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Issues in monetary policy and economic expectations

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Part I

Unconventional Monetary Policy and Financial System

At the beginning of the financial crisis of 2007-08, the theoretical and empirical studies of monetary policy fostered the leading capacity of central banks to secure financial distress events using conventional and unconventional policy actions. Historically, monetary authorities used to respond to global crisis by cutting interest rates to lower levels and by embarking a series of unconventional measures such as operations that change or expand the composition of their balance sheets or that try to guide longer interest rate expectations (i.e.,forward guidance). However, when the short-term nominal interest rate reaches the zero lower bound, monetary policy loses the power to cut the interest rate to counterbalance the negative effect of financial crisis and to control the inflation rate in the economy.

Thus, at the zero lower bound the rule of the unconventional monetary policies appears even more important. ECB defines unconventional monetary policy as those policies that directly target the cost and availability of external finance to banks, households and non-financial companies[1]. Unconventional monetary instruments include:

- *balance-sheet policies*, comprising various types of quantitative easing (QE) and credit easing policies (see, for example, Gagnon, Raskin, Remache and Sack, 2011, Woodford, 2012).

- *emergency lending programmes* and other forms of subsidized access to credit. These

[1] https://www.ecb.europa.eu/press/key/date/2009/html/sp090428.en.html

policy instruments are seen as providing additional easing even without any change in the risk-free nominal interest rate.

- *macroprudential policies*, which place additional restrictions on access to credit above and beyond the interest rate charged (for a survey, see Galati and Moessner, 2013).

Before and during the recent financial crisis, the most high-profile form of unconventional monetary policy has been Quantitative Easing (QE). The phrase was first applied to Japan as it dealt with the bursting real estate bubble and the deflationary pressures that followed in the 1990s. The 'non-conventional' characteristic is that QE targets directly the level of reserves in the bank system, while conventional monetary policy operates through affecting short-term interest rates through open market operations. In other words, by either buying or selling securities from the banking system, the central bank influences the level of reserves that commercial banks hold in the system. Therefore, the latter produces fluctuations in the volume of reserves that are merely a by-product and not a focus target of policy itself. Instead, with QE, monetary authorities target directly cash reserves increasing the money supply by flooding financial institutions with capital in an effort to promote increased lending and liquidity. For instance, in the 1990s the Bank of Japan, purchasing government securities from banking sector, boosted the level of cash reserves of the banks held in the system.

During the recent financial crisis, QE has played an important rule to stabilize the economy and to mitigate the financial markets. The central banks of the US, the Euro area, UK and Japan all adopted massive expansion of central banks' balance sheets and attempted at influencing interest rates other than the usual short-term official rates. For instance, the Federal Reserve implemented policies known as 'credit easing' when they purchased mortgage-backed securities. The purchase of these securities meant that the Fed now held more assets and so its balance sheet expanded. The purchase of these assets provided liquidity to a market that had dried up in the wake of the financial crisis and helped lower

mortgage interest rates directly and provided credit lines to an important part of the economy. On contrary, the expansion of the European Central Bank (ECB) balance sheet has come about largely though repo-operations that is, the provision of loans (mostly long term) in exchange for collateral (mostly which are bank loans and not government bonds).

A huge literature is devoted to provide an estimate of the effect of an identified conventional monetary policy shock on the real economy, while far fewer works studied the effects of the unconventional monetary policy because of its difficulties. These difficulties evidently arises as there is no clear measure of the central bank's policy stance, and no easy way to determine policy expectations. In the literature, a number of approaches have been used to identify the effects of exogenous unconventional monetary policy shock on financial markets and macroeconomic variables. Some authors, such as Doh (2010), Gagnon et al. (2011), Meaning and Zhu (2011), Neely (2010), Krishnamurthy and Vissing-Jorgenson (2011), Joyce and Tong (2012) and Swanson (2011), measure the effect of unconventional policy on financial markets as the jumps in asset prices in short windows bracketing identified unexpected announcements. These argue that this is the case for some important announcements by the Federal Reserve (Fed) and the Bank of England (BOE) in 2008 and 2009. In this work, we contribute to this literature providing new empirical evidences on the effects of unconventional monetary policy on corporate bonds' yields and market liquidity.

1 Financial shock and the real economy

Economists have long recognized that adverse shocks to the financial sector can have significant effects on the real economy. The chance that financial instability will lead to macroeconomic instability is often termed 'systemic risk' and the bankruptcy of Lehman Brothers and the near-failure of AIG represent near evidence. Historically, policymakers have been unable to anticipate a financial crisis, presumably because they have lacked mea-

sures to evaluate the health status of the financial system. However, nowadays the requirement of connecting and studying the impact of financial stress and financial frictions on real macroeconomic variables is becoming essential to answer so many questions involving financial crises.

The literature about financial frictions and real economy in macroeconomics come back to the seminal papers of Bernanke, Gertler (1989) and Bernanke, Gertler, Gilchrist (1998, hereafter BGG) which studied the effects of financial frictions on macroeconomic aggregates in a general equilibrium framework and introduced the idea of "financial accelerator" as an additional mechanism that amplifies the effects of orthogonal shocks in the economy.

While in classical papers on the "financial accelerator" the emphasis is on how financial frictions affect the propagation of technology or money shocks (see Carlstrom, Fuerst (1997) and BGG), a set of recent papers focuses instead on the effect of "financial shocks" on the economy. They can be classified in two groups:

- papers in which the financial intermediaries sector is a veil and is not explicitly modeled (Jermann and Quadrini (2012, hereafter JQ), Khan and Thomas (2013, hereafter KT) and Hall (2011));

- papers in which the financial intermediaries sector is modeled and is characterized by exogenously or endogenously generated constraints (Christiano, Motto and Rostagno (2010 and 2013, hereafter CMR), Gertler and Karadi (2011), and Gertler and Kiyotaki (2012)).

What is meant by "financial shocks" varies through the papers. For instance, in JQ, and KT the financial shock reflects stochastic variations in the parameters that characterize the enforcement/incentive compatibility constraint for the contract between entrepreneurs and supplier of funds. While JQ develop a representative firm model, KT introduce collateral constraints in an economy with production heterogeneity. In Hall (2011) it is an exogenous

disturbance to the wedge between the cost of funds for the borrowers and the rate of return paid to lenders. In CMR (2010) the financial shock is a shock to the survival probability of entrepreneurs. They also consider technology shocks in the banking sector. CMR (2013), instead, emphasize risk shocks. Gertler and Karadi (2011) on the other hand, try to capture the shock to the quality of the assets held by intermediaries and model it as a capital specific technology shock in the capital accumulation equation and,hence, in the production function. In this work, we instead focus on the effects of a financial stability shock on the real economy. The literature on financial stability shock is quite recent and it founds recent developments after the last financial crises. As for "financial shocks" we don't have a unique definition of "financial stability shock". In this paper we consider a "financial stability shock" as an unexpected change in the volatility and in the "health" conditions of the financial system. This definition is very close to the concept of financial stress as defined by the Federal Reserve and meant by the economic literature. In this last branch of the literature, several papers contribute significantly to our knowledge. For instance, Balakrishna (2009) analyzes how financial stress is transmitted in the past and during the current global crisis. He finds that financial stress tends to spread rapidly to emerging economies and with a high pass-through. According to his conclusions, financial system appears to be a key conduit of transmission: emerging economies with higher foreign liabilities to advanced economies are more affected by financial stress in advanced economies than less linked emerging economies. Others have worked on the relationship between financial stress and economic cycles. Carderelli et al. (2009) have conducted an empirical analysis on 17 countries and have shown that financial stress is often, but not always, a precursor to an economic slowdown or recession. Moreover, they have found that a rapid expansion of credit, a run-up in house prices, and large borrowings by the corporate and household sectors all contribute to a higher likelihood that stress in the financial system will lead to more severe economic recession. Davig and Hakkio (2010) explore the theoretical links between financial stress and economic activity

demonstrating that financial stress can slow down economic activity through a combination of increased uncertainty, increased cost of finance, and tighter credit standards. Finally, Apostolakis and Papadopoulos (2014) have examined cross-country stress spillovers in the G7 advanced economies using an FSI and they have investigated how financial stress innovations stemming from these markets influence economic activity and price levels.

Following this stand of the literature, we contribute exploring the causal effect between financial instability and confidence level. In particular, we use a linear regression framework to asses the contribution of negative shock of financial stability on consumption and business expectations. We show that a decrease in the level of financial stability leads households' consumption and business confidence to fall.

Our work is divided in two parts. In the first part, we estimate our own a financial stress index for European countries because of the lack of such index for all European countries. Then, we estimate the impact of financial instability shock on business and consumption expectations. In the second part, we study the effect of the unconventional monetary policy (CSP programme by ECB) on market liquidity and yields using a quasi-natural experiment.

Part II

The impact of financial stress conditions on economic expectations

Abstract

I investigate the effects of a financial instability shock on consumption and business expectations using the "Announcements" of the European Central Bank in favor of stability as source of exogenous variation. Using quarterly data on the European countries, I show that a financial instability shock depresses the aggregate expectations on investment while the effects are mixed for aggregate consumption confidence. These results are robust to different identification schemes and several estimation methodologies. Finally, I estimate an impulse response function for a financial instability shock on consumption and investment confidence using local projection on a 20 period horizon.

1 Introduction

Mapping linkages between the financial system and the real economy has taken on a new significance and urgency following the systemic financial crisis which was triggered by high default rates among sub prime mortgage loans. Following the failure of Lehman Brothers in the Autumn of 2008, the disruption of financial linkages and the appearance of dysfunctional financial markets both the interbanking and debt securities markets generated widespread concern about the impact of a financial shock on domestic and foreign economy in United States and Europe.

In Europe, according the *Financial Stability Review* published by ECB on May 2017, the domestic demand remained the mainstay of economic growth, supported by the ECBs very accommodating monetary policy stance, which continued to be passed through the real economy. During the last years, the recovery in investment has been promoted by favorable financing conditions and improvements in corporate profitability, while sustained employment gains have provided support to households' real disposable income and thus private consumption. At the same time, euro area export growth has continued to pick up on the back of a gradual improvement in global trade.

If the real economy seems to be finding the right path, an economic policy climate of uncertainty, against the background of a combination of critical national (electoral cycle), supranational (Brexit process) and global developments, has remained unchanged. In figure 1, we report a graph of the *Composite index of macroeconomic uncertainty and economic policy uncertainty* in the euro area from 2001 to 2017 as published on the Financial stability review 2017.

[Insert Figure 1 about here]

As in chart 1, low macroeconomic uncertainty partly reflects economic policy uncertainty until 2009. After that, the former remains low despite a spike in political uncertainty. In this climate of high political uncertainty, the euro area economy is still lagging in terms of the ground covered since the onset of the global financial crisis, compared with more buoyant developments in other major advanced economies, notably the United States.

