The impact of monetary policy announcements on the stock price of large European banks during the financial crisis

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1. Introduction

As outlined by the European Central Bank (ECB, 2010), central banks and governments worldwide responded decisively to the challenges posed by the global financial crisis since it erupted in summer 2007. Monetary authorities around the globe reduced their key policy interest rates to unprecedented low levels. In addition to this, in order to overcome the malfunctioning of the interbank market and keep the transmission mechanism through the interest rate channel fully operational, they intervened with a number of non-standard policy measures, such as monetary easing and liquidity provision. Non-standard measures aimed at supporting funding conditions for banks, in order to enhance lending to the private sector, and contain contagion in financial markets (ECB, 2011). The introduction of these measures has contributed to significant changes in bank's funding patterns: "*constraints and higher costs in interbank market funding, as well as in funding through debt securities, have led banks to increase their recourse to central banking funding substantially with respect to the pre-crisis period*" (ECB, 2012, p. 25). The increase in the dependency on the ECB liquidity has been particularly significant for banks domiciled in countries under financial assistance and/or experiencing sovereign tensions (BIS, 2013).

What is the impact of both conventional and non-conventional monetary policy announcements on the stock price of banks? What are the main determinants of banks' response to monetary policy interventions? The objective of this paper is to answer these questions with reference to a sample of large European banks over the period June 2007-June 2013. The remainder of the paper is organized as follows: Section 2 reviews the existing literature and develops our main hypotheses; Section 3 describes the investigated sample, the methodology and the variables used in our empirical research design. Section 4 discusses our main results, and Section 5 presents conclusions, limitations and directions for future research.

2. Past Literature and testable hypotheses

The impact of monetary policy interventions on the financial market has always raised the interest of both academics and policy makers. Responses to conventional monetary announcements (i.e., changes in policy interest rates) have been investigated with respect to a large set of financial variables: stock prices and volatility (Bomfin, 2003; Ehrmann and Fratzscher, 2004; Bernanke and Kuttner, 2005; Chulià *et al*., 2010; Rangel, 2011; Rosa, 2011), international bond returns (Bredin *et al.*, 2010), interest rates (Hausman and Wongswan, 2011; Leòn and Sebestyén, 2012) and exchange rates (Hausman and Wongswan, 2011). This literature grow up during the last decade; most papers (Bomfin, 2003; Ehrmann and Fratzscher, 2004; Bernanke and Kuttner, 2005; Chulià *et al*., 2010; Hausman and Wongswan, 2011; Rangel, 2011; Rosa, 2011) focus on the U.S. assessing how the central banks' intervention on interest rates relates to asset prices, while there are a very few papers dealing with other currency areas (e.g., Leòn and Sebestyén, 2012 analyzing the ECB monetary policy; Bredin *et al.*, 2010 considering U.K., U.S. and the Euro area). It is also possible to observe that most empirical analyses generally end before 2008, not considering the spread of the global financial crisis. As a consequence, while there is a substantial literature dealing with conventional interest rate decisions, there is a much lower number of empirical contributions assessing the impact of non-conventional measures, that were quite sporadic before the beginning of the 2007 financial crisis. Since then, central banks have been increasingly using non-standard interventions, such as monetary easing (i.e., central banks' purchases of government or corporate bonds), and liquidity support (i.e., the provision of liquidity in the domestic currency by more

frequent auctions, longer maturities for refinancing operations or extension of accepted collaterals; the provision of liquidity in foreign currencies through swap agreements). All these non-conventional monetary policy interventions aim to support the economic activity and banking stability, but the market reaction to their announcement may be different (ECB, 2010, p. 62; ECB, 2011, p.55). As highlighted by Cecioni *et al*. (2011), non-conventional measures may affect economic and financial variables through two channels of transmission: the "signalling channel" and the "portfolio-balance channel". The first is activated through communication: especially when interest rates are near to the zero lower bound, the announcement of non-conventional measures is able to impact investors' expectations signalling the strong commitment of central banks in contrasting the crisis and providing stimulus to the economy. The second channel operates solving difficulties in some specific dysfunctional segments of the financial market: central banks resort to asset purchases and liquidity injections to influence the prices of a wide set of securities and to mitigate financial frictions due to funding conditions. The study of Cecioni *et al*. (2011) also provides a comprehensive review of empirical contributions related to the impact of non-conventional measures on financial and macroeconomics variables, with reference to both the U.S. and the Euro area. The evidence suggests that these measures have been generally effective in reducing interest rates and avoiding a larger collapse in output. Nevertheless, the authors underline that there is a very large degree of uncertainty surrounding the precise quantification of these effects for several reasons, including the difficulties in capturing the role of non-conventional measures in contrasting credit rationing.

At our knowledge, the only paper focusing on the effect of both conventional and non-conventional monetary policy announcements over the crisis period is the one by Aït-Sahalia *et al.* (2012), a broad study assessing the impact on the credit market of a wide set of policy measures in various countries. Specifically, Aït-Sahalia *et al.* (2012) examine the effect of policy announcements (fiscal and monetary policy, financial sector policy, and ad-hoc bank failures) on the interbank credit and liquidity risk premia in the U.S., Euro area, U.K. and Japan between June 2007 and March 2009. The authors assess the policy effect on the day-to-day changes in the 3-month LIBOR–Overnight

Indexed Swap (OIS) rate spread (where the authors choose the LIBOR-OIS spread as a proxy for the liquidity and counterparty risk premia in the global interbank markets). Nevertheless, the paper of Aït-Sahalia *et al.* (2012) does not consider the impact on equity markets.

At our knowledge, there are no studies investigating the impact of both conventional and non-conventional monetary policy announcements on stock prices. Up to now, the impact of monetary interventions on individual stock prices has been studied with reference to standard policy interest rate decisions and non-financial companies. Bernanke and Kuttner (2005) suggest that changes in policy interest rates may influence: 1) expected future cash flows; 2) expected future risk-free rate used to discount cash flows, and 3) risk premia. They also show that the effect on the risk-free rate is only a small portion of the total market reaction, that is mainly driven by the impact on expected future cash flows. The latter is strongly influenced by some firm-specific features. For example, Ehrmann and Fratzscher (2004), studying the impact of the U.S. Federal Reserve monetary policy on the 500 individual stocks comprising the S&P500 over 1996-2003, find that firms smaller in size, with low cash flows, poor credit ratings, low debt to capital ratios, high price-earnings ratio and high Tobin's q are more affected than others by monetary policy. Focusing on the risk premia component, the ECB (2008) suggests that monetary policy interventions are able to exert a direct impact on the perceived riskiness of certain assets (e.g., through an increase of funding cost and the consequent weakening of firms' balance sheets) and risk compensation required by investors (e.g., modifying their risk appetite). We believe that this way of reasoning may be applied also to non-standard monetary policy measures. For example, it is quite logical to expect that a liquidity injection may affect both future cash flows and risk premia for non-financial firms, improving funding conditions (and consequently making possible new investments, and/or avoiding liquidity problems). This common conceptual framework does not allow to formulate specific hypotheses on the magnitude of the effect of each monetary policy measures on stock prices, but suggests that it makes sense to empirically assess and compare the impact of both standard and non-standard measures on asset pricing in a crisis period.

What about the effect on the individual stock price of banks? At our knowledge, there are no

studies measuring the impact of both conventional and non-conventional measures on individual bank stock prices and trying to assess their determinants. One exception is the working paper of Grammatikos *et al.* (2013) that, using the same database of Aït-Sahalia *et al.* (2012), assesses the effect of both conventional and non-conventional monetary policy decisions on the stock price of globally systemically important financial institutions (G-SIFIs). However, their analysis ends in March 2009 and merely measures investors' reaction for G-SIFIs without investigating its determinants.

