Does Monetary Policy Impact Market Integration? Evidence from Developed and Emerging Markets

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ABSTRACT

We investigate the impact of monetary announcements of the ECB and the FED on integration in the equity and sovereign CDS markets for a large cross-section of 18 Developed and 21 Emerging countries over 2006 to 2015. The effect of both announcements is negative or muted in the pre-crisis period, while it turns strongly positive during the financial crisis of 2007-2009. ECB interventions lead to more integration in the equity market during 2010 to 2012, but dis-integration in the CDS market in the ECB Quantitative Easing period (2013 to 2015), especially for emerging countries. In contrast, FED announcements are perceived as global factors in the CDS emerging market and are accompanied with an increase in integration both when the FED implements and unwinds its unconventional measures. The relation between the global factor and the U.S. market increases during FED interventions, the same does hold for the European market during ECB announcements. The exposure of emerging markets to outside monetary policy shocks can be explained in terms of their degree of trade and financial openness.

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"The current non-system in international monetary policy is, in my view, a source of substantial risk, both to sustainable growth as well as to the financial sector. It is not an industrial country problem, nor an emerging market problem, it is a problem of collective action."

- Raghuram Rajan, Governor, Reserve Bank of India, 2014

1 Introduction

Many central banks have introduced quantitative easing (QE) as a new policy tool where they massively buy bonds from market participants with the intent of providing liquidity to the market, reducing the cost of capital, and ultimately fostering economic growth. These policies were introduced by the Federal Reserve in the aftermath of the financial crisis, and by the ECB as a response to the crisis in the Eurozone sovereign bond market. As central banks are still undertaking these measures, a number of studies highlight their effect on bond yields, stock prices, and exchange rates of the developed countries where they are being implemented.[1] However, while QE appears to have produced the desired effect in the home (U.S., and to a much lesser extent Euro) market, several open questions remain with respect to its ultimate effect on global markets. In particular, given the unprecedented size of these interventions it is natural to ask how their introduction (and subsequent unwinding) affects not only domestic markets but more generally the whole international financial system.

In this paper, we contribute to the understanding of the global consequences of conventional and unconventional monetary policies by examining to what extent do the ECB and the FED policy announcements affect international market integration. In particular, we seek to address the following four questions: i) Is the impact of FED's announcements on market integration different from those from the ECB?, ii) How is this effect changing through time, as a function of the policies being adopted?, iii) Is the impact similar across major financial assets?, and iv) Are there differences between developed and emerging countries?

[1] See for example Krishnamurthy and Vissing-Jorgensen (2011), Krishnamurthy, Nagel, and Vissing-Jorgensen (2014) D'Amico et al. (2012), D'Amico and King (2013), Banerjee, Latto, and McLaren (2014), and Li and Wei (2013), Rogers, Scotti, and Wright (2014), Pericoli and Veronese (2016), Eser and Schwaab (2016) among others.

We investigate these questions by studying a large cross-section of 39 countries, of which 18 Developed and 21 Emerging markets, during the 2006 to 2015 decade. To highlight the effect of varying monetary policies, we break down the sample into four periods characterized by markedly different central banks' interventions. We look at financial integration with respect to both the equity and the sovereign credit risk (i.e. CDS) markets, as turmoil in these two markets was at the root of the introduction of QE policies. Finally, we study market integration across all countries, between developed and emerging countries, and at the regional (continent) level.

Our analysis focuses on market integration given its key role in international asset pricing. Increasing integration is often accompanied with globalization and risk sharing, with the consequent decline (increase) in the importance of the local (global) factors. Market integration also affects asset allocation choices from another viewpoint. A surge in integration across markets also reveals a decrease in diversification benefits. This is particularly relevant in the most recent years where the search for performance by institutional investors, in particular those focusing on sovereign markets, lead to an increase in the weights associated with emerging markets. Finally, better integration across markets also generates potential risks associated with the diffusion of local shocks within the entire system. Regulators that are worried about the stability of financial markets are thus particularly concerned about the consequences that excessive integration may have on the level and management of systemic risk.

In light of these considerations, a distinguishing feature of our study is the analysis of the effect of integration separately within various groups of countries – Eurozone, Developed markets outside the Eurozone, and Emerging countries in different areas – as well as between Developed and Emerging markets. This analysis allows us to assess whether changes in monetary policies by the ECB and the FED have been accompanied by a change in either regional integration, global integration, or both. Moreover, emerging markets offer an ideal laboratory to study the effect of foreign monetary policies for several reasons. First of all,

it is well-known that equity returns to emerging markets tend to be particularly volatile and subject to structural changes (see e.g. Bekaert and Harvey (1997) and Bekaert and Harvey (2000)). Emerging markets have also been shown to offer diversification benefits in international asset allocation thanks to variations and heterogeneity in their return asymmetries, see Ghysels, Plazzi, and Valkanov (2016). There is also evidence of a strong factor structure in their sovereign credit risk (Longstaff et al. (2011)), which suggests that a large part of this risk may be originating from common (possibly external) shocks. The Fed's and ECB's policies have indeed been accused of having created excessive global liquidity, and thus caused the massive acceleration of capital flows to emerging markets since 2009. Our analysis therefore contributes to the debate put forward by several policymakers in emerging countries[2] about the risk that QE policies may generate a monetary tsunami, currency wars, and new protectionism forms around the world. Our analysis sheds some light on whether QE policies introduced by FED and ECB indeed act as global shocks that spill over to EM thereby reducing the relevance of local sovereign credit risk – and the ability of local regulators to control this risk.

In the financial literature, integration is often expressed as either the proportion of a country's returns that can be explained by global factors, or by the extent of returns co-movement. In line with the first definition, we concentrate on a latent factor approach and measure integration by the fraction of overall variance that can be explained by the first principal component. We also follow the second definition and look at the average pairwise correlation. We complement these commonly-used metrics with a third novel measure that well combines the features of the first and second definition. This new measure focuses on market fragmentation as it looks at the overall covariance structure captured by principal component analysis, and measures how the correlation structure of a set of countries differs with respect to the extreme case of independence among them. We estimate the three measures separately on the announcement and non-announcement days of a given central

[2]The list of these policymakers includes Raghu Rajan, former Governor of the Bank of India (see our opening quote), or Brazil's President Rousseff (2012).

bank, and ask whether the distance is significantly different from zero. Given that the asymptotic distribution for some of these statistics is unknown, we rely on a newly proposed bootstrap procedure which allows us to obtain confidence intervals under the null hypothesis of no changes in the correlation structure.

We find that monetary policy announcements do impact market integration, and in particular that of emerging markets. However, we also uncover significant differences with respect to the period considered, between the equity and sovereign CDS market, and between ECB and FED announcements.

From a global perspective, for the equity market we find that the FED announcements are accompanied with higher market integration during the global crisis and in the following period. This effect is largely confined to emerging markets, and in particular those in the Asia&Pacific region which are highly exposed to the U.S. from direct investments or trading of goods. For these countries, FED monetary policy announcements lead to a substantial strengthening of return co-movements. In contrast, ECB announcements have a positive and significant impact only during the sovereign crisis of 2010-2012. Surprisingly, such an impact is more modest for EMU countries and highest for emerging markets in Europe&MiddleEast. Even more striking is the evidence that during the recent period, when the ECB started its QE policies and the FED started QE tapering, the impact of ECB on equity market integration is mildly negative, small, and not statistically different than zero. Thus, ECB QE policies were not perceived as a global shock in equity markets, not even in the Eurozone.

The results on the pricing of sovereign risk are instead quite different. In particular, we find that the FED and ECB announcements have an *opposite* effect on market integration. ECB interventions induce largely market fragmentation, especially in the last QE period and within EMU countrines. The FED actions are instead perceived as a common global factor and lead to an overall increase in market integration. Moreover, the effect of FED's announcement on sovereign CDS market integration is extremely large and positive in the last five years. The first hints are observer during the massive QE intervention of 2010-

2013 on emerging Asia&Pacific area, at the expenses of EMU integration. In the June 2013 to November 2015, as the FED starts tapering its unconventional monetary policies we observe a large and positive impact on market integration across all countries. The change in integration is not much driven by a larger integration between developed and emerging markets, but rather within developed and emerging markets with quite significant heterogeneity in the size of the increase among the different markets. This finding therefore lends support to the concerns of some policymakers in emerging markets that FED's actions are partly eroding these countries' ability to control sovereign risk.

In addition to comparing the effect during and outside announcement days, we also investigate whether integration varies as a function of the actual size of the monetary policy shock, i.e. yield surprise. To do so, we follow Rogers, Scotti, and Wright (2014) and Pericoli and Veronese (2016) and use the first principal component (the 'level' factor) of the Term Structure of U.S. and Eurozone yields as indicator of 'surprise'. We find that changes in integration are mostly pronounced during events accompanied by a negative and a large change in the level of yields.

To further understand the channel of ECB and FED's announcements on the correlation structure of the market data we separately analyze factor exposures (eigenvalues) and the nature of the first principal component. We find very limited evidence of changes in factor loadings around announcement days. In contrast, we detect significant changes when regressing the first principal component on local shocks in the U.S. (for the FED) or Germany (for the ECB), and on a large array of global factors including aggregate market volatility and the oil price. In particular, we see that FED announcements are always accompanied with an increase in R-squared of the regression. This increase comes through a larger role of U.S. equity and (especially) CDS spreads, at the expenses of the other factors. ECB announcements are instead associated with a mild change in R-squared for equity, and a more pronounced drop for CDS. Overall, the message that emerges from these findings is that FED monetary policy decisions make U.S. local factors more globally relevant, while

the same does not hold for the ECB.

Finally, we dig deeper into the nature of PCA factor loadings. The evidence that no significant changes occur around announcement days suggests that a country' exposure to outside monetary policy revisions is related to structural characteristics. To formally explore this hypothesis, we relate these exposures to the degree of a country' trade and financial openness. Several studies have shown that liberalization, globalization trends, and their interaction explain booms, crashes, and asymmetries in emerging markets stock market returns, see Martin and Rey (2006), Kaminsky and Schmukler (2008a), and Ghysels, Plazzi, and Valkanov (2016). Complementary to this literature, we find that emerging countries with higher financial openness and (to a less extent) trade openness are more exposed to global shocks. The interaction between the openness measures also enters with a significant, negative sign. These results hold both in the equity as well as in the sovereign CDS market, and explains why these countries are more impacted by outside monetary policy shocks.

The remainder of the paper is organized as follows. Section 2 discusses related literature. Section 3 review the various phases of monetary policy interventions over the last 10 years. We outline our data and methodology in Section 4. Section 5 presents our empirical results. Section 6 analyzes factor loadings and the global nature of the first principal component. Section 7 relates factor loadings to measures of openness. Finally, Section 8 offers concluding remarks.

2 Related literature

Our paper contributes to different strands of the literature. First, the paper relates to a number of studies that investigate the impact of monetary policy on market valuations. In particular, the role of monetary policy announcements on asset pricing is well documented (see Cook and Hahn (1989), Bernanke and Kuttner (2005), Gurkaynak, Sack, and Swanson (2005), Ehrmann and Fratzscher (2004), Bjornland and Leitemo (2009) and Ippolito,

Ozdagli, and Perez (2015), among others). Within this context, the literature on QE and near-zero rates is still in its infancy and has thus far focused mainly on measuring the effect of QE on macroeconomic aggregates such as inflation and GDP (see Chen, Curdia, and Ferrero (2012), Chung et al. (2012), Gambacorta, Hofmann, and Peersman (2014), and Kapetanios et al. (2012) among others). A series of papers looks the effects of QE policy measures on financial markets, mainly interest rates and equities in the U.S. and developed European countries. Examples for works in this area are Krishnamurthy and Vissing-Jorgensen (2011), D'Amico et al. (2012), D'Amico and King (2013), Banerjee, Latto, and McLaren (2014), Li and Wei (2013) and Pericoli and Veronese (2016). Recently, a few studies explore the impact of QE on Emerging markets. Fratzscher, Duca, and Straub (2014) investigate international spillovers and transmission channels originating from ECB unconventional monetary policy actions for a sample of 16 developed and 22 emerging countries and find that ECB policies have a positive impact on global equity markets and confidence. Similarly, Fratzscher, Lo Duca, and Straub (2013) and Chen, Mancini Griffoli, and Sahay (2014) show that U.S. monetary policy shocks do affect capital inflows and asset price movements in emerging market economies. Unlike these studies, we focus our attention on measures of market integration, and study how these vary through time for the equity and CDS markets as a function of time and monetary policies, both conventional and unconventional.

The paper also naturally adds to the vast literature on market integration.[3] This literature looks at a wide array of measures of integration, including cross-country differences in cost of capital (Bekaert and Harvey (2000)), volatilities (Bekaert and Harvey (1997)), and correlations (Goetzmann, Li, and Rouwenhorst (2005)), and the role of global versus local factors in explaining these differences. Principal component analysis has also been recently extensively used as a statistical tool to extract common factors from a cross-section of economic indicators (see e.g. Ludvigson and Ng (2009)) or asset prices. The closest studies to

[3] A (very) partial list of studies include see Stulz (1981), Errunza and Losq (1985), Stulz (1987), Cappiello, Engle, and Sheppard (2006), and Kumar and Okimoto (2011), Mauro, Sussman, and Yafeh (2002), Codogno, Favero, and Missale (2003), Geyer, Kossmeier, and Pichler (2004), and Pagano and von Thadden (2004), Remolona, Scatigna, and Wu (2008), Pan and Singleton (2008), Ehrmann et al. (2011), Bernoth and Erdogan (2012), Jotikasthira, Le, and Lundblad (2015)). Volosovych (2011), Dahlquist and Hasseltoft (2013), Carrieri, Errunza and Hogan (2007) and Pukthuanthong and Roll (2009).

ours in this context are Pukthuanthong and Roll (2009) and Namvar et al. (2016) for equity, and Longstaff et al. (2011) who document a large role for the first factor in explaining a large cross-section of sovereign CDS. The ability of few 'global' factors to summarize the full covariance or correlation structure, and conversely the percentage of the variance of individual country movements explained by such factors are commonly utilized as indicators of integration. From an economic viewpoint, the ECB and FED monetary policy decisions may be regarded as global shocks, as their announcements affects contemporaneously different financial markets (equity and sovereign bonds) and both developed and emerging countries. Our analysis sheds light to what extent can these decisions be regarded as global factors, and in which direction do they affect the market interactions. By breaking down our analysis at the country type, time, and asset level we are able to identify the markets that were most affected (positively and negatively) by the central banks decisions, and gain a better understanding of their ultimate economic global impact.