Even though the research has largely documented the impact of the recent financial crisis on the real economy, less work has been done to investigate the causal effect of financial instability on consumer and business expectations.

In the literature, Fornari and Stracca (2013) attempt to provide international evidence on the impact of financial shocks on key indicators of real activity and financial conditions. In their work, financial shocks are identified through sign restrictions derived partly from intuition and partly from dynamic stochastic general equilibrium (DSGE) models with financial frictions. According to this work, financial shocks are identified as structural shocks having:

- a positive impact on both the absolute share price of the financial sector as well as the share price relative to remaining sectors;
- a positive impact on credit to the private sector and on investment;
- do not lead to a fall in the short term interest rate;

They find robust evidence that financial shocks can be separately identified from other shock types and that they exert a significant influence on key macroeconomic variables such as GDP and (particularly) investment.

The cited paper represent one of an increasing important literature that interprets financial shocks as resulting from disequilibrium condition originating endogenously within the financial sector.

In this branch of the literature, other contributions emphasize how changes in asset prices may be driven by non-fundamental or 'inefficient' shocks. Gilchrist and Leahy (2002), for example, identify asset price bubbles as resulting from favorable news about future productivity that eventually fail to materialize. A small but growing literature examines the relevance of 'news' and 'confidence' shocks, as in Blanchard et al. (2009), Barsky and Sims (2008), and Beaudry and Portier (2006). Farmer (2009) proposes a model in which confidence is an independent driver of economic activity. In this literature, confidence may be driven, in particular, by 'noise shocks', i.e. news items which are wrongly interpreted as anticipation of gains in productivity and which therefore lead to a later reversal in confidence and in real activity. In our work, we estimate the impact of financial instability on real expectations using ECB announcements as a source of exogenous variation for the financial instability variable.

Our results are close to the findings in D'Acunto (2016). We document a negative causal effect of an unexpected financial instability shock on real economy for the European countries. We show that a negative stability shock into the financial system maybe have an impact on the mechanism of formation of the expectation about the future investments and level of consumption, documenting a further channel through which financial crisis affect the real economy.

Our contribution mostly concerns the empirical analysis of the effects of an increasing financial instability level on business expectations. To our knowledge, we are the first to investigate the effect of financial instability using the announcements of ECB as a source of exogenous variation for the financial stress in the economy. We will show that high financial instability corresponds to lower level of confidence about the future and the magnitude of this effect decline over time.

Our work is organizes as follows: in the first section we discuss the relation between financial stability and real economy. Then, we estimate a measure of financial instability

for the European countries using different approaches. Finally, we discuss our identification assumption and show the results of our model in a static context and in a dynamic setting.

2 A Literature Review on the Financial Stress Indexes

In this section we provide a brief literature review on the different measures of financial instability used in the literature.

Economists recognize that adverse shocks to the financial sector can have significant effects on the real economy and its clearest sign often results in financial crisis and/or financial distress of banks or other financial institutions. The opportunity to mitigate the damages or avoid financial crises requires that policymakers correctly predict these phenomena ahead of time. Historically, policymakers have been unable to anticipate financial instability events perhaps because they have lacked measures to evaluate the health status of financial system. Nowadays, there is a widely spread literature attempting to set up a valid index to measure the condition and the stability of financial system. Most of the literature offered a measure of financial stress for the United States.

Until the last century, the standard approach in the empirical literature was to treat the financial stress as a binary variable with either crisis or non-crisis values. Kaminsky and Reinhart (1996, 1999) and Frankel and Rose (1996) uses in their works a dummy variable which identify if a crises occurred. Recently, one approach is attempting to construct a financial index, which contains an entire set of information that describes conditions of the entire financial system, either loose or stress by predetermined standards. The advantage of this approach is that the index can assume values on a continuum interval.

The literature distinguishes two continuum measures of financial stess: Financial Condition Indexes (FCIs) and Financial Stress Indexes (FSIs). According to Illing and Liu (2003), these indexes provide a timely snapshot of the contemporaneous severity in a financial sys-

tem, and offer a valid instrument to analyze the condition in the financial system as a whole. Financial Condition Indexes are used to estimate the stress exerted on economic agents by uncertainty and increasing losses in financial markets and institutions (Illing and Liu (2003)) while, Financial Stress indexes, according the description of the IMF, provide insight into the financial health and soundness of a country's financial institutions as well as corporate and household sectors and can be employed for identifying the financial distress severity and dating the systemic conditions, and thereby warning and predicting the possible breakthrough of a crisis in the financial system" (Sun, Huang 2016).

Furthermore, FSIs and FCIs are distinguished by two features in the building process: variables choice and weighted method. The variables choice should include the main components of the different markets of the system. For the Financial Stress Indexes (FSI), generally scholars have included: banking system indexes, market measures, foreign exchange markets and credit markets while, for Financial Condition Indexes (FCI) researchers used to add also variables related to the level of investments, households' consumption and productivity. Because of that, the former indexes are not directly connected to the economic conditions of the real economy while, the latter confounds the economic status of the real economy and the financial system. Regards the weighted methods, the literature suggests to use one of the following: (1) equal weights, (2) equal variance weights, (3) credit weights, (4) principal component. The advantages and disadvantages will be analyzed in the next section. In the rest of this section we offer a broad perspective of main Financial Stress Indexes as built in the literature.

A first attempt is made by Illing and Ying Liu (2003) who estimate a credit weighted average FSI for Canada using three types of variables: (1) variables that explain expected losses; (2) Variables that primarily reflect risk; (3) Variables that primarily reflect uncertainty.

For the US, Oet et al. (2011) develop the so called Cleveland Financial Stress Index (CFSI) integrating 11 daily financial market indicators grouped into four sectors (debt,

equity, foreign exchange and banking markets). The building process consists of two steps. As first, they normalize the raw indicators by transforming the values of each series into the corresponding values of their empirical CDF. Then, they aggregate the transformed indicators into the composite indicator by applying time-varying credit weights which are proportional to the quarterly financing flows through the four markets concerned.

More recently, Hollo et al (2012) contribute to the literature introducing a new estimation methodology. They construct an indicator of contemporaneous stress in the financial system named Composite Indicator of Systemic Stress (CISS). The CISS comprises 15 mostly market-based financial stress measures equally split into five categories, namely the financial intermediaries sector, money markets, equity markets, bond markets and foreign exchange markets, arguably representing the most important segments of an economy's financial system. Then, an unique measure for the financial instability index is obtained looking at the correlations between the five categories[2]. As a results, the CISS puts relatively more weight on situations in which stress prevails in several market segments at the same time, capturing the idea that financial stress is more systemic and thus more dangerous for the economy as a whole if financial instability spreads more widely across the whole financial system.

Instead, in our work we estimate a Financial Stress index for all European countries following Balakrishna (2009). The former builds up the FSI comprising five variables, which are aggregated into an overall index to capture credit conditions in three financial market segments (banking, securities markets, and exchange markets). As we discuss in next section, this approach has the advantage to distinguish financial instability at different levels and for different segments. Before us, G.Christopoulos (2011) follow this approach to construct an index for England, France, Japan, the United States and Greece that capture the instability on financial system.

In the next sections we proceed to construct an index of financial instability for almost all

[2]For more details look at Hollo et al. (2012)

the countries is the Euro zone.

3 A Financial Stability Index for the European Countries

In this section we develop a new methodology to construct an index of financial stability for the European countries.

3.1 Variable selection

Here, we describe the data that we use to construct an index of financial stability for the European countries. With the aim of estimating the impact of a financial shock on investment expectations, we need to assess a measure of financial instability. We construct an FSI for each of the 28 countries of Europe following Balakrishnan (2009), Cardarelli (2009), Hollo, Kremer and Lo Duca (2012). The data source for this part of the work is Eikon Datastream. We use monthly time series data starting from January 1997 to the end of 2016 for most of European countries. Measuring financial stability requires to identify the main segments of the financial system and to estimate the contribution provided by each of them.

In the literature, two main classifications are prominent. Hollo et al. (2012) distinguish financial instability among three main building blocks: markets, intermediaries and infrastructures. Then, each of these blocks is divided into specific segments (e.g., the financial block can be separated into different sectors like banks, insurance companies, hedge funds etc.). A second classification shared among most of the literature argues that financial instability can be measured at different levels. The lower one includes the contribution provided

at "micro" level by economic agents, while the middle one aggregates these contributions for each block. At the top, a financial stability index is estimated combining the information of each single block. However, by estimating separately the financial stability at middle level using micro data we neglect the strict relationship among variables at the lower level. Therefore in what follows, we provide different measures of financial stability at macro level identifying the main components for each segment. As in the previous studies, our composite FSI for each economy covers the major financial sectors of the economy including specific variables for banking sector, securities and foreign exchange markets and international financial stress. The variables are summarized at the end of the paper. Here, we briefly list and discuss the selected variables:

- **Stock market returns**: measured as the first difference of the log return of the main stock market index for each of the countries. Following Cardarelli (2009) we multiply our series for -1 so that a sharp drop in stock prices registers as an increase in the index;

- **Equity market volatility Index**: we estimate an index for stock market volatility as the time varying volatility of monthly changes in the nominal stock market return, also derived from a Garch (1,1) specification (Cardarelli, 2009). As pointed out in the literature, high volatility in the stock market undermines stability of financial and economic system by worsening the opportunity of investment in financial assets;

- **Government bond market volatility index**: as learned during last financial crisis, government financial situation can mine the financial stability of system. We suggest to use a volatility index as a proxy of the sovereign debt contribution to the total uncertainty at the macro level. As in the previous case, we derive this volatility index from a Garch (1,1) specification of government bond monthly return;

- **Volatility Index (VIX)**: we add in our analysis the volatility index as a proxy of the international source of instability. We obtain this series directly through Datastream. We add an international index (i.e., mainly connected to the volatility in the stock market in the United States) to capture the financial instability in other countries and thus, the risk of potential systemic crisis. Since, the VIX has been built on USA economy, it could be a good proxy for the financial riskiness out of Europe;

- **Banking stock return**: measured as the first difference of the log return of banking sector indexes for bank industries. A sudden drop in banking stock return is interpreted as a signal of instability for the banking industry;

- **Banking market volatility index**: this index captures the level of uncertainty in banking system using the information of stock market return for banking industries. As for other series we derive a volatility index for equity market in banking industries using a Garch(1,1) specification;

- **Foreign exchange market volatility**: measured as the volatility of monthly changes in nominal exchange rate to the US Dollar for Euro-Zone Countries and to Euro currency for non Euro-Zone countries. It is clear that higher level of foreign exchange volatility affects negatively the future level of investment in the economy. Thus it has a clear contribution on financial instability;

- **Interbank offered rates volatility index**: this index captures the volatility of the interbank market in Euro Zone. As other indexes, we derive the volatility index with a Garch(1,1) model. Many studies underline that before the recent financial crisis the difference between Overnight Indexed Swap (OIS) and Libor suddenly jumped. Today, the LIBOR-OIS spread is considered a key measure of credit risk within the banking sector and its volatility can be interpreted as the level of uncertainty in the interbank

markets;

- **TED spread**: The TED spread, which is measured here as the difference between interbank rates and the 10 year-yield on Treasury bills, captures the premium banks charge each other over treasury bill rates, and is a proxy for counterparty risk.

