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QUANTITATIVE EASING, TAPERING AND STOCK MARKET INDICES

Abstract: We investigate a series of unconventional monetary policies put forward by the Federal Reserve in order to fight the economic turbulence that followed the crisis of 2008. Building on our previous work, we study QE and tapering initiatives, focusing on the impact induced on a series of stock indices belonging to both mature and developing markets. A special attention is given to CEE markets. Our results indicate the fact that both the QE policy and the gradual exit from it had serious effects on the dynamics of the considered indices in terms of volatility.
Keywords: quantitative easing, tapering, monetary policy, stock markets.

JEL Classification: G14, G15, E44, E52

1. Introduction:

The classical solution of reducing short term interest rates did not prove an efficient tool in the quest of counterbalancing the great economic shocks that derived from the financial crisis that shook the system in 2008. This lack of efficiency of the zero lower bound urged central banks to pursue unconventional measures. In concordance to other major central banks, Federal Reserve shown a great effervescence in implementing such measures, putting forward a vivid arsenal of actions that fit under the general classification of quantitative easing (QE).

The first move came at the end of 2008 when Fed announced the launch of what became known as QE1. This program consisted in purchases of MBSs and debt elements from GSEs, having a budget of 600 billion dollars. This amount was dwarfed by the following actions conducted in 2009 which took the implication in QE up to 1.75 trillion dollars by March 2010.
QE1 was only the bridge head of Federal Reserve's quantitative easing policy. The program got a second phase (QE2) in June 2011 that targeted the acquisition of treasuries. QE2 was followed by a maneuver designed to extend the maturity of Fed's

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treasury bonds. Bearing the name of Operation Twist, this program started with the acquisition of treasury bonds with maturities ranging from 6 to 30 years and assumed also the selling of bonds with maturities lower than three years.

The last trimester of 2012 brought the third phase of quantitative easing (QE3). This program had a distinct architecture in comparison to its predecessors and assumed the perpetual acquisition of 40 billion dollars worth of MBS and of 45 billion dollars worth of long term treasuries. This purchase scheme was designed to function until the restoration of the labor market.

Given the scale and the nature of Federal Reserve's unconventional monetary policy, a large block of academic attention has been oriented towards the investigation of the effects that stem from these initiatives. Key contributions in this direction can be found in Doh (2010), D'Amico and King (2010), Gagnon et al (2011), Hamilton and Wu (2012), Saghaian and Reed (2015) or Belke et al (2016).

Despite the fervor of the Fed's implication in quantitative easing, at the end of May 2013, Ben Bernanke hinted at a possible gradual exist from monetary stimulus. This became a reality in December 2013, when the FOMC decided to lower the pace of QE by 10 billion dollars per month. From this point, the communications of the FOMC oscillated from further reductions to maintaining the existing level of stimulus. This progressive reduction of asset purchases became known as tapering and triggered a massive wave of market uncertainty and attention from both academics and practitioners. Investigations on the impact, effects and characteristics of tapering have been put forward in studies such as: Eichengreen and Gupta (2013), Aizenman et al (2014), Mishra et al (2014), Ogawa and Wang (2015) or Călin (2015).

This paper continues this strand of literature by aiming to determine the potential effects of both Federal Reserve's quantitative easing and tapering decisions on a large set of stock market indices belonging to developed and emerging markets. In an event-study setup build on 32 GARCH-type specifications we determine the impact of the above mentioned decisions in terms of abnormal volatility.

The remainder of this paper is organized in the following manner. Section two provides a brief literature review on the topic of unconventional measures employed by the Fed. Section three discusses the data and the methodology used and section four presents the results obtained. Section five concludes.

2. Literature review:

As stated above, the present research relates to the strain of financial literature studying the outcomes of quantitative easing. D'Amico and King (2010) study the impact of Federal Reserve's 2009 unconventional program. The results show that each purchase lowered on average yields with 3.5 basis points. This reduction occurred on the days of the purchases, phenomenon named by the authors "flow effect". Moreover, the study finds that the entire program managed to trigger a fall in the yield curve ranging up to 50 basis points.

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Krishnamurthy and Vissing-Jorgensen (2011) aim at the impact of QE1 and QE2 on interest rates. Using an event study method build to accommodate daily and intraday data, the authors document on a solid decrease of nominal interest rates for high quality long term assets. The authors also point out to smaller effects deriving from QE1 on the nominal interest rate of corporate assets. Using also an event study methodology, Gagnon et al. (2011) observe that the LSAPs of QE1 determined a drop of about 150 basis point in the yields of treasuries. Under a similar modeling structure, Christensen and Rudebusch (2012) report homogenous results.

The same topic is covered in D'Amico et al (2012). The authors show that the 2009 program determined a reduction of 35 basis points in the long term yields. Morever, the results exhibit the fact that the 2010-2011 asset purchases produced an even greater reduction, of about 45 basis points. The results of D'amico et al (2012) are partly supported by Fratzsher et al (2012). The latter study also observes that the QE2 measures led to a move of capital towards emergent states.

Albu et al (2014) employ also an event study methodology in order to quantify the influence of QE initiatives on sovereign CDSs. The authors report a clear impact on the prices of the above mentioned assets, impact that can be used as a proxy for credit risk for the countries included in the study.

More recently, Carpenter et al (2015) investigate the types of investors that participated in the asset purchases and their portfolio adjustments in order to observe the transmission of quantitative easing. One of their conclusions hints to the fact that an important number of investors rebalanced their portfolios in the direction of riskier assets during the times of QE.

Belke et al (2016) study the effects of unconventional monetary policies on the dynamics of international yields. In a CVAR setup built on data ranging from 2002 to 2014, the authors find only sparse evidence that can lead to the conclusion that Federal Reserve's QE1 altered the interest rate relationship between US and EU.

