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ECB Unconventional Monetary Policy: Market Impact and International Spillovers

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This paper assesses the financial market impact of ECB unconventional monetary policy between 2007 and 2012. The paper looks at a broad range of asset prices and portfolio flows in the euro area and globally, using data at daily frequency. It finds that ECB policies boosted equity prices and lowered bond market fragmentation in the euro area. Spillovers to advanced economies and emerging markets included a positive impact on equity markets and confidence. The effects of ECB policies on bond markets outside the euro area were negligible. ECB policies also lowered credit risk among banks and sovereigns in the euro area and other G20 countries, while there is limited evidence of portfolio rebalancing across regions and assets on impact. [JEL E52, E58, F32, F34, G15]
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The domestic effectiveness of unconventional monetary policies and their international spillovers to global asset prices and capital flows have dominated policy discussions over recent years.[1] On the one hand, policymakers in emerging markets emphasize that unconventional monetary policy could have destabilizing international spillovers by leading to volatility swings in capital flows

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[1]See for example R. Rajan, "Global Monetary Policy: A View from Emerging Markets," Brookings Institution, April 10, 2014.

and asset prices. Therefore, they call for more policy coordination and cooperation across the globe. On the other hand, policymakers in advanced economies argue that, while there are indeed risks associated with unconventional monetary policies, they are effective from the domestic point of view and help the economic recovery. In doing so, unconventional monetary policies ultimately have overall positive spillovers to the global economy. Furthermore, it has been argued that market volatility and in particular "risk on" and "risk off" modes in global markets are often determined by exogenous events which are not under the direct influence of central banks.[2] In this context, policymakers in emerging markets should focus on adopting appropriate domestic policies which would preserve monetary independence, smooth the spillovers of third countries' policies, and preserve macrofinancial stability.

This empirical study analyzes and quantifies the financial market impact of the most important ECB's nonstandard policy measures since the start of the global financial crisis and until September 2012.[3] In line with the bipolarization of the debate, we differentiate between the spillovers to emerging markets and to other advanced economies. Following a related paper on the spillovers of U.S. unconventional monetary policy (Fratzscher, Lo Duca, and Straub, 2013), we differentiate between the impact of announcements of policies and the impact of their actual implementation thereafter.

More specifically, we look at the impact of ECB policies on equity and exchange rate returns, changes in yields, changes in risk measures and capital flows across countries in a panel model over the period May 2007 to September 2012, using daily data. We control for a large number of shocks including, among other things, macroeconomic data releases, sovereign bond auctions in troubled euro area countries, and U.S. monetary policy announcements. Our modeling strategy combines an event study methodology (that is, using impulse dummies) to capture the announcement effects of policies with an approach that measures the impact of ECB long-term loans to banks (focusing on Supplementary Long Term Refinancing Operations, SLTROs) and Securities Markets Programme (SMP) bond purchases.

Generally, endogeneity concerns (that is, policies reacting to market developments) complicate the measurement of the effects of policies. In this paper we make attempts to alleviate endogeneity concerns in several ways. Using daily data allows for a more precise identification of the effects of unconventional monetary policy on financial variables (Rogers, Scotti, and Wright, 2014, among several others), under the assumptions that policy actions are the main shocks driving markets during the daily window while, at the same time, policies are decided by looking at the broader picture and not at specific developments in one day. For identifying the effects of policy announcements, we further ensure that they were perceived as key drivers of markets and they contained an element of surprise for market participants. We do so by selecting key announcements to analyze on

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[2]B. Bernanke, "Challenges of the Global Financial System: Risks and Governance under Evolving Globalization," Tokyo, October 14, 2012.

[3]Other recent articles focus on the impact of the ECB Extended Asset Purchase Programme (see, for example, Altavilla, Carboni, and Motto, 2015).

the basis of the press coverage. For liquidity providing operations (SLTROs), we assume that changes in daily market conditions in the proximity of an SLTRO auction have no impact on the demand for long-term liquidity at horizons longer than six months which is determined by other factors that operate at lower than daily frequency. To substantiate this view, in the robustness section we show that daily changes in equity prices and yields (our key dependent variables) do not predict variables associated with banks liquidity demand and do not exhibit systematic patterns when interbank tensions are high (as measured by money market spreads). Finally, for the SMP, we propose an approach that relies on publicly available data and uses deviations from an estimated reaction function to identify the impact of purchases. This approach is designed to reduce the endogeneity bias that emerges when the ECB SMP daily purchases depend on the deterioration of market conditions.

Our paper relates to a number of strands of the empirical literature studying the impact of central banks' unconventional policies on financial markets, using ("high frequency") daily data. First, it relates to empirical papers quantifying the impact of policies on domestic asset prices. In this field, the literature has predominately looked at the impact of QE on U.S. domestic financial markets (D'Amico and King, 2011; Gagnon and others, 2011; Joyce and others, 2011; Wright, 2012 for the United Kingdom; Hancock and Passmore, 2011; Rosa, 2012; Stroebel and Taylor, 2012; Gilchrist and Zakrajsek, 2013; Hattori, Shrimpf, and Sushko, 2013). In this context, our paper is the first one to offer a comprehensive assessment of the impact of ECB policies on asset prices across the euro area "core" and "periphery," going beyond announcement effects. In addition, our paper presents an approach that uses publicly available data to identify the effects of the SMP by addressing the endogeneity bias that emerges when the ECB purchases bonds in response to a deterioration of market conditions. Therefore, our paper links to studies attempting to identify the effects of the SMP (Eser and Schwaab, 2012; Ghysels and others, 2014) and proposes an alternative approach. Second, our paper relates to empirical studies analyzing the spillovers of central bank policies to global asset prices and capital flows (Neely, 2010; Chen and others, 2012; Gambacorta, Hofmann, and Peersman, 2012; Leduc and Glick, 2012; Fratzscher, Lo Duca, and Straub, 2013; Bowman, Londono, and Sapriza, 2014; Chen and others, 2014; Gilchrist, Yue, and Zakrajsek, 2014; Lim, Mohapatra, and Stocker, 2014; Lo Duca, Nicoletti, and Vidal, 2016; McCauley, McGuire, and Sushko, 2014; Rogers, Scotti, and Wright, 2014). Our paper also relates to the recent literature on the relation between the global financial cycle and monetary policy in advanced economies (Rey, 2013; Miranda-Agrippino and Rey, 2014; Obstfeld, 2014). In this context, to our knowledge, our paper is the only one looking at the global impact of ECB policies. Finally, by looking at a wide set of variables, including portfolio flows and risk measures, this study contributes to the literature that analyzes how unconventional monetary policies are transmitted to global markets (Krishnamurthy and Vissing-Jorgensen, 2011; Christensen and Rudebusch, 2012; Bauer and Neely, 2014; Bauer and Rudebusch, 2014).

The main findings of this study are as follows. Although ECB policies mainly affected financial markets in the euro area, they also had positive spillovers to

global markets by increasing equity prices and lowering risk aversion and credit risk. Liquidity injections via Supplementary LTROs (with maturity from 6 to 36 months), the announcement of Outright Monetary Transactions (OMT) and the SMP (both announcements and operations) positively affected equity prices (both broad equity indices and banking indices) in the "core" and the "periphery" of the euro area, while they decreased bond yields in the "periphery." The OMT announcement and the SMP (both announcements and operations) had also positive spillovers to equity prices worldwide (both broad equity indices and banking indices), while the overall effect of policies on international yields was negligible. The euro slightly depreciated in response to the ECB's unconventional measures, with the exception of the OMT announcement which led the euro to appreciate slightly. Unconventional monetary policies in the euro area affected global markets mainly through a rise in confidence/ decrease in risk aversion (as measured by a decrease in option implied equity market volatilities). They also led to a reduction of sovereign risk in euro area and other G20 countries and to a decrease in bank credit risk for euro area banks and Global Systemically Important Banks (G-SIBs). The effect of policies on risk perceptions partially explains the larger worldwide impact of policies on riskier assets such as equity prices than safer assets such as bonds.

Interestingly, we find that the response of international portfolio flows to ECB policies was small. This suggests that the price impact on ECB policies reflected mainly domestic investors' decisions. This is in contrast with Federal Reserve's unconventional policies that led to large portfolio rebalancing across assets and countries (Fratzscher, Lo Duca, and Straub, 2013; Lim, Mohapatra, and Stocker, 2014).

The above results document that ECB policies had beneficial effects on international financial markets in the short term by lifting global asset prices and by lowering the global price of risks in periods of elevated uncertainty. Assessing the longer term implications of policies for the pricing of financial assets requires different modeling strategies that would take the findings of this paper as a starting point and is left for future research. It is also beyond the scope of this study to shed light on the macroeconomic effects of ECB policies.[4]

The article is organized as follows. Section I briefly reviews the nonstandard monetary policy measures adopted by the ECB that are covered in the empirical analysis and the potential channels of transmission to financial markets; Section II describes the data and the empirical approach; Section III presents and discusses the empirical findings; Section IV discusses a number of robustness tests; Section V concludes.

I. ECB Nonstandard Monetary Policy Measures

This section provides an overview of the different unconventional policy instruments used by the ECB and highlights potential channels of transmission of policies to asset markets.

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[4]Altavilla, Giannone, and Lenza (2014) analyze the financial and macroeconomic implications of the ECB announcement of "Outright Monetary Transactions."

ECB Unconventional Policies

The reversal of the housing boom in the United States and the collapse of the U.S. subprime mortgage market resulted in a crisis of a global dimension in 2008. In the euro area, the economic and financial collapse escalated into a banking and sovereign crisis in 2010. At that time, markets started questioning the solvency of countries with large fiscal deficits and high debt, and a feedback loop between banking and sovereign credit risk started.

Since the initial market strains began in 2007 and in response to the escalation of the crisis, major central banks entered into unchartered territory by adopting unconventional monetary policy actions in line with their operational frameworks and mandates. Fawley and Neely (2013) provide a detailed overview of unconventional policies of major central banks, including the ECB. We sketch below the main policy actions adopted by the ECB between 2007 and 2012 that are the focus of this paper,[5] namely long-term liquidity provision (SLTROs), the SMP, and the OMT.

Supplementary Long-Term Refinancing Operations (SLTROs), with maturity between six months and one year and "Very" Long Term Refinancing Operations (VLTROs), with maturity of three years.[6] To address the illiquidity in euro area money markets, and in particular tight financing conditions at long maturities, the ECB changed the maturity structure of its liquidity-providing operations by providing collateralized loans over longer than usual time horizons. In addition to its regular and supplementary three-month long-term refinancing operations (LTROs/SLTROs), the ECB introduced six-month SLTROs in March 2008 and 12-month SLTROs in May 2009. Six-month operations in the ECB balance sheet peaked at around 160 euro billions in March 2009, while 12-month operations peaked at around 660 euro billions between late 2009 and early 2010. In December 2011, as the sovereign crisis intensified, the ECB announced two "very" long-term refinancing operations (VLTROs) with three-year maturity. In these two VLTROs, the ECB allotted around 1,019 euro billions in total.[7,8]

Securities Markets Programme (SMP). On May 10, 2010, in order to address tensions in certain market segments that hampered the monetary policy transmission mechanism, the ECB announced direct purchases of government bonds in

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[5]We do not analyze the impact of swap lines between major central banks and the ECB covered bond program. The latter was relatively small in size compared with other unconventional monetary policy actions and targeted a specific market segment.

[6]The ECB did not officially use the name Very Long Term Refinancing Operations or VLTROs.

[7]See Figure 1 for the evolution of the balance sheet of the ECB.

[8]It is worth noting also the following technical details: first, all the SLTROs and VLTROs were preannounced by the ECB who communicated to markets precise schedules for operations. Second, initially, auctions took place for preset amounts at variable rate tenders where banks bid both the amount of money and the interest rate. In these auctions, the ECB would satisfy the demand of liquidity starting from the highest offered interest rate until exhaustion of the preset amount of loans available for auction. However, in October 2008, as the crisis intensified, the ECB moved to a framework where it agreed to satisfy all the liquidity demanded by banks ("full allotment") against collateral. Also, the variable rate tenders were abandoned and the cost of liquidity was linked to the average main refinancing rate (the discount rate) of the ECB over the life of loans.