The selection of candidates in the FSI takes into account two main aspects. First, we want to use a uniform set of time series across all 28 countries and for some countries not all the data were available. Secondly, we follow a criterion of parsimony, that is, we try to use a minimum set of time series that would signal financial stress episodes. The intuition is that by adding too many variables we are exposed to the risk of contaminating the FSI with noisy information. Furthermore, the qualitative patterns of many financial series are similar (i.e., many measures of volatility and premia increase during financial stress episodes) that is a sign that the marginal informative content of additional series diminishes quite rapidly.

The FSI can be custom tailored for an individual country, and this would be a natural extension for country-specific case studies. While more series would surely improve the informational content of the country-specific index, this would also complicate the signal extraction problem. With these considerations in mind, it is also important to emphasize that, as we elaborate further below, the FSI is quite robust in capturing the main financial stress episodes documented in narrative descriptions and in the literature (Cardarelli, 2009).

3.2 Standardization and aggregation methods

In this section we describe the aggregation method that we have used to obtain a unique index of financial instability for each of the 28 European countries object of our study. The aggregation of individual stress indicators is arguably the most difficult aspect in constructing composite financial stress indexes (Illing and Liu 2006). Once the data for an FSI are

collected, they must be aggregated into one measure. This process tends to be slightly more difficult as the number of levels to aggregate increases. The first arguable question is whether the information is representative of financial conditions at macroeconomic level. An example helps in clarifying the issue. If we collect data about the financial conditions of banks, households, firms, the first process of aggregation would give us a measure of financial stress at sector level. Then, a second stage has to re-aggregate those variables to obtain a systemic measure of macroeconomic financial condition. In the literature, researchers often summarize the information in several series with a single index (e.g., the indexes of coincident, leading, and lagging indicators) after converting all the variables with some transformations. As we collect data of several series, the first problem is the common unit, as different variables are evaluated following a different scale measure. Thus, we convert our data to a common scale. The most common conversion is standardizing each random variable. This is usually done by subtracting its historical (sample) mean and dividing by its standard deviation (Nelson and Perli, 2007; Cardarelli, Elekdag, and Lall, 2011; CLNFCI; STLFSI; KCFSI). With this approach, fluctuations across variables are on the same scale. Other methods of standardization include studying the difference in a variable's level relative to an average from a reference period (the Goldman Sachs Financial Conditions Index [GSFCI], Dudley and Hatzius, 2000) or standardizing based on each indicator's cumulative density function (CDF; CFSI). More complicated methods include passing data through various filters (NFCI) or eliminating variability that can be explained by historical real activity of inflation (Hatzius et al., 2010). In this work, we use the first approach. We subtract to each variable its historical mean and divide by its standard deviation.

The second problem that can arise during the aggregation process is the choice of grouping and the related weighted method. Indeed, data may be grouped into sub-indexes which is especially useful when multiple variables from the same subcategory are used. However, this method it amplifies fluctuations among highly correlated variables. Furthermore, the

results are slightly affected by the weighting method used by the researcher for aggregating sub-indexes. For instance, Cardarelli and Lall (2011) aggregate the factors in each subindex using equal weighting, while Nelson and Perli (2007) create sub-indexes that measure 3 different traits (level, volatility, and co-movement) of 12 variables. In particular, the level sub-index standardizes the variables based on their long-run averages, and the volatility sub-index equally weights the sums of the squared 8-week rolling window changes in the data. Finally, the co-movement sub-index tracks the percentage of total variation of the individual variables that is defined by a single common factor.

More complicated aggregation methods include regression-based, principal components (PCs), or credit-based weighting. Regression-based weights can be constructed by regressing the financial indicators on a measure of output growth (GSFCI) as in Nelson and Perli (2007), who use a logistic regression of known periods of financial stress to construct regression-based weights, while the indexes that do not use a regression-based method (Hatzius et al., 2010; STLFSI; KCFSI; NFCI) generally determine weights using principal component analysis (PCA).

In the literature, principal components has found extensive applications because of its simplicity and few assumptions. PCA assumes that each of the variables used to construct the FSI captures some aspect of financial stress. As a result, as the level of financial stress in the economy changes, the principal components used to construct the FSI, are likely to move in the same direction. However, it is necessary that the entire information set is sufficient to explain the whole instability of the system. If this is not the case, the PCA gives an inefficient and a distorted measure of the illness of the financial system. Moreover, the information estimated using the PCA is distributed and encapsulated among several components and either the researcher decides to aggregate with appropriated method or just select one and explain the reasons of that choice. For instance, in the case of the St. Louis Fed Financial index (STLFSI), it is assumed that financial stress is the most important factor in explaining

the comovement of the 18 variables used to construct the index. This factor, which is the first PC, becomes the FSI. For its simplicity and flaws, others propose to use alternative ways. Oet et al. (2011) calculate weights using data from the Federal Reserve Board's flow of funds statistical release. In their methodology, the flow of funds data are separated into four sectors: bank loans, foreign exchange credit, equity, and debt. Then they calculate a z-proportion of the flow of funds through each of those sectors. Finally, they produce an aggregate index averaging the z-proportion across the number of indicators in the sector.

Given the many weighting and aggregating schemes, many researcher have tries to address whether any particular method outperforms the rest.

Oet et al. (2011) and Illing and Liu (2006) compare alternative weighting schemes. Illing and Liu (2006) find that credit weights based on the sum of bank credit, corporate bonds, government bonds, equities, and U.S. dollar credit minimize errors attributable to rank ordering, minimize root mean squared errors (RMSEs), and Granger-cause financial stress crises. Oet et al. (2011) also find that credit weights based on the flow of funds are optimal if the FSI is intended to be an early warning sign of a crisis. They compare the number of stress episodes detected by candidate FSI series (credit weights, PC weights, equal variance weights, and equal weights) with the number detected by benchmark volatility measures (VIX, Merrill Lynch Option Volatility Estimate Index, the implied volatility of the Deutscher Aktien Index, Lehman Brothers Swaptions Volatility Index, and Barclays Swaptions Volatility index).

In this work we proceed following two steps. First, we start putting the individual raw stress indicators on a common scale using standardization. Following Caldarelli et al. (2011), we subtract the sample mean from the raw score and divide this difference by the sample standard deviation. This procedure requires that, for each series, the stochastic process generating the data is weakly stationary, that is, each observation is extracted from a random variable with same mean and same variance at each date. Further, we need to assume that the stochastic process is ergodic in variance, which means assuming that the sample variance

represents a consistent estimate of the population variance. Therefore, we check that data comes from weakly stationary stochastic processes while ergodicity is assumed. In any case, most of the works in the literature show that, after the aggregation, financial instability index is not significantly different from the other ones (without standardization). Further, standardization easily corrects for different scaling measure among variables. For this reason, before we aggregate our data, we apply the following transformation:

$$Y = \frac{X - \mu}{\sigma}$$

where the variable X is our input variable, μ is its sample mean and σ is its sample standard deviation. As a result, our variables have zero mean and the same variance equal to one.

At the second stage we have to select different weighting methods and after we compare them. We aggregate the different components of financial instability according to 3 methods:

- **Structural equation modelling**; this statistical technique is commonly used in social sciences to estimate variables as intelligence, depression, cognitive ability that cannot be objective measured but are manifested in other variables that we can measure and observe. So, we can imagine that financial instability is our latent variable, that is not observable but, we can infer its behavior from the volatility and uncertainty into the financial system. Under the assumption that the different sources of volatility are pairwise correlated and each of them explains a portion of the whole instability in the system, we estimate this measure for all 28 European countries. We refer to this index as SEMFSI (i.e., Structural Equation Modelling Financial Stability Index) in the following sections.

- **Weighted variance method**; this estimation method is one of the most commonly

used in the literature. After the researcher has applied standardized transformation to the variables, he/she estimates a measure of the financial instability as an average of the variables. The main advantage of this technique is that is very simple and allows to give the same weight to each variable in explaining the level of instability of the financial system. Following Balakrishna (2009)" this approach adjusts the stress subindex for differences in volatility, allows a simple decomposition of stress components, and is also the most common weighting method in the literature". We label this index EFSI.

- **Principal component analysis**; the principal component analysis (PCA,hereafter) is generally used to summarize information coming from several variables. This method is a valid instrument to reduce the number of variables in a regression but still preserving the core information. So, as last method of aggregation we propose to use a principle component analysis to extract information among our variables and aggregate the information of all the variables and we compute the number of components that give us almost 75 per cent of the total information (in mostly of the cases 3 components) and finally we compute an eigenvalue weighted average to estimate a measure of financial instability for each country. As the reader can notice, we reject the hypothesis that FSI is fully entered in the first principal component. We refer to this index as PFSI (i.e., Principal component Financial Stability Index).

In our analysis, we refer to the financial stability index as derived from the structural equation modeling (SEMFSI) as a proxy for financial instability that we don't observe. The use of the structural equation modelling, hereafter SEM, is commonly justified in the social sciences because of its ability to impute relationships between unobserved constructs (latent variables) from observable variables. In our case, the concept of financial stability cannot be measured directly as one could measure height or weight. Instead, we can develop hypothesis of financial instability and select specific variables that measure different aspects of a variable

that we don't observe (latent variable). With SEM, "financial instability" would be the latent variable and the set of volatility connected to the several block of financial system would be the observed variables. Precisely, our hypothesis is that the identified observed variables are correlated and represent the main aspect of the financial instability that we want to measure. We plot aggregated FSI using SEM and business confidence index in the next section. Plot of SEMFSI against consumption confidence is omitted as data are not available for many countries.

4 Consumption expectation and business expectation

In this section we describe the dataset using appropriate summary statistics and we introduce a baseline model to study the effects of a financial shock on economic expectations.

4.1 Data Sources

In order to estimate the causal effect of the impact of financial instability shock on economic expectation, we use business confidence index (BCI) and consumer confidence index (CCI). We obtain access to the macro data from OECD Data for the period starting in January 1997 and ending in December 2016. The business confidence index (BCI) is based on enterprises' assessment of production, orders and stocks, as well as on the current financial position and expectations for the immediate future. The consumer confidence index (CCI) is based on households' plans for major purchases and their economic situation, both currently and their expectations for the immediate future. Opinions compared to a "normal" state are collected and the difference between positive and negative answers provides a qualitative index on industrial and consumption expectations.