Besides the studies that consider the US quantitative easing, a solid block of literature focuses on the exit from such monetary stimulus, important results deriving from works such as: Eichengreen and Gupta (2014), Dahlhaus and Vasishtha (2014),Park, Ramayandi, and Shin (2014), Matheson and Stavrev (2014), Mishra et al. (2014), Meinusch and Tillmann (2015) In a similar investigation to the present one, Aizenman et al (2014) try to assess the impact of tapering announcements on emergent financial markets. The authors use announcements about both QE and tapering and a panel setup with fixed effects. Aizenman et al (2014) report that the prices of financial assets react more substantially to the statements made by Benanke and are far less influenced by the communications of other Fed representatives. In addition to this, the authors report that states with solid macroeconomic fundamentals exhibited larger signs of influence than states with a weaker macroeconomic position. Călin (2015) investigates the potential influences that tapering might have induced on

the US real estate market. In an event-study approach, the author notices only a mild reaction.

Shaghil et al (2015) focus on tapering realities of 2013 from the perspective of shock transmission towards emergent financial markets, documenting on the role of economic fundamentals. In contradiction to the previously mentioned research, Shaghil et al (2015) report that those countries with stronger macroeconomic fundamentals showed a lower influence from the taper-tantrum.

Gosh and Sagaar (2016) analyse the tapering period and demonstrate that the conditional volatility observed during the tapering talk was greater than that observed during the actual time frame of tapering. This is a result that confirms the findings of our investigation.

Another research that reports similar results to those of this paper has been put forward by Estrada et al (2015). Analyzing the spillovers that derive from the tapering initiatives, the authors find empirically that the entire series of emerging equity markets were influenced.

3. Data and methodology

This study follows the dynamics of a large set of stock market indices observed in the 01.01.2008 – 29.07. 2015 time frame. We use the closing prices on a daily frequency for these assets. The data were gathered from Bloomberg and represent a total of 118 stock market indices distributed randomly among countries and being representative for both mature and developed markets, and developing and frontier markets.

In addition to this, we employ the calendaristic dates of a series of quantitative easing and tapering announcements launched by the Federal Reserve in the 22.05.2013 - 29.10.2014 interval. These dates derive from the public statements of Federal Reserve and have been previously used in financial literature.

Given the fact that we aim at a GARCH – type analys, our methodology starts with the investigation of the statistical properties of the data in order to establish if the data are suitable for the requirements of GARCH modeling. Therefore, we focus on basic dynamics of prices and returns, central moments of returns, degree of autocorelation of simple and squared returns.

After this point we calibrated for each financial assets the following models belonging to the GARCH family: GARCH, EGARCH, GJR-GARCH, APARCH, TARCH, NAGARCH, IGARCH and FIGARCH, each with four types of errors, namely: normal, student – t, GED, and skewed. In other words, we calibrated 32 models for each of the 118 financial assets.

The mathematical representation of these models is the following:
GARCH model:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i a_{t-i}^2 + \sum_{j=1}^{s} \beta_j \sigma_{t-j}^2$$

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EGARCH model:

$$\log \sigma_t^2 = \omega + \sum_{i=1}^{m} \beta_i \log \sigma_{t-i}^2 + \sum_{j=1}^{s} \alpha_j \left[\frac{|a_{t-j}|}{\sigma_{t-j}} - E\left(\frac{|a_{t-j}|}{\sigma_{t-j}} \right) \right] + \sum_{j=1}^{s} \gamma_j \left(\frac{a_{t-j}}{\sigma_{t-j}} \right)$$

GARCH – GJR model

$$\sigma_t^2 = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{s} \alpha_j a_{t-j}^2 + \sum_{j=1}^{s} \gamma_j I_{t-j} a_{t-j}^2$$

A-PARCH model

$$\sigma_t^\delta = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i}^\delta + \sum_{j=1}^{s} \alpha_j \left(|a_{t-j}| - \gamma_j a_{t-j} \right)^\delta$$

TARCH model

$$\sigma_t = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i} + \sum_{j=1}^{s} \left(\alpha_j a_{t-j}^+ + \gamma_j |a_{t-j}^-| \right)$$

NAGARCH model

$$\sigma_{t+1}^2 = \omega + \alpha R_t^2 + \beta'^{\sigma_t^2} - 2\alpha\delta z_t \sigma_t^2$$

IGARCH model

$$\sigma_t = \omega + \sum_{i-1}^{q} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

FIGARCH model

$$\sigma_t^2 = \frac{\omega}{1 - \beta(L)} + \left\{ 1 - \frac{\alpha(L)(1-L)^d}{1-\beta(L)} \right\} a_t^2 = \frac{\omega}{1-\beta(L)} + \lambda(L) a_t^2$$

After calibrating these models we incorporated them in an event study framework, similar to our previous work shown in Albu et al (2014b). In a window sample of ten days before each event in our investigation and ten days after the respective event, we used the value predicted by the above-mentioned models to obtain a gauge of the daily variances. On one hand, these 21 variances (ranging from day -10 to day 10, where day 0 denotes the day of the event) were compared with the realized variances inside this window, generating the so-called *forecasted abnormal variances*. On the other hand, the last 20 days before the beginning of this window (from day -40 to day -11) were used to compute the so-called *estimated abnormal variances*. For this latter set of abnormal variances we computed the mean and standard deviation for each volatility model mentioned above. Their randomness should reflect the in-sample

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power of the model, i.e. the extent to which each model succeeds to generate variances that are similar to reality. We will consider the distribution of these *estimated abnormal returns* as a benchmark for the manner in which these models reflect the reality. According to this view, we can conjecture that *forecasted abnormal variances* larger than twice the standard deviation of the *estimated abnormal variances* should signal the manifestation of significant changes in the volatilities of the log-returns for the specific combination of asset, event and model. A statistic for the number of such occurrences across models is recorded at each running of this algorithm and reported in the results section.

4. Results

As stated above, our analysis focused on determining the impact of the QE and tapering events on a large set of stock market indices. Our first landmark is placed in May 2013. At that time, given the fact that the labor market was signaling a sounder evolution, the president of Federal Reserve hinted at a possible gradual reduction of the asset purchase programs. The results of the GJR – GARCH model with normal errors point out abnormal variances on the announcement day for the *DOW JONES UTIILITIES*. In addition to this we find substantial influences in the period that follows the launch of the event for an important number of financial assets, among which we observe: *BIST NATIONAL 100, FTSE 100, IDX COMPOSITE, MSCI PACIFIC U$, NIKKEI 225 STOCK AVERAGE, PHILIPPINE SE I (PSEi), SWISS MARKET (SMI), TOPIX, TSE SECOND SECTION*. The results obtained for the GJR-GARCH model with normal errors is presented in Figure 1.