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Figure 1. ECB Balance Sheet *(euro trillions)*
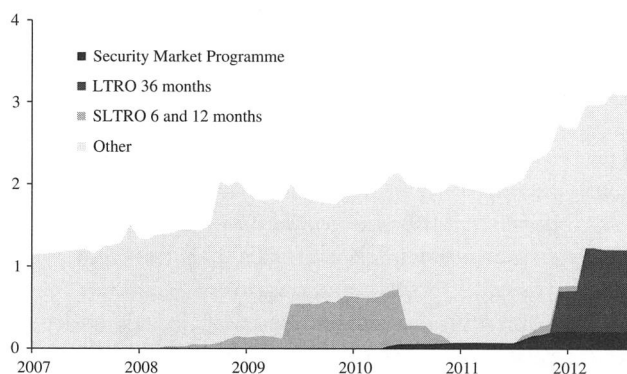
secondary markets under the SMP.[9] Initially, starting from May 2010, purchases were limited to Greek, Portuguese, and Irish Government bonds. In a second round of purchases that started in August 2011, the ECB extended the SMP to Italian and Spanish Government bonds. As market conditions improved during early 2012, the ECB stopped purchasing bonds. In February 2012, as a result of SMP purchases, the ECB held around 220 euro billions of sovereign bonds of countries experiencing financial stress. In September 2012, the SMP was officially discontinued with the introduction of the OMT.

Under the SMP, the ECB intervened by purchasing government bonds potentially on a daily basis, without any predetermined public target in terms of price or quantity. Although the end of the program was officially communicated in September 2012, there were periods when the program was simply "dormant" while potentially active.[10]

Outright Monetary Transactions (OMTs). In September 2012, in order to repair the monetary policy transmission mechanism by containing redenomination risk due to fears of a euro area break up and to avoid self-fulfilling bad equilibria, the ECB announced the introduction of a new policy instrument, the OMT. The latter consists of the possibility of purchases of government bonds (up to the three-year maturity bucket and without any "ex ante" limitation in terms of quantities) issued by countries under a European Stability Mechanism (ESM) macroeconomic adjustment program or a precautionary program ("Enhanced Conditions Credit Line"). The latter conditions addressed concerns regarding the distorted incentives for governments to adopt sound policies that were present with the SMP. The OMT announcement was sufficient to calm markets. At the time of writing, the OMT was never activated, while a round of asset purchases, the Extended Asset Purchase Programme (EAPP), was implemented by the ECB in 2015. The latter, however, is not analyzed in this article (Figure 1).

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[9]The liquidity created by bond purchases under the SMP was sterilized by the ECB via weekly liquidity absorbing operations.

[10]For example, after the initial activation in mid-2010, the SMP became "dormant" in the first half of 2011 until it was reactivated in August 2011.

Channels of Transmission and International Repercussions

The literature proposes different ways of classifying the potential transmission channels of unconventional monetary policy. Krishnamurthy and Vissing-Jorgensen (2011) test for a number of channels of transmission of QE to U.S. financial markets. These channels include duration risk, liquidity risk, the safety premium, default risk and mortgage prepayment risk, a signaling[11] and an inflation channel. Krishnamurthy and Vissing-Jorgensen find that U.S. QE was transmitted to asset prices via the signaling channel and via a reduction of the safety premium. Other papers (Christensen and Rudebusch, 2012; Bauer and Rudebusch, 2014; Bauer and Neely, 2014) focus on disentangling the role of the signaling and the term premiums (portfolio balance) channels in transmitting QE to U.S. yields, although the results are not clear cut and crucially depend on the used methodology.[12]

Channels are not mutually exclusive and can work in parallel. As a consequence, they can be difficult to identify. Regarding ECB policies, we focus our attention on a number of channels that are important in relation to the goals of the analyzed ECB policies.[13]

- *Confidence channel.* By taking decisive actions, central banks might help restoring confidence in the financial system. As a consequence, risk premiums and uncertainty might decline, with a positive effect on asset prices.
- *Bank credit risk channel.* As described above, while ECB policies aimed at addressing bank liquidity concerns, they might have had an impact on bank credit risk due to the interaction between liquidity and credit risk. Lower credit risk in the banking sector might boost asset prices by decreasing risk premiums overall.
- *Sovereign credit risk channel.* The intermediate goal of two ECB policies, the SMP and OMT, was to repair the transmission mechanism of monetary policy by containing sovereign risk premiums that were considered excessive. In other words, ECB policies indirectly affected sovereign credit risk, in particular the part of it that was not in line with fundamentals and reflected panic or unfounded fears of euro area break up, and thereby impairing the transmission mechanism of monetary policy.

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[11]According to Eggertsson and Woodford (2003) central banks' large-scale asset holdings serve as a credible commitment to keep interest rates low. Therefore, by introducing the LSAP, the Federal Reserve led to expectations of low rates for long (signaling channel).

[12]Joyce and others (2011) also discuss a number of potential transmission channels.

[13]A cross-country investigation of the signaling channel would indeed offer valuable insights on how ECB policies were transmitted across countries. However, the latter analysis would entail particular challenges that go beyond the scope of this paper. The analysis would require estimating a term structure model to extract the expected path of the short-term rate for each of the more than 30 individual countries in the sample. Data limitations and modeling uncertainty would complicate the analysis. To our knowledge, from the literature it emerges that the importance of the signaling channel is model dependent (Bauer and Rudebusch, 2014; Bauer and Neely, 2014). Against the background of the impact of the modeling strategy on the results, a credible analysis of the signaling channel would call for the adoption of different term structure models. We feel that this goes beyond the scope of our paper.

● *International portfolio balance channel.* The portfolio balance is a potential channel of transmission of asset purchases to asset prices across market segments and countries (Bernanke, 2009, among many others). As investors are crowded out from some market segments by central bank purchases, they move to close substitute assets, leading to portfolio rebalancing and to a chain of price effects. More broadly, unconventional monetary policy actions by affecting risk premiums and yields of key benchmark assets (in particular, government bonds) induce investors to rebalance their portfolios, ultimately having additional price effects on a broad range of assets.

In the empirical part of the paper, in addition to testing the impact of ECB policies on equity prices, bond yields, and exchange rates, we also test the impact of policies on a number of variables that might be associated with the above transmission channels. In particular, we look at implied volatilities (confidence channel), banks CDS spreads (bank credit risk), Government CDS spreads (sovereign credit risk), and portfolio flows (portfolio balance channel).

II. Empirical Methodology and Data

In this section, we discuss the empirical strategy that we employ for assessing the impact of ECB policies on a range of variables. We start the section by outlining the data set, in particular the fund-level data on portfolio flows that will be used to test the international portfolio balance channel.

Data

The time period covered in our data set ranges from 1 May 2007 to 30 September 2012. We cover a set of 38 advanced and emerging economies (see Table A1 in the online annex). Countries are clustered in regional groups. Within the euro area, we separate between a group of highly rated euro area countries (Austria, Finland, Germany, and the Netherlands) and large systemic countries experiencing sovereign tensions (Italy and Spain).[14] In line with the bipolarization of the debate over the global spillovers of unconventional monetary policies, we split the remaining countries into emerging and advanced economies, further separating emerging EU countries from other emerging markets.

Summary statistics and other information for the key data used in this study are displayed in Tables 1 and 2. Daily data on equity prices, interest rates, yields, exchange rates, CDS spreads, and implied volatilities were collected via Datastream; the source for data on macroeconomic releases and expectations is Bloomberg; data on the ECB balance sheet, including SMP purchases (at weekly frequency) and long-term refinancing operations were collected directly from the

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[14]In the EA core, we include countries whose AAA credit rating was never questioned in the period under review (Austria, Finland, Germany, and Netherlands). In the EA periphery, we include countries where re-pricing of sovereign risk took place but we exclude countries that lost market access as bond pricing signals for the latter group of countries might be distorted. This is the reason why we include only Italy and Spain in the EA periphery. However, including Ireland, Portugal, and Greece does not have strong implications on the results of the paper.

Table 1. Summary Statistics for the Dependent Variables (Sample period 5/1/2007 – 9/30/2012, daily data)

Variable	Unit	Source	Country Group	Units (countries)	Observations	Mean	Std Dev	Minimum	Maximum
10-Year Sovereign Yield	difference in p.p.	Datastream	Advanced Economies	10	13,945	-0.0018	0.0553	-0.7260	0.6240
			Emerging Markets (EU)	4	5,592	-0.0004	0.1230	-1.0350	0.9810
			Emerging Markets (ex EU)	18	23,754	-0.0014	0.1363	-2.9980	3.1300
			Euro area—Core	4	5,575	-0.0018	0.0560	-0.6580	0.6130
			Euro area—Periphery	2	2,823	0.0009	0.0839	-1.0560	0.5790
Bank Equity Index	return in % (that is, log difference * 100)	Datastream	Advanced Economies	10	13,343	-0.0470	2.4123	-21.6783	25.4870
			Emerging Markets (EU)	4	5,652	-0.0572	2.6811	-29.3593	20.9158
			Emerging Markets (ex EU)	18	24,021	0.0148	1.8922	-25.6807	31.5882
			Euro area—Core	4	5,652	-0.1097	3.2159	-129.9141	19.6235
			Euro area—Periphery	2	2,826	-0.1015	2.5275	-11.9628	19.0584
Equity Index	return in % (that is, log difference * 100)	Datastream	Advanced Economies	10	14,130	-0.0181	1.4850	-11.5572	12.2917
			Emerging Markets (EU)	4	5,652	-0.0447	1.6943	-14.2092	15.2129
			Emerging Markets (ex EU)	18	25,434	0.0118	1.5644	-19.8503	23.1743
			Euro area—Core	4	5,652	-0.0411	1.6397	-9.2217	16.0461
			Euro area—Periphery	2	2,826	-0.0583	1.6747	-8.6364	11.7492
Bilateral Exchange Rate* (with the Euro)	return in % (that is, log difference * 100) ; "+" indicates euro appreciation	Bloomberg and ECB	Advanced Economies	10	14,130	-0.0107	0.6807	-7.0150	8.3865
			Emerging Markets (EU)	4	5,625	0.0015	0.6402	-5.0513	5.9701
			Emerging Markets (ex EU)	18	23,688	-0.0030	0.8386	-13.5854	14.6017
			Euro area (NEER)	1	4,796	-0.0022	0.3811	-2.9377	2.5191
Portfolio Bond Flows (all investors)	investment flow in percent of the assets invested in the country	Emerging Portfolio Fund Reaserach (EPFR)	Advanced Economies	10	13,897	0.0363	0.3887	-13.5506	5.3455
			Emerging Markets (EU)	4	5,620	-0.0156	0.5994	-20.1090	4.6469
			Emerging Markets (ex EU)	18	24,740	0.0706	0.6070	-16.5199	8.6015
			Euro area—Core	4	5,620	0.0024	0.5699	-21.0061	5.1412
			Euro area—Periphery	2	2,810	-0.0039	0.5737	-12.6607	6.5990

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Variable	Unit	Source	Number of Units	Observations	Mean	Std Dev	Minimum	Maximum
Portfolio Bond Flows (euro area investors) — *investment flow in percent of the assets invested in the country*		EPFR						
Advanced Economies			10	13,896	0.0126	0.2111	-3.8768	4.5033
Emerging Markets (EU)			4	5,620	-0.0226	0.2359	-2.7516	3.3322
Emerging Markets (ex EU)			18	24,735	0.0386	0.2600	-4.3019	4.1812
Euro area—Core			4	5,620	-0.0112	0.2654	-3.7213	3.2070
Euro area—Periphery			2	2,810	-0.0132	0.2658	-4.6611	2.6016
Portfolio Equity Flows (all investors) — *investment flow in percent of the assets invested in the country*		EPFR						
Advanced Economies			10	14,077	-0.0160	0.2157	-6.8840	5.7251
Emerging Markets (EU)			4	5,632	-0.0329	0.3305	-9.2540	1.8474
Emerging Markets (ex EU)			18	25,333	0.0281	0.3561	-4.1147	25.2352
Euro area—Core			4	5,632	-0.0284	0.3956	-7.9509	12.1178
Euro area—Periphery			2	2,816	-0.0354	0.1747	-2.2615	0.9012
Portfolio Equity Flows (euro area investors) — *investment flow in percent of the assets invested in the country*		EPFR						
Advanced Economies			10	14,077	-0.0240	0.1820	-3.3451	6.5091
Emerging Markets (EU)			4	5,632	-0.0317	0.1708	-1.3153	1.6244
Emerging Markets (ex EU)			18	25,333	0.0144	0.4071	-32.2558	32.5344
Euro area—Core			4	5,632	-0.0237	0.5653	-12.3603	18.2811
Euro area—Periphery			2	2,816	-0.0304	0.1498	-1.0306	0.8314