Our sample includes the main variation in: economic fundamentals for the 28 EU Countries (GDP, Total Consumption, Household Final Consumption, Gross Capital Formation,

Gross Fixed Capital Formation, Import Good Service, Tax less subsidies, Public consumption), financial variables such as bank stock return, government bond return, stock market return, inter-bank market return. In addition, a dummy variable that control for the recent financial crisis has been added in the data-set.

Moreover, since the aim of this work is to assess if a financial instability shock has a significant causal effect on business expectations, we need to identify an exogenous source of variation that affects financial stability, and does not affect economic aggregate expectation about the future. As we will discuss in the next paragraphs, we build the announcement variable selecting all the announcements of ECB, during the period that goes from 1999 to 2016, that have had a direct impact on financial stability and that are assumed to be unexpected by the economic agents as decisions out of the obligations imposed by the ECB Statute. Further discussion on this is provided in the next section.

Lastly, we also collect the date of release of the "Financial Stability review" published by ECB during the period of our interest. We use this variable as a robustness check with respect to our "exogenous" variable. The announcements are listed in a table at the end of the paper.

4.2 Descriptive Statistics

Our data-set includes time series of economic fundamentals, business expectation and a financial stress index for the 28 countries of the EU as a proxy of financial instability. As pointed out in the previous section, we estimate an index of financial instability using different techniques. The variable SEMFSI represents the level of financial stability as estimated with the structural equation modelling technique while PFSI is estimated using an average of the principal components weighted for their eigenvalues. Finally, EFSI is estimated as a weighted average of all components of financial instability. Figure 3 is a time-series plot of

the measure of financial instability estimated with structural equation modeling (SEMFSI) and business confidence indicator for all the 28 countries.

[Insert Figure 3 about here]

The data regarding financial stress are available for all 28 countries while a measure of business expectation is available for just 22 of them. We can observe that the level of confidence about the future tends to fluctuate around its mean during the period of low level on financial instability for almost all the countries. A sharp decrease of economic expectations occurs after some months since the financial crisis burst in September 2008 as the level of financial instability goes up. During the period 2008-2011, the level of financial instability in Europe is on average 1 point higher then the beginning of the 2000s with a peak of 6.28 registered in Netherlands. The data also show that during the period 2008-2011 the level of confidence about the economic activity in Europe drops on average of about 2.4 points on a maximum range of 17.50 (registered on Latvia during the period 1997-2016) while, in the same time interval, higher levels of instability are common to all countries in Europe, from Austria to United Kingdom. In the following tables we present summary statistics between financial instability and economic expectations distinguishing years of crisis or not[3].

[Insert Table 1 about here]

[Insert Table 2 about here]

[3]We divide our sample in two periods as in principle the data generating process for our variables can be different during the year of the crisis and not.

In table 1 and 2, we show summary statistics for our variables during the period 2008-2011 and 1997-2007/2012-2016. As expected, countries show on average lower growth rates in gross domestic production, investment and domestic consumption during the crisis EU. Further, household' expectations about economic performance are lower as indicated by confidence index (CCI) and business confidence index (BCI). As regards financial instability condition, our index (SEMFSI) shows that European countries are more exposed to economic shocks and downturns as the financial instability index is higher after 2008.

In table 3, we report the correlation matrix among expectation index and several measures of financial stability.

[Insert Table 3 about here]

In table 3 we show that financial instability measures present a negative correlation with business confidence index and consumption expectations. Moreover, this correlation tends to be higher, in absolute value, if we consider the correlation between EFSI and business confidence index (-0.512). Instead, the correlation between consumption confidence index and financial instability do not change as we consider different configurations of financial index. Finally, we underline that all the measures of financial instability are highly positively correlated.

4.3 A Baseline Econometric Model

The aim of this work is to investigate whether a shock of financial instability produces a substantial effect on real expectations (i.e., business and consumption confidence). Anecdotal evidence suggests the an increasing in the level of financial instability tends to reduce the level of confidence about future economic performance for several reasons.

First, because of the uncertainty about future profitability, a financial instability shock can urge the banks to reduce the amount of lending to firms jeopardizing the financial situation of existing firms and reducing the opportunities of new investments.

Second, financial instability shock tends to create volatility on financial markets. Higher volatility tends to increase the level of riskiness of financial assets urging investors to flight to safer assets (e.g., government bonds issued by "safe" countries). Therefore, expectations about future business activities would be negatively affected.

Finally, uncertainty tends to reduce the households level of consumption. Large literature documents that in periods of uncertainty households tend to have higher propensity to save than in periods of stability. As a result, the expected level of consumption in the future would be pushed down by a negative financial stability shock.

We will show empirically that a sudden increase in the level of financial stress tends to reduce the expectations on business productivity but it doesn't seem to have any impact on consumption expectations.

We follow a narrative approach to develop a baseline model that explain how economic expectations are formed by agents. We assume that the individuals are not fully informed about the economic and the financial situation of their country, but they are aware of the economic condition in the past and they "conjecture" what might be its situation in the future based on their knowledge. Hence, we assume that business confidence expectations about tomorrow, conditional on their information set I_t, is function of variables lagged back of one period plus a mean zero error. Mathematically:

$$E[Y_{t+1}|I_t] = f(X_t) + \epsilon_{t+1}$$

where $E[Y_{t+1}|I_t]$ is the expected value of a future random variable Y conditional on the information set at time t, X_t is a set of lagged economic variables relevant for predicting

the level of expectations about the future and ϵ_{t+1} is a mean-zero stochastic error. We also assume that the error term, conditional to the information set, is independent from the variables X at time t.

The advantage of this approach is that it allows us to use directly the data on expected level of consumption and business activity which we have obtained from "Datastream". From an economic prospective, we are assuming that news about the future are not incorporated by the agents to form expectations about their level of consumption. The reader notice that this approach is close to the idea in the literature on "adaptive learning" where the economic agents are meant to be "good" econometricians.

We are aware of the criticism of this approach and we test as a robustness check that our results are robust to a different baseline "expectation" model.

The analysis of the expectations is the central problem of our studying. Although our variables of expectations can be assumed present and past exogenous with respect to financial and economic conditions, still a potential problem of endogeneity due to simultaneity can arise. It is likely that when the volatility in the economy is high, the economic agents revise their expectations downward. This leads to an inconsistent estimates of the effect of financial instability shock on the economic expectations. To avoid this problem, we rely on an identification assumption that we describe in the next section.

5 Nature of the study and identification strategy

In this section we discuss our identification strategy to solve the problem of endogeneity that can arise because of reverse causality between financial instability and economic expectations.

5.1 General framework

We begin illustrating the general framework that motivates our analysis. This framework is closely related to the theoretical model in Romer and Romer (2010).
Begin considering the minimalist specification:

$$E[Y_{t+1}|I_t] = \alpha + \beta FSI_t + \varepsilon_t \tag{1}$$

where $E[Y_{t+1}|I_t]$ is a measure of the expectations about future economic aggregates given the information set at time t, FSI_t is a measure of the financial instability in the system. In this specification, obviously other shocks affect expectations about future economic activity besides financial stability and are left unspecified inside the residual component ε_t. As in Romer and Romer (2010, hereafter RR), we can think ε_t as:

$$\varepsilon_t = \sum_{i=1}^{K} \varepsilon_t^i \tag{2}$$

where ε_t^i are innovations in monetary policy, government spending or any other shock connected to the business cycle fluctuations.
Now consider a specification for the financial instability index FSI_t:

$$FSI_t = \sum_{i=1}^{K} b_t \varepsilon_t^i + \sum_{j=1}^{Q} \omega_t^j \tag{3}$$

where ε_t^i's are the same as in equation (2) and ω_t^j's are additional shocks that are assume to be orthogonal with respect to the first components. This equation, as in RR, captures the idea that financial stability condition moves because of the underlined economic activity as events of financial crisis, government spending, monetary policy shocks or because of unexpected developments that are orthogonal to the economic conditions but that can have

an effect on economic expectations.

Combining equation (1) and (3) we get our financial specification:

$$E[Y_{t+1}|I_t] = \alpha + \beta \left[\sum_{i=1}^{K} b_t^i \varepsilon_t^i + \sum_{j=1}^{Q} \omega_t^j \right] + \varepsilon_t \tag{4}$$

Rewriting the equation in this way shows why estimating equation (1) directly leads to a biased estimates of financial instability on economic expectations.

Therefore, under the assumption that ω_t^j are orthogonal to the economic conditions (i.e. ε_t^i for all i's) and along the dimension j , we can estimate an unbiased effect of financial instability on economic expectation using an exogenous variation ω_t^{j*} which is a component of the variable FSI_t. In fact, rewriting (4) more compactly we have that:

$$E[Y_{t+1}|I_t] = \alpha + \beta\omega_t^{j*} + \left[\sum_{i=1}^{K} (1 + b_t^i)\varepsilon_t^i + \sum_{j \neq j*}^{Q} \omega_t^j \right] \tag{5}$$

which leads to an unbiased estimates for β as long as ω_t^{j*} is orthogonal to ω_t^j and to $(1 + b_t^i)\varepsilon_t^i$ for all j,i and t.

In the next section we identify an exogenous variable that we assume to be exogenous with respect to the economic fluctuations.

5.2 Exogenous Financial Instability shock

Our aim is to test for the causal effect of financial instability shock on business confidence index and consumption expectations. As shown formally in the previous section, we need an exogenous shock that affects financial instability measure, and does not affect business and consumption expectations through other channels. We attempt to get close to the identifying assumption as in D'Acunto, Hoang, Weber (2016) and narrative approach (see Romer and Romer (2010)). The global financial crisis has shed new light on central banks' role in

promoting financial stability. There is considerable diversity across central banks with regard to the source of their financial stability mandates and the tools available to overcome financial tensions. Macro-prudential regulation and what is referred as non-standard policy tools are the most important and significant instruments into the hands of central banking institutions. Born, Ehrmann and Fratzscher (2014), show that central banks' communications about financial stability can have a significant impact on the stock market. In their work they analyze a dataset covering more than 1,000 releases of Financial Stability Reports (FSRs) and speeches by 37 central banks over the past 14 years. They find that:

- central banks' communications on financial stability have important repercussions for share prices.On average, a new release of FSR moves equity markets by more than 1 % during the subsequent month and it also reduces market volatility;
- the effects of FSRs and speeches depend crucially on market conditions and other factors. The effects are particularly strong if the FSR contains an optimistic assessment of the risks to financial stability;
- speeches and interviews typically have only modest effects on stock market returns and do not tend to reduce market volatility;
- during the financial crisis, FSRs were moving markets less than before the crisis, while speeches by central bank governors started to have more of an impact on markets.

The authors note that while the release schedule of FSRs is pre-determined, speeches and interviews provide a much more flexible communication tool. The completely pre-determination of the release schedule of Financial stability review doesn't allow to define this variable as exogenous because, even though the content is disclosed at a given date, it could be anticipated by the agents given the past information. However, since it is often at the discretion of the central bank governors whether or not to make statements about

financial stability, the fact that a governor feels compelled to raise financial stability issues in a speech or interview can therefore be an important additional news component and seems to be completely or at most unexpected by individuals.