Figure 1: Abnormal variances for event number 1 under the GJR - GARCH specification with normal errors
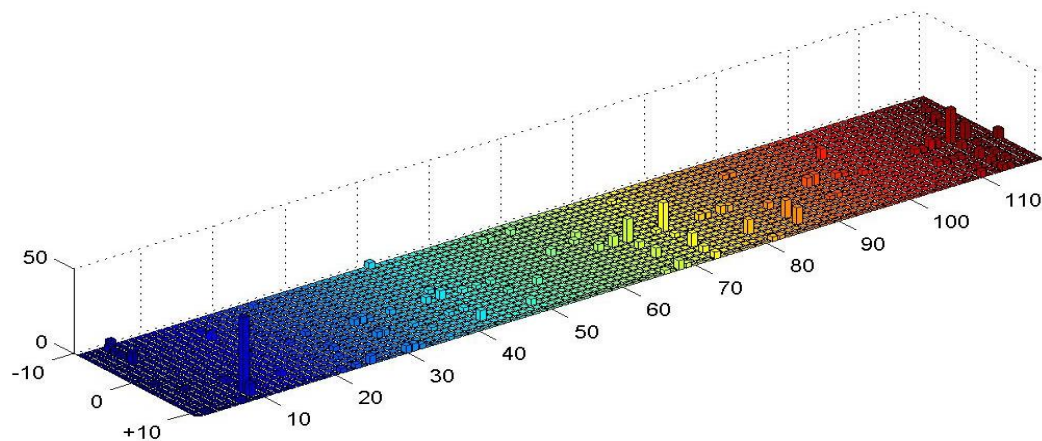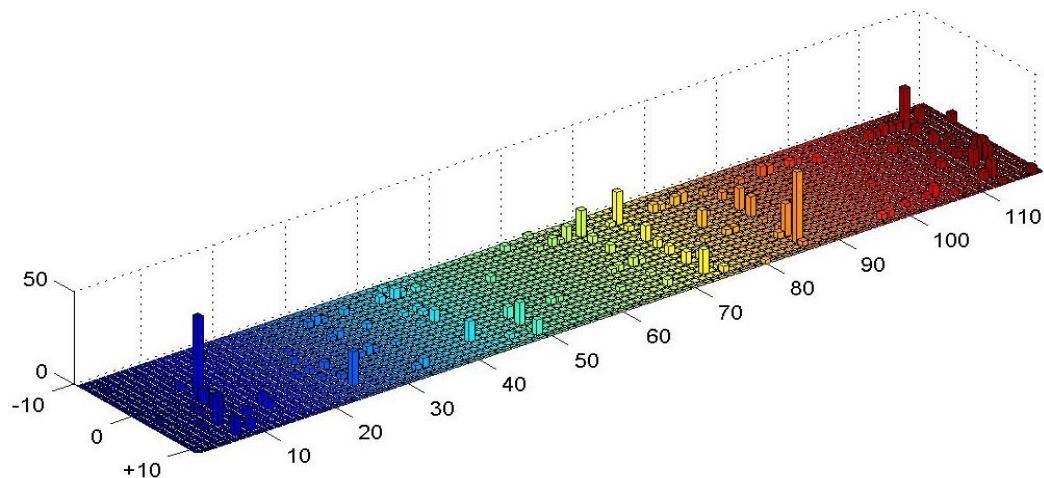

Source: Authors' computation

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In terms of magnitude, we notice that the highest percentual reaction appears for *NIKKEI 225 STOCK AVERAGE* and *TOPIX* which respond in 50% and 60% of the total number of possible cases.

The other modeling specifications reveal similar findings. For example, the set of APARCH models highlight a strong reaction from the *BUDAPEST (BUX)* on the day of Bernanke's speech on potential tapering.

The above mentioned communication was followed by a statement issued by the San Francisco Federal Reserve president, John Williams on the 3rd of June 2013. Williams stated at that time the possibility of decelerating the assets purchases during the subsequent three months and also projected a potential exit from QE by the end of 2013. This is the second announcement on US unconventional monetary policy included in our study. Its impact on the considered stock market indices is far more relevant than the one observed for the last announcement. In an EGARCH setup with normal errors we find abnormal variances on the day in which the communication was released for 8 stock market indices among which we observe: *BIST NATIONAL 100 -, TOPIX - PRICE, FTSE TECHMARK FOCUS (£), NIKKEI 225 STOCK AVERAGE* or the *SWISS MARKET (SMI).*

In a similar way to the previous situation we find abnormal variances on more than 50% of the days in the event window for the *BIST NATIONAL 100, PHILIPPINE SE I(PSEi)* and *TOPIX*. The most sensitive financial asset in this case is the *BIST NATIONAL 100.*

Figure 2: Abnormal variances for event number 2 under the EGARCH specification with normal errors
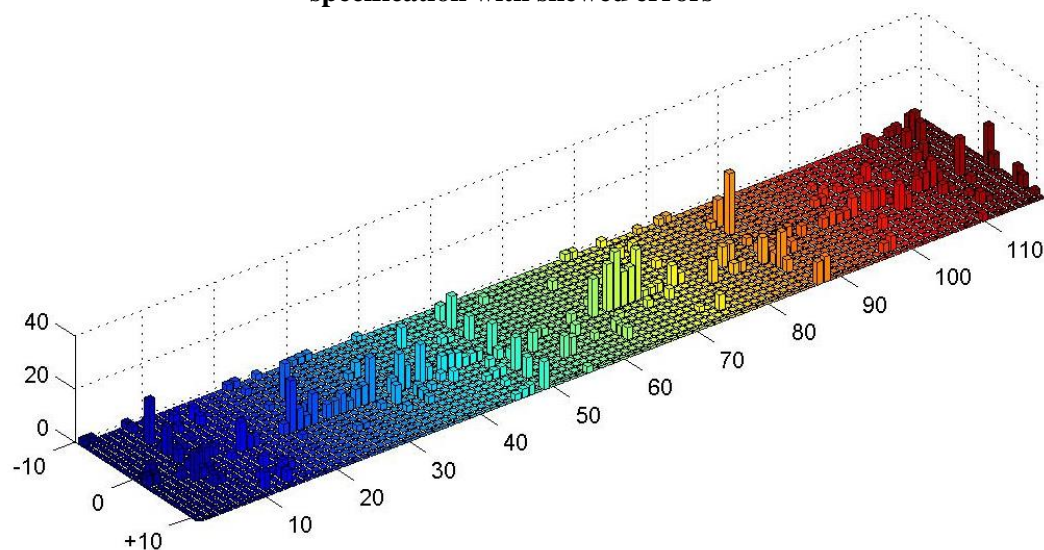

