.011 (0.766)	0.014 (0.848)	0.005 (0.679)	0.005 (0.709)	0.002 (0.581)	0.004 (0.72)	-0.001 (0.47)	-0.001 (0.452)	0.017 (0.857)	0.018 (0.919)
03-11-11	CUT, CBPP2	-2.76	0.026 (0.925)	0.015 (0.864)	0.023 (0.943)	0.01 (0.846)	0.001 (0.561)	0.004 (0.725)	0.0001 (0.568)	0.019 (0.916)	-0.01 (0.255)	0.014 (0.88)

Table 3. Event study results for equity indices for the most surprising ECB events. Values indicate the daily return on the event day. Values in parenthesis show the percentage returns that were lower than the observed return. * - return percentile smaller than 5% or larger than 95%; ** - return percentile smaller than 2.5% or larger than 97.5%; *** - return percentile smaller than 0.5% or larger than 99.5%.

Appendix E. Long-term sovereign bond yields results and returns on dates with the largest surprise factors

Event	Event group	Fac-tor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Czech Republic	Hungary	Poland
Events with the largest level factors											
26-09-08	SWAP	-2.46	**-0.119*** (0.024)	-0.043 (0.173)	-0.06 (0.127)	-0.087 (0.0215)	0.01 (0.696)	-0.202 (0.071)	0.02 (0.74)	0.01 (0.564)	0.048 (0.88)
29-09-08	SWAP	-4.24	**-0.182*** (0.0038)	**-0.107*** (0.035)	**-0.103*** (0.021)	-0.015 (0.337)	0.29 (0.93)	0.036 (0.742)	**-0.095*** (0.0422)	0.11 (0.864)	**-0.66*** (0.002)
02-04-09	CUT	2.68	**0.104*** (0.9693)	**0.091**** (0.975)	**0.093*** (0.957)	0.047 (0.905)	**0.65**** (0.988)	**0.337*** (0.962)	-0.032 (0.232)	**-0.45**** (0.011)	-0.041 (0.16)
03-03-11	FRTFA LTRO	3.19	0 (0.434)	**0.078*** (0.952)	**0.104*** (0.97)	0.02 (0.735)	0.001 (0.65)	-0.002 (0.426)	0 (0.458)	-0.03 (0.317)	0.023 (0.758)
04-08-11	FRTFA LTRO-3m	-2.77	-0.074 (0.064)	-0.054 (0.127)	-0.089 (0.053)	-0.035 (0.153)	0.01 (0.696)	0 (0.446)	0 (0.458)	0 (0.455)	-0.012 (0.369)
06-10-11	CBPP2 FRTFA LTRO-3/12m	2.40	0.078 (0.945)	0.043 (0.834)	**0.089*** (0.951)	0.03 (0.816)	-0.049 (0.254)	0.011 (0.634)	0 (0.458)	-0.19 (0.067)	-0.062 (0.093)
03-12-15	CUT	2.27	**0.113*** (0.995)	**0.125**** (0.991)	**0.16*** (0.996)	**0.111*** (0.996)	-0.04 (0.192)	-0.083 (0.097)	0.029 (0.895)	0.01 (0.604)	**0.174*** (0.995)
Events with the largest slope factors											
03-07-08	RISE	2.45	-0.076 (0.063)	-0.018 (0.351)	**-0.11*** (0.0314)	-0.038 (0.136)	0.203 (0.867)	0.043 (0.768)	-0.066 (0.094)	0.10 (0.863)	-0.01 (0.397)
06-11-08	CUT	-2.28	-0.036 (0.198)	-0.008 (0.436)	-0.066 (0.099)	**-0.085**** (0.025)	-0.006 (0.306)	**-0.711**** (0.009)	**-0.228*** (0.004)	0.01 (0.5644)	-0.037 (0.178)
04-12-08	CUT	-5.78	-0.039 (0.176)	-0.006 (0.472)	**-0.099**** (0.025)	0.009 (0.647)	0.004 (0.673)	**0.425**** (0.975)	**-0.104*** (0.036)	**-0.41**** (0.016)	**-0.101*** (0.034)
15-01-09	CUT	-4.14	**-0.13**** (0.018)	-0.045 (0.169)	-0.062 (0.12)	-0.019 (0.294)	0.002 (0.669)	-0.069 (0.184)	**-0.13**** (0.02)	-0.06 (0.204)	**0.087*** (0.962)
29-06-11	SWAP	-2.27	0.017 (0.743)	0.05 (0.864)	0.038 (0.787)	**0.074*** (0.969)	-0.134 (0.174)	0.051 (0.789)	0.016 (0.710)	-0.01 (0.414)	-0.037 (0.178)
07-07-11	RISE	3.07	0.016 (0.73)	0.051 (0.873)	0.053 (0.85)	0.048 (0.906)	-0.004 (0.314)	-0.001 (0.436)	0.056 (0.891)	0 (0.455)	0.012 (0.666)
03-11-11	CUT, CBPP2	-2.76	0.04 (0.854)	0.017 (0.679)	0.057 (0.865)	-0.015 (0.342)	0 (0.351)	0.025 (0.699)	0.047 (0.869)	**0.24*** (0.95)	-0.034 (0.193)