Thus, following this idea we collect all the announcement and decisions taken by the ECB during the period 2000-2016 that from the content are linked to the financial stability in the economy and appear unexpected by the individuals (i.e., not explicitly mentioned in the ECB statement) and unrelated to the economic events. We believe that this variable is exogenous with respect to the economic condition since it is not directly related to measure of monetary policy or required intervention of the Central Bank due to high inflation. We also believe that this variations are completely unexpected as the dates and the contents are discretionary to the central bank and plausibly hidden before the meetings. This idea is closely related to the identification assumption that we find in Romer, Romer (1989,2005,2010). We report in the table below the date and the title of the event as appearing on the ECB website in the 'Press Release' section. Table 4 reports the list of the announcements that we have identified and the related description.

[Insert Table 4 about here]

Since our study includes a period of time sufficiently large, we consider an appropriate number of shocks to have more reliable results.

From table 4, we underline to the reader that all identified events announced by ECB looks in favor of financial stability (i.e., affect financial stability index) and include in content measures not codified in the mission statement as declared by ECB.

In practice, we generate a dummy variable ("Announcement") that takes value equal 1 in correspondence of the month in which the event is made and 0 otherwise. Based on these

reasons, we argue that any movement of financial instability index falls within the exogenous announcement category following the taxonomy of RR.

Under our identification strategy unexpected announcements by ECB affects household' expectations about future consumption and investment only through the stability of the financial system.

The coefficient that we estimates will capture the effect of a financial instability shock on economic expectations mediated through unexpected exogenous announcement shocks. Because the announcement of a particular policy can be interpreted as a positive shock to the financial stability, we expect that it would lower business and consumption confidence about the future as long as other shocks of opposite sign don't hit the economy at the same time. Since we are aware that our estimates is subject to our identification assumption,as a robustness check, following the results of Born, Ehrmann and Fratzscher (2014), we will consider Financial Instability Review of ECB as exogenous source of variation of financial instability on economic expectations. In detail, the authors find that the releases of the Financial Instabily review of ECB have an impact on the level of financial stability in the system. We estimate our model considering as announcement variable the release date of financial stability report of ECB. The results are reported at the end of the chapter.

5.3 Causal Effect of Financial Instability Shock on Business expectations

Following our identification assumption, we run regress the business and consumption confidence indicator (as a proxy for aggregate economic expectations on investment and consumption) on the identified exogenous component of the financial stability index (*Announcement*).

Thus, we estimate the following specification:

$$\begin{cases} BCI_t = \alpha + \beta Announcement_t + \epsilon_t \\ \\ CCI_t = \alpha + \beta Announcement_t + \epsilon_t \end{cases} \tag{6}$$

where BCI is the the business confidence index at time t, CCI is the consumption confidence indicator, α is a constant coefficient and *Announcement* is the exogenous announcement variable of financial instability. The results are summarized in the first two columns of table 5.

Under the assumption that the variable *Announcement* move the expectations only through the financial instability shock, we estimate a contemporaneous negative effect of financial instability shock on both future business expectations and consumption confidence level. In particular, the estimated impact of a financial instability shock on business confidence index is -0.737 while -0.638 on consumption confidence index. We also notice that the effect of financial instability shock is, in absolute value, stronger on business than on consumption confidence index and in both specification the effects are significant at 0.01 confidence level.

In column 3 and 4 of table 5, we present the results of a simple extension of the models (1) and (2). We include lagged values of financial instability in both specifications. The idea is that an announcement of the ECB at time t can be driven by an high level of instability in the financial system. In this context, omitting lagged values of FSI can leads to an overestimates of the effect of financial instability shock on the economic expectations. In this case, the effect of financial instability captured by variable "Announcement" is statistically significant and larger in magnitude in both models (i.e., -0.618 on business confidence and -0.521 on consumption).

Finally, in column 5 and 6 we introduce lagged values of confidence indexes as additional regressors. Economically, we assume that households form their expectations based on

the last period confidence (i.e., consistent with adaptive expatiation hypothesis). After including lagged values of confidence indexes, we still estimate a negative effect of financial instability on economic confidence that is larger in magnitude than the previous cases and statistically significant.

In particular, the magnitude of the effect increases from -0.618 to -0.111 for business confidence index and from -0.521 to -0.069 for consumption confidence. The economic interpretation of this result is that, if in the previous period economic agents have a negative perception about future economic activity, they will more likely expect an announcement from ECB. As a result, the contemporaneous shock tend to reduce in magnitude as confirmed in the data.

The fact that variable "Announcement" is exogenous with respect to how households form their expectations doesn't solve completely the potential problem of endogeneity.

In order to estimate consistently the effect of financial instability on the latter, we need to assume that variable "Announcement" is completely exogenous with respect to past and present shocks. In other words, previous economic conditions shouldn't affect the probability to observe an announcement made by ECB in the future. However, it is likely that this assumption to be violated in our specification in Table 5.

Thus,in order to control for past developments, we assume that economic conditions can be proxied by a set of variables "X" that are informative about the future economic conditions and that could be used to predict possible announcements in advance. Technically, controlling for the past economic conditions, it allow us to relax the past exogeneity assumption for the the variable "Announcement".

In the next specifications, we include a set of pact controls in equation (1) and (2). We estimate the following equations:

$$\begin{cases} BCI_t = \alpha + \beta Announcement_t + \gamma SEMFSI_{t-1} + \gamma_1 BCI_{t-1} + \gamma_2 X_{t-1} + \epsilon_t \\ CCI_t = \alpha + \beta Announcement_t + \gamma SEMFSI_{t-1} + \gamma_1 CCI_{t-1} + \gamma_2 X_{t-1} + \epsilon_t \end{cases} \tag{7}$$

where BCI_{t-1} and CCI_{t-1} are the level of business and consumption confidence as of $t-1$ and $Announcement_t$ is the exogenous variable announcement while "X" is a matrix that captures real macroeconomic fundamentals and financial condition.

Our intuition tells us that financial conditions can be highly informative to predict financial stress conditions in the economy in the future. Therefore, in order to test intuition we split the set of controls in the matrix X in two groups: variables linked to macroeconomic fundamentals and the other group linked to financial conditions.

In table 6, we report the results under the assumption that economic agents form their expectations using only the information coming from macroeconomic fundamentals. In this case, the matrix X includes the following variables: GDP at current prices, final consumption expenditure, household financial consumption, gross capital formation, gross fixed capital formation, import good service, tax less subsides, public consumption and stability index at period $t-1$. The idea is that macroeconomic fundamentals act as common knowledge on the mechanism of formation of expectations and according to the literature have to be included when we try to assess an empirical model about expectations. Moreover, if the economy is in a period of recession the level of instability in the economy is high and it is more likely that the central bank intervene with an announcement to reduce the level of stress in the economy.

[Insert Table 6 about here]

Table 6 shows that our previous results are robust to macroeconomic fundamentals. The coefficient β of the variable 'Announcement' changes to -0.115 in the BCI regression and to -0.0719 in the CCI regression and the result are statistically significant at 1% confidence level. We argue that macroeconomic fundamentals add nothing more respect to the previous model, thus it seems that the level of financial instability at last period is sufficient to help to predict future economic conditions [4].

Finally, we ask whether financial information is irrelevant for predicting financial shocks as well. The economic intuition is that financial data may contain information available to the economic agents without delay. Examples are stock markets data, government bonds market, currency markets where the information widely spreads at low cost. Thus, we estimate a last regression adding another controls to the matrix X_{t-1} that includes: stock market returns, inter-banking returns, government bond returns, banking stock returns (we add separately as X'). We report our specification in the models below:

$$\begin{cases} BCI_t = \alpha + \beta Announcement_t + \gamma SEMFSI_{t-1} + \gamma_1 BCI_{t-1} + \gamma_3 * X_{t-1} + \gamma_4 * X'_{t-1} + \epsilon_t \\ CCI_t = \alpha + \beta Announcement_t + \gamma SEMFSI_t + \gamma_1 CCI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \end{cases} \tag{8}$$

the results are summarized in table 7.

[Insert Table 7 about here]

In table 7, the coefficient of the variable "Announcement" captures the effect of financial instability on business (column 1) and consumption confidence (column 2) for the full

[4]Notice also that according our theoretical specification in section 3, a proxy of financial instability should include contemporaneous macroeconomic fundamental and financial conditions.

specified model. The coefficient of Announcement reduces to -0.0693 for BCI and -0.0308 for CCI compared to the previous models. We find that the impact of contemporaneous financial instability shock is statistically significant at 5% in BCI case while it is statistically significant at 10%.

Further, the estimated values of the coefficients confirm our intuition. Financial data represents an important source of information for explaining future economic activity and this information goes beyond the information captured by the financial stability index. In our model omitting financial variables would means leaving in the residuals information about the past that help to predict future announcements of the monetary authority that in turn affect the expectations about consumption and investments.

An example clarifies our point. If the level of returns in stock market are low, economic agents expect that in the short-term future ECB announces some measures in favor of financial stability and this would mine the predictability of our exogenous variable. In fact, if economic agents knew about those information they would adjust their expectations starting from period $t-1$ and not at the time of the announcement. Therefore, leaving out past financial information it leads to a biased estimates of coefficient β.

Further, in the last model we also control for the crisis period. The intuition is that during the peak of the crisis the individuals can have a motivation to change their expectations about the future in sense that they expect that the central bank adopts some measures to reduce instability. To test that, in the section 5.3, we will show that the effect of a financial instability shock affects differently the business confidence and consumption confidence in period of financial tension and calm years.

5.4 Check for robustness

In this section we perform some robustness checks to validate our results. A first potential concern about the validity of the regression in table (7) is that the dependent variable on the right side are not stationary that is, present a unit root. Thus, we perform the Phillipon-Perron unit root test for the BCI and CCI for all countries. From the test, we reject at 10% confidence interval the hypothesis that the BCI and CCI have unit root at country level. This result also has an interesting economic interpretation. In fact, an high first-order auto-correlation in the consumption and investment confidence indexes look in favor of slow adjustment process of the expectations meaning that, change in expectations depends on past shocks that decay exponentially as the lag distance increases. In term of the expectation model, this implies that one period ahead expectations heavily depends on the expectations that I had yesterday about today. From an econometric point of view, rejecting the hypothesis of unit root we conclude that the auto-regressive coefficient of lag values of the confidence index in the estimates are close to one but statistically different from the unity. We also performed other cointegration tests but we did not find evidence of cointegration.

As additional checks, first we check whether our results are robust to different measures of financial instability. As pointed out, we have estimated a measure of financial stability index using three methods of estimation: the method of principal component analysis (PFSI) and weighted variance method (EFSI) derived from the literature and a structural equation modeling as a new one. We have tested that these measure are highly correlated in almost all European countries as reported in correlation matrix, table 3.