Source: Authors' computation

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On July 19 2013 the FOMC decided to supplement the acquisition of treasuries and MBSs and to continue QE measures until the labor market exhibits substantial improvements. The FOMC added at this date that their policy might assume expanding or reducing the assets purchases in order to be able to influence the labor market and inflation.

The APARCH specifications for this event indicate abnormal variances on the issuance day only for three financial assets, namely *BRAZIL BOVESPA - TOT RETURN IND, DOW JONES INDUSTRIALS* and *DOW JONES UTIILITIES*. The highest impact is visible for the Dow Jones Utilities index, and the results for this specification are visible in Figure 3.

Figure 3: Abnormal variances for event number 3 under the APARCH specification with skewed errors
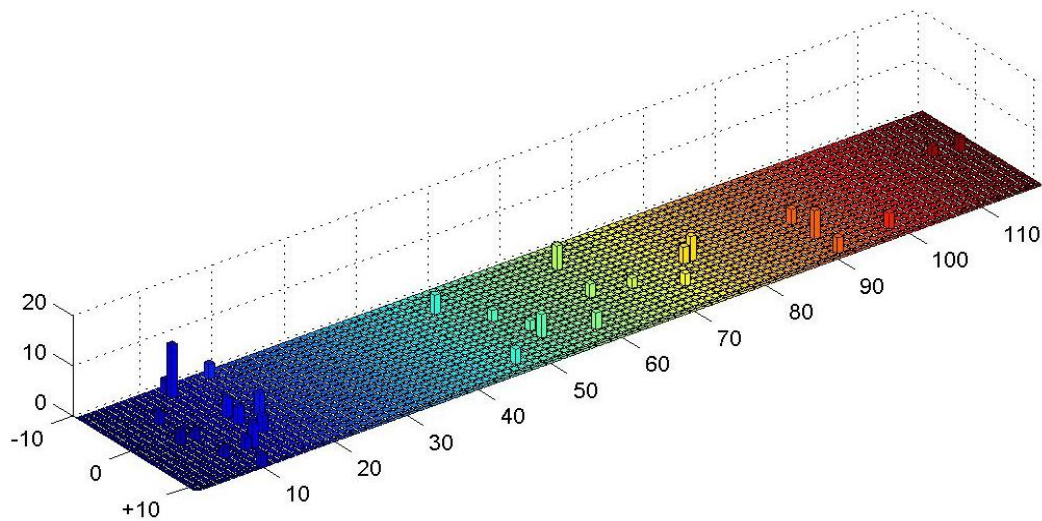

Source: Authors' computation

Despite this weak reaction found for the announcement day, an interesting result is that a large set of indices react in terms of abnormal volatilities on the day that follows event number three. The results show the fact that 69 out of the total of 118 indices included in this analysis react to Federal Reserve's decision to continue quantitative easing, which represents a high impact. Moreover, this event influences a series of indices that are relevant for the developed international financial markets such as *DOW JONES INDUSTRIALS, EURONEXT 100, FRANCE CAC 40, FTSE 100, NASDAQ COMPOSITE, S&P 500 COMPOSITE.*

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The impact generated by the next event is inferior in comparison to the last event which is natural, given the fact that event number 4 represents the decision of FOMC to gather more evidences of economic recovery before adjusting the pace of quantitative easing. Under a NAGARCH specification with skewed errors we noticed the lack of abnormal variances on the day of the event. However, despite this fact, a series of indices react on the following day, among which we observe: OMX COPENHAGEN (OMXC), MEXICO IPC (BOLSA), CHILE SANTIAGO SE GENERAL (IGPA), ATX - AUSTRIAN TRADED INDEX and the ROMANIA BET (L). The graphical representation of the results for the NAGARCH specification with skewed errors is found in Figure 4.

Figure 4: Abnormal variances for event number 4 under the NAGARCH specification with skewed errors
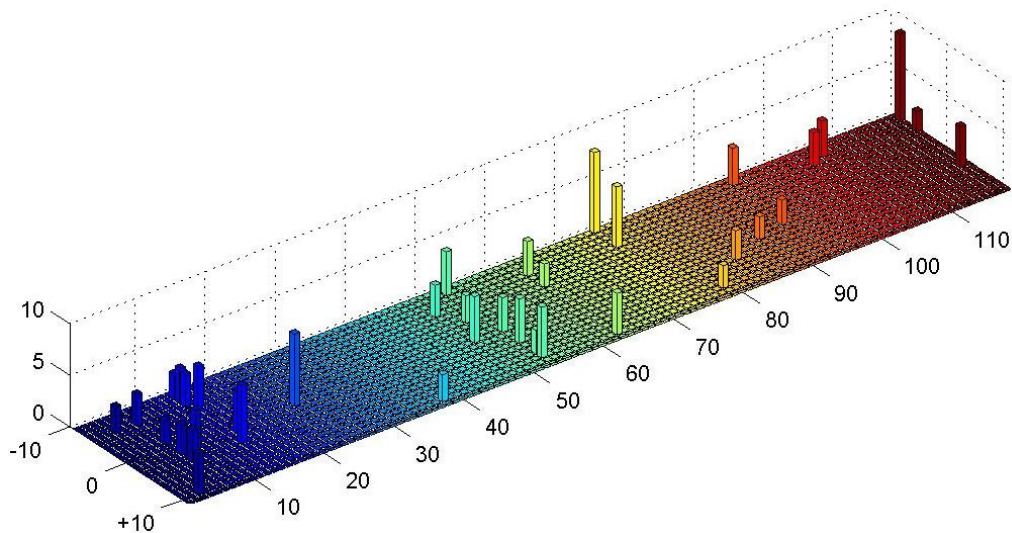