Table 4. Event study results for long term sovereign bond yields for the most surprising ECB events. Values indicated the daily change in the bond yields on event day (0.01 = 1 basis point). Values in parenthesis show the percentage returns that were lower than the observed return. * - change in bond yield percentile smaller than 5% or larger than 95%; ** - change in bond yield percentile smaller than 2.5% or larger than 97.5%; *** - change in bond yield percentile smaller than 0.5% or larger than 99.5%.

Appendix F. Exchange rates results and returns on dates with the largest surprise factors

Event	Event group	Fac-tor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Croatia	Czech Republic	Hungary	Poland
Events with the largest level factors												
26-09-08	SWAP	-2.46	-0.0004 (0.472)	0.002 (0.694)	0.0001 (0.88)	-0.002 (0.232)	0.002 (0.729)	0.0002 (0.862)	0.001 (0.772)	-0.003 (0.222)	-0.003 (0.314)	0.007 (0.874)
29-09-08	SWAP	-4.24	0.005 (0.867)	0.004 (0.834)	**-0.0003*** **(0.03)**	-0.007 (0.069)	0.005 (0.936)	-0.00005 (0.363)	**-0.002*** **(0.042)**	**0.009*** **(0.958)**	0.009 (0.877)	0.011 (0.933)
02-04-09	CUT	2.68	-0.004 (0.156)	-0.005 (0.133)	0.00003 (0.644)	0.005 (0.887)	-0.003 (0.133)	**-0.0003*** **(0.031)**	-0.002 (0.081)	**-0.02***** **(0.004)**	**-0.024**** **(0.008)**	**-0.03***** **(0.004)**
03-03-11	FRTFA LTRO	3.19	0.002 (0.703)	0.006 (0.901)	0.00005 (0.709)	**0.013**** **(0.988)**	-0.00083 (0.328)	0.00003 (0.608)	0.001 (0.722)	0.0007 (0.586)	-0.005 (0.238)	-0.00008 (0.513)
04-08-11	FRTFA LTRO-3m	-2.77	0.008 (0.934)	**0.009*** **(0.953)**	0.00002 (0.577)	-0.005 (0.123)	-0.003 (0.166)	0.0002 (0.884)	**0.002*** **(0.966)**	-0.0006 (0.439)	-0.0051 (0.211)	-0.0011 (0.441)
06-10-11	CBPP2, FRTFA LTRO-3/12m	2.40	0.0018 (0.712)	0.002 (0.719)	0.00011 (0.862)	0.004 (0.872)	-0.0004 (0.403)	-0.00005 (0.35)	0.0007 (0.755)	0.003 (0.753)	-0.011 (0.058)	-0.003 (0.257)
03-12-15	CUT	2.27	0.004 (0.782)	0.006 (0.939)	0.00001 (0.576)	0.0006 (0.679)	-0.0003 (0.381)	**0.0003*** **(0.969)**	0.0001 (0.61)	0.002 (0.923)	-0.006 (0.051)	-0.004 (0.124)
Events with the largest slope factors												
03-07-08	RISE	2.45	0.0001 (0.637)	-0.0071 (0.077)	-0.0001 (0.236)	-0.0002 (0.471)	-0.001 (0.294)	-0.00005 (0.378)	0.0005 (0.706)	-0.001 (0.367)	-0.001 (0.452)	0.00003 (0.551)
06-11-08	CUT	-2.28	0.007 (0.913)	-0.001 (0.418)	**0.00024*** **(0.963)**	-0.009 (0.051)	**0.009*** **(0.971)**	-0.0002 (0.056)	-0.0004 (0.314)	**0.019***** **(0.998)**	**0.017**** **(0.976)**	**0.016*** **(0.966)**
04-12-08	CUT	-5.78	**0.015**** **(0.988)**	**0.013**** **(0.979)**	0.00009 (0.818)	-0.0009 (0.36)	0.0014 (0.713)	-0.0002 (0.076)	**0.002*** **(0.96)**	-0.003 (0.256)	-0.002 (0.387)	0.01 (0.913)
15-01-09	CUT	-4.14	-0.0004 (0.472)	**-0.01*** **(0.032)**	-0.00005 (0.282)	-0.001 (0.381)	-0.0002 (0.448)	-0.0001 (0.154)	-0.001 (0.221)	**0.01*** **(0.969)**	**0.013*** **(0.954)**	**0.021**** **(0.983)**
29-06-11	SWAP	-2.27	0.0004 (0.606)	**-0.009*** **(0.05)**	0.00003 (0.627)	**0.01*** **(0.966)**	0.001 (0.669)	0.00008 (0.74)	0.0011 (0.85)	0.0002 (0.537)	-0.002 (0.395)	0.0007 (0.601)
07-07-11	RISE	3.07	-0.003 (0.229)	-0.002 (0.339)	-0.00005 (0.318)	**0.011**** **(0.976)**	0.002 (0.75)	0.0002 (0.877)	-0.0004 (0.305)	-0.002 (0.308)	-0.003 (0.336)	-0.0008 (0.461)
03-11-11	CUT, CBPP2	-2.76	-0.005 (0.127)	-0.004 (0.179)	0.00011 (0.849)	-0.001 (0.301)	0.003 (0.843)	0 (0.447)	0.0005 (0.683)	-0.005 (0.137)	-0.0031 (0.31)	-0.008 (0.102)