From a methodological point of view, our analysis allows for comparison of the impact of ECB and FED monetary policy interventions addressing the relevance of "externalities" originating from a country' monetary policy decision. The main empirical problem in this context is to conduct a natural experiment that can serve as basis for comparison of QE with non-QE periods or of periods when different monetary policy instruments were applied. On this regards, our identification approach builds on the solutions proposed by Rigobon (2003), Rigobon and Sack (2004), Rogers, Scotti, and Wright (2014), Rogers, Scotti, and Wright (2015), and Pericoli and Veronese (2016).

3 Monetary policy interventions

The 2007-2009 global financial crisis forced central banks to explore a new universe – a battery of unconventional monetary policy measures that brought interest rates close to their economic lower bound equal to or even slightly less than zero. With cash being a

risk-free asset with a zero rate of interest (and only potentially small handling costs), central banks are bound by this rate and cannot lower their policy rates much further to stimulate growth if necessary. Consequently, they started to introduce new intervention tools, such as quantitative easing programs (QE), where central banks massively buy bonds from market participants with the intent of fostering economic growth.

The Fed's initial round of U.S. Treasury bond purchases in late 2009 at a volume of USD 300 billion represented an unprecedented intervention in the market for U.S. government bonds, mortgage backed securities (Large Scale Asset Purchase Program), and provided substantial forward guidance regarding the future direction of its policies. It continued in the second round (the so-called QE2), which started in November 2010, and the Maturity Extension Program announced in September 2011. On September 2012, the FED announced a new USD 40 billion per month, open-ended bond purchasing program of agency mortgage-backed securities (QE3). Moreover, the Federal Open Market Committee (FOMC) announced the aim to maintain the federal funds rate near zero at least through 2015. As a result, the balance sheets U.S central bank reached unprecedented levels. On June 2013, Ben Bernanke announced a "tapering" of some of the Fed's QE policies contingent upon continued positive economic data. As a direct consequence of the announcement, the stock market dropped by approximately 4.3% over the following three trading days, and there was a huge spike in market volatility in emerging markets.

The ECB's monetary intervention as a response to the 2007-2009 crisis and the sovereign crisis of 2010-2012 takes many forms, ranging from the jawboning and formal guidance by its board members, in particular its President, to the injection of liquidity into the major banks in the Euro-zone (the fixed-rate tender, full-allotment) and even to direct purchases of sovereign bonds in the cash markets. During the Euro-zone crisis, the policy interventions by the ECB consisted of (i) the Security Market Program, initiated in May 2010, (ii) Long Term Refinancing Operations or LTRO, announced and implemented in December 2011, (iii) policy guidance, including the "whatever it takes" speech by Mario Draghi on July 26, 2012

who unveiled the potential for new tools to ease the European sovereign debt crisis, and (iv) Outright Monetary Transactions or OMT, also announced in December 2011. On January 2015, in a dramatic change of policy, ECB announced (and in March 2015 started into) a prolonged period of quantitative easing, with an expected balance sheet expansion of more than Eur 1 trillion in the following 18 months that it has so far prolonged till March 2017, with a monthly purchases in public and private sector securities amount to Eur 80 billion.[4] Given the size and extraordinary nature of these interventions, that have no precedents in the history of ECB and other modern central banks, their impact on the well-functioning of (domestic and international) capital markets and on real growth are still being questioned.

4 Data and methodology

In Section 4.1, we describe our data for monetary policy announcements and asset prices. In Section 4.2, we outline our empirical methodology and discuss the assumptions underneath our identification approach. Finally, in Section 4.3 we take a first look at the time-series and cross-sectional properties of our dataset.

4.1 Data and variables construction

Our goal is to measure the effect of monetary policy interventions on market integration. We begin by identifying dates of central banks' interventions. To this end, we rely on the list of ECB and FED meetings and announcements that is compiled by Pericoli and Veronese (2016) (see their Appendix Table 4 and 5). This list is comprised of all scheduled and unscheduled Governing Council and FOMC meetings, combined with a series of dates where changes in QE policy were announced. In what follows, we refer to such dates simply as meetings. There are a total of 127 ECB meetings and 121 FOMC meetings during the January 2006 to November 2015 sample period, which are help on week days – mostly, on Thursday for

[4]For a more detailed description of ECB and FED's interventions, see Fawley and Neely (2013) and Borio and Zabai (2016).

ECB and Wednesday for FOMC. Given the relatively large size of the our cross-section of countries compared to the number of events, we retain the daily nature of the data in our baseline analysis in order to maximize the number of time-series observations. In Section 5.3 below we show that using data sampled at the weekly frequency yields comparably similar results.

It is quite likely that market participants react in anticipation of the actual release of information, especially for those scheduled meetings for which some action is anticipated. In addition, differences in time zone across countries may induce a lagged response in some markets. Finally, the market for credit derivatives is not centralized nor fully liquid, and therefore it may take some time before the information is fully reflected in the pricing. For these considerations, we opt for a (-1:1) event window which includes the day of the meeting and the two neighbouring days. We verify that our findings are robust to changes in the event window definition and in the data frequency, see Section 5.3.

We rely on measures of integration that are derived from the prices of equity claims and credit derivatives, i.e. CDS contracts. While market integration can be also defined with respect to national aggregates and measures of economic activity, such as GDP, consumption, or industrial production, these are available at the best at the monthly (and for most of the countries, at the quarterly or annual) frequency. In these respects, our approach is closest in spirit to Bekaert and Harvey (1995) who measure the degree of integration directly from equity return data.

For equity, we use total return indices from Datastream.[5] The indices are denominated in local currency, to avoid contaminating our results with the factor structure in exchange rates (see e.g. Lustig, Roussanov, and Verdelhan (2011)). We construct simple, daily returns. Our source for CDS contracts is Markit. Markit collects CDS prices via a survey of brokers-dealers and proceeds to clean the data by discarding stale information, outliers, and inconsistent observations. It then reports the daily composite price for each CDS con-

[5]These are the value-weighted 'DS Market' indices that are constructed using all available stocks in a given country. The only exception is Slovakia, for which we use the SAX 16 Index.

tract for each reference firm in its database. For our analysis, we utilize data for quotations that are denominated in USD and reference the sovereign of a given country.[6] To maximize sample availability, we use the most common restructuring clauses available on a given date (typically, CR or MR). We focus on quotes for the 5-year contract as this is far the most liquid issue. The data coverage varies significantly across countries, starting January 2002. Moreover, for the earlier period several series exhibit limited to no variation across several months. For this reason, we begin our sample in January, 2006 when data on most countries starts being available and is no longer stale. This choice restricts our cross-section to a total of 39 countries, which are listed in Table AI. The list is comparable to existing studies on international equity and bond markets (see inter alia Ghysels, Plazzi, and Valkanov (2016) and Longstaff et al. (2011)). The most notable exceptions are Canada, Switzerland, and the U.K. among the Developed markets (as CDS data is either stale, or starts later than 2006), and India for Emerging markets (CDS data is stale for most of the sample). We further exclude Greece as the CDS quotes are stale at above 10,000 basis points for a prolonged period during 2011-2012. We group countries into 18 Developed and 21 Emerging markets following the classification provided by FTSE.[7] We further contrast the impact of ECB and FED's interventions on the group of the 11 markets that are in the Eurozone (EMU) with that on the 8 developed markets that are not part of it (DM ex-EMU). Finally, we separately analyze the effect on emerging markets based on whether they are located in Europe&MiddleEast (8 countries), Asia&Pacific (5 countries), and Americas (6 countries). In order to study changes in integration between developed and emerging markets we also build two equally-weighted indices, that we denote respectively "DM Idx" and "EM Idx".[8]

[6] We rely on USD-denominated CDS as these are the most frequently available and liquid. Using Euro-denominated CDS does not however alter our findings. In general, given that the currency only pertains to the notional amount, exchange rates fluctuations play a very minor role in CDS contracts with respect to credit risk.

[7] We pool the group of (4) frontier markets with emerging markets, as they are too few to be analyzed separately.

[8] Note that the country equity indices are denominated in local currencies so for equity these indices do not reflect a feasible trading strategy.

4.2 Methodology

A common issue when analyzing market data for the evaluation of economic policies (even beyond the focus on monetary policies of this paper) is the identification of changes in the structural parameters of the underlying economic model. This clearly affects the covariance structure of the data (or of reduced model residuals). The latter, represents the starting point for all the analyses we perform. Therefore, we must correctly identify the periods associated with potential changes in the structural model parameters which impact the covariance and correlation structure, and ultimately integration. A possible solution is to follow the approach proposed by Rigobon (2003) and Rigobon and Sack (2004), which exploits the presence of heteroskedasticity in the data. The crucial ingredient underneath this approach is the existence of periods characterized by different volatility levels, which are then used to identify the structural model parameters under the assumption that they are invariant across periods. Our purpose, instead, is slightly different. In fact, we aim at identifying periods where the integration across countries changes, thus pointing at changes in the structural parameters. Nevertheless, we must anyway avoid to misinterpret changes in volatility with changes in structural links. Therefore, even in our case the selection of periods characterized by sensible changes in the risk level is crucial. In these respects, we build on evidence in Pericoli and Veronese (2016) that the volatility of yields in announcement days is indeed significantly different (higher) than on non-announcement days. In addition, beside the identification of sub-samples, we postulate, following Pericoli and Veronese (2016), that the integration might change if we separate announcements by non-announcement periods.

From a methodological viewpoint, the selection of the sample is thus central for our subsequent analyses. To investigate the impact of different combinations of conventional and unconventional monetary policies interventions, we split the sample over four different periods characterized by relevant changes in the activities and policies of central banks. The first period covers from January 2006 until July 2007, and represents the pre-crisis period. The second period from August, 2007 to December, 2009 spans the the global financial crisis

starting with the tensions in the subprime market, Lehman's default, and the interventions by the FED and the ECB. The third period ranges from January, 2010 until May, 2013 and includes the Euro sovereign crisis and the corresponding ECB interventions on one side, and QE2 and QE3 of the FED on the other side. The fourth and last period ranges from June, 2013 until November, 2015 and is characterized by the tapering of the FED and, in January 2015, by the beginning of ECB QE program. For each of the periods, we aim at comparing the market behavior in days with announcements to that in days without announcements. Moreover, we evaluate the heterogeneity across different groping criteria for the countries included in our study.

While changes in volatility around announcement days and across time periods play a key role in the 'structural' approach of Rigobon (2003), they may have distortive effects in 'reduced' form approaches such as event studies. Indeed, Forbes and Rigobon (2002) demonstrate that inference conducted on correlation matrices may be biased in the presence of heteroskedasiticty. Since daily data are characterized by rich dynamics in conditional volatility, these effects must be filtered away. For this reason, our first step consists of pre-filtering returns and CDS changes by time variation in conditional volatility. On each series individually taken, we fit the asymmetric GARCH model of Glosten, Jagannathan, and Runkle (1993) and treat the scaled residuals (i.e, the series scaled by conditional volatility) as our input data. This step guarantees that our measures of integration reflect only changes in the correlation structure from central banks' announcement, and are not contaminated (or, do not capture) heteroskedasiticty or potential heterogeneity in the response of volatilities to monetary policy announcements. We comment on the results when using the raw (unfiltered) series in Section 5.3.

To proceed, let X_t be the panel of market data (pre-filtered returns or CDS changes) for K countries in a specific sample period. Note that the actual K depends on the actual group of countries we include in the analysis. Consider announcements by a given central bank j, with $j = \{ECB, FED\}$. Let $X_{t,A}$ denote the subsample of X_t during the announcement

days, i.e. those falling in the event window of the meetings, and $X_{t,N}$ the non-announcement subsample of days that fall outside the event window. From these subsamples, we obtain the corresponding correlation matrices $\mathcal{R}_A$ and $\mathcal{R}_N$.

We rely on three measures of integration that reflect the correlation structure of the data. These are computed separately for each central bank j and time period combination, but to ease exposition we only keep track of the announcement A and non-announcement N subscripts.

Our first measure is the fraction of overall variance explained by the first principal component of X_t. Principal Component Analysis (PCA) has been extensively used in the financial literature as an efficient way of summarizing the joint behavior of several financial variables ranging including fixed income, equity, and exchange rates. See Pukthuanthong and Roll (2009) for a paper that defines market integration using PCA of equity returns, and Longstaff et al. (2011) for evidence on the sovereign CDS market. For each subsample $i = \{A, N\}$, the spectral decomposition of the correlation matrix is:

$$\mathcal{R}_i = L_i D_i L_i' \tag{1}$$

where L and D denote the matrix of loadings and the diagonal matrix of eigenvalues, respectively. From the decomposition, we construct principal components as $F_{t,i} = L_i' X_{t,i}$. In what follows, we use the terms principal components and factors interchangeably. We look at the fraction of total variance accounted for by the first principal component, and denote it by $F1_i = \delta_{1,i}/K$, where $\delta_{k,i}$ is the eigenvalue associated with the $k-$th principal component.

As a second measure of market integration, we look at the average pairwise correlation in X_t. Several studies look at at changes in correlation as hints of time-varying integration (see inter alia Goetzmann, Li, and Rouwenhorst (2005)). In particular, changes in the correlations of emerging country returns with global factors following major market liberalizations are usually interpreted as evidence in favor of increasing globalization. In addition, corre-

lations bring a natural interpretation as they summarize the benefits that can be achieved by international portfolio diversification. We compute the average across the off-diagonal elements and denote it $\bar{\rho}_i$, with $i = \{A, N\}$. We use Pearson correlation as it is easier to interpret from an asset allocation perspective, but our conclusions are unchanged if we compute instead Kendall rank correlation.[9]

The literature on market integration generally focuses on measures associated with integration, the higher the measure the higher the integration. Moreover, the interest lies, in almost all cases, on the first principal component or on the entire correlation matrix. We propose here a different measure of fragmentation which we recover from the entire set of principal components, rather than with just the first one. By solely focusing on the first principal component we monitor the integration across countries, implicitly assuming the existence of a single relevant common factor (the first principal component) across the modeled variables. However, the relevant underlying (latent) factor structure that might affect the dependence across variables could include more than one single driver. The existence of more than a single relevant principal component leads to the presence of relevant fractions of variance explained by a few (more than 1) principal components. Focusing on just the first one will automatically exclude the impact of, say, the second and third components. As we do not know the number of potentially relevant principal components, i.e. the number of orthogonal factors, we suggest a comprehensive measure.[10]

Given a set of K orthogonal (i.e. mutually independent) variables, the fraction of variance explained by each principal component is $1/K$ as the correlation matrix is the identity matrix. On the contrary, if just a single component is relevant, its fraction of variance explained is very close to 1, while that of the other principal components approximates zero. In that case, the correlation matrix approaches a matrix of ones. We thus rely on the following indicator measuring the distance of a correlation matrix $\mathcal{R}$ from the limiting case of orthogonality, or

[9] See Kapadia and Pu (2012) for a recent application of Kendall correlation to study the integration between the equity and CDS market.