Source: Authors' computation

In a similar way to the previous event, event number five does not generate a fundamental impact on the studied stock market indices. Therefore, the similarity in terms of meaning is doubled by a similarity in terms of influence. The results of the TARCH model with normal errors do not highlight abnormal variances on the day of the event. In a symmetrical way to the other announcements, there are indices that exhibit abnormal variances on the day that follows the launch. Such examples are: *BIST NATIONAL 100*, *CNX 500*, *KARACHI SE 100*, and *RUSSIA RTS INDEX*. We notice similar results through the use of the APARCH specification with skewed

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errors. In this modeling context we also observed pools of abnormal volatility for the following indices CHILE SANTIAGO SE GENERAL (IGPA), CNX 500, in the period that follows event number five. The results of TARCH model with normal errors are graphically presented in Figure 5.

Figure 5: Abnormal variances for event number 5 under the TARCH specification with normal errors

Source: Authors' computation

Event number six has the same consistency and meaning as the previous two. Unlike the precedent cases, it triggers a superior impact. Using an IGARCH model with normal errors we record abnormal volatilities on the day of the event for 4 indices: *DOW JONES UTIILITIES, ARGENTINA MERVAL, PORTUGAL PSI ALL-SHARE* and *PORTUGAL PSI-20.*

In addition to this, we find reactions in terms of volatility on the day that follows the communication for a set of 28 indices belonging mainly to countries with mature and developed financial markets. The majority of these indices exhibit further abnormal volatilities throughout the event window.

The first pure tapering event in this analysis occurred on December 18 2013 and consists in the decision of the FOMC to reduce the purchases of MBS from 40 billion dollars per month to 35 billion dollars per month accompanied by a reduction in the acquisition of long term treasuries from 45 billion dollars to 40 billion dollars. Following the results of the TARCH model with Student-t errors we noticed cases of

abnormal variances for a series of US indices, on the day of the event. Among this cases we observe strong reactions from: *DOW JONES COMPOSITE 65, DOW JONES INDUSTRIALS, NYSE COMPOSITE* and *S&P 500 COMPOSITE*. We also noticed reactions for the same moment for other financial assets such as: *FTSE ALL WORLD, MSCI WORLD or S&P/TSX COMPOSITE.*

This wave of uncertainty was followed by impressive moves of abnormal volatilities for December 19 for an important number of indices including European ones. Among these we mention: *BULGARIA SE SOFIX, EURO STOXX, EURONEXT 100, FTSE ALL SHARE, FTSE EUROTOP 100, IBEX 35, MADRID SE GENERAL, OMX STOCKHOLM (OMXS), STOXX EUROPE 50 or SWISS MARKET (SMI).* Figure 6 shows the results found using the above mentioned model for event number seven.

Figure 6: Abnormal variances for event number 7 under the TARCH specification with Student-t errors
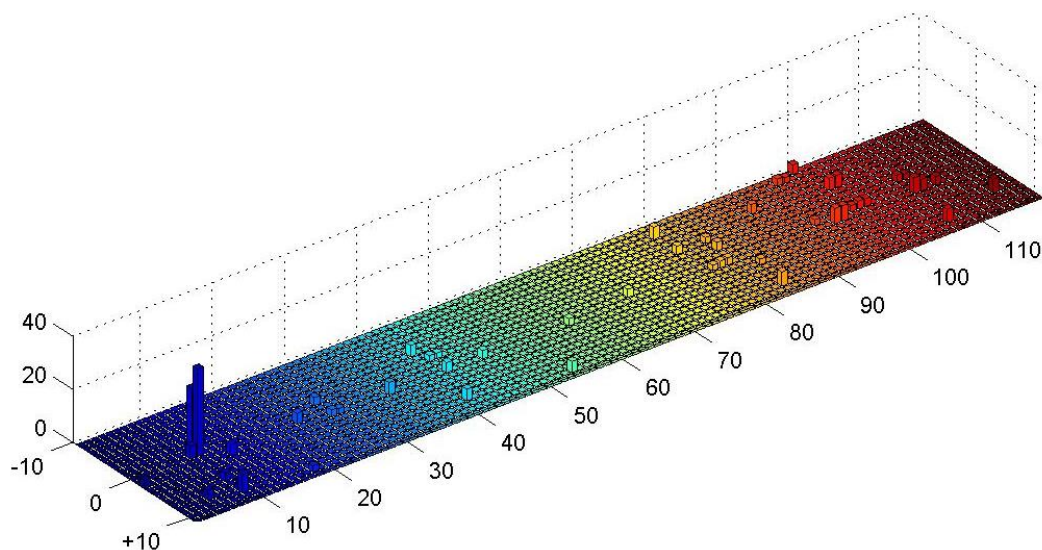
Source: Authors' computation

The following four events are all representative for Federal Reserve's tapering. For example, on 29th January 2014, the FOMC announced that starting from the following month, the purchases of MBSs will be conducted up to 30 billion dollars instead of 35 billion. In addition to this, the purchases of long term Treasuries dropped from 40 billion dollars to 35 billion. In our analysis this announcement is labeled as event number 8.

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Federal Reserve continued its tapering with a communication (event number 9) that came on the 19th of March 2014. At this point, the FOMC announced a new stage of reductions for assets purchases which would bring the acquisitions of MBSs to 25 billion and those of Treasuries to 30 billion dollars.

Event number 10 consists in the decision of FOMC to establish even lower ratios for the asset purchase program. On the 30th of April 2014, these ratios were fixed at 30 billion and 20 billion.

The last event in this series was publicized on the 18th of June 2014 and signaled supplementary reductions in acquisitions to the point of 15 billion in MBSs and 20 billion in Treasuries.