Table 5. Event study results for exchange rates for the most surprising ECB events. Values indicate one-day exchange rate (FX per euro) changes in percentage points. Values in parenthesis show the percentage returns that were lower than the observed return. * - change in exchange rate percentile smaller than 5% or larger than 95%; ** - change in exchange rate percentile smaller than 2.5% or larger than 97.5%; *** - change in exchange rate percentile smaller than 0.5% or larger than 99.5%

Appendix G. Announcements of the Fed that overlap with the ECB's announcements and robustness check results for regressions

Date	Description
18.03.2009	Federal Reserve issues FOMC statement
24.06.2009	Federal Reserve issues FOMC statement
23.09.2009	Federal Reserve issues FOMC statement
02.11.2011	Federal Reserve issues FOMC statement
01.08.2012	Federal Reserve issues FOMC statement
12.12.2012	Federal Reserve issues FOMC statement
01.05.2013	Federal Reserve issues FOMC statement
30.10.2013	Federal Reserve issues FOMC statement
17.09.2014	Federal Reserve issues FOMC statement
27.04.2016	Federal Reserve issues FOMC statement
02.11.2016	Federal Reserve issues FOMC statement
14.12.2016	Federal Reserve issues FOMC statement

Table 6. The list of the Fed's events that overlap with the ECB's announcements.