Variable	Unit	Source	Number of Units	Observations	Mean	Std Dev	Minimum	Maximum
Option Implied Equity Volatilities	*first difference in p.p.*	Datastream	5 (Vix, Vstox, FR, U.K., DE, JP)	8,478	0.0014	2.2651	-20.6300	29.0900
CDS Spreads for Euro Area Banks	*first difference in b.p.*	Datastream	48	42,999	0.2340	29.0773	-1911.7150	1519.3770
CDS Spreads for Global Systemically Important Banks (G-SIBs)	*first difference in b.p.*	Datastream	18	16,336	0.0607	13.4338	-831.0341	382.5251
CDS Spreads for euro area Sovereigns	*first difference in b.p.*	Datastream	6	8,207	0.1146	6.6176	-79.2050	72.1500
CDS Spreads for non-euro area G20 Sovereigns	*first difference in b.p.*	Datastream	14	19,034	0.0382	10.2767	-255.0000	295.0000

Note: * for euro area countries "Exchange Rate" refers to the euro Nominal Effective Exchange Rate—NEER

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Table 2 (Part 1). Summary Statistics and Information on the Explanatory Variables—ECB Policies Related Variables Included in the Benchmark Model (Sample period 5/1/2007–9/30/2012, daily data)

Variable	Code	Description	Source	Detailed description
SMP announcement	AN_SMP	impulse dummy	Authors	When the dependent variable is a price variable: the dummy is equal to 1 on May 10, 2010 (activation of the SMP) and August 8, 2011 (re-activation of the SMP), zero otherwise. Note that the announcement of the reactivation of the SMP was on Sunday August 7, 2011; therefore, the dummy has been moved to the following Monday. For portfolio flows: the dummy is equal to 1 on the above dates and on the two following days, zero otherwise.
OMT announcement	AN_OMT	impulse dummy	Authors	When the dependent variable is a price variable: the dummy is equal to 1 on July 26, 2012 (Mr. Draghi "Whatever it takes" speech) and September 6, 2012 (details of the OMT unveiled), zero otherwise. For portfolio flows, the dummy is equal to 1 on the above dates and on the two following days, zero otherwise.

Variable	description	Source	Observations	Mean	Median	Std Dev	Minimum	Maximum
Unexpected SMP purchases	SMP	Unexpected daily purchases under the SMP, billions euro	ECB and authors' calculation—see the online Annex	1,434	0.0337	0.0000	0.3714	–1.0708	4.4000
Allotted amounts at SLTROs	SLTRO	Change in outstanding amounts of SLTROs with maturity between 6 and 12 months, hundreds of euro billions. The amount is equally split in the 7 days around the auctions days/repayment days (see Section II, for details).	ECB and authors' calculation	1,428	0.0000	0.0000	0.0669	–0.6318	0.6318
Allotted amounts at VLTROs	VLTRO	Change in outstanding amounts of VLTROs with 36-month maturity, hundreds of euro billions. The amount is equally split in the 7 days around the auctions days (see Section II, for details).	ECB and authors' calculation	1,428	0.0071	0.0000	0.0718	0.0000	0.7565

Table 2 (Part 2): Summary Statistics and Information on the Explanatory Variables—Other Variables Included in the Benchmark Model

Variable	Source	Detailed description
Macroeconomic data surprises	Bloomberg	We calculated economic surprises by deducting actual data releases from median expectations, according to Bloomberg survey data. Surprises are normalized by their own standard deviation prior to 2007. We calculated surprises for a number of key economic variables for the United States, euro area, Germany, France, Italy, and Spain covering a total of 48 economic indicators. The variables are listed below. Owing to collinearity among some of the variables the actual number of surprises entering in the regressions is less than 48.
U.S. QE announcements	Fawley and Neely (2013)	Impulse dummies for key announcements related to U.S. QE policies. We include a set of 19 announcements-related dummies capturing expansion and the termination of QE policies. The considered announcements are those listed in Table 1A of Fawley and Neely (2013) that falls in our sample period (January 2007 to September 2012).
Sovereign Bond Auctions	Bloomberg	Indicators of the outcome of bond auctions for Italy and Spain, including the bid to cover ratio and the yield for bonds with 1-, 5-, and 10-year maturity.
Dummy for May 14, 2010	Authors	On May 14, 2010 equity markets recorded large losses in Europe and worldwide. Rumours about French President threatening to leave the euro area spread on May 14. Moreover, fears of a possible downgrade of France's sovereign credit rating and a statement by the German Chancellor on the gravity of the Eurozone situation exacerbated markets' fears.
Dummy for August 10, 2011	Authors	On August 10, 2011 equity markets recorded large losses in Europe and worldwide. Although speculations about France losing its triple A played a role, market stress originated mainly from fears related to the situation of European banks, especially French and Italian ones. Some Italian banks were suspended from trading from 2 pm to 3 pm

List of economic data releases

EU Area: ECB Announces Interest Rates	France: CPI YoY	Germany: GDP SA QoQ
EU Area: GDP SA QoQ	France: Consumer Confidence Index	Germany: PMI Manufacturing
EU Area: CPI YoY	France: PMI Manufacturing	Germany: Sentiment
EU Area: GDP SA YoY	France: PMI Services	Germany: IFO Business Climate
EU Area: Consumer Confidence Index	France: Industrial Production MoM	Germany: Industrial Production SA MoM
EU Area: CPI Estimate YoY	France: Industrial Production YoY	Germany: IFO Expectations
EU Area: CPI MoM	France: GDP QoQ	Germany: Factory Orders MoM
EU Area: PMI Manufacturing	France: GDP YoY	Germany: IFO Current Assessment
EU Area: PMI Composite—Output	France: Business Confidence	Germany: Unemployment Change (000s)
EU Area: PMI Composite—New Orders	France: CPI EU Harmonized YoY	Germany: GDP NSA YoY
EU Area: PMI Services		
	Spain: CPI MoM	
Italy: Consumer Confidence Index	Spain: Business Confidence	
Italy: PMI Manufacturing	Spain: Unemployment MoM net	
Italy: PMI Services	Spain: Retail Sales YoY	
Italy: Industrial Production MoM	Spain: GDP QoQ	
Italy: Business Confidence	Spain: GDP YoY	
Italy: CPI EU Harmonized YoY	Spain: Unemployment Rate	
Italy: CPI EU Harmonized MoM		
Italy: GDP WDA QoQ		
Italy: GDP WDA YoY		
Italy: CPI NIC incl. tobacco MoM		

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ECB website; dates when U.S. and ECB unconventional policies were announced were collected from the ECB website and from Fawley and Neely (2013).

The data set on capital flows consists of daily data on portfolio equity investment flows by country of destination. The data are compiled by Emerging Portfolio Fund Research (EPFR) that aggregates data on the activity of a large number of individual funds. Most of the funds are domiciled in advanced economies, prevalently in the United States. Therefore, the EPFR data on flows reflect gross flows from a balance of payment point of view when looking at countries outside the United States. In our analysis we separate between flows stemming from investment decisions of all funds and funds domiciled in the euro area.

Although EPFR assets invested in individual countries are only a fraction of the equity/bond market capitalization of these countries and the corresponding investment flows are smaller than gross portfolio flows as recorded in the balance of payments, EPFR flows display high correlation with balance of payment data for emerging markets (Miao and Pant, 2012). For this reason, an increasingly large number of policy institutions[15] and academic papers[16] use EPFR data to track portfolio flows in real time.

Regarding the drivers of flows, Raddatz and Schmukler (2012) show that EPFR flows reflect new investment into (or redemptions from) individual funds and managerial changes in country weights and cash. They also show that both managers and fund investors adjust their investing strategy by reacting to both global and country specific factors. The results of Lo Duca (2012), Fratzscher (2012) and Fratzscher, Lo Duca, and Straub (2013) show that the EPFR flows quickly respond to announcements and changes in risk factors on a daily basis.

Empirical Approach

We evaluate the impact of ECB unconventional monetary using the following model:

$$y_{i,t} = \beta \, MP_t + \gamma_1 F_t + \gamma_2 Z_{t-1} + \varepsilon_{i,t}$$
$$\text{With} \, MP_t = [AN\_OMT_t, \, AN\_SMP_t, \, SLTRO_t, \, VLTRO_t, \, SMP_t]. \tag{1}$$

The dependent variable $y_{i,t}$ is alternatively the return on the main equity index, the return of the banking equity index, the first difference of the 10-year Government bond yield, the return of the bilateral exchange rate of the euro in country i and day t. The equation is estimated separately for five groups of countries (EA core, EA periphery, Advanced Economies, Emerging Markets (ex EU), Emerging EU).

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[15]See, for example, any recent issue of the Quarterly Review of the Bank of International Settlement or of the Global Financial Stability Report of the International Monetary Fund.

[16]Lim, Mohapatra, and Stocker (2014) use EPFR to assess the impact of quantitative easing on international capital flows. Fratzscher, Lo Duca, and Straub (2013) also use high frequency EPFR data to assess the impact of quantitative easing announcements and operations on global portfolio flows. Forbes and others (2012) use EPFR data to assess the impact of capital controls, while Lo Duca (2012) uses them in a model for monitoring the drivers of capital flows in real time.

In the benchmark specification, for each country group, we estimate a panel regression with country fixed effects. Standard errors (clustered by country) are calculated with a bootstrap procedure using 1,000 repetitions. In the robustness section we use alternative estimation strategies.[17]

It is important to highlight that looking at daily data is crucial to identify the effects of policies. The decision of engaging in policy actions does not depend on changes in daily conditions in one day (that is, our dependent variable), what really matters is the "broad" picture. Conversely, a policy action might alter the "broad picture" and have significant implications on daily developments. Therefore, using daily data alleviates the risk of issues related to reverse causality.

The explanatory variables include monetary policy instruments (in the matrix MP_t) and a set of contemporaneous (F_t) and lagged (Z_{t-1}) control variables. In our benchmark specification, we take account of (i) country fixed effects to capture country-specific time-invariant elements, (ii) surprises related to the release of macroeconomic indicators in the United States and the euro area (both aggregate euro area data and data for key individual euro area countries), including conventional monetary policy decisions, (iii) key unconventional monetary policy announcements in the United States, (iv) indicators of the outcome of bond auctions in key euro area countries experiencing sovereign tensions, and (v) dummies for "special" days. Table 2 (Part 2) presents a detailed description of the explanatory variables included in the benchmark specification of the model. In Part 1 of the online annex, we report a summary description of the model and an explanation of the alternative model specifications that we use. In practice, it turns out that the inclusion of different sets of controls only modestly influences the magnitude of the estimated coefficients and does not alter the sign or statistical significance of the estimates for most of the results. This holds especially for sovereign bond yields in Spain and Italy and equity prices across the globe.

Turning to monetary policy instruments (in the matrix MP_t), we distinguish between two types of unconventional monetary policy measures, namely announcements of policies and actual market interventions. Although under the hypothesis of market efficiency prices and quantities would adjust immediately after a policy announcement, there are a number of reasons why this could not be the case, which motivates the choice of looking at the impact of actual market interventions. First, actual operations might lead to unexpected demand for some financial assets due to a portfolio rebalancing channel across market segments. Second, in the presence of market stress, which often motivates policy interventions, financial constraints might be binding. As a consequence arbitrage opportunities can only be exploited when actual operations take place (Dedola, Karadi, and Lombardo, 2013). Third, market interventions might have information content. In particular, SMP purchases might unveil relevant information to market participants on the ECB's assessment about solvency/credit risk of countries in distress (Eser and Schwaab, 2012). For these reasons, we look separately at the impact of announcements and operations. Among operations, we further separate between long-term liquidity auctions and bond purchases.

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[17]The estimation was done with STATA 12.