As outlined by Brissimis and Delis (2010), the attention of past literature was generally concentrated on the transmission of monetary policy through the lending and the risk-taking channels (e.g., Altunbas *et al.*, 2010; Gambacorta, 2009; Gambacorta and Marqués-Ibáñez, 2011). In their paper, the authors add to the existing literature by investigating the heterogeneity of banks' response to monetary policy changes with respect to their liquidity, capitalization and market power. Other than considering the effects in terms of lending and risk-taking, they also measure the impact on the attained performance. Results show that high capitalization, liquidity and market power tend to smooth the effect of a change in policy interest rates. These findings suggest that banks with healthier balance sheets are less sensitive to monetary policy.

Brissimis and Delis (2010) do not consider non-conventional measures. In addition to this, their empirical analysis does not deal with banks' stock prices and covers the period 1994-2007, ending before the spread of the global financial crisis. This makes impossible to consider the dramatic changes occurred in bank financing patterns during both the global financial crisis and the subsequent Euro sovereign debt crisis. These changes are strongly related to monetary policy, and especially to non-conventional measures that, as already outlined in the introduction section, have contributed to important changes in bank's funding patterns. The increase in the dependency on ECB liquidity has been particularly significant for banks domiciled in countries under financial assistance and/or experiencing sovereign tensions (BIS, 2013). This may lead to a higher sensitivity of the stock price of these banks to monetary policy interventions and is undoubtedly worthy of further investigation.

At our knowledge there are no papers assessing the heterogeneous response of banks' stock

price to monetary policy interventions depending on their balance sheet strength and location. The relevance of this point appears even higher if we consider that financial intermediaries, and large banks in particular, have been at the center of the financial crisis, given renewed impetus to think about the interconnection between financial stability and monetary policy (Adrian and Shin, 2008). As a consequence, banks are no more only part of the monetary transmission channel, but are now often the main subjects of some policy interventions. At our knowledge, the only paper assessing the effectiveness of policy interventions on the stock market price of banks over the crisis period is the one by Panetta *et al*. (2009). However, the authors investigate government rescue plans, finding no evidence of a positive market reaction. In their opinion, results are probably explained by concerns about the dilution of shareholders' rights, public intervention in the bank management and uncertainty regarding the duration of the plan. Monetary policy interventions, in particular non-conventional measures, are substantially different from rescue plans, but may undoubtedly contribute to restore the banking system. So their impact on individual stock prices of banks undoubtedly deserves further empirical investigation.

Our paper contributes to the previous literature in several ways.

First of all, we assess which type of monetary policy intervention has been more effective in restoring investors trust in the banking market (i.e., interest rates decisions vs. non-conventional measures). At this aim, consistently with Jawadi et *al.* (2010), we adopt a short run perspective and consider each announced intervention as effective on the basis of the accuracy and rapidity of stock market reactions in the direction expected by policy makers. Consistently with this approach, we run an event study analysis in order to estimate cumulated abnormal returns (CARs) for banks' stock prices around announcement days.

Secondly, we investigate potential differences in the banks' abnormal returns registered in several phases of the financial crisis. At this aim, we focus on a quite longer period with respect to existing papers, extending the database compiled by Aït-Sahalia *et al.* (2012) and adding three more years of observations, until June 2013. We distinguish three different stages: the U.S. subprime crisis

(from 1 June 2007 to 14 September 2008), the global financial crisis (from 15 September 2008 to 1 May 2010) and the sovereign debt crisis (from 2 May 2010 to the end of the database).

Third, we assess the reaction of large European banks to monetary policy interventions in other relevant currency areas: the U.S., the U.K., Japan, and Switzerland. This allows to estimate potential spillover effects and to understand which area is more influential on European banks.

Finally, we measure the heterogeneous response of banks and try to investigate the main determinants of this variety. This aim requires a second stage analysis, in which CARs are regressed on a set of bank specific variables and controls. The main objective of this second stage analysis is to test the base hypothesis that banks experiencing capital/liquidity tensions, or operating in countries under financial stress, are more sensitive to monetary policy decisions. More specifically, our testable hypotheses are the following:

H1: Banks with higher liquidity ratios are less sensitive to monetary policy interventions with respect to banks experiencing liquidity tensions.

H2: Banks with higher capital ratios are less sensitive to monetary policy interventions with respect to banks with a lower capitalization.

H3: Banks that are perceived as riskier by investors are more sensitive to monetary policy interventions with respect to low-risk banks.

3. Methodology

The aim of this section is to describe the collection of monetary policy interventions and the sample of banks investigated in the empirical analysis (section 3.1); it also defines the methodology used for the event study (section 3.2) and for the subsequent regression analysis (section 3.3).

3.1 Sample description

We analyze monetary policy interventions relative to five currency areas: Euro area (EUR), Japan (JPN), United Kingdom (UK), United States (US) and Switzerland (CH), considering a 6-year period, from June 2007 to June 2013. Data have been collected from different sources. For the period June 2007 – March 2009, we draw information from the database compiled by the National Bureau of Economic Research (Aït-Sahalia *et al*., 2010, 2012). For the period from April 2009 to the end of June 2013, we collected data from official announcements (in the form of press releases) from European Central Bank, Bank of Japan, Bank of England, Federal Reserve and Swiss National Bank. Specifically, we consider announcements from a single central bank[1] and coordinated measures, announced by several central banks in a joint press release (e.g., Bank of England, Bank of Japan, European Central Bank, Federal Reserve and Swiss National Bank adopting joint measures on 13/10/2008 to improve liquidity in the short-term US dollar funding market).

Building on the Aït-Sahalia *et al*. (2010, 2012) framework, we classify monetary policy interventions as follows: a) interest rate decisions; b) monetary easing decisions; and c) liquidity decisions. Specifically, interest rate decisions consists of interest rate cuts (*IR_CUT)*, increases (*IR_INCR*) and no changes (*IR_UNC).* Increases and no changes are treated as a single category (*IR_INCR_UNC*). Monetary easing decisions (*MON_EASE)* include central banks' purchases of government bonds (quantitative easing) or corporate bonds (credit easing), in primary or secondary markets. The decisions to stop a monetary easing program (e.g., the Bank of England stopping some part of the Asset Purchase Program on 15/11/2010, judging it was no longer necessary given the improvements in financial market functioning) is treated in a separate category, including contraction measures (*CONTR).*

[1] Among single announcements, we have few cases in which central banks do not release a joint communicate, but independently adopt similar decisions in the same day: in our sample there are only 4 cases, all regarding interest rate cuts: 8/10/2008 (CH, EUR, UK, US); 6/11/2008 (CH, EUR, UK); 4/12/2008 (EUR and UK); 5/03/2009 (EUR and UK).

Regarding liquidity decisions, this category includes various measures, such as[2]: 1) the provision of liquidity in the domestic currency, i.e., with more frequent auctions, longer maturities for refinancing operations or extension of accepted collaterals; 2) the provision of liquidity in foreign currencies, through swap agreements between central banks or central banks facilities for liquidity in a foreign currency; 3) restrictions to the liquidity provided in the domestic currency (e.g., the Federal Reserve reduction of credit offered with the Term Auction Facility (TAF) on 25/06/2009). The latter are included in the contraction category (*CONTR*) together with the end or reduction of monetary easing programs.

Depending on the aims of the central bank initiative, we distinguish two main categories: expansionary measures, and policy-inaction/restrictive measures[3]. Specifically, we classify interest rate cuts (*IR_CUT*), monetary easing (*MON_EASE*), and liquidity support (in both domestic and foreign currencies, *LIQ+*) as expansionary monetary policy measures. We define policy inaction/restrictive monetary policy as interest rates increases or no changes (*IR_UNC_INCR*), end of monetary easing programs and liquidity restrictions (*CONTR*).