Appendix H. Robustness check results for regressions

Country	Value	Equity indices		Long-term bond yields		Exchange rates	
		Level factor	**Slope factor**	**Level factor**	**Slope factor**	**Level factor**	**Slope factor**
Czech Republic	Coef.	**0.0077121****	0.0026212	0.0095744	**0.0144333***	-0.0009285	-0.0008819
	p-value	**(0.002)**	(0.235)	(0.066)	**(0.018)**	(0.179)	(0.141)
Poland	Coef.	**0.0068348*****	0.0023971	0.0322287	-0.0030585	-0.0016137	**-0.002438*****
	p-value	**(0.001)**	(0.198)	(0.084)	(0.758)	(0.129)	**(0.000)**
Hungary	Coef.	0.004987	0.0065908	-0.0082085	0.0139937	-0.0011051	-0.0016623
	p-value	(0.096)	(0.062)	(0.681)	(0.475)	(0.286)	(0.059)
Croatia	Coef.	0.0025628	0.0003635	-	-	0.0000144	-0.0000468
	p-value	(0.239)	(0.870)			(0.904)	(0.726)
Bulgaria	Coef.	0.0022537	0.0032531	0.0192805	-0.0045332	-0.000009	**0.0000257****
	p-value	(0.264)	(0.256)	(0.236)	(0.860)	(0.455)	**(0.009)**
Romania	Coef.	0.0041931	**0.0051578***	-	-	-0.0003624	-0.0002136
	p-value	(0.122)	**(0.036)**			(0.257)	(0.409)
Denmark	Coef.	**0.0055362 ***	0.0026855	**0.029808 *****	0.0046811	0.000017	-0.0000004
	p-value	**(0.026)**	(0.15)	**(0.000)**	(0.441)	(0.222)	(0.983)
Sweden	Coef.	**0.0067575***	**0.0051921****	**0.0223343*****	**0.0150812*****	0.0007349	-0.0006844
	p-value	**(0.014)**	**(0.007)**	**(0.000)**	**(0.000)**	(0.232)	(0.373)
Norway	Coef.	**0.0107359****	0.0053893	**0.0237359*****	**0.0126321***	0.0000793	**-0.0012568***
	p-value	**(0.003)**	(0.058)	**(0.000)**	**(0.015)**	(0.866)	**(0.026)**
Switzerland	Coef.	**0.056242****	0.002867	**0.0133338*****	0.0032323	**0.0018058*****	0.000633
	p-value	**(0.007)**	(0.062)	**(0.001)**	(0.290)	**(0.000)**	(0.073)

Table 7. Robustness check for regressions results. * - coefficient significant at 5%; ** - coefficient significant at 1%; *** - coefficient significant at 0.1%

Appendix I. Event study robustness check results for equity indices

	Event group	Fac-tor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Croatia	Czech Republic	Hungary	Poland
Events with the largest level factors												
26-09-08	SWAP	-2.46	**-0.06221 *** **(0.027)**	0.005714 (0.62)	-0.01711 (0.17)	0.005174 (0.644)	-0.02442 (0.14)	**-0.0419 *** **(0.038)**	0.003937 (0.65)	-0.00712 (0.33)	**0.043411 *** **(0.954)**	0.025662 (0.92)
29-09-08	SWAP	-4.24	**-0.1482 ***** **(0.0031)**	**-0.07766 **** **(0.008442)**	**-0.07801 **** **(0.00844)**	**-0.06627 **** **(0.012)**	-0.04501 (0.06)	0.001742 (0.61)	-0.02638 (0.08)	**-0.07593 **** **(0.015)**	-0.02198 (0.16)	**-0.04108 *** **(0.038)**