Explanatory Variables Capturing Policy Announcements

We define a number of impulse dummies to capture the announcement effects of policies on asset prices. In order to measure the market impact of announcements with dummies, we need to ensure that the announcement shock was sufficiently unexpected and large enough to affect markets. For this reason, we focus only on ECB announcements that were covered in the front page of the *Financial Times* (on the following day) as reported in Table 3A. This alleviates the concern that announcements were not important enough (too small shock to drive markets) or were simply "no news" (widely expected).[18] The four selected announcements cover two key unconventional policies by the ECB, namely the SMP and the OMT. Accordingly, we define two impulse dummies. The dummy AN_OMT_t is equal to one on the day of ECB President Draghi's speech in London (July 26, 2012— "Whatever it takes" speech) and on the day of the Outright Market Transactions (OMT) announcement (September 6, 2012). The dummy AN_SMP_t is equal to one on the 10th of May 2010, when the ECB announced the Securities Markets Programme in response to the escalation of the Greek Crisis, and on the 8th of August 2011, when the ECB re-activated the programme.[19] In the robustness section (see details in Part 5 of the online annex), we further discuss the choice of event dummies extending the analysis to other events and reporting the impact of individual events.

Explanatory Variables Capturing V/SLTROs Liquidity Injections

The second set of policy measures relates to (i) long-term liquidity provision with maturity from 6 to 12 months via SLTROs; (ii) long-term liquidity provision with maturity of 36 months via VLTROs.

The explanatory variable capturing SLTROs (VLTROs) is defined in the following way:

$$(V)\text{SLTRO}_t = \frac{(\Delta\, Loans)}{7}; on\ t - 3\ to\ t + 3\ where\ t\ is\ the\ day\ of\ the\ liquidity\ auction$$

$$(V)\text{SLTRO}_t = 0; on\ other\ days,$$

where Δ *Loans* is the change in the amounts outstanding of loans (in hundreds of euro billions) with maturity from 6 to 12 months (36 months) in the balance sheet of the ECB after the liquidity auction. The change is expressed in hundreds of euro billions and it is equally split over the seven days around the auction and/or repayment date (that is, between day t–3 and t+3 where t is the auction/repayment day). In this way the estimated coefficient for SLTROs (VLTROs) can be interpreted as the impact of net loan expansion of 100 billion euro on the dependent variable.

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[18]This approach also reduces the concern that other events occurring over the same day drive market developments.

[19]The ECB communicated the intention to "actively implement its Securities Markets Programme" on Sunday, August 7, 2011.

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Table 3A. Press Coverage of ECB Actions (Between 2007 and 2012)

Date	Event	Financial Times Headline	Headline article	Front page	VIX	Dummy
3/28/2008	6-month SLTROs	U.S. sends in back-up for Iraqi offensive	No	No	-0.17	
9/4/2008	Roll over of the outstanding 6-month SLTROs	U.S. stocks suffer on fear for economy	No	No	2.6	
10/15/2008	6-month SLTROs and other measures	Fresh squall rattles markets	No	No	14.12	
5/7/2009	12-month SLTROs and other measures (including covered bond purchases)	U.S. banks must add $74.6bn in equity	No	text	0.99	
6/4/2009	Details for the purchase programme of covered bonds	Obama appeal to muslims	No	No	-0.84	
5/10/2010	SMP and other measures	Markets rally on EU bail-out	main text	—	-12.11	AN_SMP
6/30/2010	Completion of covered bond purchases	EU bank bonus rules sow confusion	No	No	0.41	
8/4/2011	SLTROs and other measures	Stock markets plunge worldwide	main text	—	8.28	
8/7/2011	SMP reactivation	Traders braced for more turmoil	main text	—	16	AN_SMP
10/6/2011	12-month SLTROs and covered bond purchases	ECB raids policy cupboard	title	—	-1.54	
12/8/2011	36-month VLTROs and other measures	European banks' shortfall at €115bn	—	—	1.92	
7/26/2012	Mr. Draghi's Speech "Whatever it takes"	Nomura axe falls on top staff	No	title	-1.81	AN_OMT
9/6/2012	Details for the OMT	ECB signals resolve to save euro	title	—	-2.14	AN_OMT

Note: Column "Event" describes the policy announcement; "*Financial Times* Headline" indicates the title of the "top story" on the front page of the *Financial Times*; "Headline Article" indicates where the ECB action is mentioned in the top story on the front page of the *Financial Times* (title, subtitle or main text); "Front page" indicates where the ECB action is mentioned on the front page of the *Financial Times*, if not in the "top story" (title, subtitle or main text). "VIX" indicates the change in the VIX on the day of the announcement; "dummy" indicates the impulse dummy capturing announcements effects in the baseline analysis.

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Table 3B. Press Coverage of Federal Reserve's Actions

Date	Event	Financial Times Headline	Headline article	Front page	VIX
11/25/2008	LSAPs announced	Fed adds $800bn to boost borrowing	title	—	-3.80
12/1/2008	Bernanke first suggestion of extending QE to Treasuries	Evidence of deep recession mounts	main text	—	13.23
12/16/2008	First suggestion of extending QE to Treasuries by FOMC	U.S. Fed slashes rates to near zero	main text	—	-4.39
1/28/2009	Federal Reserve stands ready to expand QE and buy Treasuries	Economic pain to be "worst for 60 years"	main text	—	-2.59
3/18/2009	QEs expanded	Fed purchase plan stuns investors	title	—	-0.74
8/27/2010	Bernanke suggests role for additional QE	Fed ready to boost economy	title	—	-2.92
10/12/2010	FOMC says additional accommodation may be appropriate	Fresh Fed boost more likely	title	—	-0.03
10/15/2010	Bernanke says Federal Reserve stands ready for action	Bernanke hints at further stimulus	title	—	-0.85
11/3/2010	QE2 announced	Fed to pump in extra $600bn	title	—	-2.01
9/21/2011	Maturity Extension Program announced	Fed "twist" seeks to boost U.S. economy	title	—	4.46
6/20/2012	Maturity Extension Program extended	Fed opts to extend its "Operation Twist" plan	title	—	-1.14
8/22/2012	FOMC says additional monetary accommodation is likely	SA mining unrest spreads	No	title	0.09
9/13/2012	QE3 announced	Bernanke takes plunge with QE3	title	—	-1.75
12/12/2012	QE3 expanded	Fed links interest rates to U.S. unemployment figures	main text	—	0.38

Note: See notes to Table 3A. The table focuses on a set of the 14 "expansionary" announcements listed in Table 1A in Fawley and Neely (2013), covering the period 2007–12.

Focusing on a seven-day window centered on the auction date allows us to capture a number of effects. First, in the days before the auction ($t-3$ to $t-1$) banks might demand bonds that can be used as collateral in liquidity operations, thereby driving down yields. Other investors might also buy bonds in anticipation of higher demand for these securities after the auction, when banks might use the money borrowed from the ECB to buy government bonds. These actions might drive yields down and affect other asset prices before the auction takes place.[20] Second, including the auction day and in the immediate aftermath of it (between t and $t+3$) might capture the price effects of banks investing the borrowed money in financial assets.

As the demand for long-term liquidity by banks depends on long-term expectations on cash flows and funding conditions (for example, loan and bond rollover needs over the coming months), endogeneity should not be a concern in our "high frequency" (daily) analysis of the impact of SLTROs and VLTROs. Putting it differently, we assume that changes in daily market conditions in the proximity of a V/SLTRO auction have no impact on the demand for long-term liquidity at horizons longer than six months which is determined by other factors that operate at lower frequency than daily. To substantiate this view, in the robustness section we show that daily changes in equity prices and yields (our key dependent variables) do not predict variables associated with banks liquidity demand and do not exhibit systematic patterns when interbank tensions are high (as measured by money market spreads). Therefore, we assume that after controlling for other shocks, any systematic movement in prices around auctions/repayments would reflect the impact of changes in central bank liquidity.[21]

Explanatory Variable Capturing SMP Purchases

The last policy tool that we analyse is the SMP. Under the SMP, the ECB engaged in Treasury purchases on a daily basis when market conditions deteriorated, which introduces an endogeneity bias and complicates the assessment of the impact of purchases on asset prices. In other words, by simply plugging SMP purchases in Equation (1), we would obtain a positive coefficient for the SMP when yields are the dependent variable. This would happen for the simple reason that the ECB intervened when yields were increasing.

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[20]Using information on the total allotment before the auction takes place might be problematic if the sum finally allotted is not known in advance. Two considerations alleviate this concern. First, there could be market expectations on the size of the allotment. Second, before the auction, banks might start frontloading collateral (also government bonds) on the basis of their predetermined demand of liquidity that will be revealed (to the public) at the auction. In the robustness section, we do some tests on the ex-ante inclusion of the allotted amounts.

[21]It is worth highlighting that our approach does not assume that the market situation "today" does not matter for the demand of long-term liquidity by banks. In our approach, we simply argue that the *change* in the market situation today (daily developments) does not really alter the "broad picture" and does not matter for the demand of liquidity in the long term.

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A number of studies attempted to address this issue by either looking at high frequency micro data on bond purchases (Ghysels and others, 2014) or by comparing market prices with model-based counterfactuals in the absence of the SMP (Eser and Schwaab, 2012). Although those two studies rely on confidential data, in this study, we propose an easily replicable approach that uses publicly available data and is based on the estimation of an ECB's SMP reaction function. Essentially, our approach identifies the price impact of purchases that are "unexpected" according to an estimated reaction function which summarizes market beliefs on how the ECB would act. The reaction function takes into account that purchases might relate to market tensions and exhibit some persistence. Accordingly, the reaction function has the following form:

$$Y_t = c + \beta Y_{t-1} + \gamma X_t + \mu_t, \qquad (2)$$

where Y_t denotes the SMP bond purchases in week t (until Friday close of business).[22] The function takes into account that the ECB would use information on market conditions at the market opening (early in the morning) on each day to decide the intensity/upper limits of SMP purchases.[23] Indicators of market conditions are captured by the matrix X_t and include average overnight returns[24] and the overnight realized volatility of bonds of troubled EA countries during week t. After estimating the reaction function for the two SMP periods,[25] we calculate predicted SMP purchases. We assume that the latter are the markets' best guess of the ECB intervention and, therefore, they are already incorporated in bond prices. Thus, we focus on the unexpected part of the SMP (that is, the difference between actual purchases and predicted purchases) that contains new information and should have an impact on prices. Practically, the variable SMP_t that enters in the main Equation (1) is calculated in the following way:

- SMP_t = actual SMP purchases during the first week when the program is active (that is, week May 10–14, 2010 for SMP 1 and week August 8–12, 2011 for SMP 2). This is to capture the fact that the first interventions in each of the two phases of the SMP came as a surprise to market participants.
- $SMP_t = \mu_t$ (that is, the residual of equation (2)) on the weeks when the SMP is active, except for the first week.
- $SMP_t = 0$ in other weeks.

As Equation (1) uses data at daily frequency, we equally split the above values over the relevant week.

In the online annex, we present a detailed description of the methodology for the calculation of the unexpected component of SMP purchases on the basis of the

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[22]SMP holdings are publicly available at weekly frequency. Therefore the equation is estimated with weekly data.

[23]Unfortunately, little public operational details are available for the SMP.

[24]The overnight return is the percentage price change between the closing price on day t-1 and the opening price on day t (source: Bloomberg).

[25]As purchases are nonnegative, we estimate the reaction function with a Tobit model.

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reaction function approach, we present the estimated coefficients of Equation (2) and we discuss a number of alternative specifications around the benchmark.

There are two important caveats with the above approach that should be highlighted. First, the ECB might adjust purchases on the basis of the evolution of the market conditions during the day. Unfortunately, we have no way to tackle this issue with publicly available data. On this front, however, it is important to note that observing market conditions early in the morning was relevant in determining the upper limits of SMP purchases in one day. Second, a complication arises because the ECB did not clearly announce the end of the program until September 2012. For several months, after the two rounds of interventions in mid-2010 and late 2011, the program was dormant, that is, the program was active but it was not used. This implies that we cannot consider the intervention and nonintervention periods as exogenous when estimating the reaction function. We address this issue with an alternative approach in the robustness section.