In what follows, we test if the results of financial instability shock can be affected by different financial instability measures. We run the following regressions for PFSI:

$$\begin{cases} BCI_t = \alpha + \beta Announcement_t + \gamma_1 BCI_{t-1} + \gamma_2 PFSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \\ CCI_t = \alpha + \beta Announcement_t + \gamma_1 CCI_{t-1} + \gamma_2 PFSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \end{cases} \tag{9}$$

while using weighted variance financial stability index (EFSI), we run the following:

$$\begin{cases} BCI_t = \alpha + \beta Announcement_t + \gamma_1 BCI_{t-1} + \gamma_2 EFSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \\ CCI_t = \alpha + \beta Announcement_t + \gamma_1 CCI_{t-1} + \gamma_2 EFSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \end{cases} \tag{10}$$

where PFSI is the financial stress index aggregated with principal component analysis and EFSI is the financial index estimated with weighted variance method. The result are summarized in the table 8 and 9.

[Insert Table 8 and 9 about here]

As the reader will notice, our result are robust to different financial instability measures. The β coefficient is very close to our first regression for both the estimated model and the significance level at 1% is maintained for business confidence while consumption confidence loses its significance at 10%. This results are expected given the high correlations between the different indexes.

The second check of robustness is about our identifying assumption. Our strategy was based on the identification of an exogenous variable that affected financial instability level but didn't affect directly business confidence and orthogonal to past and present economic conditions.

Here, we check that our results are robust to a different exogenous source of shock. We

follow the work of Born, Ehrmann and Fratzscher (2014). They find that the releases of the "Financial Stability review" of ECB affects the level of financial stability in the system and most of the time is unpredictable by economic agents. Thus, we replace the variable "Announcement" with the releases of the Financial Stability Review, "FSr". So, we construct another variable that takes value 1 during the month in which the Financial Stability review (FSr, henceforth) has been released and 0 otherwise. Then, we re-perform our regression using FSr as an exogenous component for the financial instability. So, we are going to estimate the following models:

$$\begin{cases} BCI_t = \alpha + \beta FSr_t + \gamma_1 BCI_{t-1} + \gamma_2 FSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \\ CCI_t = \alpha + \beta FSr_t + \gamma_1 CCI_{t-1} + \gamma_2 FSI_{t-1} + \gamma_3 X_{t-1} + \gamma_4 X'_{t-1} + \epsilon_t \end{cases} \tag{11}$$

where, FSr is the exogenous variable and FSI is the financial stress index estimated with different techniques. The results are summarized in tables 10 and 11.

[Insert Table 10 and 11 about here]

Here, the β coefficient captures the effect of a financial instability shock on real expectations. The β reduces in magnitude from 0.0693 to 0.0509 (third column) for the business expectations while it slightly increases in the consumption regression. The beta is still significant at 10 per cent in the first case while lose its significance in the second one. However, as Born and Fratzscher (2014) have shown, the results may lack of consistency as the release of the Financial Instability review is sometimes anticipated by the individuals.

Our conclusion after the robustness check is that business confidence is negatively affected by financial instability shock while for consumption expectations the registered effect is mixed. In the next section we ask for how long a financial instability shock has an effect on business

and consumption expectations.

5.5 Impulse response using Local Projection

We use Jorda's (2005) local projection method to estimate impulse responses in our baseline. The Jorda method simply requires estimation of a series of regressions for each horizon h for each variable. The linear model looks as follows:

$$Y_{t+h} = \alpha_h + \delta_h X_{t-1} + \beta_h \,\text{Announcement}_t + \varepsilon_{t+h} \qquad h = 0, 1, 2, ..., \tag{12}$$

where Y is the variable of interest (BCI and CCI in our case), X is a vector of control variables and Announcement is the identified exogenous shock. Our baseline vector of controls contain macroeconomic fundamentals, lagged value for financial stability index and additional financial information as specified in equation (8). The coefficient β_h gives the response of Y ar time $t + h$ to the shock at time t. Thus, one constructs the impulse response as a sequence of the β_h's estimated in a series of single regressions for each horizon. In contrast to the standard method of the VAR, the local projection method doesn't require an iterative structure on the DGP of our data. The advantage is that we can exploit the time varying response of a variable Y to an exogenous shock with a lower number of assumptions. In the figure 5, we report the impulse response function of a unit shock in Announcement on business confidence index.

[Insert Figure 4 about here]

The tick blue line reports the sequence of β_h estimated using local projection while, the dot red line report the 95% confidence interval.

The results are statistically significant for a 20 periods horizon. At the impact a financial instability shock through announcement leads the investment expectations to fall. The effect reaches a maximum after 6 periods and then reverts to die out after 18 periods.
We then, investigate the effect on consumption expectations.

[Insert Figure 5 about here]

As before, the thick line represent the sequence of $_h$'s estimated using local projection and the dot red line is the 95% confidence interval. In this case the results are not statistically significant. According to the figure (5), a financial instability shock doesn't have any impact on consumption expectations at any horizon.
This result is quite controversial. A possible story is that consumers expectations are formed differently respect to the investors. Because investors are more affected by the aggregate fluctuations in the financial system, they tend to pay more attentions to the announcements of the monetary authority and revise more frequently their expectations while the opposite for consumers. On aggregate, consumption expectations tend to respond less to macroeconomic shocks, in particular to stability announcement, because households tend to smooth out negative shocks through investment and savings.

6 Conclusion and discussion

This research has focused on estimating the effect of financial instability shocks on business and consumption confidence. Our contribution to the existing literature is threefold:

1. We develop a measure of financial stress for the European countries using the technique of structural equation modeling (SEM).

2. Financial instability shocks have a negative impact on business expectations through financial stability announcement while the effect on consumption expectations is quiet negligible.

3. We find that the magnitude of the effect on investment expectations is stronger after 6 periods the shock hits the economy while the effect is statistically not significant for consumption expectations.

For estimating the effect of financial stability shock on business and consumption confidence we have constructed an exogenous variable that lists all the announcements of ECB on the period 2000-2016. The peculiarity of this variable is that we look at all those that can be considered unexpected by the economic agents. Under this assumption, the variable "Announcement" captures the effect of financial instability shock on economic expectations.

Using Jorda Projection, we have estimated the effect over time of a financial instability shock on economic expectations. In line with the economic intuition, we observe a negative impact of financial instability shocks on business expectations throughout the entire period that eventually tend to dies out after 18 periods.

Appendix: figures and tables

Figure 1: *Financial Stability Review* 2017, Introduction Composite index of macroeconomic uncertainty and economic policy uncertainty

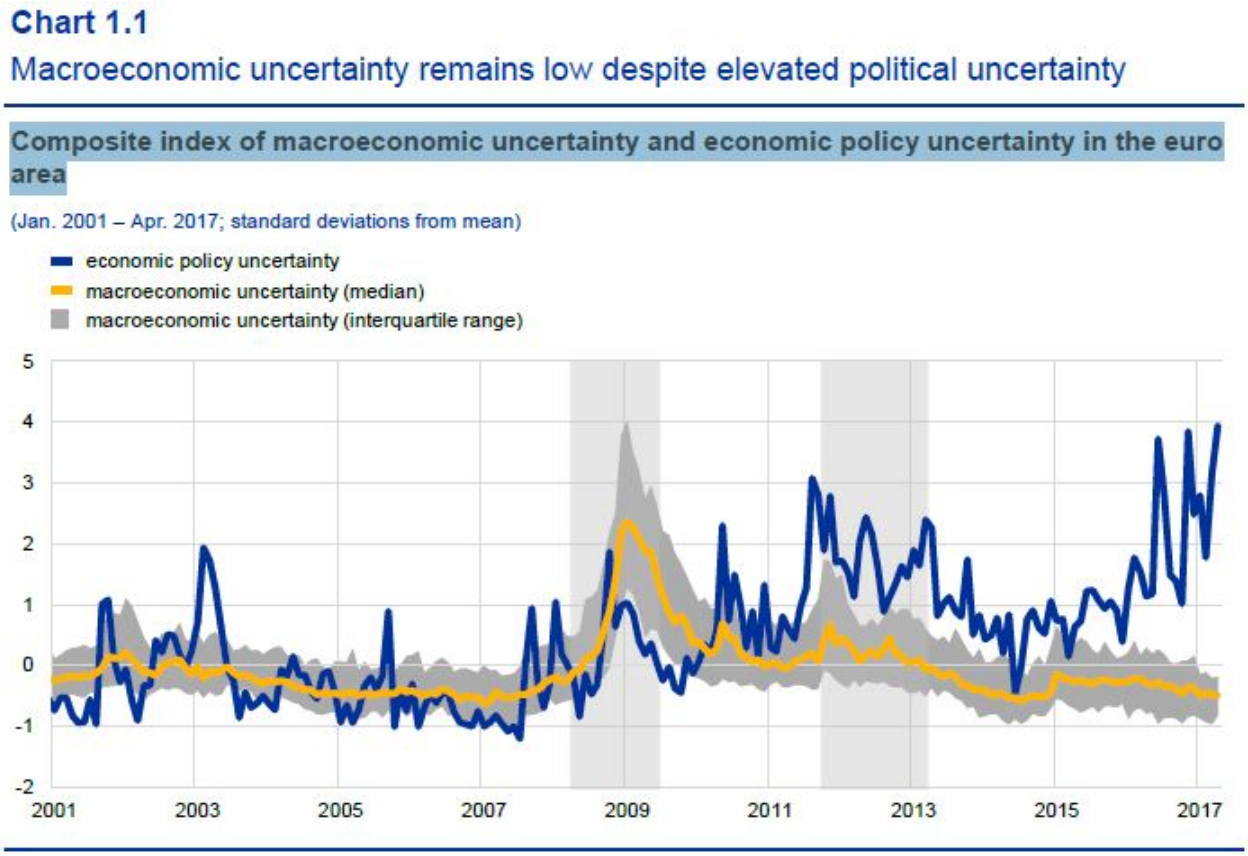


Table 1: Summary statistics period: 2008-2011

Variable	Obs	Mean	Std. Dev.	Min	Max
GDPCurrentPrice	1344	.001596	.010362	-.051107	.072201
FinalConsumptionExp	1344	.001849	.011615	-.06538	.125717
HouseholdFinalconsumption	1344	.001838	.010476	-.081713	.128663
GrossCapitalFormation	1296	.000821	.027246	-.291626	.203576
GrossFixedCapitalFormation	1344	.001023	.016659	-.163237	.216985
ImportGoodService	1344	.002155	.012016	-.065624	.107099
TaxlessSubsidies	1296	.001829	.037842	-.271867	.269353
PublicConsumption	1344	.001803	.028054	-.173065	.154733
InterbankReturn	1124	-.068545	.550167	-6.25	6.72
GovBondReturn	1125	.000269	.053388	-.396902	.638842
StockMarketReturn	1344	-.016493	.091961	-.480967	.399699
BankStockReturn	1136	.028543	.159627	-.581767	1.620717
SEMFSI	1344	.839118	1.172084	-.887375	6.239671
BCI	1012	-1.115822	2.515405	-13.94083	2.787876
CCI	1056	-.975275	2.465701	-16.1554	4.448601