By using an event study methodology, we have to deal with the problem of overlapping events. Focusing on press releases by the same institution, falling in the same day, we adopt the following criteria: 1) when different announcements belong to the same event-type category, we treat them as a single event: e.g., on the 6/02/2009 the Bank of England announced the purchase of corporate bonds trough a secondary market scheme, a commercial paper facility and also the acquisition of Gilts. All them are considered as a single event in the category of monetary easing, *MON_EASE*; 2) when there is a decision to change the target interest rate, we consider it as the main event, dropping all the others from the event study analysis: e.g., on the 5/03/2009 the European Central Bank decreased the main refinancing rate by 50 basis points and also decided to continue the fixed rate tender procedure with full allotment for all main refinancing operations, special-term refinancing operations and supplementary

[2]Restrictions to the liquidity provided in foreign currencies are not considered in the empirical analysis, because we found only two cases in which central banks decided to discontinue some foreign swap agreements previously signed.
[3]This classification is consistent with Aït-Sahalia *et al*. (2012).

and regular longer-term refinancing operations for as long as needed, and in any case beyond the end of 2009. In this case we give more relevance to the interest rate cut; 3) when there is a decision to leave the current situation unchanged or to continue with a measure previously defined, we consider it less important of other announcements in the same press release: e.g., on the 28/10/2010 the Bank of Japan declared to maintain the Overnight Call Rate at 0-0.1% and announced an asset purchase program to encourage the decline in longer-term interest rates and risk premia. In this case we consider the asset purchase program the main event. We apply the same criterion also for announcements not exactly leaving the situation unchanged, but simply giving some technical specifications for programs already announced to the market; and 4) if the above mentioned criteria are not sufficient to extrapolate a single event from a package of interventions, we identify the main event on the basis of its prominence in the financial press, as in Aït-Sahalia *et al*. (2012).

At the end of the selection process, our final sample (excluding overlapping announcements[4]) includes 490 announcements from single central banks (235 expansionary measures and 255 restrictive measures). A more detailed description is reported in Table 1, Panel A. In addition to this, we have 38 joint announcements, all belonging to the category of liquidity provision in foreign currency through swap agreements.

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To investigate whether the impact of monetary policy interventions change over time, we divide the time period investigated (June 2007-June 2013) into three different sub-periods. Consistently with Aït-Sahalia *et al*. (2010, 2012), the first period is between the 1st June 2007 and 14th September 2008 (i.e., the day before the collapse of Lehman Brothers), labeled as "subprime crisis phase". The second period runs from the 15th September 2008 to the 1st May 2010 (i.e., the day before the beginning of the European sovereign debt crisis phase, generally identified on the 2nd May 2010, when the Euro zone members and the International Monetary Fund agreed a bailout package to rescue Greece for €110

[4] Once that we have excluded overlapping announcements, there are still some cases of events that are separated one from each other by less than 3 days. These may be considered overlapping for the longest windows of our event study. However we decide to keep them in the sample in order to avoid a discretional selection.

billion): we label this sub-period as "global financial crisis". Finally, the third period is between the 2nd May 2010 and the end of the investigated period: we labeled this sub-period as "sovereign debt crisis". The distribution of the monetary policy interventions over these three sub-periods is reported in Table 1, Panel B.

Consistently with the aim of the paper, we select a sample of large European banks that meet the following requirements: 1) the bank is based in a country of the European Monetary Union (EMU); 2) the bank was subject to the 2011 EU-wide stress test or to the 2012 EU capital exercise conducted by the European Banking Authority (EBA); 3) the bank is listed on a stock exchange; 4) the bank hasn't been liquidated, nationalized or declared insolvent during the investigated period (i.e., we drop Dexia from the sample); 5) the bank is not located in a country joining the Euro over the financial crisis period (i.e., we drop Cipro, Malta and Slovenia from the sample).

As a result, we have a sample of 32 EMU banks, reported in Table 2.

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3.2 Event study

We measure the stock price reaction for large European banks by estimating abnormal returns (ARs), which are the forecast error of a specific normal return-generating model. First of all, for each bank, we measure the reaction to monetary policy announcements by the European Central Bank. In addition to this, in order to measure potential spillover effects, we also estimate the reaction to monetary policy announcements in other relevant currency areas (U.S., U.K., Switzerland and Japan) and to swap agreements jointly announced by several central banks.

Regarding the estimation procedure, we estimate the abnormal return (AR), adopting the market model (MacKinlay, 1997). Normal returns for every *i-th* observation (R_{it}) are obtained as a function of the market portfolio return (R_{Mt}), represented by a broad equity index:

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \qquad E(\varepsilon_{it}) = 0,\ \text{var}(\varepsilon_{it}) = \sigma^2{}_{\varepsilon_i} \tag{1}$$

Market model parameters are obtained with daily log returns of each bank and a broad reference index, able to represent the market portfolio over a 252-day estimation period, ending 20 days before the announcement. More specifically, we consider that most of these banks are operating at a European level and we try the robustness of our results with three different reference indices: the MSCI Europe, the MSCI European Union, and the MSCI Monetary Union[5]. ARs are then obtained as the difference between the actual stock return and the return predicted by the market model:

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{Mt}) \tag{2}$$

ARs are cumulated over a time period (Cumulative Abnormal Return, CAR) around the announcement date (t=0). Following Aït-Sahalia *et al*. (2010, 2012), we focus on the following short event windows: 5-day (-1; +3), 3-day (-1;+1) and one-day (0;0). As a robustness check, we also estimate CARs on (0; +1). For each event window, CARs are obtained as follows:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it} \tag{3}$$

where t_1 and t_2 are the start and the end date of the considered window. ARs can be aggregated on a time or a cross-section basis for a portfolio of N observations. The Cumulative Average Abnormal Return (CAAR) is calculated as:

$$CAAR(t_1, t_2) = \frac{1}{N} \sum_{i=1}^{N} CAR_i(t_1, t_2) \tag{4}$$

After the calculation of CAARs, we test the hypothesis of a market reaction significantly different from zero. As noted in Cummins and Weiss (2004), various studies have documented a variance increase in ARs during the days near to the event, with respect to the estimation period, as an effect of the announcement. If hypothesis testing is conducted without considering this increase in variance, results can be biased in the direction of a too frequent rejection of the null hypothesis in favor

[5] We also run the analysis using country indices (i.e., the MSCI Germany for Deutsche Bank, the MSCI France for BNP Paribas, and so on), and results remain substantially unaltered.

of the alternative. In order to overcome this limitation and avoid considering as significant a null value creation or destruction, we follow the approach first proposed by Mikkelson and Partch (1988) and then adopted in some recent studies (e.g., Harrington and Shrider, 2007; Mentz and Schierek, 2008), suggesting using the Boehmer *et al*. (1991) test statistic. First of all, we calculate a standardization factor:

$$SR_i = \frac{CAR_i(t_1,t_2)}{\hat{\sigma}_{\varepsilon_i}\sqrt{T_s + \frac{T_s^2}{T} + \frac{\sum_{t=t_1}^{t_2}\left(R_{Mt} - T_s(\overline{R}_M)\right)^2}{\sum_{t=1}^{T}\left(R_{Mt} - \overline{R}_M\right)^2}}} \qquad (5)$$

where $\hat{\sigma}_{\varepsilon_i}$ is the standard deviation of abnormal returns estimated with the market model; T_s is the number of days in the considered event window (t_1, t_2); T is the number of days in the estimation period; R_M is the market portfolio return and $\overline{R}_M$ is the average market portfolio return during the estimation period. Then, the Z statistic (with a t-distribution with T-2 degrees of freedom and converging to a unit normal) is determined as follows (Mentz and Schierek, 2008, p. 207):

$$Z = \frac{\frac{1}{N}\sum_{i=1}^{N} SR_i}{\sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N}\left(SR_i - \sum_{i=1}^{N}\frac{SR_i}{N}\right)^2}} \qquad (6)$$

A recent study by Kolari and Pynnönnen (2010) proposes a new test statistic that modifies the one suggested by Boehmer *et al*. (1991) in order to consider possible cross-sectional correlation among abnormal returns. The adjusted test statistic is obtained applying the following correction factor to the above defined Z:

$$\sqrt{\frac{1-\bar{r}}{1+(N-1)\bar{r}}} \qquad (7)$$

where $\bar{r}$ is the average of the sample cross correlations of the estimation period residuals and N is the number of observations in the considered sample.