[10] We could identify the factors by standard heuristic criteria such as the scree plot, or the fraction of variance explained. Since the outcome may likely vary across specifications, we opt for a more general criterion.

its fragmentation:

$$\mathcal{FR}_i = 1 - \frac{K^p}{(K-1)^p + K - 1} \sum_{k=1}^{K} \left| \frac{\delta_{k,i}}{K} - \frac{1}{K} \right|^p \quad . \tag{2}$$

The power p can be set to 1, or to 2 if we want to give more weight to large deviations from the orthogonality case. The scaling factor in front of the second term is used to normalize the indicator. Note that the fragmentation indicator takes only positive values. It equals to 1 in the case of orthogonal variables, that is, in the limiting case of disintegration. Differently, the indicator equals 0 in the limiting case of the first principal component capturing 100% of the overall variance. A larger value (an increase) of the indicator suggests a large (an increase in) fragmentation across the variables (i.e the countries in our cross-section). We stress that such an indicator accounts for the role played by *all* principal components.

Under the assumption that central bank j's announcements are not accompanied by a change in the integration in a given period $\mathcal{M}$,[11] we expect that $\mathcal{R}_A = R_N$. Consequently, the fraction of variance explained by the first principal component, the average correlation, and the fragmentation index should be identical during announcement days and non-announcement days. Under this null hypothesis, we expect that the distances

$$\Delta F1 \equiv F1_A - F1_N \tag{3}$$

$$\Delta\rho \equiv \bar{\rho}_A - \bar{\rho}_N \tag{4}$$

$$\Delta\mathcal{FR} \equiv \mathcal{FR}_A - \mathcal{FR}_N \tag{5}$$

should all be zero. We report the estimates for these distances for each time period, central bank, and X_t composition, and test whether they are significantly different from zero. Given that our sample size may not be sufficiently large to trust asymptotic approximations, we resort to a bootstrap procedure that takes all features of the data into account. The procedure

[11] Note that our measure is robust to possible changes in the variance level as we focus solely on correlations.

is detailed in Appendix A.[12]

4.3 A first look at the data

As a prelude to our analysis, we summarize the time-series and cross-sectional properties of equity returns and sovereign CDS spreads during the sample period considered. To this end, the top plot of Figure 1 displays the cumulative, equally-weighted average equity return (black thick line) separately computed across EMU countries (left plot), Developed markets ex-EMU (middle plot), and emerging markets (right plot). The vertical dotted lines mark the end of the periods considered. We note broadly similar patterns across groups, with a run-up in prices during the pre-crisis period, and a large drop followed by a recovering toward the end of 2010, the turmoil of the European sovereign debt crisis (which is especially pronounced in EMU countries), and the increase in valuations in the last part of the sample reaching levels above the pre-crisis period.

To give a sense of the cross-sectional distribution within countries of a given group, we plot the cross-sectional standard deviation (blue dotted line) on a common scale across the three groups. Overall, the cross-sectional dispersion is much higher for Emerging markets, and shows pronounced spikes exceeding 5% during the major events in the sample. The volatility of EMU countries returns during the sovereign debt crisis is at comparable levels to the 2008-2009 period, and remains high in the last part of the sample. In contrast, the dispersion in returns for developed markets ex-EMU shows a declining trend after 2012 and hovers around lower values. The fact that Emerging markets display rich (heterogeneous) cross-sectional dynamics is consistent with the evidence in e.g. Ghysels, Plazzi, and Valkanov (2016) and underscores the potentials for looking at the transmission of monetary policy shocks toward these countries.

The bottom figures plot the time-series pattern of equally-weighted average sovereign

[12] In short, the bootstrap generates artificial samples of scaled X_t, on which we impose the null hypothesis of equal correlation structure. We then simulate artificial announcement and non-announcement dates in a size equal to that observed in a given sample, and compute estimates of the distances in (3)-(5) under the null. By repeating the procedure a large number of times, we obtain the empirical confidence interval that we use to assess the significance of our sample values.

CDS spread (black thick line). The differences across the three groups of countries are even more pronounced. It is noteworthy that the CDS spreads for EMU countries reached their maximum at 420bps in the middle of the third period, and then calmed down following the ECB intervention reaching values in the 50bps range toward sample end. In contrast, the CDS spread of the other Developed markets has its maximum around 200bps at the peak of credit crisis in 2009, increased to a more modest 100bps level in 2012, and decreased almost steadily thereafter to a level of 30bps. Finally, Emerging markets reach averages above 700bps in 2009 and 300bps in 2012, and are characterized by a distinct upward trend in the later part of the sample to values in the 400 to 500bps range.

We summarize the cross-sectional distribution of sovereign CDS spreads by the standard deviation of their changes divided by the average CDS in a given group (blue dotted line). This 'coefficient of variation' is scale-free, and allows us to account for the marked differences in average CDSs. We see that this coefficient is lowest for Developed markets ex-EMU, while EMU countries show cyclical spikes in their dispersion. The variability of CDS spreads for Emerging markets is highest in the last part of the sample, again suggesting that Emerging markets provide a potentially diverse set of countries to look at.

5 Results

In this section we outline the results of our empirical analysis. In Section 5.1, we discuss estimates for our baseline model linking monetary policy announcements to market integration. In Section 5.2, we refine our analysis further by looking at the intensity and sign of the announcements, and at complementary measures of integration. Finally, Section 5.3 collects a series of robustness checks.

5.1 Baseline model

Tables 1 to 4 present our main empirical results. Within each table, for each of the four sample periods considered we report the estimates for $F1$ (Panel A), $\bar{\rho}$ (Panel B), and $\mathcal{FR}$ (Panel C) computed on either the announcement or non-announcement event days, and their difference Δ. Statistically significant Δ estimates at the 10% level using the boostrap method described in Appendix A are marked in bold. The analysis is performed by pooling data across all countries, and separately for: the group of EMU countries; developed markets (DM) ex-EMU (i.e. Australia, Denmark, Israel, Korea, Japan, Norway, Sweden and the U.S.); all emerging markets (EM); emerging markets in either Europe&MiddleEast, Asia&Pacific, or Americas; and finally, the bivariate system consisting of the developed market and emerging market indices (DM Index & EM Index).

We begin by discussing Table 1, which looks at the impact of ECB announcements on equity market integration. Focusing on Panel A, we note that market integration, independently from ECB interventions, was higher during the global crisis and the sovereign crisis (second and third sample, from August 2007 till May 2013). This increase is observed both when considering all 39 countries together, as well as when we investigate market integration at the regional level. It is also present *between* developed and emerging markets. Compared to the pre-crisis period, we also see that equity market integration in the last period of ECB QE policies is in general lower, in particular within EM and between DM and EM.

The impact of ECB policies on market integration has been generally negative in the initial period, where the difference between the ex-ECB and ECB announcement days is a modest (and not statistically significant) -2.03% across all countries. During the crisis period, in general all the markets are more integrated but ECB announcements induce an additional slight increase in integration overall, and between developed and emerging markets; however, none of the differences meets statistical significance. The third period from January 2010 till May 2013 is characterized by the European sovereign crisis, where the ECB heavily intervened to avoid the breakup of the Euro area. During this period, ECB

announcements are accompanied by a significant and markedly positive effect on integration, as $F1$ increases by a full 5.25% from 39.03% to 44.27%. Statistically significant $\Delta F1$ are observed both between developed and emerging markets (from 87.68% to 91.41%) as well as within different geographical areas: EMU by 2.86% (not statistically significant), DM ex-EMU by 6.89%, and EM by 5.79%. If we look at Emerging markets broken down by geographical regions, we note that ECB announcements have a strong impact for EM Europe&MiddleEast (7.30%), that is, within countries that are geographically (and also commercially) highly related to the EMU area. The impact is much lower and not statistically significant for EM Asia&Pacific, i.e. China, Malaysia, Philippines, and Thailand and EM Americas. Interestingly, we find that the most recent sample period of QE monetary policy is accompanied by a general decrease in market integration. Developed and emerging markets are less integrated by 6.70% (statistically significant) and emerging markets were *negatively* impacted by 0.429%, with the EM Europe&MiddleEast by 2.79%. However, none of these differences is statistically different from zero. Therefore, our analysis shows that the recent ECB QE policies didn't strongly alter international equity market integration, and if any, it increases market dis-integration between developed and emerging countries.

The results for the average correlation in Panel B convey a very similar message. Changes in correlations are large in the crisis periods, and statistically significant only during the sovereign crisis. Again, the larger variation is manifest within EM Europe&MiddleEast while EM Asia&Pacific and EM America are not significantly affected. The increase in correlation is confirmed both between developed and emerging as well as within these markets. Finally, Table 1 Panel C reports the results of the Fragmentation index. The table shows that the conclusions we draw from Panel A and B are robust, as even considering all latent factors do we observe a reduction in market fragmentation following ECB announcements in the third period. The analysis confirms that the ECB announcements largely affects market integration between geographical area and developed countries during the sovereign crisis.

The evidence for the reaction of equity markets to announcement by the FED is reported

in Table 2. We note several differences with respect to Table 1, which are particularly pronounced for emerging markets.

First, FED's announcements are generally accompanied by an increase in $F1$ also in the first period, i.e. before the global financial crisis. This increase is largest for emerging markets at 5.94%, and mainly for emerging markets in Europe&MiddleEast (at 10.47%, statistically significant). Second, the positive effect remains large and significant also in the crisis period, with emerging markets displaying again the largest difference $\Delta F1$ at about 9%, and developed markets ex-EMU at 8.09%. The FED's announcements significantly alter market integration both between and within developed and emerging markets. Thus, its announcements are truly perceived as global shocks. Among emerging markets, the change is statistically significant for all the groups of emerging countries. Third, FED's QE2 and QE3 interventions (during the sovereign crisis, i.e. the third period) had a dramatic impact on the co-movements of emerging markets, leading to an across-the-board $\Delta F1$ in excess of 6%. This result provides empirical support for the concerns of policymakers in emerging markets that changes in FED's monetary policy spill over to EM, and are amplified. Finally, the market reaction in the last period is mildly positive, although not statistically significant. The role of FED's announcements as a global shock is largely confirmed by the correlation analysis reported in Panel B and by the fragmentation index in Panel C, with a decrease in nearly all combinations which is particularly strong (and significant) in the global and sovereign crisis and post-crisis samples.

In sum, we find that in the second period the FED announcements have a strong impact on global market integration. This effect is larger than that of ECB announcements during the sovereign crisis, as the FED' announcements of the introduction of the QE2 and QE3 policies are felt strongly by the group of emerging markets.

We next turn to the discussion of market integration in the CDS market. Panel A of Table 3 reports the impact of the ECB announcements on CDS changes. The table shows that CDS market integration increases during the global and sovereign crises periods. In the

pre-crisis period ECB announcements are not perceived as global shock, but have mainly a negative impact on integration between developed and emerging markets and also over all with a reduction of the variance explained by $F1$ respectively of 11.59% and 7.96%. The impact within EMU and developed markets ex-EMU is instead positive albeit not statistically significant. In the following periods, the ECB announcements increase market integration largely during the sovereign crisis; the effect is significant for all countries, within emerging markets, and in particular within EM Europe&MiddleEast and EM Americas.

In the last period, ECB announcement and implementation of its unconventional QE policy lead to an overall *decrease* in market integration. If we consider all 39 countries, we see that $F1$ drops by 1.92% during ECB announcements but the difference is not statistically significant. The same applies to all the other groups with the only exception for the group of Asia&Pacific countries where the difference equals a significant -5.21%. As discussed in the robustness Section 5.3, working on the raw (not volatility-filtered) data reveals a large drop in integration in EMU countries. This implies that QE policies did reduce integration among EMU countries in the form of induced heterogeneity in the magnitude of the shocks, rather than in their direction. The results are confirmed by the pairwise correlation analysis reported in Panel B and the fragmentation index reported in Panel C.

Taken together, the analysis indicates that ECB announcements are largely not global risk factors for sovereign CDS, not even for the EMU countries in line with the fragmentation among core and peripheral countries that have a different reactions to ECB announcements. The impact on emerging markets is largely confined to the EM Europe&MiddleEast and EM Americas countries during the sovereign crisis period.

The reaction of the CDS market integration to FED announcements is, instead, quite different with respect to the one of the ECB. In the first period, before the global crisis we see that FED's announcements reduce market integration. The result is confirmed by the pairwise correlation, but the fragmentation index indicates a reduction of fragmentation. However, the difference is not statistically different from zero for all the three measures. The

difference is not statistically different for all the three measures also in the second period, i.e. during the global crisis with Lehman default and several FED announcements of unconventional monetary policies surrounded by large uncertainty. During the QE2 and QE3 we observe the first significant impact of FED announcements on CDS market integration with a positive impact on EM Asia&Pacific confirmed by all the three measure with a difference that is statistically different than zero. This indicates that the FED announcements starts to be a global risk factor for these markets as claimed by several policymakers of these countries.

The most striking result for the sovereign CDS market is found in the last period, when the FED starts tapering the QE. Market integration among the 39 countries increases substantially with the first factor that explains an additional 11.81% of overall variance. This change is largely significant. The impact on market integration between DM and EM is also positive, but quite lower (and not significant) at 5.46%. Indeed, the effect of FED monetary policy announcements is mostly within the countries in the different geographical areas, with the largest increase concentrated for the groups of EM Europe&MiddleEast (16.89%) and DM ex-EMU (14.50%). The only exception is the impact on EM Americas where the difference is negative and statistically significant. These results are in line with those of the pairwise correlation index and the fragmentation index both in terms of the magnitude of the increase and statistical significance. This indicates that in the last period the FED policy plays a relevant role for CDS markets: it is indeed a global factor that generates spillovers to both developed and emerging countries.

5.2 Further analysis

In our baseline specification above, we contrast the behavior of market integration measures during and outside meetings. This analysis treats all meetings equally without taking into account whether the announcement was expected or unexpected. Market efficiency implies that financial markets should only react to the arrival of new, unexpected information.

Therefore, in order to differentiate the analysis based on the sign and magnitude of the meetings' impact on the market, we follow Rogers, Scotti, and Wright (2014) and Pericoli and Veronese (2016) and use a measure of the overall 'surprise' in yields. This measure is the first factor in the Principal Component Analysis of the Term Structure of zero-coupon bond Euro yields (for ECB meetings) and U.S. yields (for FOMC meetings), which is computed separately across sub-periods to account for changes in their loadings.[13] We cumulate the change over the three days that constitute our event window. Given this overall shock, we separate meetings associated with a positive versus negative surprise. Alternative, we separate large versus small shocks, by focusing on the quartiles of the surprise index. That is, large shocks are defined as those above the 75% quantile or below the 25% quantile.