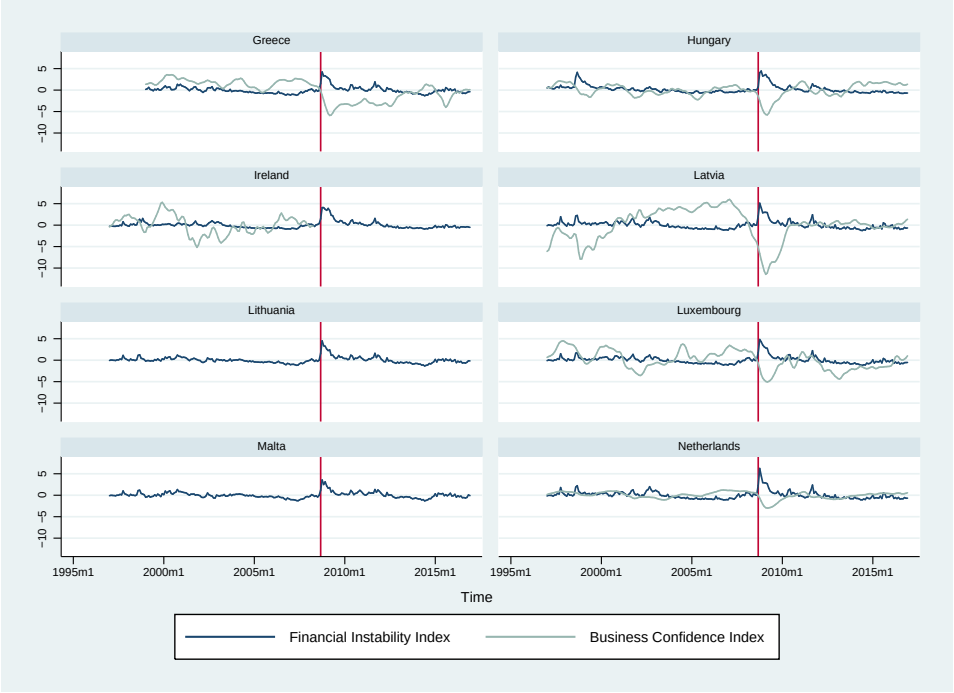
Table 2: Summary statistics period: 1997-2007 / 2012-2016

Variable	Obs	Mean	Std. Dev.	Min	Max
GDPCurrentPrice	5023	.002795	.011179	-.047406	.26481
FinalConsumptionExp	5023	.002717	.011907	-.075427	.241848
HouseholdFinalconsumption	5023	.002446	.011045	-.102187	.229074
GrossCapitalFormation	4837	.001978	.029406	-.448169	.378677
GrossFixedCapitalFormation	5023	.002196	.02159	-.197056	.592626
ImportGoodService	5023	.001252	.013011	-.167596	.216647
TaxlessSubsidies	4873	.003125	.034329	-.285805	.290463
PublicConsumption	5023	.003656	.029602	-.215695	.32123
InterbankReturn	4140	-.034285	2.938449	-51.96001	126.46
GovBondReturn	3677	-.000632	.055307	-.662375	.753772
StockMarketReturn	4951	.0085	.06376	-.538528	.337944
BankStockReturn	4123	-.005477	.093017	-.711659	1.628814
SEMFSI	5327	-.161502	.619832	-2.100679	4.131234
BCI	4134	.273152	1.552188	-7.889658	7.771585
CCI	4009	.511734	1.760211	-6.33815	7.977898

Table 3: Correlation Matrix. From the left to the right we report financial stability index constructed with structural equation modeling (SEMFSI), pricipal component analysis (PFSI) and weighted average (EFSI). We also include business (BCI) and consumption confidence index (CCI).

Variables	SEMFSI	PFSI	EFSI	BCI	CCI
SEMFSI	1.000				
PFSI	0.814	1.000			
EFSI	0.896	0.922	1.000		
BCI	-0.392	-0.439	-0.512	1.000	
CCI	-0.302	-0.369	-0.388	0.590	1.000

Figure 3: Structural Equation Modeling FSI and Business Confidence index for 28 Europe countries. We plot Financial Stability index (solid line in blue) estimated with SEM and Business confidence index (solid line in light green). The vertical line represents the beginning of 2008 financial crisis.


Greece
Hungary
Ireland
Latvia
Lithuania
Luxembourg
Malta
Netherlands
−10 −5 0 5
1995m1 2000m1 2005m1 2010m1 2015m1
Time
Financial Instability Index
Business Confidence Index

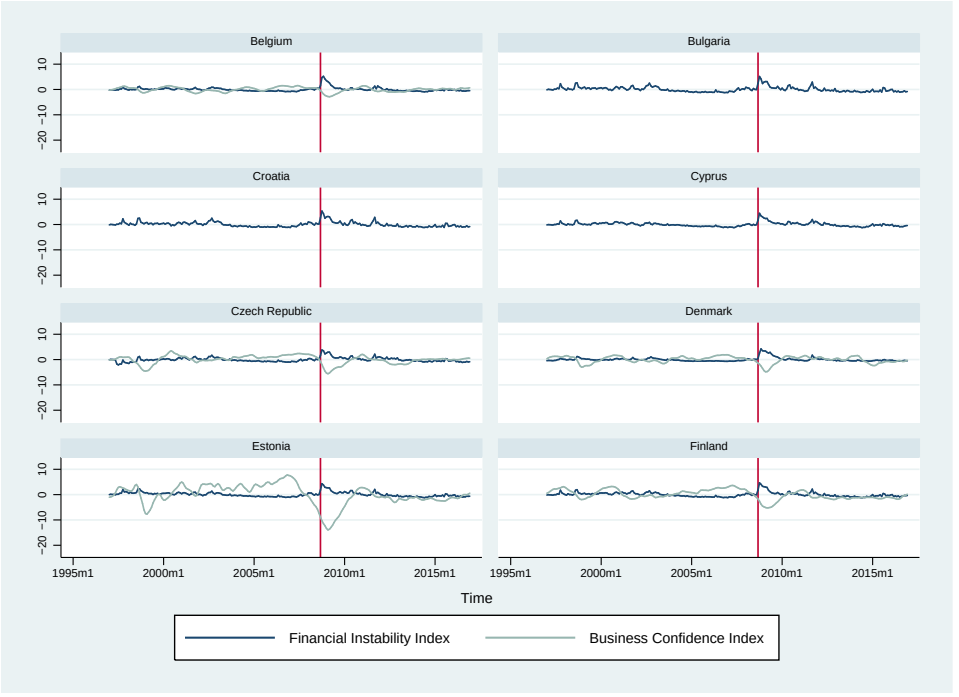

Belgium
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
−20 −10 0 10
1995m1 2000m1 2005m1 2010m1 2015m1
Time
Financial Instability Index
Business Confidence Index

Table 4: Unexpected exogenous variable announcement. Data are available on the ECB official.

Date	**Press Release**
Jun-16	European Central Bank is closely monitoring financial markets: The ECB will continue to fulfil its responsibilities to ensure price stability and financial stability in the euro area.
Jul-15	ELA to Greek banks maintained: The Governing Council is closely monitoring the situation in financial markets and the potential implications for the monetary policy stance and for the balance of risks to price stability in the euro area. The Governing Council is determined to use all the instruments available within its mandate.
Jun-15	ELA to Greek banks maintained at its current level Yannis Stournaras, Governor of the Bank of Greece, said: âThe Bank of Greece, as a member of the Eurosystem, will take all measures necessary to ensure financial stability for Greek citizens in these difficult circumstances.â
Jan-15	ECB announces expanded asset purchase program: An expansion in the asset purchase program was not announced before and not part of the statute of the ECB.
Oct-14	ECB announces operational details of ABS and Government Bond Purchase programmes It will enhance transmission of monetary policy, support provision of credit to the euro area economy and, as a result, provide further monetary policy accommodation
Nov-13	ECB announces details of refinancing operation with settlement in the period 9 July 2014 to 7 July 2015
Mar-13	ECB announces changes to the use as collateral of certain uncovered government guaranteed bank bond
Nov-12	ECB announces rescheduling of loan level data repartition requirements
Sep-11	ECB announces additional US dollar liquidity providing operations over year-end
Nov-10	ECB Governing Council welcome the request of the Irish government for financial assistance: we are confident that this programme will contribute to ensuring the stability of the Irish banking system and permit it to perform its role in the functioning of the economy.
May-10	ECB decides on measures to address severe tensions in financial markets: measures not due by ECB statute and with the intent to regain financial stability.
Jun-09	Purchase Program for covered bond: unconventional monetary policy.
Jan-09	Adjustment of risk control measures for newly issued ABS and for uncovered bank bonds
Oct-08	Publication of the report of EU bank structure: eliminate uncertainty on the EU bank structure.
Sep-08	Measures designed to address elevated pressure in short term US dollar funding markets
Jul-08	Measures designed to address elevated pressure in short term funding markets
Dec-07	Measures designed to address elevated pressure in short term funding markets
Apr-05	EU banking sector stability
Feb-03	EU banking sector stability
Sep-00	ECB announces joint intervention in exchange markets

Table 5: Results of OLS regression equations (6).
The coefficient of the variable "Announcement" capture the effect of an exogenous shock on financial instability on business confidence index (BCI) and consumption confidence index (CCI)

	(1) BCI	(2) CCI	(3) BCI	(4) CCI	(5) BCI	(6) CCI
Announcement	-0.737***	-0.638***	-0.618***	-0.521***	-0.111***	-0.0690***
	(-6.77)	(-5.63)	(-6.13)	(-4.79)	(-5.33)	(-3.73)
SEMFSI_1			-0.918***	-0.755***	-0.103***	-0.0730***
			(-31.95)	(-23.97)	(-16.06)	(-13.02)
BCI_1					0.962***	
					(332.17)	
CCI_1						0.976***
						(402.37)
_cons	0.0458*	0.244***	0.0801***	0.249***	0.0127**	0.0130***
	(1.71)	(8.48)	(3.15)	(8.79)	(2.43)	(2.69)
N	5146	5065	4906	4825	4898	4817
adj. R^2	0.005	0.002	0.177	0.108	0.965	0.974

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Results of OLS regression equations (7).
In this model we add macroeconomic fundamentals as additional controls for future announcement.