For event number 8, the APARCH and GJR-GARCH models, both with skewed errors point out to volatility accumulations in the (-10; -1) interval for a wide range of stock market indices, as it can be seen in Figure 7. We noticed the fact that on the announcement day several indices such as: *DOW JONES INDUSTRIALS, NIKKEI 225 STOCK AVERAGE* or *TOPIX* exhibit abnormal variances. Unlike the previous cases we detect a limited number of abnormal variances for the day that follows the launch of the event. This was the case only for the *NASDAQ COMPOSITE* and *KENYA NAIROBI SE* indices.

Towards the end of the estimation window we observed occurrences of abnormal volatility for indices like *ARGENTINA MERVAL,* and *STOXX EUROPE.*

Figure 7: Abnormal variances for event number 8 under the GJR-GARCH specification with skewed errors
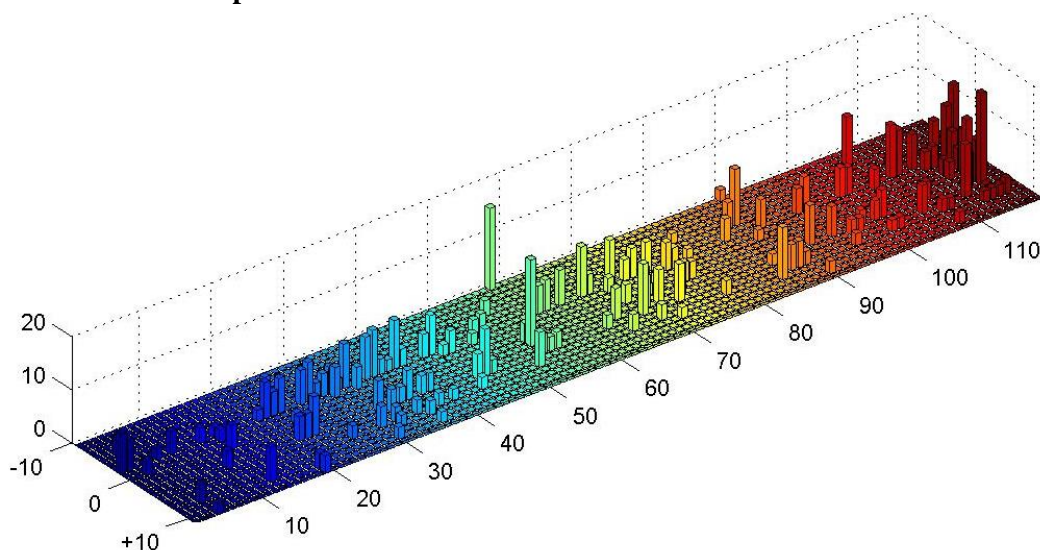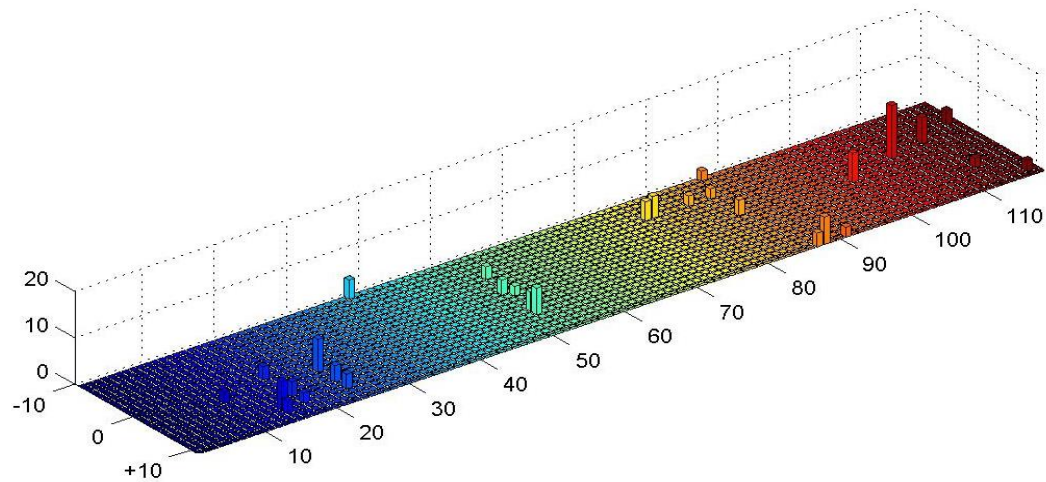

Source: Authors' computation

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   The IGARCH specification with GED variances reveals for the launch day of event number 9 abnormal variances for three indices: *DOW JONES UTIILITIES, CYPRUS GENERAL* and *BULGARIA SE SOFIX.* These are followed by abnormal variances recorded for day 1 of the estimation window for *MEXICO IPC, OMAN MUSCAT SECURITIES MKT* and *MSCI PACIFIC U$.* A similar restricted impact is observed for event number 10. In this case, the EGARCH specification with student t errors shows abnormal variances for day 0 for three indices, namely: *S&P/NZX 50, CROATIA CROBEX* and *CHILE SANTIAGO SE GENERAL.* Under the above mentioned specification we did not record cases of abnormal values in any of the investigated financial assets. The results for the two events are shown in Figure 8.

Figure 8: Abnormal variances for events number 9 and 10 under the IGARCH specification with GED errors and EGARCH specification with Student-t errors