3.3 Regression analysis

As a second step, with reference only to single announcements by the European Central Bank, we investigate the determinants of different banks' stock price reaction by running the following OLS regression:

$$CAR_{i,j}^{t_1,t_2} = \alpha + \sum_j \beta_j ANN_j + \sum_k \gamma_k BANK_{i,k} + \sum_n \lambda_n time\_dummy_n + \varepsilon_{i,j}^{t_1,t_2} \qquad (8)$$

where the dependent variable is the cumulated abnormal return (CAR) for the *i-th* bank to the *j-th* announcement over the event window (t_1, t_2); *ANN* is a vector of *j* categorical variables identifying the type of monetary policy announcement; *BANK* is a vector of *k* firm-specific variables relative to banks. Furthermore, we add a set of *n* dummy variables to identify the several stages of the financial crisis.

The model is separately run for expansionary and inaction/restrictive measures. For the former the dummies identifying the possible types of interventions are: interest rate cuts (*IR_CUT*), liquidity provisions (*LIQ+*) and monetary easing (*MON_EASE*). The first is dropped to avoid multicollinearity problems and serves as the reference category. For inaction/restrictive measures, the possible categories are the decision to increase or leave unchanged interest rates (*INT_INC_UNC*), that is assumed as the base category, and the end of previous expansionary measures (*CONTR*).

In both cases, the set of bank-specific variables considered is the same. For each announcement, the value of these variables is relative to the last available balance sheet (or report from the Economic Intelligence Unit for ratings).

Our interest variables are those related to liquidity, capitalization and level of perceived risk. With reference to liquidity, we consider two different indicators: the ratio between "Due from banks" and "Loans from banks" (INTERBANK), and the ratio of customers deposit in total short-term funding

(DEP_SHARE). The underlying idea is that banks in a debt position on the interbank market and for whom customer deposits represent a low portion of total funding are more likely to experience liquidity tensions. Consistently with our hypotheses, we assume that banks with low liquidity ratios are more sensitive to monetary policy announcements, i.e., they benefit more from expansionary measures than their more liquid competitors. At the same time, they are expected to respond in a less favorable manner to restrictive measures. As a consequence, H1 is confirmed if the coefficients for INTERBANK and DEP_SHARE are statistically significant at the 10% confidence level or less, with a negative sign in the expansionary model, and a positive sign in the restrictive model.

With reference to capitalization, we consider the TIER1 ratio, i.e., the ratio between the regulatory primary capital and the total amount of risk weighted assets. Consistently with our hypotheses, we assume that banks with low capital ratios are more sensitive to monetary policy announcements, i.e., they benefit more from expansionary measures than their more capitalized competitors. At the same time, they are expected to respond in a less favorable manner to restrictive measures. As a consequence, H2 is confirmed if the coefficient for the TIER1 ratio is statistically significant at least at the 10% confidence level, with a negative sign in the expansionary model, and a positive sign in the restrictive model.

Finally, with reference to the level of risk, we take into consideration two different measures. First of all, we consider the ratio between risk weighted assets and total assets (RWA_RATIO). In addition, we also include the rating for the country banking system where the institution is located (BANKSYS_RAT), issued by the Economic Intelligence Unit. As stated in the Country Risk Service Handbook (EIU, 2010, p. 6), "*this risk category gauges the risk of a systemic crisis whereby bank(s) holding 10% or more of total bank assets become insolvent and unable to discharge their obligations to depositors and/or creditors*". This risk is influenced by several indicators, including political, policy, cyclical and structural variables. As usual in the literature (see, for example Beirne and Fratzscher, 2013), we convert the alphabetic code of ratings in numbers, so that higher values indicate more risk. Consistently with our hypotheses, we assume that banks with high risk perceived from investors are

more sensitive to monetary policy announcements, i.e., they benefit more from expansionary measures than their low-risk competitors. At the same time, they are expected to respond in a less favorable manner to restrictive measures. As a consequence, H3 is confirmed if the coefficients for RWA_RATIO and BANKSYS_RAT are statistically significant at least at the 10% confidence level, with a positive sign in the expansionary model, and negative in the restrictive model.

Finally, in addition to our interest variables, the model includes also some controls: the level of profitability (measured as the return on average assets, ROAA) and the level of efficiency (measured by the cost-to-income ratio, COST_INC).

We control the absence of multicollinearity problems, both measuring cross correlations among variables and checking for the values of the variance inflation factor (VIF).

4. Results

This section discusses our main results: first of all, in Section 4.1, we present the evidence provided by the event study analysis; second, in Section 4.2, we comment on findings from the regression analysis.

4.1 Results from the event study analysis

Table 3 reports the results for the event study conducted on European banks with reference to the ECB monetary policy announcements. The index chosen as representative of the market portfolio is the MSCI Europe. Results remain substantially unaltered using the MSCI European Union or the MSCI Monetary Union indices[6]. As shown in Table 3, once that the relevant statistics are adjusted to account for possible cross sectional correlation among abnormal returns (as suggested by Kolari and Pynnönnen, 2010), there are very few CAARs that remain statistically significant at the 10% confidence level or less. More in detail, there is a strong evidence that restrictive measures in the form of liquidity drain or end/reduction of monetary easing programs caused a significant negative reaction in the stock price of European banks, irrespective of the investigated period. It is also worth noticing that liquidity provision

[6] These results are not tabulated for reason of brevity. However they are available from the author upon request.

was accompanied by a negative reaction during the global crisis period and a positive one during the sovereign debt crisis, when also monetary easing programs seemed effective in moving stock prices upward. Four main considerations arise from these findings: first of all, CARs show a large variance, so that there is a strong heterogeneity in market response and it is worth to investigate the determinants of this variety; second, banks' reaction to monetary policy announcements seems to be more relevant for non-conventional measures with respect to traditional interest rate decisions. Third, the reaction to the same type of announcement may be different depending on the considered stage of the financial crisis: e.g., liquidity provision was followed by a negative reaction during the global crisis stage and by a positive one during the debt crisis. One possible explanation is that investors, in the deepest moment of the turmoil, interpreted these measures as a signal of the crisis' severity. After some months, when many banks started to recover from the most problematic situations, investors may have gained more trust in authority's interventions. Finally, it is interesting to notice that prices' reaction is particularly strong in magnitude for contraction measures, confirming that many banks are nowadays viewed as dependent from monetary policy interventions and central banks funding.

<<<INSERT TABLE 3>>>

Table 4 considers the existence of potential international spillover effects. In this case, CAARs are estimated for the sample of large European banks with reference to monetary policy announcements in other relevant currency areas. As for the case of interventions announced by the ECB, the index chosen as representative of the market portfolio is the MSCI Europe. Results remain substantially unaltered using the MSCI European Union or the MSCI Monetary Union indices[7]. Once that results are adjusted to consider the potential cross sectional correlation problem, the only strong evidence is in favor of a positive reaction to expansionary measures announced by the Federal Reserve, for which the CAAR is statistically significant at the 10% confidence level or less in 3 of 4 event windows. This result is not surprising if we consider that the U.S. play a pivotal in the world economy and that it was there the origin of the global financial crisis.

[7] These results are not tabulated for reason of brevity. However they are available from the author upon request.

<<<INSERT TABLE 4>>>

We do not report results for joint announcements of swap agreements among several central banks because, once that we correct for cross sectional correlation, they are never statistically significant at the 10% confidence level or less.