III. Empirical Results

This section presents the findings of the benchmark model in Equation (1) by presenting the "total impact" of ECB policies. The latter is equal to the total size of unconventional operations multiplied by the estimated coefficients of the underlying econometric model in Equation (1). For example, the impact of VLTROs on bond yields in Italy and Spain which is −0.52 percentage points (see Table 4A) results from multiplying the estimated coefficient of a 1 billion euro VLTRO loan (−0.00051) with the total 1,019 euro billions VLTROs loans granted over the period and still outstanding at the end of our sample in September 2012.[26]

This way of calculating the total impact of policies implies that the effects of operations and announcements are permanent. The persistence of unconventional monetary shocks, however, is the subject of an expanding literature which did not bring conclusive evidence so far. According to recent studies, the impact of monetary policy shocks on long-term yields either "wears off" fairly slowly (Rogers, Scotti, and Wright, 2014) or is very persistent (Neely, 2014). In particular, Neely (2010) highlights that once VAR models are made consistent with standard asset price models via an appropriate set constraints, they generate much more persistent impulse responses to monetary policy shocks. Intuitively, finding systematic asset price patterns in response to policy shocks in the medium term would violate even "light" assumptions on the form of market efficiency. As Neely puts it "monetary policy shocks appear to be very persistent, although we cannot really know how persistent."[27] Keeping in mind these caveats, we find that presenting the total effects of policies under the assumption that effects are permanent is a reasonable way forward. The full estimation results are available in Part 4 of the online annex.

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[26]For the announcement dummies the procedure is the same, that is, we multiply the number of ones/events by the estimated coefficients of the dummies.

[27]An earlier version of this paper presented an impulse response analysis consistent with the findings of Neely.

Table 4A. Total Impact of ECB Unconventional Monetary Policy on Prices
(Italy and Spain)

	10-year yields (diff. in p.p.)	Equity Returns (% change)	Bank Returns (% change)	NEER (% change, "+" euro appreciation)
AN_OMT	-0.74***	8.69***	13.63***	0.72**
AN_SMP	-1.21***	6.92***	15.65***	-0.58
SLTRO	-0.24***	4.15***	5.33***	0.08
VLTRO	-0.52***	5.68***	8.24***	-1.21
SMP	-0.70***	5.47***	5.33***	-1.31

Note: Total impact of ECB policies according to the benchmark model. The total impact is equal to the total size of unconventional operations multiplied by the estimated model coefficients. Stars refer to the significance of the β coefficients of the underlying equation (*** 1% confidence level; ** 5% confidence level; *10% confidence level - see the online annex for the full set of results). For SLTROs the total impact is calculated at the peak expansion of loans with maturity between 6 and 12 months (March 2010, 660 euro billions). For other instruments the number refers to the cumulated impact at the end of the sample period in September 2012. For the announcement dummies (AN_OMT and AN_SMP), we multiply the number of events covered by the dummy by the estimated coefficients of the dummies (AN_OMT is one on 26/7/2012 and 6/9/2012; AN_SMP is one on 10/5/2010 and 8/8/2010)

Table 4B. Total Impact of ECB Unconventional Monetary Policy On Prices
(Germany, Austria, Finland and Netherlands)

	10-Year Yields (diff. in p.p.)	Equity Returns (% change)	Bank Returns (% change)	NEER (% change, "+"euro appreciation)
AN_OMT	0.10**	4.03***	5.31***	0.72**
AN_SMP	0.01	-0.97	5.85*	-0.58
SLTRO	-0.05***	3.88***	3.29***	0.08
VLTRO	-0.06***	6.09***	11.28***	-1.21
SMP	0.01	10.69***	7.04***	-1.31

Note: see note to Table 4A

Impact of ECB Policies on Financial Markets Inside the Euro Area

Tables 4A and 4B reports the total impact of ECB policies in highly rated euro area countries ("Core" euro area, that is, Finland, Germany, Austria, and the Netherlands) and two large euro area countries that experienced sovereign tensions (Spain and Italy).

OMT-related announcements (July 26 and September 6, 2012) led do a cumulated -74 b.p. decline in 10-year government bond yields in Italy and Spain, while they led to a cumulated +10 b.p. increase in yields of bonds of highly rated euro area countries. Equity indices in Italy and Spain increased by around +9 percent, while bank equity prices went up by around +14 percent. Also in highly rated euro area countries equity indices and bank equity prices went up, although the increase was smaller than in Italy and Spain. In response to the OMT announcement, the euro nominal effective exchange rate (NEER) appreciated by +0.72 percent.

SMP related announcements (May 10, 2010 and August 8, 2011) led to a cumulated -121 b.p. decrease in the 10-year sovereign yields of Italy and Spain,

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while they did not affect the yields of highly rated euro area sovereigns. The SMP announcement positively impacted the main equity indices in Italy and Spain (+7 percent) and bank equity prices (+15 percent). The SMP announcement led also to an increase in bank equity prices by around +6 percent in highly rated euro area countries.

Regarding operations, our results show that S/VLTRO loans and SMP purchases had an impact on yields and equity prices across the euro area. At the peak of the expansion (660 euro billions in early 2010), 12-month SLTROs led to a cumulated decline of 10-year government bond yields by −24 b.p. in Italy and Spain, and by −5 b.p. in highly rated euro area countries. SLTROs boosted equity returns (main equity indices and bank indices) by around 4 percent in the whole euro area. The 1,018 euro billions VLTROs loans led to a cumulated decline of 10-year government bond yields by −52 b.p. in Italy and Spain, while in highly rated euro area countries yields went down by −6 b.p.. VLTROs positively affected broad equity indices and bank equity prices (+5 percent and around +10 percent respectively across the whole euro area).

SMP purchases decreased yields in Italy and Spain by around −70 b.p. and lifted equity prices across the euro area. Main equity indices and bank equities went up by around +5 percent in Italy and Spain and by around +10 percent in highly rated euro area countries. It is important to point out that, while we find that the SMP purchases decreased yields and boosted equity prices on impact, the paper is mute on whether the SMP was overall an effective crisis management tool. The results simply indicate that bond purchases lifted equity prices and were effective in temporarily lowering yields and decrease market fragmentation.[28]

Regarding the SMP, it is worth noting that the above results are in line with the findings of other studies that adopt different modeling strategies to address the endogeneity problem. Using confidential data on the SMP purchases by country, Eser and Schwaab (2012) found that cumulated SMP purchases of the order of 50 billion euro in one sovereign market led to a persistent reduction in yields by approximately −90 b.p. in large countries (that is, Italy and Spain). Ghysels and others (2014) found results of the same order of magnitude.

To gauge the economic magnitude of the above results in the context of large swings in asset prices during the economic and sovereign crisis in Europe, Figure 2(a) and 2(b) show actual and counterfactual yields and equity prices. The counterfactual is calculated by deducting the estimated impact of monetary policy according to the benchmark model specification from the actual values of the dependent variable.[29] The figures show that without policy interventions yields in Italy and Spain would have been higher at the end of our sample (in September 2012) by around +300 b.p., while yields in highly rated euro area countries were not significantly affected (they would be only +5 b.p. higher). These results suggest

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[28]The results above survive a number of robustness tests that are described in the next sections and in the online annex. For Italy and Spain, however, the positive impact of the SMP on equity prices crucially depends on the inclusion of the dummies for May 14, 2010 and August, 10 2011 which capture particularly bad days for global stock markets.

[29]Also here, we assume that the effects of operations and announcements are permanent.

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Table 4C. Total Impact of ECB Unconventional Monetary Policy on Prices
(Advanced Economies)

	10Year yields (diff. in p.p.)	Equity returns (% change)	Bank returns (% change)	Exchange rate (% change, "+" euro appreciation)
AN_OMT	0.11***	2.55***	2.52***	0.45**
AN_SMP	0.04	−1.85***	0.36	−0.76***
SLTRO	−0.08***	2.62***	1.13	0.57
VLTRO	0.00	2.97***	4.52***	−0.73***
SMP	−0.03	8.83***	5.74***	−1.37*

Note: see the note to Table 4A

Table 4D. Total Impact of ECB Unconventional Monetary Policy on Prices
(Emerging Markets (ex EU))

	10-year yields (diff. in p.p.)	Equity Returns (% change)	Bank Returns (% change)	Exchange Rate (% change, "+" euro appreciation)
AN_OMT	0.01	2.53***	2.47***	0.66**
AN_SMP	−0.11***	−3.49***	−4.18***	1.11***
SLTRO	0.03	0.12	−0.29	−0.18
VLTRO	0.08	0.76	0.23	−1.08***
SMP	−0.08	6.26***	7.65***	−5.07***

Note: see the note to Table 4A

that ECB policies contributed to the decrease in bond spreads between the "periphery" and the "core" of the euro area and lowered market fragmentation. Regarding equity prices, the figures show that at the end of the sample equity prices would have been lower by around 10 p.p. without unconventional monetary policy interventions.

Impact of ECB Policies on Financial Markets Outside the Euro Area

Tables 4C, 4D, and 4E report the total estimated impact of ECB unconventional monetary policy outside the euro area.

The OMT announcements boosted equity prices across countries while they did not have significant implications for global sovereign yields. In response to OMT announcements, broad equity indices and bank equities recorded cumulated increases by around +2 percent across advanced economies and emerging markets. Sovereign yields were stable across emerging economies while they went up in advanced economies by around +10 b.p., consistent with the unwinding of safe haven flows. Interestingly, the euro depreciated by around −1 percent vis-à-vis emerging EU currencies, while it appreciated by around +0.5 percent vis-à-other currencies (advanced economies and other emerging markets).

SMP-related announcements had heterogeneous impact on financial markets. Although the first SMP announcement in May 2010 had positive spillovers, the second announcement in August 2011 was probably overshadowed by other negative developments (results are in the Part 5 of the online annex), including

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Table 4E. Total Impact of ECB Unconventional Monetary Policy on Prices
(Emerging EU)

	10Year yields (diff. in p.p.)	Equity Returns (% change)	Bank Returns (% change)	Exchange Rate (% change, "+" euro appreciation)
AN_OMT	−0.03	1.08***	2.60***	−0.95***
AN_SMP	−0.13	0.89	4.68***	−0.42*
SLTRO	0.03	−1.37	−0.83	−0.79*
VLTRO	−0.02	3.28	4.74***	−0.05
SMP	−0.37	−2.81	−5.88	−1.71***

Note: See the note to Table 4A

the U.S. rating downgrade. As a consequence, while the beneficial effects were visible in Italy and Spain, the cumulated spillovers of the two SMP announcements to the rest of the world are mixed. Overall, the SMP announcements had a smaller impact than the OMT announcements across the globe. The positive effects were mainly limited to emerging EU, where yields went slightly down and bank equity prices increased by around +4 percent. In advanced economies, yields did not move in cumulated terms after the two SMP announcements, although equities were slightly down reflecting mainly developments on August 8, 2010. In other emerging market economies (ex EU), yields went down by a cumulated −11 b.p., while equity prices declined by around −4 percent, reflecting no variation on May 10, 2010 and large declines on August 8, 2011.

Regarding exchange rates, the euro depreciated vis-à-vis advanced economies and emerging EU, while it did not significantly move vis-à-vis other emerging markets.

Turning to operations, we found that, in advanced economies, SLTROs decreased yields by around −8 b.p., consistent with the results for highly rated euro area countries. VLTROs and SLTROs had a positive impact on broad equity indices and bank equity indices in advanced economies, although the effects were smaller than in the euro area. STLROs and VLTROs did not have price effects on emerging markets, including emerging EU. In the latter region, there are positive gains in bank equity prices (+4 percent) associated with VLTROs, while the negative impact of SLTROs on equity prices is not robust. Overall, we interpret this evidence as suggesting that price spillovers of S/VLTROS were limited to other advanced economies and bank equities in emerging EU. Regarding exchange rates, VLTROs depreciated the euro by around −1 percent vis-à-vis advanced and emerging markets (ex EU), while SLTROs depreciated the euro vis-à-vis emerging EU by around −0.8 percent. Overall, we interpret this evidence as suggesting that S/VLTROs slightly depreciated the euro.

Finally, regarding SMP purchases, we find that they boosted equity prices overall and bank equities by more than +5 percent across advanced economies and emerging markets (ex EU), consistent with the results for the euro area. We do not find any significant price impact on emerging EU. In addition, the SMP purchases led to a depreciation of the euro vis-à-vis all country groups

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(by around −1.5 percent against currencies in advanced economies and emerging EU, by more than −5 percent against currencies of other emerging markets).

The counterfactual analysis in Figure 2(c)-(e)C, 2D and 2E summarizes our findings and shows that ECB policies had positive impact on equity prices worldwide, stemming mainly from SMP purchases and OMT announcements. At the same time, ECB policies did not have sizable spillovers to global sovereign yields, with the exception of emerging EU where yields would have been higher by around +50 b.p. without policies. The latter result, however, mainly reflects the impact of SMP purchases which were not statistically significant in our baseline model and were hardly significant in other specifications for emerging EU.