Table 5 reports the results. To save on space, we report only the distance in the fraction explained by the first principal component, $\Delta F1$, for positive minus negative and large minus small shocks. The results for the other two measures yield similar insights. It is important to emphasize that this analysis compares solely announcement days. We use the same bootstrap procedure adopted for the previous analyses to test for significance in $\Delta F1$.[14]

We note that much of the effect of monetary policy on market integration is concentrated on negative and large shocks. This is particularly true for the CDS market, and from August 2007 onward. Across the four periods, we do observe different responses for equities and CDS, and also to the policy action of the ECB versus the FED. During the crisis period, we observe a larger reaction of the equity and CDS markets to the ECB meetings, with a more pronounced impact of large shocks to the equity market and of negative shocks to the ECB. When contrasting emerging to developed, the former are more impacted by shocks as both large and negative shocks are relevant. During the sovereign crisis and in the last period, the FED seems more relevant, mostly on CDS. Notably, FED meetings are not significant for CDS when considering the EMU countries during the sovereign crisis period, while ECB

[13] We are extremely grateful to Pericoli and Veronese (2016) for sharing their data with us.

[14] In few instances, especially in the first period for positive versus negative shocks, there are not sufficient time-series observations to carry the analysis. These instances are denoted with a dash.

meetings with negative shock display a significant impact.

5.3 Robustness tests

We perform an extensive set of checks and additional analyses to confirm and extend our main results along various dimensions. For brevity, we do not tabulate these checks as they are in agreement with our main findings.

Event window: We perform sensitivity analysis with respect to the length and start of the event window. We modify the window so that the start is at the event day, and thus focus on (0,+2). Such a first choice allows verifying the possible role of anticipation. We also consider windows of larger size, defined as (-2,+2) and (0,+4), to capture potentially long-lasting news.

Unfiltered data: Instead of pre-filtering the data by asymmetric volatility, we examine the correlation structure of the raw series. The most striking differences appear in the effect of ECB announcements on the sovereign CDS market, especially for EMU countries where the percentage explained by the first principal component drops by 9.3%. This suggests that while ECB interventions did not significantly affect the correlation structure of EMU asset markets, they nevertheless induced disintegration in the form of heterogeneity in their volatility.

Weekly data: We run our analysis on data sampled at the weekly frequency. Given the international nature of our dataset, working on weekly data guarantees that the information has reached the markets by the end of the observation period thereby solving issues related with differences in time zones. Also, daily variations in CDS prices tend to be small and infrequent, and this staleness may artificially inflate our integration measures. When dealing with weekly data, we assigning each event to the last open market day of the event week. In that case, the events will last for just a single week. Again, we find that our main conclusions still hold.

Alternative covariance estimator: As an alternative to the use of weekly data to capture

markets a-synchronicity, we retain the daily nature of the data but rely on a Newey-West type of estimators that also takes into account one lead/lag effect. We found our main findings remain robust.

Dynamic factor model: As an alternative to the use of Principal Components Analysis where we recover factors from a decomposition of the correlation matrix, we estimate a variation of the latent factor model of Breitung and Eickmeier (2015). The idea is to filter unobservable factors driving the evolution of the cross-section of equity or CDS that are specific to meeting and ex-meeting days. We defer a description of the model we adopt to Appendix B. The corresponding results are reported in Table AII. We note that, even focusing on a different approach for estimating the factors, our main conclusions regarding the impact of ECB and FED policy announcements on market integration remain valid.

6 What drives market (dis)integration?

Our evidence that the FED and ECB interventions have significant (and potentially even opposite) effects on market integration merits further investigation. In particular, changes in the correlation structure of financial markets around meeting days can originate from changes in factor exposures or in the 'systematic' nature of the principal components. To see this formally, consider a particular time period and central bank j, with $j = \{ECB, FED\}$. Let $\hat{F}_{t,A} = L_N' X_{t,A}$ be the "synthetic factor" in the announcement sample, that is, the factor we would have observed during the meeting days had the announcement not changed the factor loadings from the non-announcement sample. We can therefore decompose the panel

of market data X_t in the announcement sample as:

$$\begin{aligned} X_{t,A} &= L_A F_{t,A} \\ &= L_A F_{t,A} + L_N \hat{F}_{t,A} - L_A \hat{F}_{t,A} \\ &= L_N \hat{F}_{t,A} + (L_A - L_N)\, \hat{F}_{t,A} + L_A \left(F_{t,A} - \hat{F}_{t,A} \right) \\ &= L_N \hat{F}_{t,A} + (\Delta L)\, \hat{F}_{t,A} + L_A\, (\Delta F) \end{aligned} \tag{6}$$

Equation (6) clarifies that if both the factors and the loadings are not changing from the N to A sample, then the first term should be the only one relevant. On the other hand, monetary policy announcements can affect financial market through either changes in factor loadings (the ΔL term), changes in the nature of the factors (the ΔF term), or a combination of the two. We now dig deeper into our findings by separately analyzing these two components.

6.1 Analysis of factor loadings

We begin by test for changes in factor loadings, that is, in the exposure of country shocks to the aggregate factors. Our test exploits the fact that, if the two correlation matrices in the N to A sample of central bank j meetings in a given period $\mathcal{M}$ are identical, then the orthonormality property of eigenvectors implies that:

$$L_A L_N' \sim I \ . \tag{7}$$

This suggests that changes in the loading structure with respect to the first principal component can be detected by the following statistic:[15]

$$\Delta D = [L_A L_N']_{1,1} - 1 \tag{8}$$

[15] For comparability of the principal components we impose that the loading to the first principal component of the first asset is positive in both samples.

where $[.]_{1,1}$ identifies the element in position (i, j).

Table 6 presents estimates of the statistic in equation (8) for the assets, time periods, central banks, and countries in our sample. We note that across all combinations, the differences are fairly small and hardly ever meet statistical significance (the only exception is the effect of ECB on CDS in the first period). In particular, during the QE period of the ECB and the FED the difference averages at -0.01 for both returns and CDS changes. Overall, it appears that monetary policy announcements do not result in pronounced shifts in eigenvectors, that is, in the exposure to factors.

6.2 Analysis of factors

We examine the systematic nature of the first principal component by relating it to aggregate factors capturing news in fundamentals or revisions in risk premia, similarly to Longstaff et al. (2011). Our list of factors is constrained to market variables that are available on a daily basis, and that are likely to represent global shocks. Drawing from prior studies, we include the following seven variables: the return to a weighted average index of exchange rates of the USD against the currencies of a large group of major U.S. trading partners[16]; the VIX equity implied volatility index; the equity volatility risk premium, measured by the difference between the VIX and the realized volatility over the past 22 days of daily returns to the S&P500 index; the TYVIX index of implied volatility in the fixed income market, see Mele and Obayashi (2015); the volatility risk premium in the fixed income market, measured by the difference between the TYVIX and the realized volatility over the past 22 days of daily returns to a 10-year bond index; the change in the price of Crude Oil; and the return to the Bloomberg Commodity Index, which comprises of 22 commodity futures. While some of these factors are constructed on the U.S. market, we include them following the argument in Longstaff et al. (2011) that they presumably highly correlate with global-wide shocks. Moreover, they potentially represent exogenous news when we later focus on

[16]The source is Datastream, mnemonic: US$CWBN.

emerging markets only.

We augment this set of explanatory variables with the equity return and sovereign CDS of the U.S. (for FED meetings) or Germany (for ECB meetings). The rationale is to understand whether the "local" shocks in the area whose monetary policy is being revised become more globally important. We treat Germany as the representative country for the Eurozone, as in Ang and Longstaff (2013).[17]

Given then relatively high dimensionality of our study – featuring several asset classes, time periods, cross sections, central banks, and regressors – we provide a selected discussion that focuses on the most representative findings, and relegate detailed results in the Internet Appendix. In particular, we restrict our attention to the Jan2010-May2013 and Jun2013-Nov2015 periods that are characterized by the introduction of unconventional monetary policies, and to the integration of emerging markets either vis-à-vis developed markets or alone.

Table 7 collects the coefficients of the regression of the first principal component from the two DM and EM indices on the aforementioned variables. In the table, coefficients that are significant at the 10% level are marked in bold. The last column reports the R-squared statistic. The variables are standardized to mean zero an unit variance within each sample to ease comparisons.

We start with Panel A of the table that relates equity integration between DM and EM with our list of regressors during ECB meeting and ex-meeting days. In the first period, three out of the nine variables enter the regressions with significant coefficients in both samples. The overall effect is a small increase in the R-squared of the regression in the announcement sample, from 0.71 to 0.76. This differences reverse in the following Jun2013-Nov2015 period. What is striking is that the coefficient on the equity return to Germany is essentially unchanged (also with respect to the previous period) but the variance factors are no longer significant. Overall, it appears that ECB monetary policy interventions did

[17] Including alternatively an equally weighted average of the equity or sovereign CDS of EMU countries does not alter our conclusions on the difference between the A and N samples.

not alter the exposure of global integration toward the European stock market. The only exception is the oil risk factor that remains significant in both the samples. Structural models of default suggest that the impact of equity and CDS should go in opposite directions. This is indeed what we find in the table. However, note that the CDS is that of the sovereign and not of the underlying corporate.

Panel B of the table reports analogous statistics for FED meetings. We note that in the first period of U.S. quantitative easing, the effect of monetary policy decisions on equity integration comes mainly through the USD exchange rate and volatility, and to a lesser extent through U.S. equity returns. Unlike the ECB, FED announcements during Jun2013-Nov2015 are instead accompanied with a higher R-squared, and the role of both the U.S. equity and CDS on driving market integration becomes stronger.

We next turn to the principal component of the sovereign CDS market. In Panel C, we see that ECB announcements register an increase in the R-squared from global shocks in the Jan2010-May2013 period. This result however originates from an increase (in absolute value) of the coefficients on the volatility factors, while both the loadings on the equity return and CDS of Germany actually *de*crease, with the former losing significance. In the most recent period, the picture changes dramatically as the R-squared decreases from 0.47 to 0.38 during meeting days, the number of significant coefficients halves from six to three, and the coefficient on the CDS of Germany shrinks from 0.31 to 0.23. These patterns are consistent with the dis-integration documented in Panel A of Table 3.

The effect of FED monetary policy revisions are presented in Panel D. We note that FED announcements are always associated with an increase in the systematic nature of the principal component, as demonstrated by the positive difference in R-squared with respect to non-announcement days. This is especially true in the most recent period, where the R-squared jumps from 0.43 to 0.65. What is also striking is the evidence that FED meeting days are accompanied with a decrease in the number of significant coefficients, a large increase in the magnitude of the coefficient of the U.S. CDS, and a decrease in that of U.S. equity.

Altogether, these effects appear even more pronounced than for equity. They show that FED revisions in monetary policy are truly perceived as global factors in the CDS market, as the role of U.S. news in explaining the first principal component raises significantly.

To conclude, we note that the relatively high R-squared in several specifications suggests that our list regressors is indeed capturing a great wealth of global shocks. Also interesting is the evidence that the importance of the TYVIX is not subsumed by (and sometimes is larger than) the VIX, especially in the CDS market. This is consistent with Mele, Obayashi, and Shalen (2015) who show that fixed income and equity volatility react to different events and risk factors, thereby providing complementary information.

Next, we squarely focus on changes in market integration among emerging markets. We estimate the regressions above separately on meeting and ex-meeting days for the four groups of EM, namely all countries, Europe&MiddleEast, Asia&Pacific, and Americas. To summarize the results, for a given specification – i.e., an asset class-period-central bank combination – we compute the average coefficient to a given variable across the groups. We do the same for a dummy variable that takes the value one when the coefficient is significant at the 10% level, and for the R-squared. We next take the differences between the A and N sample, and plot them in Figure 2 (for equity returns) and Figure 3 (for sovereign CDS spreads). Each figure has four plots corresponding to the combinations of two periods times two central banks. Inside each plot, the first column in black is the difference in average coefficient (left Y-axis) while the second column in blue is the difference in the dummy (right Y-axis). To fix ideas, a -0.75 column for the dummy means that the corresponding variable is no longer significant in three groups (out of four, or 75% of the times) when moving from the N to the A sample. The last column in each plot displays the difference in the average R-squared, measured on the left Y-axis.

In the top two plots of Figure 2 we report the results for EM equity returns during the Jan2010-May2013 period. We observe that both ECB and FED meetings were accompanied by an increase in the regression R-squared, and by a larger exposure to the nine risk factors

considered, in particular to equity and fixed income volatility. The effect of ECB and FED monetary policy revisions is quite different in the following period, bottom two plots. For ECB, there is a general reduction in the value and especially significance of most global factors, including the equity return of Germany. Thus, it appears that ECB QE policies were not felt as a global shock affecting EM stock market valuations. To the contrary, the exposure to the equity return to the U.S. increases, and so does the overall R-squared. These findings match quite closely the evidence documented in Table 7.

In Figure 3, we draw similar or even more pronounced conclusions for sovereign credit risk. During Jan2010-May2013 period, ECB and even more so FED announcements become more globally relevant, and lead to higher EM integration. While the effect ECB comes primarily through fixed income volatility, FED monetary policy revisions generate an across-the-board increase in the significance of several factors, including U.S. credit risk. The second row of the figure refers to the Jun2013-Nov2015 period. When moving from ECB ex-meeting to meeting days, we observe a marked reduction in the impact of several variables, and especially in their significance. This is true even for the return to the German equity, which becomes nearly insignificant. Overall, the result is an almost 0.15 drop in R-squared. On the other hand, the sovereign risk of the U.S. becomes the leading factor explaining EM market integration, as both its coefficient and significance experience a sharp increase. This comes at the expenses of other global shocks, most notably the Oil price, with the net effect being a slight increase in the R-squared. Thus, as the FED started to relax its QE policies, shocks in the sovereign credit risk of EM became more correlated with those in the U.S. equity and sovereign markets.

7 Factor exposures and country globalization

Our empirical approach relies on principal component analysis as a way to capture dependencies to systematic shocks. This methodology is extremely parsimonious as it only requires

information on the correlation matrix of market data and is silent on the underlying driving forces that make a country more or less exposed to global shocks. From an economic perspective, a natural question is whether exposures to latent factors captured by PCA reflect structural differences in the degree of countries' globalization. In the international economics literature, there is mounting evidence that a country' financial and goods market openness matter in explaining market integration. In particular, several studies show that the occurrence of booms and crashes in the equity market are linked to financial and trade liberalizations, and that these effects are particularly pronounced for emerging countries (see Martin and Rey (2006), Kaminsky and Schmukler (2008b), and Ghysels, Plazzi, and Valkanov (2016)). Guided by this literature, we formally explore whether such a link exists also with respect to emerging markets integration measures that emerge from PCA.