4.2 Results from the regression model

Table 5 reports results from the regression model explaining the CARs registered by large European banks in correspondence of expansionary measures announced by the European Central Bank.

<<<INSERT TABLE 5>>>

First of all, considering that the reference category is the decision to cut interest rates, we can observe that liquidity provision was less effective in restoring investors' trust in banks, while there is some evidence that monetary easing was more effective. This finding is consistent with results from the descriptive univariate analysis of CAARs and could be a signal that investors view monetary easing interventions as especially directed to restore the stability of banks rather than of the whole system. In addition to this, we can notice that expansionary measures were less effective during the global financial crisis period with respect to other stages of the crisis. This was already evident in the univariate analysis. It may be that in this period monetary policy action was not able to restore confidence and trust, with the continuous intervention by authorities probably interpreted as a signal of the crisis' severity. Turning the attention to bank-specific variables, the coefficient for the *DEP_SHARE* variable is always negative and statistically significant (at least at the 10% confidence level in three of four models). This means that banks with a higher portion of customer deposits in their short term funding are less sensitive to expansionary measures, registering a less favorable reaction with respect to their competitors. This is consistent with our first hypothesis, i.e., that less liquid banks are more dependent on ECB interventions for their funding and so have a more positive response to their announcement. The other variable measuring liquidity conditions, INTERBANK, is never statistically significant at the 10% confidence level or less.

Moving to capitalization, we can notice that the coefficient for TIER1 is always negative, even if statistically significant only for one event window. This provide partial support to our second hypothesis, i.e., that more capitalized banks are less sensitive to expansionary monetary policy interventions.

With reference to the variables measuring risk, we can notice that the coefficient for RWA_RATIO is always positive, but it is never statistically significant at the 10% confidence level or less. The coefficient for BANKSYS_RAT is also positive and statistically significant in three of four event windows. This result is consistent with our third hypothesis and is an indication that banks operating in countries where the banking system is perceived as riskier are more dependent on ECB funding and so are more sensitive to expansionary measures. Finally, with reference to our control variables, we can see that abnormal returns are on average higher for more profitable banks (the coefficient for ROAA is positive and statistically significant in three of four event windows), and with a higher ratio between cost and income (the coefficient for COST_INC is positive and statistically significant in two of four event windows). The index chosen as representative of the market portfolio is the MSCI Europe. Results remain substantially unaltered using the MSCI European Union or the MSCI Monetary Union indices[8]. We also try models in which we add some variables to account for the level of asset diversification (between loans and other earning assets) and for the global systemic relevance of some banks in the sample (as stated by the Financial Stability Forum): all findings remain absolutely the same.

Table 6 reports results from the regression model explaining the CARs registered by large European banks in correspondence of policy inaction and restrictive measures announced by the European Central Bank.

<<<INSERT TABLE 6>>>

First of all, considering that the reference category is the decision to raise or leave unchanged interest rates, we can observe that contraction measures (i.e., liquidity drain or the end/reduction of monetary

[8] These results are not tabulated for reason of brevity. However they are available from the author upon request.

easing programs) generate a negative reaction among European banks. This finding is consistent with results from the descriptive univariate analysis of CAARs and could be a signal that investors view these restrictions as a potential problem for the stability of the banking industry. In addition to this, we can notice that the dummies related to several stages of the financial crisis do not give a clear signal, because their coefficients assume different signs and level of statistical significance. With reference to firm-specific variables, we do not find any relevant evidence for indicators related to the liquidity and capitalization profiles. So we do not find empirical support for both hypotheses H1 and H2.

On the other hand, risk variables seem to play a pivotal role: both RWA_RATIO and BANKSYS_RAT show always a negative coefficient, indicating an inverse relationship between the reaction to restrictive measures and the risk perceived by investors. The level of statistical significance is lower than 10% in two event windows of four. The index chosen as representative of the market portfolio is the MSCI Europe. Results remain substantially unaltered using the MSCI European Union or the MSCI Monetary Union indices[9]. We also try models in which we add some variables to account for the level of asset diversification (between loans and other earning assets) and for the globally systemic relevance of some banks in the sample (as stated by the Financial Stability Forum): all findings remain absolutely the same.

5. Research limitations/implications and conclusions

At our knowledge, this is the first paper investigating the reaction of large European banks to both conventional and non-conventional monetary policy announcements, trying also to assess the origin of the heterogeneity in banks' response. The methodology applied consisted of two steps: as a first step, an event study analysis to measure cumulated abnormal returns around the announcements, and a second step regression aimed at identifying the determinants of different responses by several banks.

Our main finding from the event study analysis is that banks were more sensitive to non-conventional measures than to interest rate decisions. This is a indication of the relevance of non-

[9] These results are not tabulated for reason of brevity. However they are available from the author upon request.

standard interventions in a crisis period, when the traditional transmission channels may be seriously compromised. The strongest reaction, with a negative sign, is registered around the announcement of the end/reduction of monetary easing programs and liquidity drains. Another interesting result is that the same type of intervention may have a different impact depending on the stage of the financial crisis. For example, liquidity provision was succeeded by a negative market reaction during the global crisis period, and a positive one during the debt crisis period. It may be that investors, in the deepest moment of the crisis, interpreted these measures as a signal of the crisis' severity. After some months, when many banks started to recover from the most problematic situations, investors may have gained more trust in authority's interventions. Finally, estimating potential spillover effects, we find that large European banks did not answer exclusively to ECB decisions, but also reacted to monetary policy announcements in other relevant currency areas. In particular, they had a positive reaction to the expansionary policy of the U.S. Federal Reserve.

Our main results from the regression analysis outline that banks with weaker balance sheets and operating with high-risk are more sensitive to monetary policy interventions. More in details, banks with a high TIER1 ratio and a large proportion of customers deposit in short-term funding have a smaller reaction to expansionary measures with respect to their less liquid and capitalized competitors. In addition to this, there is evidence that institutions operating in countries where the banking system is perceived as riskier, benefit more from expansionary measures and have a worse response to restrictive interventions. It seems that systemic risk at the country level is one of the most important variable in determining the heterogeneity of banks' response to monetary policy announcements, significant in both the expansionary and the restrictive models, showing that investors are very attentive to the location of the bank in a more or less healthy banking system.

We acknowledge some limitations of our analysis that suggest some interesting directions for future research. First of all, we adopt an event study methodology that has the advantages of simplicity and parsimony, being designed to work also with a limited number of observations and avoiding the problem of possible wrong regression models' specification. The main limitation of this approach is due

to the particular time period analyzed (June 2007 - June 2013), that was characterized by an unprecedented frequency of policy interventions. Using an event study methodology, we have to deal with the problem of overlapping events and set some selection criteria to overcome this problem. Even though we apply these criteria, it is not possible to exclude the presence of some confounding effects. In addition to this, a further limitation of the study is that we cover only monetary policy decisions and do not consider the effect of other policy interventions (e.g., fiscal policy, financial sector policies and rescue programs).

Despite the existence of these limitations, the study provides empirical evidence of the higher dependency on monetary policy decisions for banks with a low level of liquidity and capitalization, located in countries where investors perceive a higher systemic risk. This raises some concerns for the weakest European banks as a consequence of the future unavoidable phasing out, suggesting policy makers a progressive and cautious turning back to a conventional monetary policy.

References

Adrian, T., and Shin, H. S. (2008), Financial intermediaries, financial stability, and monetary policy. Federal Reserve Bank of New York Staff Report No. 346.

Aït-Sahalia, Y., Andritzky, J., Jobst, A., Nowak, S. and Tamirisa N. (2010), Market response to policy initiatives during the global financial crisis, National Bureau of Economic Research. Working paper No. 15809.

Aït-Sahalia, Y., Andritzky, J., Jobst, A., Nowak, S. and Tamirisa N. (2012), Market response to policy initiatives during the global financial crisis, Journal of International Economics 87, 162-177.