Impact of ECB Policies on Portfolio Flows and Risk Perceptions

This section assesses the impact of ECB policies on portfolio flows and risk indicators that might also give indications on the channels of transmission of ECB unconventional policies to global asset markets.

Impact on Portfolio Flows Across Regions

To analyze the impact of policies on flows, we use daily data on portfolio bond and equity flows by country of destination, stemming from allocation decisions of mutual funds (EPFR data, see the section "Data"). Furthermore, we differentiate between flows stemming from allocation decisions of all the funds covered in the data set ("all funds" or "global funds") and flows stemming from funds domiciled in the euro area ("EA funds"). The latter group of funds might shed light on the specific reaction of euro area investors to ECB policies. We use the same framework described in Equation (1) in the section "Empirical approach" with the only difference that the dependent variable $y_{i,t}$ measures net portfolio equity/bond inflows in country i and day t scaled by the equity/bond assets invested in country i.[30] The panel regression is estimated separately for bonds and equity flows, and for all funds and euro area funds for each of the five group of countries.

The results presented in Tables 5A-5E show that, while statistically significant, the total impact of ECB policies on global portfolio flows (all funds and euro area funds) was economically small.[31]
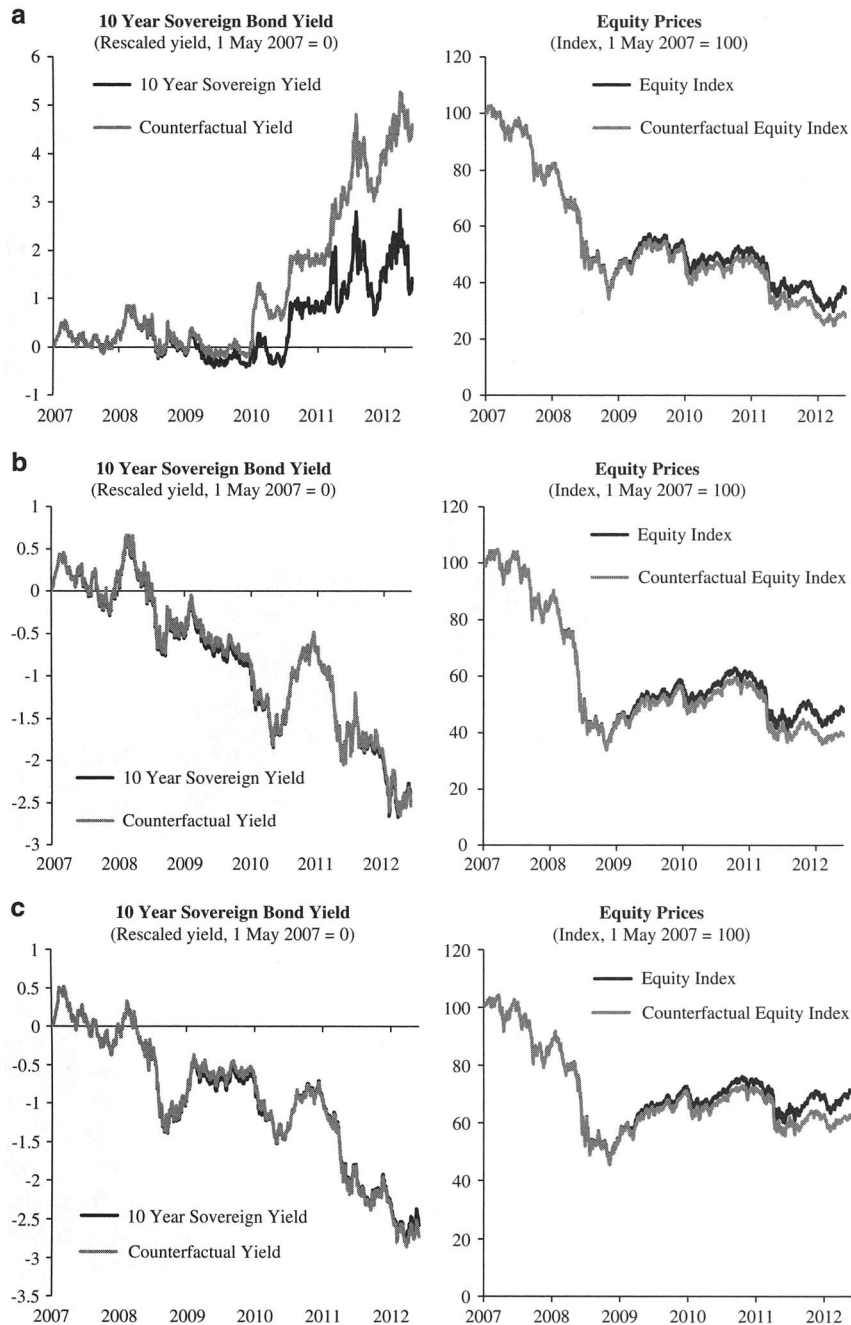
The OMT announcements led to bond and equity portfolio inflows in Italy and Spain by global and euro area investors, while, overall, there were little or no flows

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[30]As flows tend to react more sluggishly than prices to news and announcements, we slightly modified the specification of some of the explanatory variables in the model. In particular, all the announcement dummies take value one on the day of the announcement and in the following two days. Also for the other variables, we consider up to three lags. Finally, to take into account the persistence of the flows, we also estimate the model by adding three lags for the dependent variable. The latter modification does not impact the results.

[31]The results refer to the baseline specification. We conducted a number of checks as we did for asset prices (different set of control variables, Pesaran-Smith mean group estimator, robust regressions, random effect estimator). The tests indicate that the baseline specification delivers fairly robust results. We do not report the results for brevity.

Figure 2. Counterfactual Analysis: (a) Italy and Spain; (b) Germany, Austria, Finland, and Netherlands; (c) Advanced Economies; (d) Emerging Markets (ex EU); (e) Emerging EU

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d

10 Year Sovereign Bond Yield
(Rescaled yield, 1 May 2007 = 0)

Equity Prices
(Index, 1 May 2007 = 100)

— 10 Year Sovereign Yield
···· Counterfactual Yield

— Equity Index
···· Counterfactual Equity Index

e

10 Year Sovereign Bond Yield
(Rescaled yield, 1 May 2007 = 0)

Equity Prices
(Index, 1 May 2007 = 100)

— 10 Year Sovereign Yield
···· Counterfactual Yield

— Equity Index
···· Counterfactual Equity Index
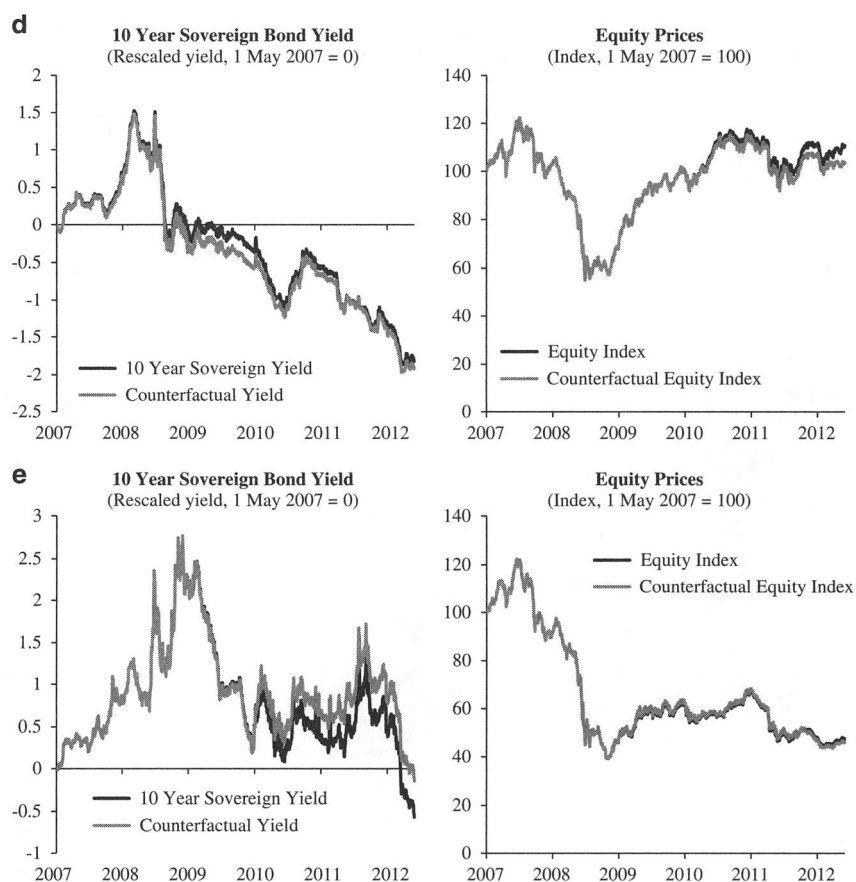
Note: The counterfactual is calculated by deducting the cumulated estimated impact of monetary policy (according to the benchmark model) from actual values.

into highly rated euro area countries. After the OMT announcements, bond inflows into other regions also slightly increased across global and euro area investors.

In response to VLTROs, global funds invested more in equity and bonds in emerging markets and in the euro area "periphery," while they invested only in bonds in advanced economies and in the euro area "core." In response to VLTROs, euro area funds moved out from highly rated euro area countries into bonds worldwide and into bonds and equities into the euro area periphery. The impact of SLTROs on flows was mixed. In particular, there is some evidence suggesting that global funds rebalanced from bonds to equities worldwide, while the activity of euro area funds was very small. Similarly, euro area funds moved from equities into bonds, especially into the euro area periphery, advanced economies and emerging markets, while exiting highly rated euro area countries.

Overall, however, the detected flows in response to ECB policies were negligible compared with the observed total movements in portfolio flows. When deducting the estimated contribution of monetary policy actions according to the baseline model from actual flows (Figure 3(a) to 3(e)), it is possible to spot

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Table 5A. **Total Impact of ECB Unconventional Monetary Policy on Portfolio Flows**
(Italy and Spain)

	Equity	Bond	Equity EA	Bond EA
AN_OMT	0.30***	0.11***	0.44***	0.26***
AN_SMP	−0.03	−2.04***	−0.10**	−1.26***
SLTRO	0.05***	−0.88***	−0.13***	0.09
VLTRO	0.20***	1.16***	0.14***	0.48**
SMP	−0.81***	2.42***	0.11	0.49***

Note: "EA" indicates the results for funds domiciled in the euro area. Portfolio flows expressed in percent of the asset under management (that is, assets invested) in country *i*. see the note to Table 4A

Table 5B. **Total Impact of ECB Unconventional Monetary Policy on Portfolio Flows**
(Germany, Austria, Finland and Netherlands)

	Equity	Bond	Equity EA	Bond EA
AN_OMT	0.13***	0.00	−0.05	0.11
AN_SMP	−1.28	−1.68***	−2.52**	−1.16***
SLTRO	1.12	−1.10***	−0.19	0.28***
VLTRO	−0.26	1.03***	−0.89*	0.02
SMP	−3.96	1.67***	−3.85	0.23

Note: "EA" indicates the results for funds domiciled in the euro area. Portfolio flows expressed in per cent of the asset under management (that is, assets invested) in country *i*. see the note to Table 4A

Table 5C. **Total Impact of ECB Unconventional Monetary Policy on Portfolio Flows**
(Advanced Economies)

	Equity	Bond	Equity EA	Bond EA
AN_OMT	0.07	0.43*	0.00	0.25***
AN_SMP	−0.04	−1.04***	−0.58***	−1.21***
SLTRO	0.08	−0.68*	0.29	−0.07
VLTRO	−0.05	1.44***	0.12	0.31***
SMP	−1.07***	0.65	−0.22	0.57**

Note: "EA" indicates the results for funds domiciled in the euro area. Portfolio flows expressed in percent of the asset under management (that is, assets invested) in country *i*. see the note to Table 4A

differences from actual and counterfactual (with no monetary policy actions) flows only in a few cases. First, flows by global investors into bonds across the euro area would have been slightly lower in a scenario with no monetary policy actions. Second, equity flows by global and euro area investors into highly rated euro area countries would have been higher. This suggests that part of the inflows into euro area bonds might be the result of rebalancing from equities in highly rated euro area countries to bonds across the euro area in response to monetary policy actions. Third, investment into equity and bonds into emerging markets by global investors would have been slightly smaller, suggesting that by boosting global confidence, ECB actions slightly revived the appetite for emerging market securities. Finally, also investment by global funds into bonds of advanced economies would have been smaller in the absence of ECB policies.