Our empirical design is as follows. Every year, we store the first eigenvector – that is, the exposure to the first principal component – corresponding to emerging markets when pooling equity returns (or sovereign CDS changes) to all countries during central banks' meeting days. This gives us a cross section of loadings in each year from 2006 to 2015, which represent our dependent variables. We relate these exposures to a country' prior year financial and trade openness. Following Ghysels, Plazzi, and Valkanov (2016), we measure financial openness (FO) by a country' Chinn and Ito (2006) index of capital account openness, and trade openness (TO) by a country' ratio of import plus export over GDP. Countries with higher values for FO and TO are more open to capital flows and to the trading of goods.

Table 8 collects the resulting regression estimates. In the left four blocks we show the results for a panel regression, whereas the right four blocks are from a single cross-sectional regression on average loadings across the 21 emerging markets. Below the coefficients, we display p-values.

We start our discussion with Panel A, which refers to equity returns. When relating factor exposure to FO and TO, we see that financial openness enters with a positive and significant (in the panel regression framework) coefficient. Thus, countries that are more

open to financial flows exhibit higher exposure to the aggregate factor, and therefore their financial markets are more integrated. In contrast, the effect of trade openness is negative and significant in specifications (1) and (3), while it turns insignificant in the cross-sectional regression.

An important message from the literature on equity markets (see e.g. Table I in Martin and Rey (2006)) is that financial and goods markets openness have important direct as well as interaction effects on equity crashes. As the table shows, including the interaction term in the equity regression has a relevant impact. Its coefficient is negative and highly significant in the panel regression (columns (2) and (4)), and marginally so in the cross-sectional regression for FED meetings (column (8)). Moreover, the direct effect of trade openness turns now positive, and only marginally insignificant (p-value of 0.13) in the panel regression in the case of FED meetings. The direct effect of financial openness is also much larger, and the R-squared increases substantially. These findings confirm the importance of taking into account the joint effect of openness to trade and flows when considering market integration of emerging markets. Notably, the sign of the coefficients in the specifications with the interaction term are consistent with Ghysels, Plazzi, and Valkanov (2016) who study equity asymmetries.[18]

Panel B of the table reports the estimates for the regressions on sovereign CDS spreads. The sign and significance of the coefficients are generally in agreement with (and sometimes stronger than) those in Panel A. Indeed, financial openness is always positively associated with an increase in exposure to systematic shocks. The effect of trade openness is negative, and generally insignificant when excluding the interaction term (the exception is ECB in the cross-sectional regression, where the p-value is 0.07). As for equity, the role of financial and trade openness in explaining sovereign CDS exposures is enhanced when their interaction enters the analysis. The sign and significance of trade openness generally increases. Trade

[18] See column (4) in the regression analysis of Panel A of their Table V. Since the skewness of the world index is negative, the sign are flipped with respect to our analysis – i.e. higher integration implies higher exposure to aggregate shocks, and hence more negatively skewed returns.

openness is now also positive and significant in the case of FED announcements, where the interaction terms has a negative effect.

These results show that the exposures obtained via principal component analysis indeed line up with a country degree of globalization, consistent with recent evidence on equity volatility and asymmetry. The finding that globalization in the financial and good markets also play a role in explaining the degree of transmission of monetary policy shocks to sovereign CDS markets is also a novel finding.

8 Conclusions

How does monetary policy affect the broader economy? As pointed out by Bernanke (2003), answering this question requires an understanding of how policy actions affect both domestic as well as foreign financial markets.

In this paper we show that monetary policy announcements affects market integration. This effect is particularly evident in the recent periods which were characterized by unconventional monetary policies. Both ECB and the FED are found to impact market integration. For the equity markets, ECB announcements increase market integration particularly when the euro area generates the larger spillovers, i.e. during the sovereign crisis. Instead, the FED was largely relevant during the global crisis both for developed markets and emerging and between the two. For sovereign CDS the picture is quite different. ECB announcements related to the implementation of QE policies is accompanied if anything with an overall decrease in integration. This fragmentation is quite pronounced for EMU countries and the other developed countries, and to a lesser extent for emerging markets. The FED announcements are instead perceived as a global risk factor. Now that that the FED is unwinding and tapering its unconventional monetary policy interventions, it has a strong impact both between and within developed and emerging markets, and mostly in the sovereign CDS market.

In sum, our analysis provides novel evidence that monetary policy affects the level of integration between developed and emerging markets, and within these markets. Our findings have clear policy implications. The fact that FED announcements induce higher market integration, especially on sovereign CDS, supports concerns expressed by policymakers in emerging countries: FED monetary policy has a strong impact on the price of sovereign risk on both developed and emerging markets. We do not find a similar result for ECB interventions. This indicates that, at least for FED monetary policy, more coordination is needed at the global level in order to deal with externalities and spillovers. Our findings also beg interesting questions for future research. Equity prices obtain as the present discounted value of future cash flows. Thus, they comprise of both a discount rate (risk premium) and a cash flow ('real') component. Similarly, CDS reflect both the compensation for bearing credit risk and the physical probability of default and recovery rate. Identifying the effect of monetary policy shocks separately on these components would shed further light on the underlying economic mechanisms and the identify of the global factors which are responsible of market integration.

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Table 1. Equity markets integration and ECB meetings

This table presents the percentage explained by the first principal component (Panel A), the average pairwise correlation (Panel B), and the fragmentation index (Panel C)of country stock market returns during ECB and ex-ECB meeting days, and the difference in the two group estimates (Δs), across the four subsamples considered. Results are reported across All countries, EMU countries, Developed countries ex-EMU, all Emerging countries, Emerging countries in Europe&Middle East, Emerging countries in Asia&Pacific, and Emerging countries in Americas. The last row in each panel reports results for the two equally-weighted Developed Markets and Emerging Markets indices. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007			Aug2007-Dec2009			Jan2010-May2013			Jun2013-Nov2015		
Panel A: Percentage explained by 1st Principal Component												
Countries	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$
All	32.47	35.49	*-3.03*	40.93	42.87	*-1.93*	44.27	39.03	***5.25***	30.61	31.66	*-1.05*
EMU	67.23	67.65	*-0.41*	70.50	72.29	*-1.79*	74.34	71.47	*2.86*	68.70	66.55	*2.15*
DM ex-EMU	39.90	44.96	*-5.06*	49.95	48.56	*1.40*	54.64	47.79	***6.85***	38.98	41.16	*-2.18*
EM	18.92	23.89	*-4.97*	28.99	31.98	*-2.99*	31.76	25.97	***5.79***	20.16	20.58	*-0.42*
EM Europe&ME	32.53	33.19	*-0.66*	40.93	45.56	*-4.63*	41.23	33.94	***7.30***	22.71	25.50	*-2.79*
EM Asia&Pacific	36.52	35.98	*0.54*	43.44	43.07	*0.38*	45.60	39.29	*6.31*	34.64	36.15	*-1.50*
EM Americas	36.24	40.59	*-4.35*	49.75	48.04	*1.71*	50.74	44.64	*6.11*	41.01	37.76	*3.24*
DM Idx & EM Idx	85.05	86.84	*-1.79*	90.04	91.56	*-1.52*	91.41	87.68	***3.74***	74.67	81.38	***-6.70***
Panel B: Avg. pairwise correlation												
Countries	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$
All	0.22	0.27	*-0.05*	0.34	0.36	*-0.02*	0.35	0.31	*0.05*	0.21	0.23	*-0.02*
EMU	0.56	0.59	*-0.03*	0.60	0.62	*-0.02*	0.65	0.61	*0.04*	0.60	0.58	*0.02*
DM ex-EMU	0.30	0.37	*-0.07*	0.41	0.40	*0.01*	0.47	0.39	***0.08***	0.29	0.32	*-0.03*
EM	0.10	0.15	*-0.06*	0.22	0.23	*-0.02*	0.21	0.17	*0.04*	0.11	0.13	*-0.02*
EM Europe&ME	0.16	0.17	*-0.02*	0.28	0.32	*-0.03*	0.27	0.18	***0.09***	0.06	0.10	*-0.05*
EM Asia&Pacific	0.18	0.16	*0.02*	0.27	0.25	*0.01*	0.30	0.23	*0.07*	0.13	0.19	*-0.06*
EM Americas	0.18	0.23	*-0.05*	0.36	0.31	*0.05*	0.27	0.29	*-0.02*	0.24	0.20	*0.04*
DM Idx & EM Idx	0.70	0.74	*-0.04*	0.80	0.83	*-0.03*	0.83	0.75	***0.07***	0.49	0.63	***-0.13***
Panel C: Fragmentation index												
Countries	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$
All	0.50	0.57	*-0.07*	0.48	0.51	*-0.03*	0.47	0.55	***-0.08***	0.57	0.62	*-0.06*
EMU	0.36	0.35	*0.00*	0.32	0.30	*0.02*	0.28	0.31	*-0.03*	0.34	0.37	*-0.03*
DM ex-EMU	0.59	0.58	*0.01*	0.48	0.51	*-0.02*	0.45	0.51	*-0.06*	0.66	0.63	*0.03*
EM	0.67	0.73	*-0.06*	0.63	0.67	*-0.04*	0.62	0.73	***-0.10***	0.72	0.79	*-0.07*
EM Europe&ME	0.74	0.72	*0.02*	0.64	0.62	*0.02*	0.64	0.74	***-0.09***	0.82	0.84	*-0.01*
EM Asia&Pacific	0.77	0.79	*-0.02*	0.71	0.71	*0.00*	0.68	0.76	*-0.08*	0.80	0.80	*0.00*
EM Americas	0.73	0.71	*0.02*	0.58	0.62	*-0.04*	0.59	0.66	*-0.07*	0.69	0.74	*-0.06*
DM Idx & EM Idx	0.30	0.26	*0.04*	0.20	0.17	*0.03*	0.17	0.25	***-0.07***	0.51	0.37	***0.13***

Table 2. Equity markets integration and FED meetings

This table presents the percentage explained by the first principal component (Panel A), the average pairwise correlation (Panel B), and the fragmentation index (Panel C)of country stock market returns during FED and ex-FED meeting days, and the difference in the two group estimates (Δs), across the four subsamples considered. Results are reported across All countries, EMU countries, Developed countries ex-EMU, all Emerging countries, Emerging countries in Europe&Middle East, Emerging countries in Asia&Pacific, and Emerging countries in Americas. The last row in each panel reports results for the two equally-weighted Developed Markets and Emerging Markets indices. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007			Aug2007-Dec2009			Jan2010-May2013			Jun2013-Nov2015		
Panel A: Percentage explained by 1st Principal Component												
Countries	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$
All	38.51	34.86	*3.65*	48.93	41.03	***7.90***	40.75	39.83	*0.92*	32.63	31.29	*1.33*
EMU	67.29	67.55	*-0.26*	74.99	71.23	*3.77*	71.38	72.10	*-0.72*	65.16	67.23	*-2.07*
DM ex-EMU	45.42	44.19	*1.23*	55.20	47.11	***8.09***	45.04	49.70	*-4.66*	47.09	39.72	***7.37***
EM	28.90	22.96	*5.94*	38.60	29.79	***8.82***	32.71	25.94	***6.77***	20.51	20.52	*-0.01*
EM Europe&ME	42.40	31.93	***10.47***	50.90	43.27	***7.63***	42.53	33.96	***8.58***	24.79	25.28	*-0.49*
EM Asia&Pacific	39.53	36.44	*3.10*	50.78	41.00	***9.77***	47.93	38.87	***9.06***	37.60	35.41	*2.19*
EM Americas	43.74	39.64	*4.10*	53.73	46.91	***6.82***	51.04	44.72	*6.32*	38.90	38.01	*0.89*
DM Idx & EM Idx	88.76	86.31	*2.45*	93.53	90.75	***2.78***	88.96	88.27	*0.69*	84.99	79.67	*5.32*
Panel B: Avg. pairwise correlation												
Countries	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$
All	0.29	0.26	*0.02*	0.42	0.33	***0.09***	0.32	0.31	*0.01*	0.25	0.23	*0.02*
EMU	0.57	0.59	*-0.02*	0.65	0.61	*0.04*	0.61	0.62	*-0.01*	0.56	0.58	*-0.02*
DM ex-EMU	0.36	0.36	*0.01*	0.48	0.39	***0.09***	0.36	0.42	*-0.06*	0.38	0.30	***0.08***
EM	0.16	0.14	*0.02*	0.30	0.21	***0.09***	0.23	0.17	***0.06***	0.12	0.12	*0.00*
EM Europe&ME	0.22	0.16	*0.06*	0.38	0.29	***0.08***	0.28	0.19	***0.09***	0.06	0.10	*-0.05*
EM Asia&Pacific	0.08	0.17	*-0.09*	0.34	0.24	***0.11***	0.34	0.22	***0.11***	0.20	0.17	*0.03*
EM Americas	0.28	0.21	*0.07*	0.41	0.30	***0.11***	0.27	0.29	*-0.02*	0.22	0.20	*0.02*
DM Idx & EM Idx	0.78	0.73	*0.05*	0.87	0.81	***0.06***	0.78	0.77	*0.01*	0.70	0.59	*0.11*
Panel C: Fragmentation index												
Countries	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$
All	0.45	0.58	*-0.12*	0.43	0.53	***-0.10***	0.47	0.55	*-0.08*	0.55	0.63	*-0.08*
EMU	0.35	0.36	*0.00*	0.27	0.32	*-0.04*	0.31	0.31	*0.01*	0.38	0.36	*0.02*
DM ex-EMU	0.61	0.57	*0.04*	0.45	0.52	***-0.07***	0.50	0.50	*0.00*	0.59	0.64	*-0.06*
EM	0.58	0.74	*-0.16*	0.56	0.69	***-0.12***	0.60	0.73	***-0.13***	0.71	0.80	*-0.08*
EM Europe&ME	0.61	0.74	*-0.13*	0.54	0.65	***-0.11***	0.61	0.74	***-0.12***	0.81	0.84	*-0.03*
EM Asia&Pacific	0.76	0.79	*-0.04*	0.61	0.74	***-0.13***	0.65	0.76	***-0.11***	0.78	0.81	*-0.03*
EM Americas	0.64	0.72	*-0.08*	0.56	0.63	*-0.08*	0.59	0.66	*-0.08*	0.73	0.74	*-0.02*
DM Idx & EM Idx	0.22	0.27	*-0.05*	0.13	0.19	***-0.06***	0.22	0.23	*-0.01*	0.30	0.41	*-0.11*