Altunbas, Y., Gambacorta, L., and Marqués-Ibáñez, D., (2010), Bank risk and monetary policy, Journal of Financial Stability, 6, 121–129.

Bank for International Settlement (2013), Financial crises and bank funding: Recent experience in the Euro area, BIS Working Papers No 406.

Beirne, J., and Fratzscher, M. (2013), The pricing of sovereign risk and contagion during the European sovereign debt crisis, Journal of International Money and Finance, 34, 60-82.

Bernanke, B.S. and Kuttner, K.N. (2005), What explains the stock market's reaction to Federal Reserve policy? Journal of Finance 60, 1221-1257.

Boehmer, E., Musumeci, J., and Poulsen A.(1991), Event-study methodology under conditions of event-induced variance, Journal of Financial Economics 30, 253-272.

Bomfin, A. N. (2003), Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market, Journal of Banking & Finance 27, 133-151.

Bredin, D., Hyde, S., and O. Reilly, G. (2010), Monetary policy surprises and international bond markets, Journal of International Money and Finance 29, 988-1002.

Brissimis, S.N., and Delis, M.D. (2010), Bank heterogeneity and monetary policy transmission, European Central Bank, Working Paper Series No. 1233.

Brown, S.J. and Warner, J.B. (1985), Using daily stock returns: The case of event studies, Journal of Financial Economics 14, 205-58.

Cecioni, M., Ferrero, G., and Secchi, A. (2011), Unconventional monetary policy in theory and in practice, Bank of Italy, Occasional Paper No. 102.

Chuliá, H., Martens, M., and van Dijk, D. (2010), Asymmetric effects of federal funds target rate changes on S&P100 stock returns, volatilities and correlations, Journal of Banking & Finance 34, 834-839.

Cummins, J.D., and Weiss, M.A. (2004), Consolidation in the European insurance industry. Do mergers and acquisitions create value for shareholders?, Brookings-Wharton Papers on Financial Services, 217-258.

Economist Intelligence Unit (2010), EIU Country Risk Service March, Handbook 2010

European Central Bank (2008), The role of banks in the monetary policy transmission mechanism, Monthly Bulletin, August 2008, 85-98.

European Central Bank (2010), The ECB's response to the financial crisis, Monthly Bulletin, October 2010, 59-74.

European Central Bank (2011), The ECB's non-standard measures –impact and phasing-out, Monthly Bulletin, July 2011, 55-69.

Ehrmann, M. and Fratzscher, M. (2004), Monetary policy transmission to equity markets, Journal of Money, Credit and Banking 36, 719-737.

Gambacorta, L. (2009), Monetary policy and the risk-taking channel, BIS Quarterly Review, December 2009, 43-53.

Grammatikos, T., Lehnert, T., and Otsubo, Y. (2013), Market perceptions of US and European policy actions around the subprime crisis
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2132434

Harrington, S., and Shrider, D. (2007), All events induce variance: Analyzing abnormal returns when effects vary across firms, Journal of Financial and Quantitative Analysis 42, 229-256.

Hausman, J., and Wongswan, J. (2011), Global asset prices and FOMC announcements, Journal of International Money and Finance 30, 547-571.

Jawadi, F., Arouri, M.H., and Nguyen, D.K. (2010), Global financial crisis, liquidity pressure in stock markets and efficiency of central bank interventions, Applied Financial Economics 20, 669-680.

Kolari, J.W., and Pynnönen, S.(2010),Event study testing with cross-sectional correlation of abnormal returns. Review of Financial Studies 23, 3996-4025.

León, Á., and Sebestyén, S. (2012), New measures of monetary policy surprises and jumps in interest rates, Journal of Banking & Finance 36, 2323-2343.

MacKinlay, A.C. (1997), Event studies in economics and finance, Journal of Economic Literature 35, 13-39.

Marqués-Ibáñez, D., and Gambacorta, L. (2011), The new bank lending channel: Evidence from the crisis, Economic Policy, 26, 135-182.

Mentz, M., and Schiereck, D. (2008), Cross-border mergers and the cross-border effect: The case of the automotive supply industry, Review of Managerial Science 2, 199-218.

Mikkelson, W.H.and Partch, M.M.(1988), Withdrawn security offerings, Journal of Financial and Quantitative Analysis 23, 119-133.

Panetta, F., Faeh, T., Grande, G., Ho, C., King, M., Levy, A., Signoretti, F., Taboga, M., and Zaghini, A. (2009), An assessment of financial sector rescue programmes, Bank of Italy, Occasional Paper No. 47.

Rangel, J.G. (2011), Macroeconomic news, announcements, and stock market jump intensity dynamics, Journal of Banking & Finance 35,1263-1276.

Rosa, C. (2011), Words that shake traders. The stock market's reaction to central bank communication in real time, Journal of Empirical Finance 18, 915-934.

Table 1
Monetary policy interventions between June 2007 and June 2013 in 5 currency areas: European Union, Japan, U.K., U.S. and Switzerland

This table lists all monetary policy interventions collected from European Central Bank, Bank of Japan, Bank of England, Federal Reserve and Swiss National Bank over June 2007 – June 2013. The operational classification adopts the following categories: Expansionary measures (EXP_MP), where: IR_CUT denotes interest rate cuts; LIQ+ indicates liquidity provision, in both domestic or foreign currencies; MON_EASE indicates monetary easing interventions; and Policy Inaction and Restrictive Measures (INA_RES) where: IR_UNC/INCR indicates interest rates increased or unchanged; CONTR indicates liquidity drain or end/reduction of monetary easing programs. Subprime crisis denotes the period between 1st June 2007 and 14th September 2008. Global financial crisis denotes the period between 15th September 2008 and 1st May 2010. Sovereign debt crisis denotes the period between 2nd May 2010 and 30th June 2013.

Source of data: Authors' elaboration on European Central Bank, Bank of Japan, Bank of England, Federal Reserve and Swiss National Bank institutional websites; Aït-Sahalia *et al*. (2010, 2012).

PANEL A – SAMPLE DESCRIPTION

	IR_CUT	LIQ+	MON_EASE	EXP_MP	IR_ UNC/ INCR	CONTR	INA_RESTR	TOTAL
Swiss National Bank (CH)	7	7		14	23		23	37
European Central Bank (EUR)	10	36	3	49	42	7	49	98
Bank of Japan (JPN)	3	23	47	73	55		55	128
Bank of England (UK)	9	8	9	26	58	1	59	85
Federal Reserve (US)	10	58	5	73	39	30	69	142
Total single announcements	**39**	**132**	**64**	**235**	**217**	**38**	**255**	**490**
Total joint announcements		**38**						

PANEL B – TIMELINE

	Subprime crisis		Global financial crisis		Sovereign debt crisis	
	EXP_MP	INA_RESTR	EXP_MP	INA_RESTR	EXP_MP	INA_RESTR
Swiss National Bank (CH)	2	5	9	5	3	13
European Central Bank (EUR)	11	10	18	12	20	27
Bank of Japan (JPN)		17	22	15	51	23
Bank of England (UK)	5	13	18	10	3	36
Federal Reserve (US)	19	4	53	17	1	48
Single Announcements	**37**	**49**	**120**	**59**	**78**	**147**
Joint Announcements	**5**		**21**		**12**	

Table 2 – Sample of selected European banks

This table reports the list of investigated banks, selected on the basis of the following criteria: 1) the bank is based in a country of the European Monetary Union; 2) the bank was subject to the 2011 EU-wide stress test or to the 2012 EU capital exercise conducted by the European Banking Authority; 3) the bank is listed on a stock exchange; 4) the bank hasn't been liquidated, nationalized or declared insolvent (i.e., we drop Dexia from the sample); 5) the bank is not located in a country joining the Euro over the financial crisis period (i.e., we drop Cipro, Malta and Slovenia from the sample).