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Table 5D. Total Impact of ECB Unconventional Monetary Policy on Portfolio Flows
(Emerging Markets (ex EU))

	Equity	Bond	Equity EA	Bond EA
AN_OMT	0.03	0.90***	0.06	0.26***
AN_SMP	−0.36**	−2.39***	−0.88**	−1.84***
SLTRO	0.27**	−1.79***	0.10*	−0.33***
VLTRO	0.73***	1.74***	−0.06	0.38***
SMP	−1.27***	2.53***	−0.37***	1.18***

Note: "EA" indicates the results for funds domiciled in the euro area. Portfolio flows expressed in percent of the asset under management (that is, assets invested) in country *i*. see the note to Table 4A

Table 5E. Total impact of ECB unconventional monetary policy on portfolio flows
(Emerging EU)

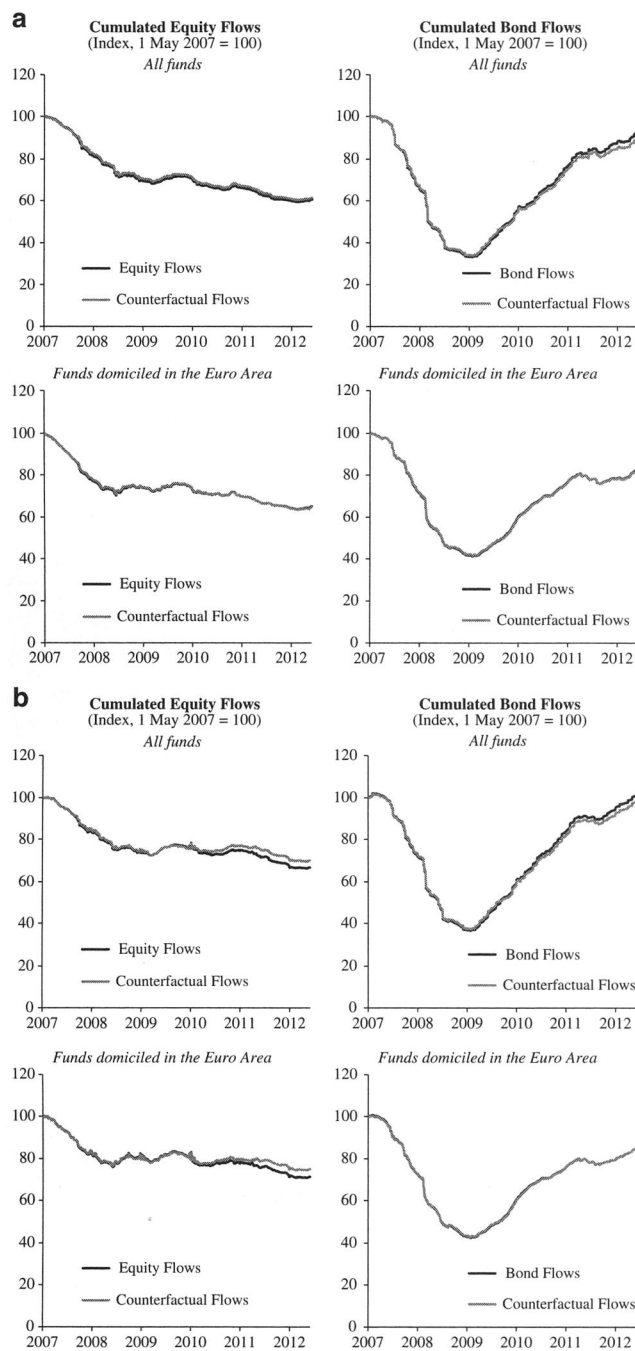|	Equity	Bond	Equity EA	Bond EA
AN_OMT	0.07**	0.17***	0.11**	0.14
AN_SMP	0.55**	−1.32**	0.08	−1.04***
SLTRO	−0.05	−0.80**	0.02	0.16
VLTRO	0.48***	2.21***	−0.21**	0.60***
SMP	−2.72***	0.58	−0.76***	−0.29

Note: "EA" indicates the results for funds domiciled in the euro area. Portfolio flows expressed in percent of the asset under management (that is, assets invested) in country *i*. see the note to Table 4A
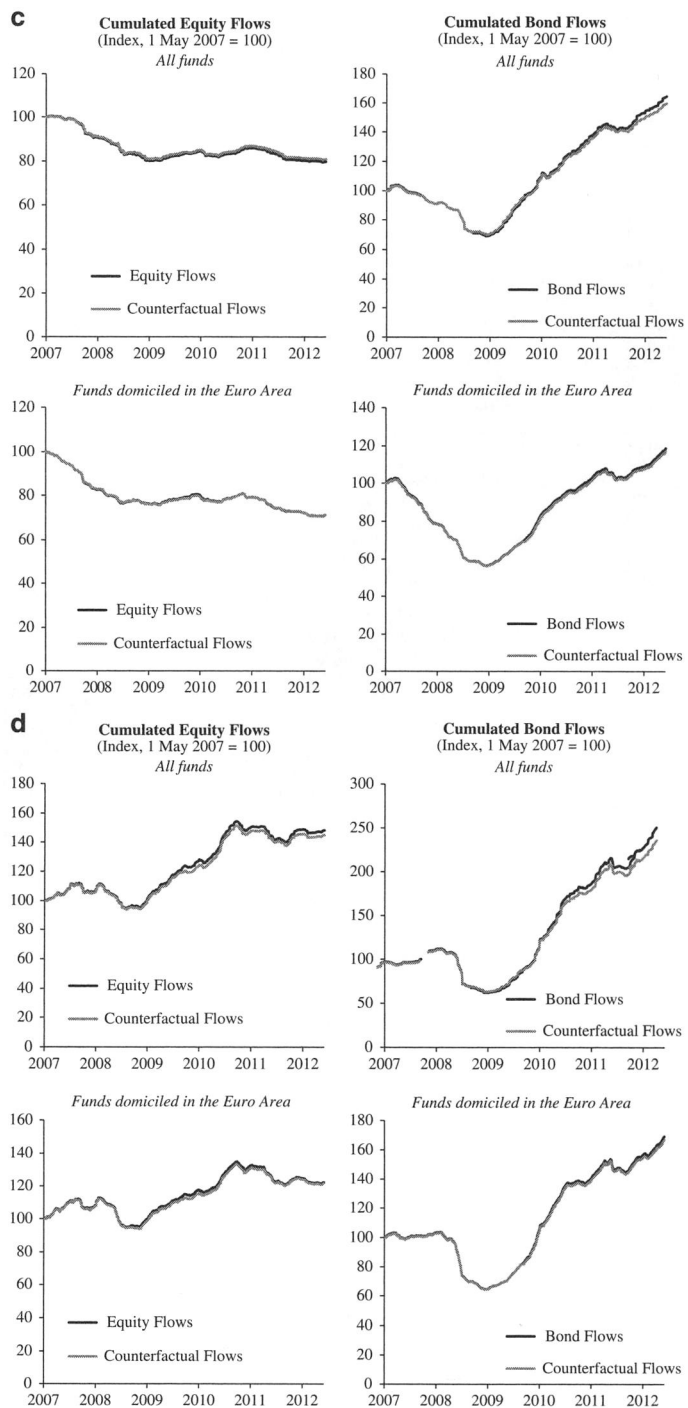
The impact of ECB policies on portfolio flows can be related to the portfolio balance channel (see the section "Channels of transmission and international repercussions"). The above findings suggest that international portfolio rebalancing was not an important channel of transmission for ECB polices. As described in the section "Data," the daily portfolio flow data from EPFR cover a small fraction of overall global portfolio flows and relate to mutual funds. In particular, they reflect portfolio reshuffling decisions and the allocation of new inflows/outflows into the funds from retail and institutional investors. Although other categories of investors might have been more affected and responsive to ECB policies, it is worth noting that other studies have found EPFR daily flows to respond promptly to changes in macro financial conditions and U.S. monetary policy (Fratzscher, 2012; Lo Duca, 2012). In particular, the small impact of ECB policies on international portfolio flows contrasts with the portfolio rebalancing across assets and countries observed in response to Federal Reserve policies in other studies (Fratzscher, Lo Duca, and Straub, 2013; Lim, Mohapatra, and Stocker, 2014). Overall, however, the difference in the total impact of ECB and Federal Reserve policies on capital and asset prices might be a reflection of the different size of the operations and the differences in instruments used.

Impact on Confidence/Risk Aversion

To measure the impact of ECB policies on confidence/risk aversion, we look at implied volatilities in key markets. We adopt the same framework outlined in
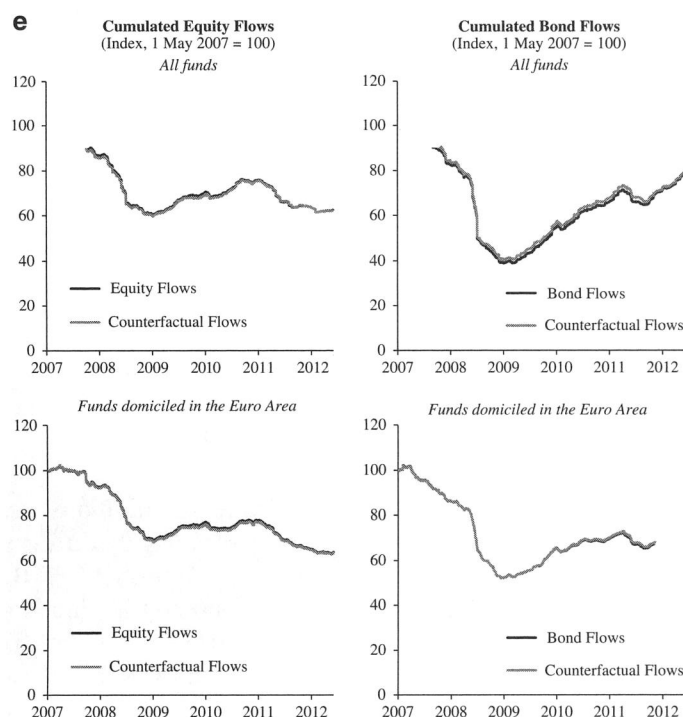
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Figure 3. Counterfactual Analysis for Portfolio Flows: (a) Italy and Spain; (b) Germany, Austria, Finland, and Netherlands; (c) Advanced Economies; (d) Emerging Markets (ex EU); (e) Emerging EU

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c

Cumulated Equity Flows
(Index, 1 May 2007 = 100)
All funds

Cumulated Bond Flows
(Index, 1 May 2007 = 100)
All funds

— Equity Flows
— Counterfactual Flows

— Bond Flows
— Counterfactual Flows

Funds domiciled in the Euro Area

Funds domiciled in the Euro Area

— Equity Flows
— Counterfactual Flows

— Bond Flows
— Counterfactual Flows

d

Cumulated Equity Flows
(Index, 1 May 2007 = 100)
All funds

Cumulated Bond Flows
(Index, 1 May 2007 = 100)
All funds

— Equity Flows
— Counterfactual Flows

— Bond Flows
— Counterfactual Flows

Funds domiciled in the Euro Area

Funds domiciled in the Euro Area

— Equity Flows
— Counterfactual Flows

— Bond Flows
— Counterfactual Flows

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Note: The counterfactual is calculated by deducting the cumulated estimated impact of monetary policy (according to the benchmark model for capital flows) from actual values.

Equation (1) in the section "Empirical approach" where the dependent variable $y_{i,t}$ is the first difference of implied volatility in market i in day t and i is the VSTOXX index for Europe, VIX for the United States, VFTSE for the United Kingdom, the VDAX for Germany, the VCAC40 for France, and a volatility index for the Japanese NIKKEI.