Table 3. Sovereign CDS integration and ECB meetings

This table presents the percentage explained by the first principal component (Panel A), the average pairwise correlation (Panel B), and the fragmentation index (Panel C)of changes in sovereign CDS during ECB and ex-ECB meeting days, and the difference in the two group estimates (Δs), across the four subsamples considered. Results are reported across All countries, EMU countries, Developed countries ex-EMU, all Emerging countries, Emerging countries in Europe&Middle East, Emerging countries in Asia&Pacific, and Emerging countries in Americas. The last row in each panel reports results for the two equally-weighted Developed Markets and Emerging Markets indices. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007			Aug2007-Dec2009			Jan2010-May2013			Jun2013-Nov2015		
Panel A: Percentage explained by 1st Principal Component												
Countries	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$	ECB	ex-ECB	$\Delta F1$
All	16.27	24.23	*-7.96*	38.21	41.50	*-3.29*	52.84	46.63	***6.21***	27.17	29.09	*-1.92*
EMU	32.59	18.94	*13.66*	58.86	56.53	*2.33*	71.81	68.37	*3.44*	48.48	47.58	*0.90*
DM ex-EMU	24.81	16.55	*8.26*	36.30	36.53	*-0.23*	50.12	40.12	***10.00***	27.58	31.67	*-4.09*
EM	28.38	40.44	*-12.06*	49.93	53.56	*-3.63*	60.14	53.15	***7.00***	38.25	37.35	*0.90*
EM Europe&ME	35.60	45.75	*-10.16*	64.99	67.85	*-2.85*	81.14	75.17	***5.98***	44.92	39.82	*5.11*
EM Asia&Pacific	52.80	55.34	*-2.54*	68.10	69.05	*-0.94*	72.79	70.11	*2.68*	62.46	67.66	***-5.21***
EM Americas	63.22	72.96	*-9.75*	80.68	75.63	*5.04*	84.95	77.17	***7.78***	78.46	77.65	*0.81*
DM Idx & EM Idx	60.00	71.59	*-11.59*	81.59	82.94	*-1.35*	80.42	80.60	*-0.18*	69.37	70.50	*-1.13*
Panel B: Avg. pairwise correlation												
Countries	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$	ECB	ex-ECB	$\Delta\rho$
All	0.05	0.15	***-0.10***	0.35	0.38	*-0.03*	0.49	0.42	***0.07***	0.22	0.25	*-0.03*
EMU	0.04	0.10	*-0.05*	0.54	0.52	*0.03*	0.68	0.64	*0.04*	0.41	0.40	*0.01*
DM ex-EMU	0.00	0.02	*-0.02*	0.25	0.27	*-0.02*	0.42	0.29	***0.12***	0.15	0.20	*-0.05*
EM	0.19	0.34	*-0.15*	0.45	0.48	*-0.03*	0.55	0.48	***0.07***	0.32	0.31	*0.01*
EM Europe&ME	0.18	0.34	*-0.17*	0.60	0.63	*-0.03*	0.78	0.71	***0.07***	0.35	0.30	*0.05*
EM Asia&Pacific	0.40	0.43	*-0.03*	0.55	0.51	*0.04*	0.54	0.54	*0.00*	0.41	0.51	***-0.09***
EM Americas	0.49	0.66	*-0.16*	0.76	0.69	*0.07*	0.82	0.72	***0.10***	0.73	0.72	*0.01*
DM Idx & EM Idx	0.20	0.43	*-0.23*	0.63	0.66	*-0.03*	0.61	0.61	*0.00*	0.39	0.41	*-0.02*
Panel C: Fragmentation index												
Countries	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$	ECB	ex-ECB	$\Delta\mathcal{FR}$
All	0.50	0.64	*-0.13*	0.43	0.48	*-0.05*	0.33	0.41	***-0.08***	0.51	0.56	*-0.04*
EMU	0.65	0.83	*-0.18*	0.45	0.48	*-0.03*	0.31	0.35	*-0.04*	0.54	0.54	*0.00*
DM ex-EMU	0.73	0.90	*-0.17*	0.69	0.71	*-0.02*	0.50	0.62	***-0.12***	0.71	0.74	*-0.03*
EM	0.56	0.52	*0.04*	0.39	0.42	*-0.03*	0.32	0.39	***-0.07***	0.50	0.53	*-0.03*
EM Europe&ME	0.65	0.59	*0.06*	0.40	0.37	*0.03*	0.22	0.28	***-0.07***	0.61	0.69	*-0.08*
EM Asia&Pacific	0.59	0.56	*0.03*	0.40	0.39	*0.01*	0.34	0.37	*-0.03*	0.47	0.40	***0.06***
EM Americas	0.44	0.32	*0.12*	0.23	0.29	*-0.06*	0.18	0.27	***-0.09***	0.26	0.27	*-0.01*
DM Idx & EM Idx	0.80	0.57	*0.23*	0.37	0.34	*0.03*	0.39	0.39	*0.00*	0.61	0.59	*0.02*

Table 4. Sovereign CDS integration and FED meetings

This table presents the percentage explained by the first principal component (Panel A), the average pairwise correlation (Panel B), and the fragmentation index (Panel C)of changes in sovereign CDS during FED and ex-FED meeting days, and the difference in the two group estimates (Δs), across the four subsamples considered. Results are reported across All countries, EMU countries, Developed countries ex-EMU, all Emerging countries, Emerging countries in Europe&Middle East, Emerging countries in Asia&Pacific, and Emerging countries in Americas. The last row in each panel reports results for the two equally-weighted Developed Markets and Emerging Markets indices. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007			Aug2007-Dec2009			Jan2010-May2013			Jun2013-Nov2015		
Panel A: Percentage explained by 1st Principal Component												
Countries	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$	FED	ex-FED	$\Delta F1$
All	24.24	23.58	*0.66*	42.53	40.82	*1.71*	46.36	48.21	*-1.84*	38.84	27.03	***11.81***
EMU	18.62	18.84	*-0.22*	58.58	56.80	*1.78*	63.87	69.75	***-5.89***	54.38	46.69	*7.69*
DM ex-EMU	23.74	16.92	*6.82*	32.44	37.07	*-4.63*	42.23	42.24	*-0.01*	43.14	28.64	***14.50***
EM	41.14	39.33	*1.80*	56.68	52.29	*4.40*	58.64	53.73	*4.91*	41.42	36.85	*4.57*
EM Europe&ME	39.73	45.30	*-5.57*	67.47	67.57	*-0.10*	80.91	75.22	*5.69*	54.68	37.80	***16.89***
EM Asia&Pacific	59.49	55.00	*4.50*	71.95	68.39	*3.56*	77.02	69.84	***7.19***	70.98	65.83	***5.15***
EM Americas	72.37	72.12	*0.25*	82.65	75.21	*7.44*	85.30	77.33	***7.97***	71.46	78.81	***-7.35***
DM Idx & EM Idx	65.95	71.76	*-5.81*	82.40	82.96	*-0.56*	72.09	82.04	***-9.95***	75.00	69.54	*5.46*
Panel B: Avg. pairwise correlation												
Countries	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$	FED	ex-FED	$\Delta\rho$
All	0.10	0.15	*-0.05*	0.38	0.37	*0.01*	0.43	0.44	*-0.01*	0.35	0.23	***0.12***
EMU	0.03	0.10	*-0.07*	0.54	0.52	*0.02*	0.59	0.66	***-0.07***	0.48	0.39	*0.10*
DM ex-EMU	0.04	0.02	*0.02*	0.21	0.27	*-0.06*	0.32	0.32	*-0.01*	0.33	0.16	***0.17***
EM	0.32	0.33	*-0.01*	0.53	0.46	*0.06*	0.55	0.48	*0.07*	0.36	0.30	*0.06*
EM Europe&ME	0.25	0.34	*-0.09*	0.62	0.62	*0.00*	0.78	0.71	*0.07*	0.48	0.28	***0.20***
EM Asia&Pacific	0.48	0.43	*0.06*	0.61	0.49	***0.13***	0.68	0.52	***0.15***	0.55	0.48	*0.07*
EM Americas	0.59	0.65	*-0.06*	0.78	0.68	*0.10*	0.82	0.72	***0.10***	0.62	0.73	***-0.11***
DM Idx & EM Idx	0.32	0.44	*-0.12*	0.65	0.66	*-0.01*	0.44	0.64	***-0.20***	0.50	0.39	*0.11*
Panel C: Fragmentation index												
Countries	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$	FED	ex-FED	$\Delta\mathcal{FR}$
All	0.49	0.63	*-0.15*	0.43	0.48	*-0.05*	0.35	0.40	*-0.05*	0.43	0.57	***-0.14***
EMU	0.74	0.83	*-0.09*	0.46	0.48	*-0.02*	0.38	0.33	*0.05*	0.45	0.56	*-0.10*
DM ex-EMU	0.76	0.89	*-0.12*	0.73	0.70	*0.03*	0.57	0.60	*-0.03*	0.61	0.76	***-0.15***
EM	0.46	0.53	*-0.07*	0.38	0.43	*-0.05*	0.31	0.39	***-0.08***	0.45	0.54	***-0.09***
EM Europe&ME	0.60	0.59	*0.01*	0.37	0.37	*0.00*	0.22	0.28	*-0.07*	0.52	0.71	***-0.19***
EM Asia&Pacific	0.51	0.56	*-0.06*	0.35	0.40	*-0.04*	0.29	0.38	***-0.09***	0.36	0.43	***-0.06***
EM Americas	0.33	0.33	*0.00*	0.21	0.30	*-0.09*	0.18	0.27	***-0.10***	0.34	0.25	***0.09***
DM Idx & EM Idx	0.68	0.56	*0.12*	0.35	0.34	*0.01*	0.56	0.36	***0.20***	0.50	0.61	*-0.11*

Table 5. Market integration and sign and size of monetary policy shocks

This table presents estimates for the distance in the fraction of variance accounted for by the 1st principal component, $\Delta F1$, between announcements that are accompanied by positive versus negative (column 'Pos. vs Neg.') and large versus small (column 'Large vs Small') shocks to the level of yields. The latter is approximated by the level factor in the PCA of the Term Structure of U.S. (for FED announcements) or Eurozone (for ECB announcements), as constructed by Pericoli and Veronese (2016). Large shocks are defined as those below the 25th or above the 75th percentile of the distribution of the shock in a given period. The distance is computed on equity returns (Panel A and B) and changes in sovereign CDS spreads (Panel C and D) in correspondence to either ECB (Panel A and C) or FED (Panel C and D) announcements. Results are reported across the four periods considered for All countries, EMU countries, Developed countries ex-EMU, and all Emerging countries. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007		Aug2007-Dec2009		Jan2010-May2013		Jun2013-Nov2015	
Panel A: Equity markets integration and ECB meetings								
Countries	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small
All	-	-	-	*3.26*	*2.73*	*9.87*	*-0.21*	*-0.22*
EMU	**10.25**	**9.18**	*0.47*	*3.81*	*0.41*	*5.64*	*5.65*	*-3.31*
DM ex-EMU	*10.72*	**14.94**	*5.05*	*6.06*	*2.48*	*6.00*	*-1.13*	*-7.38*
EM	-	*0.16*	*-5.21*	*4.17*	*6.38*	**12.23**	*2.81*	*1.31*
DM Idx & EM Idx	*5.02*	*-2.37*	*-0.79*	*0.79*	*-0.43*	*2.14*	**-14.06**	*7.03*
Panel B: Equity markets integration and FED meetings								
Countries	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small
All	-	-	*-1.96*	*6.64*	*0.35*	*9.78*	*-6.02*	*1.48*
EMU	*-6.90*	*-5.47*	*2.25*	*3.95*	*0.75*	*7.12*	*-7.72*	*-2.49*
DM ex-EMU	*-13.81*	*2.57*	*-4.52*	*2.26*	*3.24*	*6.20*	*-2.01*	*-0.84*
EM	-	*-5.78*	*-1.15*	*8.17*	*0.43*	**12.84**	*-4.31*	*4.65*
DM Idx & EM Idx	*-6.23*	*9.57*	*-2.86*	*4.14*	*-2.54*	*2.03*	*-1.96*	*3.00*
Panel C: Sovereign CDS integration and ECB meetings								
Countries	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small
All	-	-	-	*-2.08*	**-14.76**	*2.75*	*8.94*	*8.95*
EMU	**-13.17**	*3.65*	**-21.11**	*-4.39*	**-9.02**	*5.39*	**21.33**	*-0.26*
DM ex-EMU	*3.11*	*11.36*	**-13.45**	*-11.20*	**-14.03**	*9.00*	*4.61*	*-4.16*
EM	-	*2.81*	*-7.86*	*0.75*	*-8.63*	*0.39*	*2.12*	*12.01*
DM Idx & EM Idx	*9.82*	*13.62*	*4.84*	*2.21*	**-13.83**	*2.63*	*7.81*	*4.76*
Panel D: Sovereign CDS integration and FED meetings								
Countries	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small	Pos. vs Neg.	Large vs Small
All	-	-	*-7.29*	*7.55*	*-9.22*	*3.28*	*-11.94*	*9.98*
EMU	*-6.93*	**-9.37**	*-10.05*	*-8.88*	*-3.22*	*1.25*	**-18.08**	*3.39*
DM ex-EMU	*3.44*	*-8.05*	*-4.58*	*-1.11*	*-5.75*	*10.98*	*-5.39*	*0.86*
EM	-	*-6.24*	*-2.81*	**10.72**	*-10.44*	*5.65*	*-13.44*	*7.91*
DM Idx & EM Idx	*2.62*	*-21.41*	**-10.60**	*7.36*	*-10.26*	*2.22*	*-8.50*	**22.79**

Table 6. Analysis of factor loadings

This table presents estimates of the ΔD test for orthonormality of the first eigenvector between the A and N sample, equation (8). The distance is computed on equity returns (Panel A and B) and changes in sovereign CDS spreads (Panel C and D) in correspondence to either ECB (Panel A and C) or FED (Panel C and D) announcements. Results are reported across the four periods considered for All countries, EMU countries, Developed countries ex-EMU, and all Emerging countries. Bold numbers denote entries that are significant at the 10% level. The full sample is daily observations from January 2006 to November 2015.