02-04-09	CUT	2.68	**0.05919 **** **(0.98)**	**0.088949 ***** **(0.996163)**	**0.072822 **** **(0.992325)**	**0.049704 **** **(0.988)**	**0.080199 **** **(0.994)**	**0.034749 *** **(0.96)**	**0.055581 **** **(0.9885)**	**0.068557 **** **(0.9885)**	**0.060439 **** **(0.978)**	**0.062539 **** **(0.993)**
03-03-11	FRTFA LTRO	3.19	0.002435 (0.54)	-0.0075 (0.31)	0.000744 (0.50)	-0.00305 (0.40)	0.00986 (0.71)	-0.00699 (0.32)	-0.00486 (0.37)	0.005995 (0.64)	0.003897 (0.59)	0.018826 (0.86)
04-08-11	FRTFA LTRO-3m	-2.77	**-0.06037 *** **(0.029163)**	**-0.07489 **** **(0.00921)**	**-0.04218 *** **(0.03)**	**-0.04833 **** **(0.018)**	-0.0322 (0.095)	-0.01548 (0.17)	-0.01389 (0.19)	**-0.04151 *** **(0.0499)**	-0.03641 (0.08)	**-0.07652 **** **(0.0053)**
06-10-11	CBPP2 FRTFA LTRO-3/12m	2.40	**0.062616 **** **(0.986186)**	**0.059855 **** **(0.986953)**	0.00219 (0.54)	**0.035281 **** **(0.98)**	0.020913 (0.85)	0.006898 (0.76)	0.014404 (0.86)	**0.050328 **** **(0.976)**	**0.070395 **** **(0.99)**	0.031349 (0.94)
03-12-15	CUT	2.27	-0.0191 (0.11509)	-0.01854 (0.11)	-0.01241 (0.18)	-0.01581 (0.11)	0.000356 (0.49)	-0.00332 (0.35)	-0.00208 (0.36)	-0.01855 (0.081)	-0.00669 (0.27)	**-0.0235 *** **(0.04)**
Events with the largest slope factors												
03-07-08	RISE	2.45	-0.02791 (0.13)	0.012419 (0.75)	-0.01725 (0.17)	-0.00082 (0.44)	-0.01095 (0.27)	-0.01968 (0.13)	-0.00546 (0.36)	-0.01179 (0.25)	-0.00098 (0.49)	-0.00962 (0.26)
06-11-08	CUT	-2.28	**-0.11364 **** **(0.00614)**	**-0.08119 **** **(0.0054)**	**-0.10423 ***** **(0.0031)**	**-0.07713 **** **(0.0031)**	-0.02257 (0.15)	-0.01739 (0.15)	**-0.08812 **** **(0.00691)**	**-0.07628 **** **(0.015)**	**-0.12435 ***** **(0.0023)**	**-0.05642 **** **(0.021)**
04-12-08	CUT	-5.78	-0.00159 (0.45)	0.005873 (0.62)	-0.00227 (0.41)	0.019944 (0.90)	-0.00069 (0.48)	**0.03364 *** **(0.961)**	**0.030554 *** **(0.952)**	0.024651 (0.90)	0.017374 (0.80)	0.011205 (0.75)
15-01-09	CUT	-4.14	-0.02183 (0.17)	**-0.05687 **** **(0.022)**	**-0.0446 *** **(0.0299)**	-0.02783 (0.057)	-0.01626 (0.20)	**-0.08526 **** **(0.008)**	-0.03585 (0.054)	-0.033 (0.076)	-0.03606 (0.077)	**-0.04155 *** **(0.038)**
29-06-11	SWAP	-2.27	0.036616 (0.94)	0.028717 (0.91)	0.021317 (0.87)	0.018315 (0.89)	0.011322 (0.74)	0.020628 (0.92)	0.006274 (0.71)	0.0206 (0.87)	0.009611 (0.68)	0.009516 (0.71)
07-07-11	RISE	3.07	0.003412 (0.56)	0.006975 (0.65)	-0.00287 (0.40)	-0.00512 (0.34)	-0.00221 (0.44)	-0.00294 (0.43)	-0.00271 (0.43)	-0.00114 (0.46)	0.004797 (0.60)	0.00974 (0.72)
03-11-11	CUT, CBPP2	-2.76	**0.045956 *** **(0.96)**	0.035233 (0.94)	0.021595 (0.87)	0.014122 (0.83)	-0.00284 (0.42)	-0.00575 (0.35)	-0.01204 (0.22)	0.028239 (0.92)	**-0.05248 *** **(0.033)**	0.003717 (0.57)