Source of data: Authors' elaboration on European Banking Authority (2011, 2012)

N.	Bank name	Country
1	Agricultural Bank of Greece	Greece
2	Allied Irish Banks PLC	Ireland
3	Alpha Bank AE	Greece
4	Banca Civica SA	Spain
5	Banca Monte dei Paschi di Siena SpA	Italy
6	Banco Bilbao Vizcaya Argentaria SA	Spain
7	Banco BPI SA	Portugal
8	Banco Comercial Portugues SA	Portugal
9	Banco de Sabadell SA	Spain
10	Banco Espirito Santo SA	Portugal
11	Banco Popolare SC	Italy
12	Banco Popular Espanol SA	Spain
13	Banco Santander SA	Spain
14	Bank of Ireland	Ireland
15	Bankinter SA	Spain
16	BNP Paribas SA	France
17	Commerzbank AG	Germany
18	Credit Agricole SA	France
19	Deutsche Bank AG	Germany
20	Erste Group Bank AG	Austria
21	Eurobank Ergasias SA	Greece
22	Hypo Real Estate Holding AG	Germany
23	Intesa Sanpaolo SpA	Italy
24	KBC Groep NV	Belgium
25	National Bank of Greece SA	Greece
26	Oesterreichische Volksbanken AG	Austria
27	Permanent TSB Group Holdings PLC	Ireland
28	Piraeus Bank SA	Greece
29	Societe Generale SA	France
30	TT Hellenic Postbank SA	Greece
31	UniCredit SpA	Italy
32	Unione di Banche Italiane SCPA	Italy

Table 3 – European bank's reaction to ECB monetary policy announcements

This table reports the descriptive statistics of Cumulated Abnormal Returns estimated over various event windows for 98 monetary policy interventions from the European Central Bank (ECB) over June, 2007 – June, 2013. The impact of the 98 announcements is estimated for the stock prices of all banks listed in Table 2 resulting in 2,876 total observations. Daily Abnormal Returns are obtained using the market model with a 252-day estimation period. The market portfolio is represented by the MSCI Europe Index. The statistical significance of Cumulated Average Abnormal Returns (CAAR) is tested using the Boehmer et al. (1991) procedure to capture the event-induced increase in returns volatility. CAARs in bold are those that remain statistically significant also with the adjustment suggested in Kolari and Pynnönen (2010) in order to account for possible cross sectional correlation of abnormal returns. IR_CUT indicates interest rate cuts; IR_UNC/INCR indicates interest rates increased or unchanged; MON_EASE indicates monetary easing intervention; LIQ+ indicates liquidity provision, in both domestic or foreign currencies; CONTR indicates liquidity drain or end/reduction in monetary easing programs. Subprime crisis: 1st June 2007 – 14th September 2008. Global financial crisis: 15th September 2008 – 1st May 2010. Sovereign debt crisis: 2nd May 2010 – 30th June 2013. ***,**,* denote that estimates are statistically significant at the 1, 5 and 10% levels.

Source: Authors' elaboration on European Central Bank, Bank of Japan, Bank of England, Federal Reserve and Swiss National Bank institutional websites; Aït-Sahalia et al. (2010, 2012). Source of financial data: Datastream

All sample period	**IR_CUT**	**286 obs**	**LIQ+**	**1070 obs**	**MON_EASE**	**84 obs**	**IR_UNC/INCR**	**1235 obs**	**CONTR**	**201 obs**
	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat
CAR(-1,3)	-0.0118***	-3.0104	-0.0038**	-2.3630	0.0157	1.4346	0.0031*	1.7906	**-0.026*** **	-5.8440
CAR(-1,1)	0.0046	0.8784	-0.0034	-1.4982	0.0234***	3.7931	0.0055***	3.5106	**-0.027*** **	-5.3265
CAR(0,1)	0.0081***	2.5773	-0.0039	-0.8355	0.0099*	1.7623	0.0026**	2.0425	**-0.0147*** **	-4.4373
CAR(0,0)	0.0025*	1.9352	-0.0031**	-2.1756	0.0104***	2.9252	0.0011	1.4903	**-0.0088*** **	-5.1430
Subprime crisis	**IR_CUT**	**0 obs**	**LIQ+**	**332 obs**	**MON_EASE**	**0 obs**	**IR_UNC/INCR**	**301 obs**	**CONTR**	**0 obs**
	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat
CAR(-1,3)	-	-	0.03%	-1.0723	-	-	-0.04%	-0.4058	-	-
CAR(-1,1)	-	-	0.29%	0.2459	-	-	0.25%	1.1394	-	-
CAR(0,1)	-	-	0.36%	1.0811	-	-	0.02%	0.0668	-	-
CAR(0,0)	-	-	0.38%**	2.4974	-	-	0.15%	1.0456	-	-
Global Crisis	**IR_CUT**	**204 obs**	**LIQ+**	**302 obs**	**MON_EASE**	**30 obs**	**IR_UNC/INCR**	**273 obs**	**CONTR**	**89 obs**
	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat
CAR(-1,3)	-0.0111**	-2.0274	**-0.0276*** **	-5.2277	0.0098	0.0125	-0.0021	-0.7394	-0.0276***	-2.8876
CAR(-1,1)	0.0063	1.4520	**-0.0257*** **	-5.2593	0.0037	-0.4246	0.0069	1.0259	-0.0262**	-2.5187
CAR(0,1)	0.0112***	2.9037	**-0.0238*** **	-5.6193	0.0007	-0.2602	0.0082***	2.6879	-0.008	-1.4941
CAR(0,0)	0.0007*	1.8631	**-0.0178*** **	-5.6364	-0.0071	-1.5694	0.0034	1.0630	-0.0132***	-3.7979
Sovereign Debt Crisis	**IR_CUT**	**82 obs**	**LIQ+**	**436 obs**	**MON_EASE**	**54 obs**	**IR_UNC/INCR**	**661 obs**	**CONTR**	**112 obs**
	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat	CAAR	Z-stat
CAR(-1,3)	-0.0134***	-2.9644	0.0096***	3.6261	0.019	1.5360	0.0068***	3.3952	-0.0248***	-6.0785
CAR(-1,1)	0.0004	-1.3792	**0.0073*** **	4.6098	**0.0343*** **	4.4619	0.0062***	3.3535	**-0.0276*** **	-6.7392
CAR(0,1)	0.0004	-0.5296	0.0041**	1.9746	0.015**	1.9768	0.0013	1.2597	**-0.02*** **	-6.2774
CAR(0,0)	0.0072	0.5815	0.0019*	1.6529	0.0202***	3.4876	0.0001	0.6476	**-0.0053*** **	-3.5329

Table 4 – International spillover effects

This table reports the descriptive statistics of Cumulated Abnormal Returns estimated over various event windows for, respectively, 37, 128, 85 and 142 monetary policy interventions from the Swiss National Bank, the Bank of Japan, the Bank of England and the Federal Reserve over June, 2007 – June, 2013. The impact of these announcements is estimated for the stock prices of all banks listed in Table 2 resulting in 11,528 total observations. Daily Abnormal Returns are obtained using the market model with a 252-day estimation period. The market portfolio is represented by the MSCI Europe Index. The statistical significance of Cumulated Average Abnormal Returns (CAAR) is tested using the Boehmer et al. (1991) procedure to capture the event-induced increase in returns volatility. CAARs in bold are those that remain statistically significant also with the adjustment suggested in Kolari and Pynnönen (2010) in order to account for possible cross sectional correlation of abnormal returns. EXP_MP indicates expansionary monetary policy measures and INA_RESTR monetary policy inaction or restrictive measures. Subprime crisis: 1st June 2007 – 14th September 2008. Global financial crisis: 15th September 2008 – 1st May 2010. Sovereign debt crisis: 2nd May 2010 – 30th June 2013. ***,**,* denote that estimates are statistically significant at the 1, 5 and 10% levels.