	Jan2006-Jul2007	Aug2007-Dec2009	Jan2010-May2013	Jun2013-Nov2015
Panel A: Equity markets integration and ECB meetings				
Countries	ΔD	ΔD	ΔD	ΔD
All	-0.02	0.00	-0.01	-0.01
EMU	0.00	0.00	0.00	0.00
DM ex-EMU	-0.01	0.00	0.00	-0.01
EM	-0.05	-0.01	-0.01	-0.02
Panel B: Equity markets integration and FED meetings				
Countries	ΔD	ΔD	ΔD	ΔD
All	-0.04	-0.01	-0.01	-0.01
EMU	0.00	0.00	0.00	0.00
DM ex-EMU	0.00	0.00	0.00	-0.01
EM	-0.10	-0.01	-0.01	-0.03
Panel C: Sovereign CDS integration and ECB meetings				
Countries	ΔD	ΔD	ΔD	ΔD
All	-0.18	-0.01	-0.01	-0.03
EMU	**-0.70**	0.00	0.00	-0.01
DM ex-EMU	**-0.72**	-0.03	-0.01	-0.02
EM	-0.05	-0.01	0.00	-0.01
Panel D: Sovereign CDS integration and FED meetings				
Countries	ΔD	ΔD	ΔD	ΔD
All	-0.08	-0.01	-0.01	-0.04
EMU	-1.33	0.00	0.00	-0.01
DM ex-EMU	-1.11	-0.01	-0.01	-0.02
EM	-0.02	-0.01	-0.01	-0.04

Table 7. Principal component to DM and EM Indices and global factors

This table presents the coefficients from regressing the first principal component from the two equally-weighted Developed Markets and Emerging Markets indices of equity returns (Panel A and B) or sovereign CDS (Panel C and D) on risk factors. The principal components are constructed from the correlation matrix separately computed on central bank' (ECB in Panel A and C, or FED in Panel B and D) meeting and ex-meeting days, during the Jan2010-May2013 or Jun2013-Nov2015 periods. The risk factors are defined in Section 6.2. A bold character denotes coefficients that are significant at the 10% level. The last column reports the R-squared statistic.

Panel A: Equity markets integration and ECB meetings

Period	r_{Ger}	CDS_{Ger}	USD	VIX	VRP	TYVIX	VRPFX	Oil	Comm	R^2
Jan2010-May2013										
ECB	**0.62**	-0.06	**-0.17**	0.12	-0.06	-0.09	0.04	**0.18**	0.01	0.76
ex-ECB	**0.60**	-0.03	**-0.26**	-0.04	**0.11**	0.01	-0.03	0.04	0.05	0.71
Jun2013-Nov2015										
ECB	**0.68**	-0.09	-0.11	-0.06	-0.02	-0.01	-0.03	**0.19**	-0.03	0.61
ex-ECB	**0.67**	**-0.13**	-0.04	**-0.16**	**0.10**	-0.05	-0.02	**0.09**	0.00	0.65

Panel B: Equity markets integration and FED meetings

Period	r_{US}	CDS_{US}	USD	VIX	VRP	TYVIX	VRPFX	Oil	Comm	R^2
Jan2010-May2013										
FED	**0.33**	-0.10	**-0.52**	-0.14	0.15	-0.07	**-0.13**	0.10	0.00	0.70
ex-FED	**0.50**	**-0.05**	**-0.37**	0.10	0.08	0.01	-0.03	**0.13**	0.06	0.60
Jun2013-Nov2015										
FED	**0.66**	**-0.16**	-0.03	0.14	-0.02	-0.15	0.08	0.03	**0.19**	0.51
ex-FED	**0.53**	-0.01	0.01	-0.06	0.11	**-0.09**	0.00	**0.16**	-0.01	0.34

Panel C: Sovereign CDS integration and ECB meetings

Period	r_{Ger}	CDS_{Ger}	USD	VIX	VRP	TYVIX	VRPFX	Oil	Comm	R^2
Jan2010-May2013										
ECB	-0.10	**0.41**	**0.39**	**-0.18**	**0.18**	**0.19**	-0.06	-0.05	0.02	0.73
ex-ECB	**-0.17**	**0.45**	**0.28**	**0.11**	**-0.10**	-0.02	0.06	0.04	-0.04	0.60
Jun2013-Nov2015										
ECB	**-0.45**	**0.23**	0.00	0.08	-0.04	**0.16**	0.01	-0.05	-0.09	0.38
ex-ECB	**-0.35**	**0.31**	**0.13**	**0.12**	-0.01	**0.11**	0.03	**-0.11**	0.00	0.47

Panel D: Sovereign CDS integration and FED meetings

Period	r_{US}	CDS_{US}	USD	VIX	VRP	TYVIX	VRPFX	Oil	Comm	R^2
Jan2010-May2013										
FED	0.00	**0.47**	**0.38**	0.12	-0.05	-0.06	0.10	-0.07	0.01	0.66
ex-FED	**-0.18**	**0.44**	**0.29**	0.06	-0.05	0.01	0.05	0.04	-0.03	0.62
Jun2013-Nov2015										
FED	**-0.35**	**0.51**	0.09	0.05	-0.06	-0.07	**0.15**	-0.07	-0.05	0.65
ex-FED	**-0.38**	**0.26**	**0.11**	**0.12**	-0.02	**0.14**	0.02	**-0.11**	0.00	0.43

Table 8. Factor exposures and country globalization

This table relates a country exposure to Central Bank announcements to financial and trade openness. We measure financial openness by a country' Chinn and Ito (2006) index of capital account openness. We measure trade openness by a country' ratio of import plus export over GDP. Every year, for a given variable (equity return or sovereign CDS), we compute the loading (eigenvalue) to each emerging market with respect to the first principal component, which is constructed on the correlation matrix when pooling all countries and (ECB or FED) meetings days in that year. We regress these loadings on the previous year financial, trade openness, or their interaction in either a panel setting (left two blocks) or in a single average cross-sectional regression (right two blocks). Panel A reports the results for Equity, while Panel B for Sovereign CDS. In parenthesis below the estimates, we display p-values based on clustered standard errors.

Panel A: Equity markets integration

	Panel regression				Cross-sectional regression			
	ECB	ECB	FED	FED	ECB	ECB	FED	FED
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FO	0.04	0.12	0.04	0.15	0.04	0.14	0.04	0.18
	(0.00)	(0.01)	(0.00)	(0.00)	(0.20)	(0.10)	(0.26)	(0.06)
TO	-0.04	0.02	-0.03	0.04	-0.03	0.03	-0.03	0.06
	(0.00)	(0.48)	(0.01)	(0.13)	(0.14)	(0.48)	(0.28)	(0.20)
FO × TO		-0.10		-0.14		-0.13		-0.18
		(0.02)		(0.01)		(0.23)		(0.11)
Obs.	210	210	210	210	21	21	21	21
R^2	0.090	0.129	0.059	0.131	0.130	0.212	0.101	0.263

Panel B: Sovereign CDS integration

	Panel regression				Cross-sectional regression			
	ECB	ECB	FED	FED	ECB	ECB	FED	FED
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FO	0.05	0.08	0.01	0.09	0.04	0.09	0.01	0.11
	(0.01)	(0.05)	(0.70)	(0.00)	(0.02)	(0.09)	(0.73)	(0.14)
TO	-0.02	-0.00	-0.00	0.05	-0.02	0.01	-0.00	0.06
	(0.16)	(0.99)	(0.77)	(0.06)	(0.07)	(0.70)	(0.89)	(0.15)
FO × TO		-0.04		-0.11		-0.06		-0.12
		(0.41)		(0.01)		(0.22)		(0.07)
Obs.	210	210	210	210	21	21	21	21
R^2	0.067	0.074	0.002	0.048	0.256	0.309	0.006	0.156

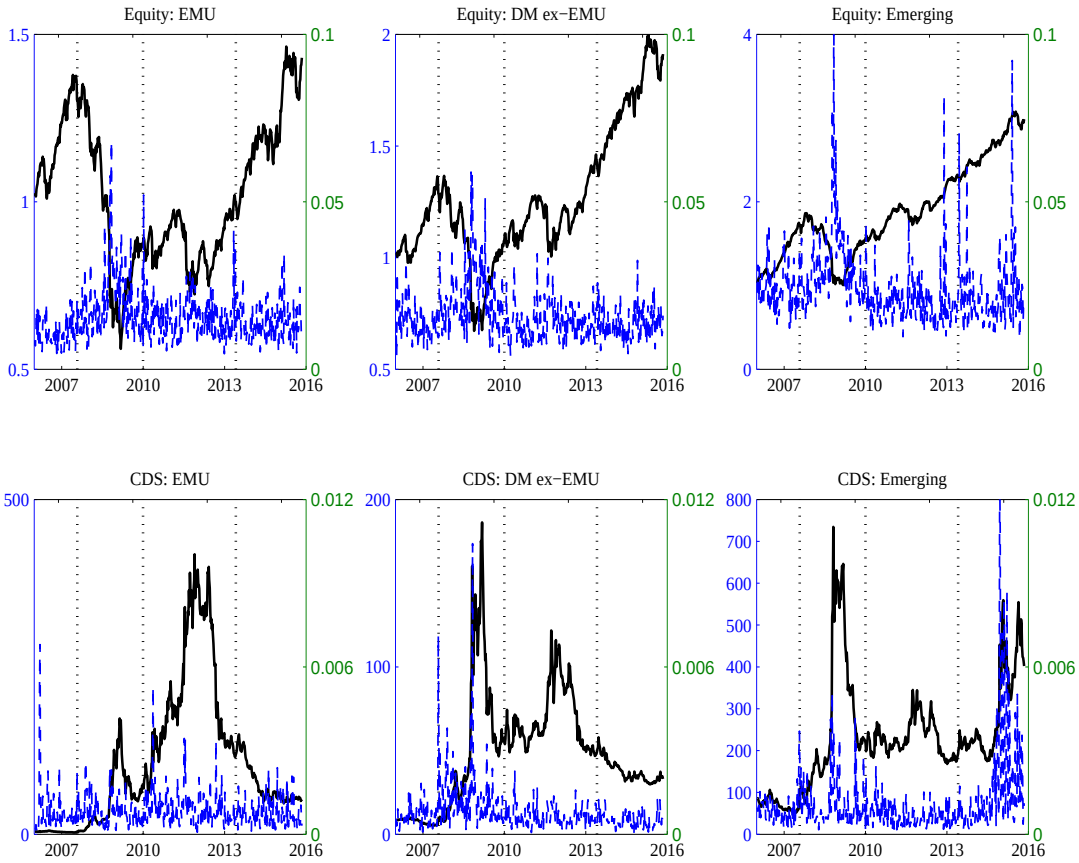

Figure 1. Equity and Sovereign CDS Spreads. The top three figures plot the time-series pattern of cumulative equally-weighted average equity returns (black thick line, left Y axis) and the cross-sectional standard deviation (blue dotted line, right Y axis) separately computed across EMU countries (left plot), Developed markets ex-EMU (middle plot), and Emerging markets (right plot). The bottom figures plot the time-series pattern of equally-weighted average sovereign CDS spread (black thick line, left Y axis) and the ratio between the cross-sectional standard deviation of changes in sovereign CDS spreads and the average sovereign CDS spread (blue dotted line, right Y axis) separately computed across EMU countries (left plot), Developed markets ex-EMU (middle plot), and Emerging markets (right plot). The vertical dotted lines mark the end of the subsamples considered. The full sample is daily observations from January 2006 to November 2015.

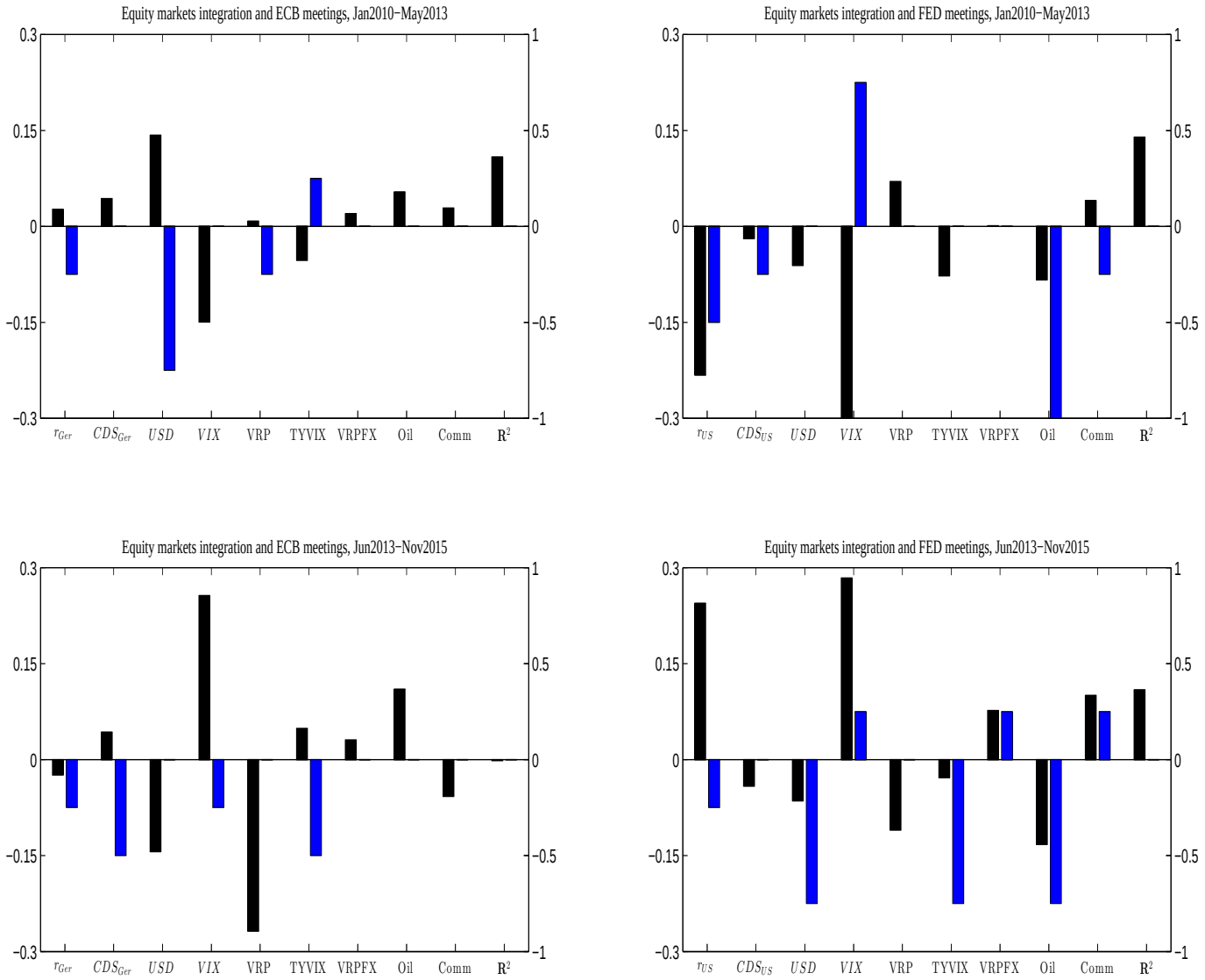

Figure 2. Regression of principal component of equity returns to EM on global factors. We extract the first principal component of equity returns across the four groups of EM during ECB or FED meeting and ex-meeting days, and regress it on the global factors. We plot the difference from moving from the N to A sample in the average coefficient (dark column, left Y-axis), dummy for significance at the 10% level (blue column, right Y-axis), and R-squared (dark column, left Y-axis). The top two plots are for the Jan2010May2013 period, while the bottom two plots are for the Jun2013Nov2015 period.