Table 8. Robustness check results for equity indices for the most surprising ECB events. Values indicate the daily return on the event day. Values in parenthesis show the percentage returns that were lower than the observed return. * - return percentile smaller than 5% or larger than 95%; ** - return percentile smaller than 2.5% or larger than 97.5%; *** - return percentile smaller than 0.5% or larger than 99.5%.

Appendix J. Event study robustness check results for long-term sovereign bond yields

	Event group	Fac-tor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Czech Republic	Hungary	Poland
Events with the largest level factors											
26-09-08	SWAP	-2.46	-0.054 (0.19)	0.041 (0.76)	-0.024 (0.40)	-0.056 (0.14)	-0.24 (0.14)	-0.022 (0.37)	0.02 (0.70)	0.04 (0.66)	0.031 (0.74)
29-09-08	SWAP	-4.24	**-0.301 *** (0.0015)**	**-0.146 * (0.029)**	**-0.167 ** (0.024)**	**-0.102 * (0.043)**	0.3 (0.92)	-0.166 (0.10)	-0.075 (0.14)	0.12 (0.81)	**-0.609 *** (0.00077)**
02-04-09	CUT	2.68	0.098 (0.92)	**0.125 * (0.959)**	0.116 (0.93)	0.054 (0.87)	0 (0.39)	**0.311 * (0.959)**	-0.059 (0.19)	**-0.78 ** (0.0069)**	-0.049 (0.21)
03-03-11	FRTFA LTRO	3.19	0 (0.46)	0.068 (0.85)	**0.164 ** (0.979)**	0.011 (0.64)	-0.004 (0.33)	0.004 (0.59)	0 (0.50)	-0.08 (0.25)	0.038 (0.78)
04-08-11	FRTFA LTRO-3m	-2.77	0.07 (0.88)	-0.083 (0.12)	-0.096 (0.10)	-0.004 (0.50)	0.08 (0.76)	0 (0.49)	0 (0.50)	0.13 (0.82)	-0.044 (0.24)
06-10-11	CBPP2 FRTFA LTRO-3/12m	2.40	0.123 (0.948)	**0.158 ** (0.98)**	**0.201 ** (0.988)**	0.07 (0.92)	0.001 (0.61)	0.011 (0.63)	0.021 (0.70)	**-0.45 * (0.032)**	**-0.122 * (0.049)**
03-12-15	CUT	2.27	**0.1 * (0.959)**	**0.117 * (0.973)**	**0.174 ** (0.99)**	**0.123 ** (0.991)**	0 (0.46)	-0.083 (0.14)	0.018 (0.79)	0.06 (0.80)	**0.174 ** (0.976)**
Events with the largest slope factors											
03-07-08	RISE	2.45	-0.014 (0.39)	0.05 (0.80)	-0.024 (0.40)	-0.016 (0.40)	0.002 (0.65)	0.056 (0.76)	-0.032 (0.30)	0.14 (0.84)	0.07 (0.88)
06-11-08	CUT	-2.28	-0.072 (0.14)	0.044 (0.77)	**-0.158 * (0.027)**	-0.064 (0.11)	-0.25 (0.09)	0.119 (0.86)	**-0.269 ** (0.0053)**	**-0.94 *** (0.0038)**	**-0.19 ** (0.016)**
04-12-08	CUT	-5.78	-0.102 (0.08)	**-0.147 * (0.028)**	-0.085 (0.13)	-0.067 (0.10)	0.004 (0.66)	**0.425 * (0.969)**	-0.023 (0.36)	**-0.43 * (0.035)**	-0.112 (0.06)
15-01-09	CUT	-4.14	**-0.256 ** (0.007)**	0.051 (0.80)	**-0.13 * (0.047)**	-0.016 (0.40)	0.15 (0.82)	-0.043 (0.30)	**-0.205 ** (0.016)**	-0.23 (0.10)	0.048 (0.82)
29-06-11	SWAP	-2.27	0.017 (0.71)	0.097 (0.92)	0.096 (0.91)	0.064 (0.90)	-0.009 (0.32)	0.047 (0.74)	0.048 (0.81)	-0.1 (0.22)	-0.073 (0.13)
07-07-11	RISE	3.07	-0.018 (0.36)	-0.015 (0.43)	-0.009 (0.49)	0.006 (0.60)	-0.004 (0.33)	0.033 (0.70)	0.043 (0.79)	-0.01 (0.46)	0.029 (0.73)
03-11-11	CUT, CBPP2	-2.76	0.061 (0.85)	0.077 (0.87)	**0.154 ** (0.977)**	0.025 (0.73)	0.06 (0.75)	-0.2 (0.08)	0.105 (0.93)	0.12 (0.81)	-0.035 (0.29)

Table 9. Robustness check results for sovereign bond yields for the most surprising ECB events. Values indicate the daily return on the event day. Values in parenthesis show the percentage returns that were lower than the observed return. * - return percentile smaller than 5% or larger than 95%; ** - return percentile smaller than 2.5% or larger than 97.5%; *** - return percentile smaller than 0.5% or larger than 99.5%.