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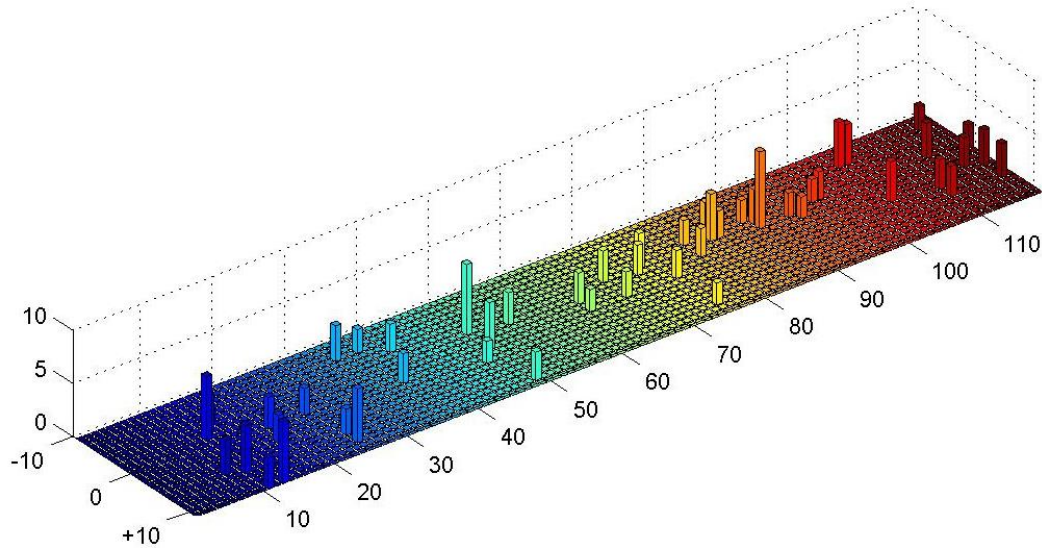
Source: Authors' computation

Event number 11 continues the series of announcements with low impact. In both NAGARCH and GJR-GARCH setups with Student-t and normal errors we find only one case of abnormal variance on the day of the announcement. This was recorded for the *DOW JONES UTIILITIES* index. Furthermore, we notice traces of abnormal variances on day 1 for a limited set of assets, namely: *BOTSWANA SE* and *ARGENTINA MERVAL.*

After the day of announcement we notice a significant reaction from the BULGARIA SE SOFIX index in more than 50% of the cases of the event window. The results of NAGARCH specification with Student – t errors is depicted in Figure 9.

Figure 9: Abnormal variances for event number 11 under the NAGARCH specification with Student – t
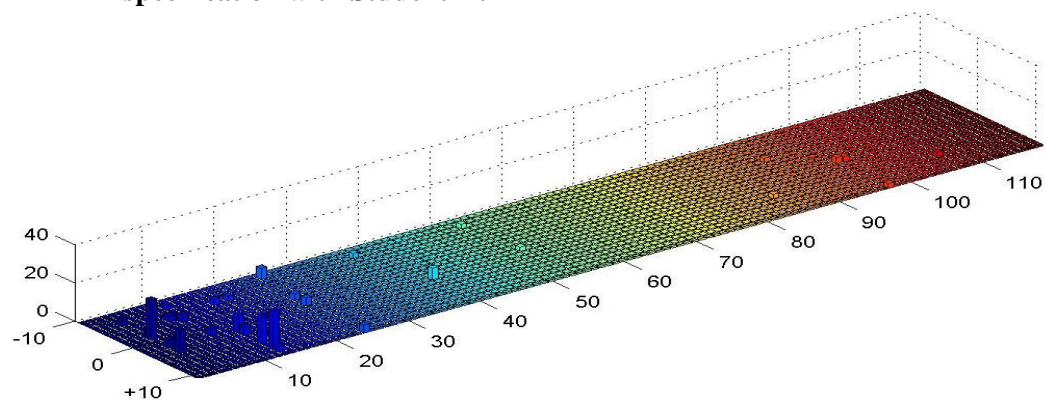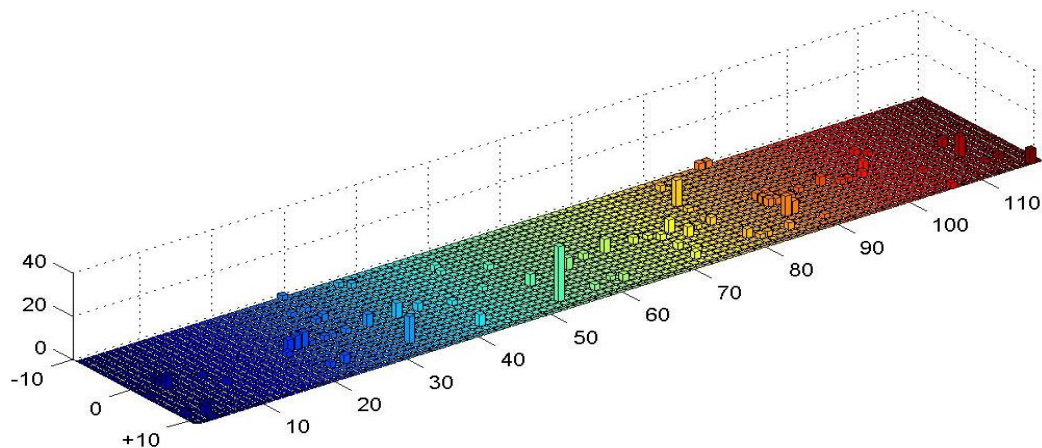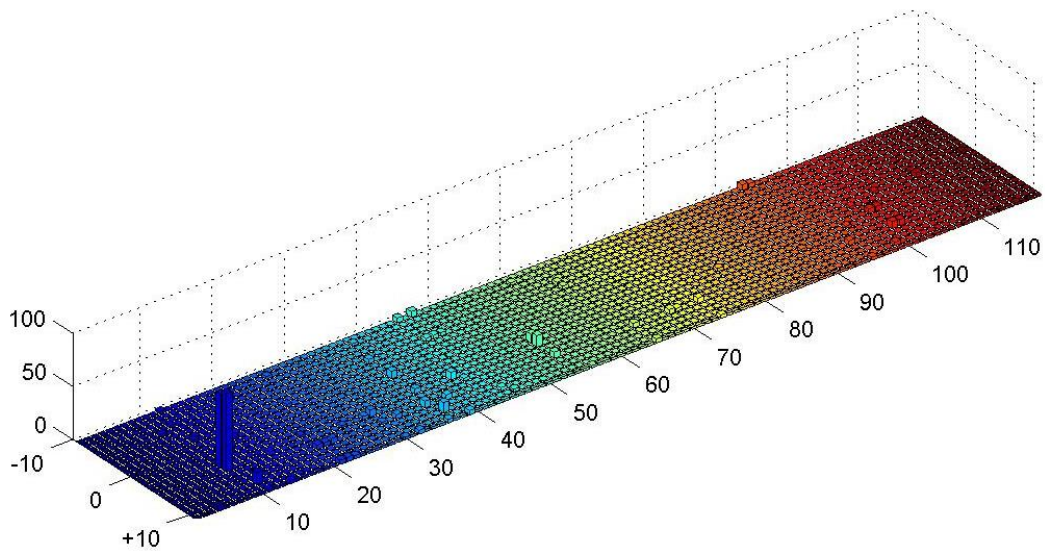