Source: Authors' elaboration on European Central Bank, Bank of Japan, Bank of England, Federal Reserve and Swiss National Bank institutional websites; Aït-Sahalia et al. (2010, 2012). Source of financial data: Datastream

CHE	**EXP_MP**	415 obs	**INA_RESTR**	674 obs
CAR(-1,3)	-0.0035	-1.4688	-0.0043**	-2.1551
CAR(-1,1)	0.0033	0.8197	0.0011	0.3255
CAR(0,1)	0.0075***	2.7355	0.003**	2.2247
CAR(0,0)	0.0038***	2.7913	0.0003	-0.7658

JPN	**EXP_MP**	2,119 obs	**INA_RESTR**	1,621 obs
CAR(-1,3)	0.0033**	2.3237	0.0046*	1.7168
CAR(-1,1)	0.0012	1.0306	0.0001	-0.6262
CAR(0,1)	0.0006	0.6748	-0.0001	-0.4107
CAR(0,0)	0.0033***	4.8572	0.0015**	2.1323

UK	**EXP_MP**	766 obs	**INA_RESTR**	1,731 obs
CAR(-1,3)	0.0071	1.2920	0.0057***	3.9764
CAR(-1,1)	0.0048*	1.8524	**0.0065*** **	5.3279
CAR(0,1)	0.0018	1.0366	0.0029***	2.6181
CAR(0,0)	0.0013**	2.4848	0.0025***	3.2977

US	**EXP_MP**	2,182 obs	**INA_RESTR**	2,020 obs
CAR(-1,3)	**0.0096*** **	4.6787	0.0003	-0.7217
CAR(-1,1)	0.0044***	3.3942	-0.0003	-0.6638
CAR(0,1)	**0.0042*** **	4.7690	0.003	1.2162
CAR(0,0)	**0.0024*** **	5.0185	0.0011**	2.4575

Table 5 – European bank's reaction to ECB expansionary measures

This table reports empirical results by running an OLS regression over Cumulated Abnormal Returns calculated over various event windows for expansionary policy interventions announced over June, 2007 – June, 2013. Robust standard errors are in parentheses. ***,**,* denote that estimates are statistically significant at the 1, 5 and 10% levels.

LIQ+ is a dummy indicating liquidity provision interventions; MON_EASE is a dummy indicating monetary easing interventions; SUBPRIME is a dummy indicating the subprime crisis period (1st June 2007 – 14th September 2008); GLOBAL is a dummy indicating the global crisis period (15th September 2008 – 1st May 2010); INTERBANK is the ratio between due from banks and loans from banks; DEP_SHARE is the proportion of customers deposit in total short term funding; TIER1 is the ratio between primary regulatory capital and risk weighted assets; RWA_RATIO is the ratio between risk weighted assets and total assets; BANKSYS_RAT is the numeric transformation of the rating issued from the Economic Intelligence Unit for the country banking system; ROOA is the return on average assets; COST_INC is the cost to income ratio.

	(1)	(2)	(3)	(4)
	CAR(0;0)	CAR(-1;0)	CAR(-1;+1)	CAR(-1;+3)
LIQ+	-0.00683***	-0.01178***	-0.00886*	0.00582
	(0.00250)	(0.00384)	(0.00466)	(0.00576)
MON_EASE	-0.00304	-0.00629	0.00594	0.01875**
	(0.00350)	(0.00585)	(0.00700)	(0.00889)
SUBPRIME	0.00276	0.00485	-0.00155	-0.00182
	(0.00269)	(0.00420)	(0.00491)	(0.00653)
GLOBAL	-0.01133***	-0.01258***	-0.01705***	-0.01997***
	(0.00250)	(0.00407)	(0.00468)	(0.00584)
INTERBANK	0.00062	0.00077	0.00071	0.00125
	(0.00050)	(0.00083)	(0.00091)	(0.00145)
DEP_SHARE	-0.00835	-0.02432**	-0.03080***	-0.03010**
	(0.00526)	(0.01178)	(0.01068)	(0.01321)
TIER1	-0.00095**	-0.00067	-0.00053	-0.00076
	(0.00046)	(0.00079)	(0.00089)	(0.00117)
RWA_RATIO	0.00000	0.00014	0.00010	0.00002
	(0.00005)	(0.00011)	(0.00010)	(0.00013)
BANKSYS_RAT	0.00306**	0.00436**	0.00459*	0.00416
	(0.00140)	(0.00219)	(0.00261)	(0.00326)
ROAA	0.00275***	0.00399*	0.00390**	0.00158
	(0.00084)	(0.00214)	(0.00188)	(0.00316)
COST_INC	0.00006**	0.00036	0.00016**	0.00003
	(0.00002)	(0.00025)	(0.00008)	(0.00009)
Constant	0.00641	-0.01200	0.00736	0.00618
	(0.00767)	(0.01679)	(0.01486)	(0.01831)
Observations	1,275	1,275	1,275	1,275
R-squared	0.04006	0.05381	0.03725	0.03105

Table 6 – European bank's reaction to ECB restrictive measures

This table reports empirical results by running an OLS regression over Cumulated Abnormal Returns calculated over various event windows for policy inaction and restrictive interventions announced over June, 2007 – June, 2013. Robust standard errors are in parentheses. ***,**,* denote that estimates are statistically significant at the 1, 5 and 10% levels.

CONTR indicates liquidity drain or end/reduction in monetary easing programs; SUBPRIME is a dummy indicating the subprime crisis period (1st June 2007 – 14th September 2008); GLOBAL is a dummy indicating the global crisis period (15th September 2008 – 1st May 2010); INTERBANK is the ratio between due from banks and loans from banks; DEP_SHARE is the proportion of customers deposit in total short term funding; TIER1 is the ratio between primary regulatory capital and risk weighted assets; RWA_RATIO is the ratio between risk weighted assets and total assets; BANKSYS_RAT is the numeric transformation of the rating issued from the Economic Intelligence Unit for the country banking system; ROOA is the return on average assets; COST_INC is the cost to income ratio.

	(1)	(2)	(3)	(4)
	CAR(0;0)	CAR(-1;0)	CAR(-1;+1)	CAR(-1;+3)
CONTR	-0.00975***	-0.01556***	-0.02209***	-0.02831***
	(0.00186)	(0.00292)	(0.00388)	(0.00494)
SUBPRIME	0.00402*	0.00110	-0.00604	-0.01335**
	(0.00211)	(0.00343)	(0.00500)	(0.00607)
GLOBAL	-0.00050	0.00503*	-0.00219	-0.00862*
	(0.00174)	(0.00266)	(0.00396)	(0.00490)
INTERBANK	0.00026	-0.00122	-0.00153	-0.00016
	(0.00046)	(0.00093)	(0.00114)	(0.00146)
DEP_SHARE	-0.00495	-0.00429	-0.00917	-0.00788
	(0.00373)	(0.00613)	(0.00900)	(0.01233)
TIER1	0.00038	0.00078	0.00046	0.00003
	(0.00028)	(0.00060)	(0.00087)	(0.00117)
RWA_RATIO	-0.00006	-0.00013**	-0.00021**	-0.00006
	(0.00004)	(0.00006)	(0.00008)	(0.00011)
BANKSYS_RAT	0.00141	-0.00068	-0.00443*	-0.00609**
	(0.00098)	(0.00173)	(0.00261)	(0.00304)
ROAA	0.00042	0.00011	0.00068	-0.00081
	(0.00066)	(0.00153)	(0.00201)	(0.00210)
COST_INC	0.00002	0.00004	0.00004	0.00004
	(0.00001)	(0.00003)	(0.00004)	(0.00006)
Constant	-0.00388	0.00423	0.03340**	0.03657**
	(0.00547)	(0.00920)	(0.01342)	(0.01720)
Observations	1,285	1,285	1,285	1,285
R-squared	0.03272	0.03639	0.04827	0.04336