The results (Table 6) show that the OMT, SMP purchases, and V/SLTROs led to strong decreases in risk aversion. The OMT announcement decreased implied volatilities by −5.0 p.p. on average across countries. Both SLTROs and VLTROs allotments led to a decrease of implied volatilities by around −4 p.p. each. SMP purchases lowered implied volatilities by around −15 p.p.[32] The decline in risk aversion, as measured by implied volatilities, in response to S/VLTROs and the SMP is consistent with the positive impact of operations on equity prices.

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[32]Regarding the announcements related to the SMP, implied volatilities went down in response to the first SMP announcement on May 10, 2010, while they increased on the day of the second SMP announcement on August 8, 2010.

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Table 6. Impact on Risk Indicators (*Total Impact; Dependent variable as indicated at the top of each column*)

	Implied Volatilities (diff. in p.p.)	Bank CDS EA (diff in b.p.)	Bank CDS (diff in b.p.)	Sovereign CDS EA (diff in b.p.)	Sovereign CDS (diff in b.p.)
AN_OMT	−4.56***	−28.49**	−20.42***	−29.83**	−8.94***
AN_SLTRO	15.35	−37.73***	12.04	−5.32	42.42
AN_VLTRO	0.58	8.98***	10.70	25.74	4.55
AN_SMP	3.04*	n.a.	12.78	−40.95**	−9.21**
SLTRO	−3.20***	−21.32***	−5.59***	−12.58***	1.68
VLTRO	−4.30***	−98.69***	−43.91***	−40.72***	0.74
SMP	−15.14***	−10.05	7.97	−32.87*	−8.13*

Note: see the note to Table 4A

Impact on Bank Credit Risk

Although some ECB policies were targeted at addressing liquidity strains in euro area financial markets, by affecting liquidity risk they could also affect credit risk as the two risks are closely interlinked. To test for the impact of ECB policies on global bank credit risk, we adopt the framework outlined in Equation (1) in the section "Empirical approach" where $y_{i,t}$ is the first difference of the CDS spread of bank i in day t for a set of 48 euro area banks (for which CDS spreads are available) and 18 non-euro area G-SIBs. We estimate the panel regression separately for the group of euro area banks and other G-SIBs.

The results (Table 6) show that S/VLTROs and the OMT announcements decreased bank credit risk in the euro area and worldwide. In particular, VLTROs (SLTROs) led to a reduction of bank credit risk by around −100 b.p. (−21 b.p. at the peak of SLTROs in early 2010) for euro area banks and by −40 b.p. (−6 b.p.) for other G-SIBs. The OMT announcement reduced CDS spreads by more than −30 b.p. for euro area banks and by−20 b.p. for other G-SIBs.

Impact on Sovereign Credit Risk

For testing the impact of policies on sovereign credit risk, we adopt the framework outlined in Equation (1) in the section "Empirical approach" replacing the dependent variable $y_{i,t}$ with the first difference of the sovereign CDS spread of country i in day t. We estimate the panel regression separately for two groups of countries: 6 sovereigns in the euro area and other 14 non-euro area sovereigns belonging to the G20.

The results (Table 6) show that the OMT and the SMP announcements, S/VLTROs and SMP purchases led to strong declines in sovereign credit risk in the euro area and worldwide. Following the SMP announcements, sovereign CDS spreads decreased by −40 b.p. in the euro area and by −9 b.p. in other G20 countries. Following the OMT announcements, CDS spreads decreased by −30 b.p. in the euro area and by −9b.p. in other G20 countries. VLTROs led to a decrease of euro area sovereign CDS spreads by more than −40 b.p., while, at the peak of the expansion of SLTROs, CDS spreads decreased by −12 b.p. in the euro area. These

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decreases in response to V/SLTROs, however, were not transmitted to other G20 countries. Finally, SMP purchases decreased sovereign spreads by more than −30 b.p. in the euro area and by −8 b.p. in other G20 countries.

ECB Polices, the Global Financial Cycle and U.S. Unconventional Policies

The findings presented in the previous section show that ECB policies mainly spilled over to global equity markets while there was little or no impact on bond yields outside the euro area. The larger impact on equity prices is consistent with the effects of policies on risk as measured by implied volatilities and CDS premiums of banks and sovereigns. The lack of sensible effects on portfolio flows suggests that the detected price movements reflected mostly domestic investors' decisions or capital flows that are not captured by the EPFR data.

Our results also provide some insights on the role of ECB policies in driving the global financial cycle, relative to Federal Reserve policies. Rey (2013) and Miranda-Agrippino and Rey (2014) analyze the role of conventional monetary policy by the Federal Reserve and show that it plays an important role in driving VIX which in turn correlates with a global financial factor. The latter factor explains a significant part of the variation in capital flows and asset prices across the globe. Although the analysis of Rey (2013) and Miranda-Agrippino and Rey (2014) use lower frequency data and focus on conventional monetary policy, the role of the Federal Reserve in driving the global financial markets, with implications for the global financial cycle, emerges also from other empirical studies that use daily data and focus on unconventional monetary policy in the United States (Neely, 2010; Chen and others, 2012; Leduc and Glick, 2012, Fratzscher, Lo Duca, and Straub, 2013, Bowman, Londono, and Sapriza, 2014, Lim, Mohapatra, and Stocker, 2014, Lo Duca, Nicoletti, and Vidal, 2016, Rogers, Scotti, and Wright, 2014).

Overall, when relating our results to the existing literature on the global spillovers of Federal Reserve policies, ECB unconventional monetary policies seem to play a more limited role in driving global financial market developments than Federal Reserve actions. Although differences in total effects of policies between the ECB and the Federal Reserve might reflect the different size of underlying programs, the different combinations of instruments and different approaches across studies, a few tentative conclusions can be drawn. First, an analysis of the *Financial Times* headlines (Table 3A and Table 3B) shows that Federal Reserve policy announcements are perceived more frequently as market movers (or game changers) than ECB announcements. Second, according to Fratzscher, Lo Duca, and Straub (2013) who use a similar econometric approach and look at both Federal reserve announcements and purchases, QE1 and QE2 have boosted equity prices by +20 percent in emerging markets and by +15 percent in advanced economies in cumulated terms. The same study finds that QE1 and QE2 lowered yields by around −65 b.p. in emerging markets and by around −30 b.p. in advanced economies.[33] The above total effects are larger than those we found for ECB

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[33]For emerging markets, only announcements significantly reduced yields.

unconventional monetary policy, especially for bond yields. Other studies (Rogers, Scotti, and Wright, 2014; Bowman, Londono, and Sapriza, 2014) seem to suggest larger announcement effects for Federal Reserve policies relatively to ECB ones.

A number of papers analyze the impact of U.S. QE policies on capital flows. Fratzscher, Lo Duca, and Straub (2013) use an approach that is comparable to the one adopted in this paper (that is, using daily data, looking at the impact of both announcements and purchases, using EPFR data). The small impact of ECB policies on portfolio flows that we found in this study contrasts with the significant impact of QE1 and QE2 on cross-country allocations found by Fratzscher, Lo Duca, and Straub. According to the latter study a quarter of the total equity flows to emerging markets resulted from Federal Reserve policies.

This preliminary evidence suggests that, while the ECB unconventional monetary policy was transmitted to global asset prices, especially on equities, the Federal reserve plays a larger role in driving the global financial market developments and the global financial cycle. There are a number of reasons that can explain this finding. First, as Rey (2013) argues, this might be a reflection of the role of the U.S. dollar as the most important reserve currency. Second, over the period under review, there was a progressive substitution away from bank finance toward bond markets, mirrored by a boom in bond issuance around the globe and by smaller international banking flows than in the precrisis period (Shin, 2013; Turner, 2014). In this context, U.S. dollar denominated bond issuance increased outside the United States over recent years, especially in emerging markets, while the share of euro denominated issuance went down (see, for example, Caballero, Panizza, and Powell, 2014; ECB, 2014). As a consequence, the relatively stronger spillovers of U.S. QE policies can be related also to the rapidly changing financial structures across the globe and, in particular, to larger global bond markets denominated in U.S. dollars.

IV. Robustness Tests

We did extensive robustness tests in order to check the stability of the results along different dimensions. The full set of robustness checks is reported in Part 5 of the online annex. The following are the most important robustness tests and related conclusions.

Endogeneity concerns with S/VLTROs: The concern is that the dependent variable drives LTROs auction outcomes (reverse causality). First, we show that the dependent variables (daily changes of equity, yields, and so on) have little or no predictive power for money markets stress over the medium to long term which might drive banks' demand for central bank liquidity at LTROs auctions. Second, we also show that there is no systematic pattern of our dependent variables in relation to contemporaneous indicators related to banks' demand of liquidity. We, therefore, conclude that endogeneity is not a concern as the dependent variables in the proximity of V/SLTRO auctions (daily changes in asset prices) have no impact on the demand for long-term liquidity at long time horizon which is determined by other factors that operate at lower frequency.

Endogeneity concerns with the SMP; for several months, after the two rounds of interventions in mid-2010 and late 2011, the SMP became dormant, that is, the program

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was active but it was not used. The lack of ex-ante information on when the program entered into the "dormant" phase is not in line with our approach of imposing clear ending dates for the intervention periods to estimate the SMP reaction function. We address this problem by adopting a rolling reaction function where, after a while, markets "learn" that the SMP is dormant. The results confirm our baseline specification.

Announcement effects; we slightly change the definition of the analyzed policy announcement dummies and consider other announcements. Overall, the results are confirmed for the set of announcements in the benchmark specification. For other announcements the results are mixed which supports our focus on the key events included in the benchmark model.

Alternative specifications; our results turn out to be robust when using different sets of control variables and econometric techniques, including alternative ways to calculate standard errors.

Different measurement of the explanatory variables related to ECB policies; after changing the measurement strategy for V/SLTROs, the results are confirmed across country groups with only a few exceptions. Regarding the SMP, we use four alternative measures of "unexpected" purchases either based on simple "naïve" reaction functions (for example, expected purchases are last week's purchases) or based on alternative refined reaction functions. The bottom line result from the different specifications is that when fairly "sophisticated" reaction functions are used the results are stable and have the expected sign in most of the cases.

Symmetry of the effects of LTROs; the results point to some asymmetry in the impact of LTRO contractions and expansions which might stem from nonlinear effects. The latter could include the fact that LTRO expansions alleviated liquidity constraints while repayments took place when banks re-gained access to alternative sources of liquidity.

V. Conclusions

The domestic effectiveness of unconventional monetary policies and their international spillovers to global asset prices and capital flows have dominated policy discussions over recent years. Although the literature focused prevalently on the domestic impact and on the spillovers of U.S. QE, this paper analyzed the domestic and global implications on financial markets of unconventional monetary policies of the ECB over the period 2007–12. In particular, we studied the impact of ECB policies on equity and exchange rate returns, yields, risk measures, and portfolio flows across countries in a panel model, using daily data. Using daily data allows for a more precise identification of the effects of unconventional monetary policy on financial variables.

Our results show that liquidity injections via Supplementary LTROs (with maturity from 6 to 36 months), the OMT announcement and the SMP (both announcements and operations) positively affected equity prices (main equity indices and banking indices) in the "core" and the "periphery" of the euro area, while they decreased bond yields in the "periphery." ECB unconventional policies, in particular the OMT announcement and the SMP (announcements and operations), also had positive spillovers to global markets by boosting equity prices,

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while the overall effect on international yields was negligible outside the euro area. The euro slightly depreciated on average in response to the ECB's unconventional measures, with the exception of the OMT announcement which led the euro to appreciate slightly on average across different country groups.

We showed that unconventional monetary policies in the euro area affected global markets mainly through a rise in confidence/decrease in risk aversion (as measured by a decrease in option implied equity market volatilities). They also led to a reduction of sovereign risk in euro area and other G20 countries and a decrease in bank credit risk for euro area banks and non-euro area G-SIBs. The effect of policies on risk perceptions partially explains the larger worldwide impact on riskier assets, such as equity prices, compared with the impact on safer assets, such as government bonds. Interestingly, we found that the response of international portfolio flows to ECB policies was small. This seems to suggest that the price impact of ECB policies reflected mainly domestic investors' decisions and policies did not generate portfolio rebalancing across regions.

A comparison between our results on the impact of ECB policies and the literature on the impact of Federal Reserve policies suggests a bigger role for the Federal Reserve in driving global financial market developments and the global financial cycle. This might be driven by the role of the U.S. dollar as primary reserve currency, the increasing importance of bond markets, and U.S. dollar borrowing in the postcrisis period, especially in emerging market economies.

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