Source: Authors' computation

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Given the progress of the labor market, the FOMC decided at the end of July 2014 a further round of tapering. Under this logic, the purchases were reduced from 15 billion dollars to 10 dollars for MBS and from 20 to 15 billion for long term treasuries. Moreover, on the basis of a state of economic restoration, the Federal Reserve announced on the 17th of July 2014 a new stage of QE programs reductions, reaching 5 billion dollars for MBS and 10 billion for treasuries. These two moments represent events number 12 and 13 of the present study.

By investigating the impact of event number 12 through an EGARCH setup with normal errors we notice abnormal variances for day zero in the case of two financial assets: *PORTUGAL PSI ALL-SHARE* and *ARGENTINA MERVAL.* In addition to this, we observed a strong influence on day 1 of the event window for a large number of indices among which we mention: *S&P 500 COMPOSITE, PORTUGAL PSI ALL-SHARE, NASDAQ COMPOSITE, NYSE COMPOSITE, DOW JONES INDUSTRIALS, ARGENTINA MERVAL, MDAX FRANKFURT,* and *OMX ICELAND ALL SHARE.*

Event number 13 generates a lesser impact on the chosen stock market indices. Judging by the results of a TARCH model with normal errors we do not obtain abnormal values for the day of announcement and for the following day. We notice a few cases of abnormal variances in the event window, but these are randomly distributed. We observe the same results in the EGARCH specification with skewed errors and with the IGARCH model with GED errors. The graphical representation of the results is shown in Figure 10.

Figure 10: Abnormal variances for events number 12 and 13 under the EGARCH specification with normal errors and TARCH specification with normal errors

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Source: Authors' computation

The last event originates from 29th October 2014 and represents Federal Reserve's decision to exit quantitative easing programs. On the day of the announcement, the NAGARCH model with skewed errors indicates abnormal values for two Korean indices: *KOREA SE COMPOSITE* and *KOREA SE KOSPI 200.* More importantly, the model detects abnormal variances for day 1 of the event window for a basket of indices, out of which we mention: *LEBANON BLOM, MOROCCO ALL SHARE, OMX COPENHAGEN, TUNISIA TUNINDEX, RUSSIA RTS* and *DOW JONES UTIILITIES.*

Unlike the previous announcements, event number 14 generates a significant impact throughout the entire event window for the majority of indices. We notice important accumulations of abnormal volatility in the last 10 days before the event. These results were observed for all model specifications and the graphical representation of the output of the APARCH model with skewed errors can be observed in Figure 11.

Figure 11: Abnormal variances for event number 14 under the APARCH specification with skewed errors
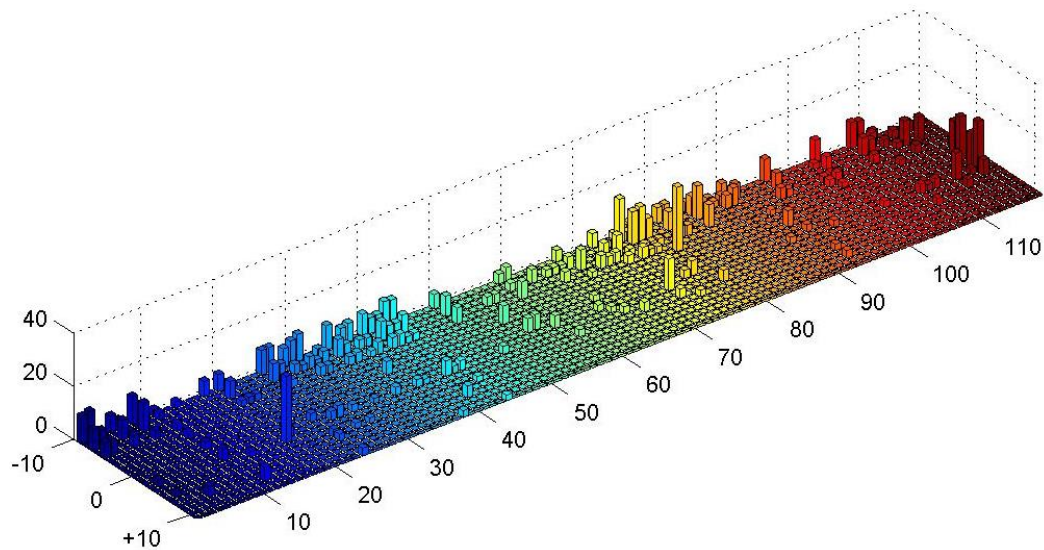
Source: Authors' computation

5. Conclusions:

In this article we aimed to determine whether the monetary policy decisions taken by the Federal Reserve during the 2013 – 2014 period influence the dynamics of a numerous set of global stock market indices.

We notice that fact that the first mentioning of the possible exit from QE generates a strong wave of abnormal variances observed especially in the day that follows president Bernanke's speech. In addition to this, further talk on potential tapering rends the same effects. Despite these intentions, in July 2013 Federal Reserve decides to continue QE. This event has the largest impact found in this study, determining abnormal variances on day 2 for 58% of the considered stock market indices. In general, the results were most significant for those indices belonging to countries with mature financial markets.

The first pure tapering announcement also generates important movements in abnormal variances. From this point we follow Federal Reserve's announcements regarding the progressive reduction of asset purchases and notice a diminishing impact in terms of abnormal volatility. The fact that the tapering talk produced higher abnormal variances that those recorded for the actual tapering events is consistent with results presented by Gosh and Sagaar (2016).

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   Unlike the previous announcements, the communication on Federal Reserve's decision to end the QE program brings a solid impact throughout the entire event window which is characteristic to the vast majority of stock market indices.

Acknowledgement

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