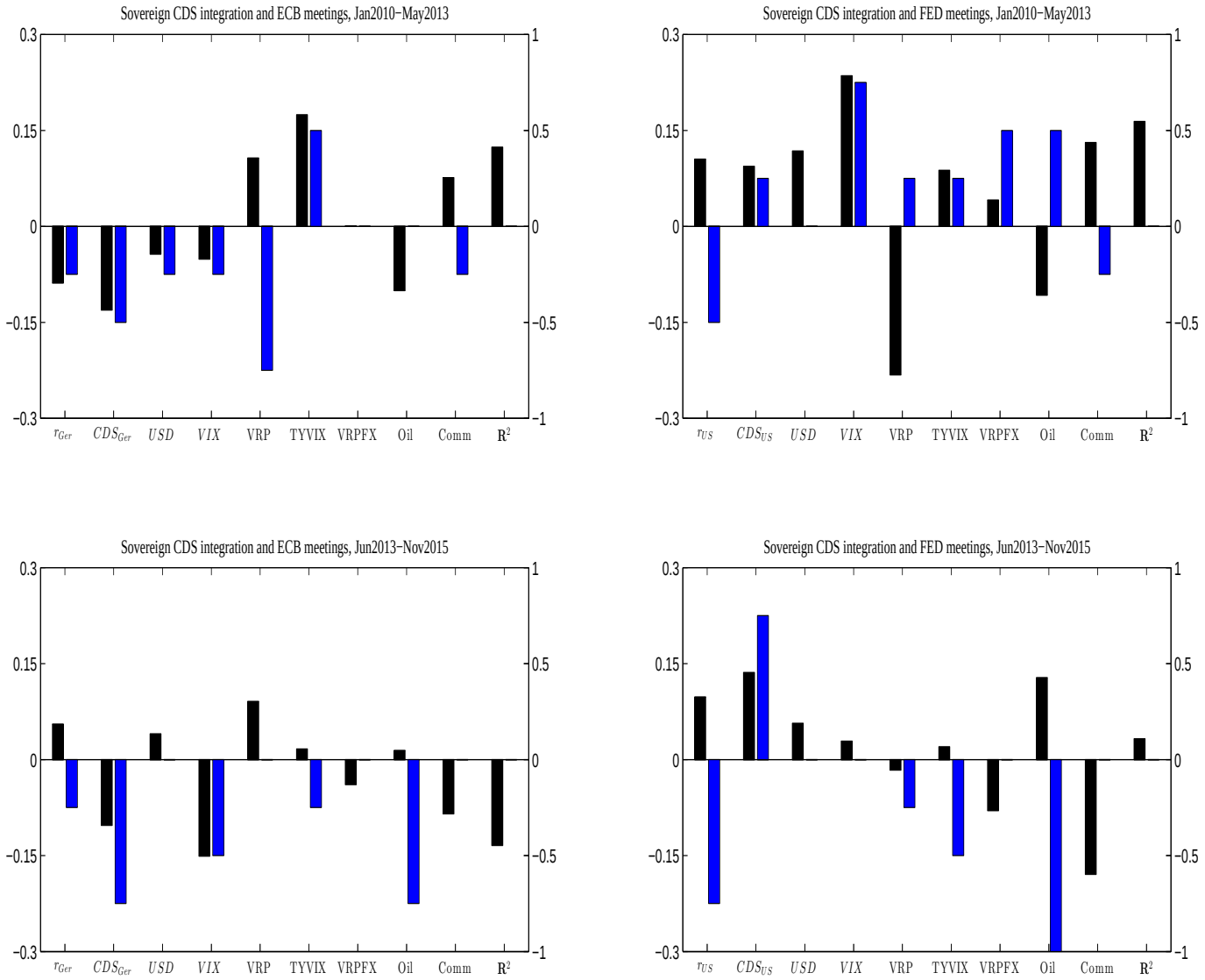

Figure 3. Regression of principal component of Sovereign CDS Spreads to EM on global factors. We extract the first principal component of sovereign CDS spreads across the four groups of EM during ECB or FED meeting and ex-meeting days, and regress it on the global factors. We plot the difference from moving from the N to A sample in the average coefficient (dark column, left Y-axis), dummy for significance at the 10% level (blue column, right Y-axis), and R-squared (dark column, left Y-axis). The top two plots are for the Jan2010May2013 period, while the bottom two plots are for the Jun2013Nov2015 period.

Appendix

A Bootstrap procedure

We rely on the following bootstrap to assess the statistical significance of the differences in the measures of integration across announcement and non-announcement days. The procedure is applied to a given asset (equity or CDS spreads) and period/central bank combination. Let T be the total number of days in that period. The procedure is organized in the following steps:

1. We estimate the covariance matrices Σ, Σ_A, and Σ_N on the full sample and separately on the event (announcement) and non-event days.

2. We compute the Cholesky decomposition of these matrices, and multiply event and non-event days by the inverse of the Cholesky matrix of the corresponding covariance matrices. This procedure gives us scaled uncorrelated shocks across both the A and N samples, which we then pool together.

3. We draw random samples of size T from these shocks using a stationary bootstrap with average sample size equal to 4. The bootstrap is made to preserve the conditional properties of the data, such as unfiltered heteroskedasticity or other forms of dependence, that are still present in the (unconditionally) scaled shocks. The shocks are sampled jointly in the cross-section of countries.

4. We multiply this new artificial dataset by the Cholesky matrix of the full-sample covariance matrix Σ. This step imposes the null hypothesis of equal correlation structure in the two periods.

5. We then draw a random set of announcement days equal to the actual number of announcements the period, and construct our (-1;+1) event window.

6. Finally, we compute distances (3)-(5) for this random sample.

We repeat steps 3 to 6 for 2,500 times, and use the empirical distribution of the Δs to construct the confidence interval under the null hypothesis.

B Latent Factor Model

As a further robustness check, we estimate on our data a latent factor model inspired by the multi-level factor model of Breitung and Eickmeier (2015). We assume that our variables of interest $X_{i,t}$ have a common dynamic behavior, which is driven by two sets of latent factors:

$$X_{i,t} = \mu_i + \beta'_{A,i} F_{A,t} + \beta'_{N,i} F_{N,t} + \varepsilon_{i,t}. \tag{9}$$

The factors included in $F_{A,t}$ appear only during announcement periods while the factors included in $F_{N,t}$ are active in non-announcement periods. Differently from Breitung and

Eickmeier (2015) we do not include a global factor appearing both on announcements and non-announcements.

We estimate the model using the approach suggested by Breitung and Eickmeier (2015) that consists of iterating between two least squares estimation steps: the first conditions on the factors in order to estimate the loadings vectors $\beta_{A,i}$ and $\beta_{N,i}$; the second steps conditions on the loadings to estimate the latent factors. We also include a normalization step to ensure we obtain orthonormal factors in both announcement and non-announcement periods. For further details on the estimation approach, see Breitung and Eickmeier (2014 and 2015).

Given the estimated factors and the corresponding loadings, we look at the fraction of variance explained by the factors for both the announcement and non-announcement period. Since the fraction of explained variance is country-specific, we focus on the median across countries and group Emerging Markets together. We assume the presence of three latent factors in the two sub-samples.[19] Table AII reports the corresponding results.

For equity, in the first and second period we do not observe large changes when contrasting announcement and non-announcement samples. In the third period, both ECB and FED interventions seem to drive a limited increase in integration, while in the fourth period we observe more heterogeneity, with a decrease in integration on EM during both central banks announcements. Turning to sovereign CDS, we observe that the fraction of total variance explained by the latent factors is higher in the second and third periods, coherently with the analyses on correlation in the main text. Moreover, we do see a different impact in the role played by the ECB and the FED. While the former seems to decrease market integration in the fourth period for the CDS case (the change is negative for all country groups), FED's announcements drive integration up as reflected by the sharp increase in the fraction of variance explained by the latent factors. In the third period, both ECB and FED interventions reduce integration for both EMU and EM markets, with a much larger impact by the FED. Overall, the message that emerges from the table lines up quite closely with that from Section 5.

[19] We also consider the presence of a single factor. Patterns appear in a more clear way when we introduce three factors, thus suggesting that a single period-specific common factor (one for announcement and one for non-announcement) is not sufficient to capture the latent behavior (and heterogeneity) of the markets.

Table AI. Country list and classification

This table presents the list of 39 countries in our sample, their classification into Developed or EM markets, their geographical classification, and the EMU dummy which is 1 for countries in the Eurozone and 0 otherwise. The classification is based on FTSE. In the analysis, we pool the group of frontier markets with emerging markets, as they are too few to be analyzed separately.

Country	Developed/Emerging	Location	EMU
Australia	Developed	Asia&Pacific	0
Austria	Developed	Europe&ME	1
Belgium	Developed	Europe&ME	1
Brazil	Emerging	Americas	0
Bulgaria	Emerging	Europe&ME	0
Chile	Emerging	Americas	0
China	Emerging	Asia&Pacific	0
Colombia	Emerging	Americas	0
Croatia	Emerging	Europe&ME	0
Czech Rep.	Emerging	Europe&ME	0
Denmark	Developed	Europe&ME	0
Finland	Developed	Europe&ME	1
France	Developed	Europe&ME	1
Germany	Developed	Europe&ME	1
Ireland	Developed	Europe&ME	1
Israel	Developed	Europe&ME	0
Italy	Developed	Europe&ME	1
Japan	Developed	Asia&Pacific	0
Korea	Developed	Asia&Pacific	0
Malaysia	Emerging	Asia&Pacific	0
Mexico	Emerging	Americas	0
Morocco	Frontier	Africa	0
Netherlands	Developed	Europe&ME	1
Norway	Developed	Europe&ME	0
Pakistan	Emerging	Asia&Pacific	0
Peru	Emerging	Americas	0
Philippines	Emerging	Asia&Pacific	0
Poland	Emerging	Europe&ME	0
Portugal	Developed	Europe&ME	1
Romania	Frontier	Europe&ME	0
Russia	Emerging	Europe&ME	0
S. Africa	Emerging	Africa	0
Slovakia	Frontier	Europe&ME	1
Spain	Developed	Europe&ME	1
Sweden	Developed	Europe&ME	0
Thailand	Emerging	Asia&Pacific	0
Turkey	Emerging	Europe&ME	0
U.S.	Developed	Americas	0
Venezuela	Frontier	Americas	0

Table AII. Dynamic factor model

This table presents the median fraction of the variance explained by the three latent factors in the dynamic factor model described in Appendix B across four groups of countries. The factors are filtered from the cross section of either equity (Panel A and B) or sovereign CDS changes (Panel C and D) during central bank' (ECB in Panel A and C, or FED in Panel B and D) meeting and ex-meeting days.

	Jan2006-Jul2007			Aug2007-Dec2009			Jan2010-May2013			Jun2013-Nov2015		
Panel A: Equity markets integration and FED meetings												
Countries	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ
All	41.80	48.10	*-6.30*	69.70	60.00	*9.70*	69.70	51.10	*18.60*	35.80	31.00	*4.80*
EMU	86.90	86.80	*0.10*	90.30	87.80	*2.50*	89.90	86.60	*3.40*	84.90	83.40	*1.50*
DM ex-EMU	74.90	74.60	*0.30*	83.50	82.00	*1.50*	85.00	76.80	*8.20*	70.10	70.50	*-0.40*
EM	80.10	80.90	*-0.80*	83.60	80.90	*2.70*	87.40	81.20	*6.20*	78.50	80.00	*-1.50*
Panel B: Equity markets integration and FED meetings												
Countries	FED	ex-FED	Δ	FED	ex-FED	Δ	FED	ex-FED	Δ	FED	ex-FED	Δ
All	53.20	44.90	*8.20*	67.00	59.90	*7.10*	70.70	53.60	*17.10*	43.50	30.20	*13.30*
EMU	87.60	85.60	*2.00*	86.90	86.70	*0.10*	89.10	86.70	*2.50*	85.70	83.70	*2.10*
DM ex-EMU	68.40	74.20	*-5.80*	87.00	81.10	*5.90*	85.70	76.40	*9.30*	69.70	70.40	*-0.70*
EM	81.20	81.50	*-0.30*	85.10	78.30	*6.80*	82.30	81.70	*0.60*	70.30	81.60	*-11.20*
Panel C: Sovereign CDS integration and ECB meetings												
Countries	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ	ECB	ex-ECB	Δ
All	7.20	19.00	*-11.80*	43.80	60.70	*-17.00*	61.50	50.50	*11.00*	16.50	28.80	*-12.20*
EMU	29.80	24.20	*5.50*	84.50	78.20	*6.30*	63.90	73.70	*-9.80*	38.10	52.00	*-13.90*
DM ex-EMU	33.50	1.80	*31.70*	70.10	55.10	*15.00*	83.20	65.50	*17.70*	39.90	57.00	*-17.00*
EM	6.50	6.90	*-0.40*	76.70	61.10	*15.60*	54.10	57.50	*-3.40*	19.30	39.60	*-20.20*
Panel D: Sovereign CDS integration and FED meetings												
Countries	FED	ex-FED	Δ	FED	ex-FED	Δ	FED	ex-FED	Δ	FED	ex-FED	Δ
All	24.00	19.80	*4.20*	54.30	56.50	*-2.30*	55.40	51.90	*3.60*	52.60	22.30	*30.40*
EMU	14.60	12.20	*2.50*	83.40	78.30	*5.00*	46.30	73.60	*-27.40*	78.10	36.20	*41.90*
DM ex-EMU	12.80	1.80	*11.00*	60.20	56.10	*4.00*	67.60	71.70	*-4.10*	72.80	51.10	*21.70*
EM	8.60	8.40	*0.20*	67.30	62.10	*5.20*	40.80	57.70	*-16.90*	64.10	31.10	*33.10*