Appendix K. Event study robustness check results for exchange rates

	Event group	Factor	Norway	Sweden	Denmark	Switzerland	Romania	Bulgaria	Croatia	Czech Republic	Hungary	Poland
Events with the largest level factors												
26-09-08	SWAP	-2.46	0.001089 (0.61)	0.00168 (0.62)	0.000181 (0.86)	-0.0044 (0.20)	0.003754 (0.81)	0.00005 (0.62)	-0.00069 (0.30)	0.000718 (0.58)	0.00195642 (0.61)	0.01443 (0.93)
29-09-08	SWAP	-4.24	0.004463 (0.78)	0.006284 (0.85)	-0.00014 (0.18)	-0.00959 (0.09)	0.006911 (0.90)	0.00010226 (0.79)	-0.00139 (0.16)	0.005589 (0.83)	0.0056648 (0.75)	**0.018102 * (0.955)**
02-04-09	CUT	2.68	-0.00474 (0.23)	**-0.01353 * (0.0399)**	0 (0.49)	0.009264 (0.93)	-0.00355 (0.17)	**-0.0002557 * (0.048)**	-0.00076 (0.28)	**-0.02947 *** (0.0023)**	**-0.031271 ** (0.0084)**	**-0.0461 *** (0.003)**
03-03-11	FRTFA LTRO	3.19	0.000324 (0.57)	**0.013284 * (0.955)**	0.00006 (0.67)	0.007894 (0.90)	-0.00219 (0.26)	-0.0000256 (0.40)	-0.00041 (0.37)	-0.00249 (0.33)	0.00103325 (0.56)	0.004056 (0.69)
04-08-11	FRTFA LTRO-3m	-2.77	0.012284 (0.95)	**0.018379 ** (0.982)**	0.000067 (0.69)	-0.00631 (0.14)	-0.00284 (0.21)	0.0001278 (0.82)	0.002375 (0.91)	0.001959 (0.66)	0.00919759 (0.82)	0.001317 (0.58)
06-10-11	CBPP2 FRTFA LTRO-3/12m	2.40	-0.00147 (0.43)	0.000805 (0.56)	0.000242 (0.91)	0.009082 (0.93)	-0.00072 (0.40)	-0.0002045 (0.08)	0.001555 (0.84)	-0.00236 (0.34)	-0.0081226 (0.17)	-0.00438 (0.30)
03-12-15	CUT	2.27	**0.10 * (0.959)**	0.002815 (0.72)	-0.000067 (0.32)	-0.00271 (0.16)	0.002897 (0.90)	0.00020449 (0.93)	0.000964 (0.82)	0.001571 (0.89)	-0.0013212 (0.39)	0.000328 (0.52)
Events with the largest slope factors												
03-07-08	RISE	2.45	-0.014 (0.39)	-0.00476 (0.25)	-0.000034 (0.41)	0.002577 (0.77)	-0.00192 (0.28)	0.0000511 (0.62)	-0.00037 (0.38)	0.001134 (0.61)	0.00334853 (0.66)	0.000477 (0.55)
06-11-08	CUT	-2.28	**0.018114 ** (0.98)**	0.012437 (0.947)	**0.00039 * (0.97)**	-0.00053 (0.45)	0.00838 (0.93)	**-0.0003835 ** (0.012)**	-0.00094 (0.24)	**0.034099 *** (0.998)**	0.00513864 (0.73)	0.002954 (0.65)
04-12-08	CUT	-5.78	0.007944 (0.89)	**0.01321 * (0.953)**	0.000208 (0.89)	0.003909 (0.82)	0.008913 (0.94)	-0.000128 (0.20)	**0.008019 *** (0.999)**	-0.00428 (0.23)	0.0011498 (0.57)	0.012545 (0.91)
15-01-09	CUT	-4.14	-0.00318 (0.31)	0.009784 (0.92)	-0.00023 (0.09)	-0.00694 (0.13)	-0.00515 (0.12)	-0.000051 (0.32)	0.000509 (0.66)	**0.021645 ** (0.994)**	-0.0033065 (0.36)	**0.01962 * (0.962)**
29-06-11	SWAP	-2.27	0.002694 (0.71)	-0.00327 (0.31)	0.000194 (0.87)	0.010271 (0.94)	-0.00083 (0.38)	-0.0000256 (0.44)	0.0000868 (0.53)	-0.00129 (0.41)	-0.0036121 (0.35)	0.002072 (0.62)
07-07-11	RISE	3.07	-0.00136 (0.44)	0.001229 (0.59)	-0.00008 (0.29)	-0.00854 (0.10)	0.006436 (0.89)	0.00005113 (0.66)	0.000368 (0.62)	-0.00122 (0.42)	-0.0011718 (0.45)	0.000279 (0.54)
03-11-11	CUT, CBPP2	-2.76	-0.00478 (0.22)	-0.00171 (0.39)	0.000141 (0.82)	-0.00288 (0.27)	0.003447 (0.79)	**-0.0003068 * (0.027)**	0.001211 (0.79)	-0.00409 (0.25)	0.0169705 (0.94)	0.00862 (0.84)

Table 10. Robustness check results for exchange rates for the most surprising ECB events. Values indicate the daily return on the event day. Values in parenthesis show the percentage returns that were lower than the observed return. * - return percentile smaller than 5% or larger than 95%; ** - return percentile smaller than 2.5% or larger than 97.5%; *** - return percentile smaller than 0.5% or larger than 99.5%.