	(1) BCI		(2) CCI	
Announcement	-0.115***	(-5.76)	-0.0719***	(-4.24)
SEMFSI_1	-0.100***	(-16.05)	-0.0714***	(-13.75)
BCI_1	0.962***	(329.54)		
GDPCurrentPrice1	1.945	(1.30)	0.0946	(0.08)
FinalConsumptionExp1	-7.554*	(-1.66)	-11.45***	(-2.89)
HouseholdFinalconsumption1	4.155	(1.19)	8.121***	(2.67)
GrossCapitalFormation1	-0.419	(-0.98)	0.0785	(0.21)
GrossFixedCapitalFormation1	-1.612	(-1.45)	0.0219	(0.02)
ImportGoodService1	3.275***	(4.46)	-0.233	(-0.37)
TaxlessSubsidies1	0.112	(0.55)	0.0536	(0.35)
PublicConsumption1	1.610	(1.30)	2.815***	(2.61)
CCI_1			0.978***	(428.40)
_cons	0.0117**	(2.08)	0.0187***	(3.81)
N	4692		4700	
adj. R^2	0.968		0.979	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Results of OLS regression equations (8).
In this model we add macroeconomic fundamentals and financial conditions as additional controls for future announcement.

	(1) BCI		(2) CCI	
Announcement	-0.0693***	(-3.53)	-0.0308*	(-1.95)
BCI_1	0.964***	(241.12)		
GDPCurrentPrice1	-2.365	(-1.29)	-1.996	(-1.57)
FinalConsumptionExp1	-3.436	(-0.79)	3.651	(1.02)
HouseholdFinalconsumption1	5.286	(1.54)	-2.640	(-0.94)
GrossCapitalFormation1	1.332***	(3.05)	0.740**	(2.19)
GrossFixedCapitalFormation1	-1.309	(-0.98)	-0.817	(-0.77)
ImportGoodService1	1.247*	(1.88)	-1.293**	(-2.40)
TaxlessSubsidies1	-0.0260	(-0.16)	0.0417	(0.36)
PublicConsumption1	1.365	(1.21)	-0.559	(-0.59)
InterbankReturn_1	0.105***	(5.55)	0.0177	(1.13)
GovBondReturn_1	-0.128	(-0.84)	-0.186	(-1.50)
StockMarketReturn_1	0.725***	(9.45)	0.800***	(12.77)
BankStockReturn_1	-0.408***	(-9.30)	-0.401***	(-11.91)
SEMFSI_1	-0.0601***	(-9.34)	-0.0254***	(-5.11)
Crisis	0.00759	(0.72)	0.0264***	(3.12)
CCI_1			0.986***	(359.16)
_cons	-0.00112	(-0.15)	-0.00165	(-0.27)
N	2946		3048	
adj. R^2	0.968		0.981	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness check results for OLS regression equations (9).
In this table we report the results for the estimated system in equation (9). We use the variable $EFSI_1$ as an alternative measure of financial instability at time t-1.

	(1) BCI		(2) CCI	
Announcement	-0.0679***	(-3.42)	-0.0264	(-1.64)
EFSI_1	-0.0754***	(-5.81)	-0.0479***	(-4.76)
BCI_1	0.968***	(228.59)		
GDPCurrentPrice1	-3.573*	(-1.83)	-1.994	(-1.49)
FinalConsumptionExp1	-5.460	(-1.18)	1.381	(0.36)
HouseholdFinalconsumption1	5.751	(1.54)	-1.743	(-0.58)
GrossCapitalFormation1	1.642***	(3.62)	0.686**	(1.96)
GrossFixedCapitalFormation1	-1.399	(-1.01)	-1.068	(-0.97)
ImportGoodService1	1.013	(1.48)	-0.938*	(-1.67)
TaxlessSubsidies1	0.0731	(0.41)	0.0538	(0.43)
PublicConsumption1	2.139*	(1.78)	-0.0364	(-0.04)
InterbankReturn_1	0.108***	(5.28)	0.00779	(0.46)
GovBondReturn_1	-0.0913	(-0.59)	-0.209	(-1.64)
StockMarketReturn_1	0.886***	(11.03)	0.912***	(13.87)
BankStockReturn_1	-0.410***	(-8.86)	-0.408***	(-11.53)
Crisis	0.00900	(0.80)	0.0377***	(4.19)
CCI_1			0.985***	(328.00)
_cons	0.00168	(0.21)	-0.0108	(-1.63)
N	2710		2812	
adj. R^2	0.968		0.980	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness check results for OLS regression equations (10).
In this table we report the results for the estimated system in equation (10). We use the variable $PFSI_1$ as an alternative measure of financial instability at time t-1.

	(1) BCI		(2) CCI	
Announcement	-0.0681***	(-3.43)	-0.0264	(-1.64)
PFSI_1	-0.0313***	(-5.17)	-0.0176***	(-3.70)
BCI_1	0.970***	(233.10)		
GDPCurrentPrice1	-3.682*	(-1.91)	-2.215*	(-1.67)
FinalConsumptionExp1	-5.023	(-1.08)	1.667	(0.44)
HouseholdFinalconsumption1	5.147	(1.38)	-1.926	(-0.64)
GrossCapitalFormation1	1.629***	(3.61)	0.711**	(2.04)
GrossFixedCapitalFormation1	-1.588	(-1.14)	-1.169	(-1.06)
ImportGoodService1	1.056	(1.55)	-0.979*	(-1.75)
TaxlessSubsidies1	0.0928	(0.52)	0.0642	(0.51)
PublicConsumption1	2.041*	(1.70)	-0.0704	(-0.07)
InterbankReturn_1	0.103***	(4.98)	0.00984	(0.57)
GovBondReturn_1	-0.102	(-0.65)	-0.201	(-1.58)
StockMarketReturn_1	0.971***	(12.30)	0.963***	(14.84)
BankStockReturn_1	-0.428***	(-9.23)	-0.416***	(-11.75)
Crisis	0.00620	(0.56)	0.0356***	(3.97)
CCI_1			0.987***	(331.13)
_cons	0.00378	(0.47)	-0.0101	(-1.53)
N	2725		2827	
adj. R^2	0.968		0.980	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness check for exogeneity of the variable Announcement.
Following the work of Born, Ehrmann and Fratzscher (2014), we replace the variable "Announcement" with the releases of the Financial Stability Review, "FSr". The coefficient of the variable FSr capture the effect of financial instability on investment expectations through an exogenous announcement made by the monetary authority.

	(1) BCI		(2) BCI		(3) BCI	
FSr	-0.0431	(-1.45)	-0.0381	(-1.28)	-0.0509*	(-1.73)
BCI_1	0.968***	(228.49)	0.971***	(232.95)	0.965***	(240.98)
GDPCurrentPrice1	-3.714*	(-1.90)	-3.823**	(-1.98)	-2.512	(-1.37)
FinalConsumptionExp1	-5.364	(-1.15)	-4.890	(-1.05)	-3.359	(-0.77)
HouseholdFinalconsumption1	5.490	(1.47)	4.866	(1.31)	5.049	(1.47)
GrossCapitalFormation1	1.683***	(3.71)	1.669***	(3.69)	1.369***	(3.13)
GrossFixedCapitalFormation1	-1.378	(-0.99)	-1.568	(-1.13)	-1.280	(-0.96)
ImportGoodService1	0.865	(1.26)	0.914	(1.34)	1.086	(1.64)
TaxlessSubsidies1	0.0799	(0.45)	0.0999	(0.56)	-0.0196	(-0.12)
PublicConsumption1	2.140*	(1.77)	2.031*	(1.68)	1.373	(1.21)
InterbankReturn_1	0.105***	(5.15)	0.100***	(4.85)	0.102***	(5.42)
GovBondReturn_1	-0.0836	(-0.54)	-0.0940	(-0.60)	-0.120	(-0.79)
StockMarketReturn_1	0.903***	(11.24)	0.990***	(12.53)	0.738***	(9.62)
BankStockReturn_1	-0.433***	(-9.45)	-0.451***	(-9.84)	-0.430***	(-9.89)
EFSI_1	-0.0781***	(-5.94)				
Crisis	0.00783	(0.69)	0.00457	(0.40)	0.00639	(0.60)
PFSI_1			-0.0322***	(-5.26)		
SEMFSI_1					-0.0616***	(-9.48)
_cons	-0.000599	(-0.07)	0.00162	(0.20)	-0.00306	(-0.42)
N	2710		2725		2946	
adj. R^2	0.968		0.968		0.968	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Robustness check for exogeneity of the variable Announcement.
Following the work of Born, Ehrmann and Fratzscher (2014), we replace the variable "Announcement" with the releases of the Financial Stability Review, "FSr". The coefficient of the variable FSr capture the effect of financial instability on consumption expectations through an exogenous announcement made by the monetary authority.

	(1) CCI		(2) CCI		(3) CCI	
FSr	0.0373	(1.55)	0.0334	(1.39)	0.0348	(1.46)
CCI_1	0.987***	(330.65)	0.985***	(327.64)	0.986***	(358.14)
GDPCurrentPrice1	-2.247*	(-1.69)	-2.024	(-1.52)	-2.034	(-1.60)
FinalConsumptionExp1	1.964	(0.51)	1.663	(0.43)	3.941	(1.10)
HouseholdFinalconsumption1	-2.130	(-0.71)	-1.942	(-0.64)	-2.853	(-1.02)
GrossCapitalFormation1	0.728**	(2.09)	0.702**	(2.01)	0.760**	(2.25)
GrossFixedCapitalFormation1	-1.123	(-1.01)	-1.030	(-0.93)	-0.779	(-0.74)
ImportGoodService1	-1.019*	(-1.83)	-0.978*	(-1.75)	-1.345**	(-2.50)
TaxlessSubsidies1	0.0618	(0.50)	0.0520	(0.42)	0.0402	(0.34)
PublicConsumption1	-0.159	(-0.16)	-0.121	(-0.12)	-0.645	(-0.68)
InterbankReturn_1	0.0100	(0.59)	0.00773	(0.46)	0.0176	(1.12)
GovBondReturn_1	-0.197	(-1.55)	-0.205	(-1.61)	-0.181	(-1.46)
StockMarketReturn_1	0.966***	(14.91)	0.918***	(13.98)	0.808***	(12.90)
BankStockReturn_1	-0.425***	(-12.16)	-0.417***	(-11.95)	-0.411***	(-12.36)
PFSI_1	-0.0165***	(-3.45)				
Crisis	0.0310***	(3.40)	0.0333***	(3.65)	0.0219**	(2.55)
EFSI_1			-0.0459***	(-4.51)		
SEMFSI_1					-0.0246***	(-4.90)
_cons	-0.0108	(-1.64)	-0.0115*	(-1.73)	-0.00254	(-0.42)
N	2827		2812		3048	
adj. R^2	0.980		0.980		0.981	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 4: Local Projection Impulse Response BCI.
In this figure, the thick blue line reports the impulse response function of a financial instability shock on Business confidence index estimated with Jorda projection on an 20 periods horizon. The dot red line reports the 95%confidence interval. We find that a financial instability shock has a negative effect on impact on investment expectations that eventually dies out after 20 periods.

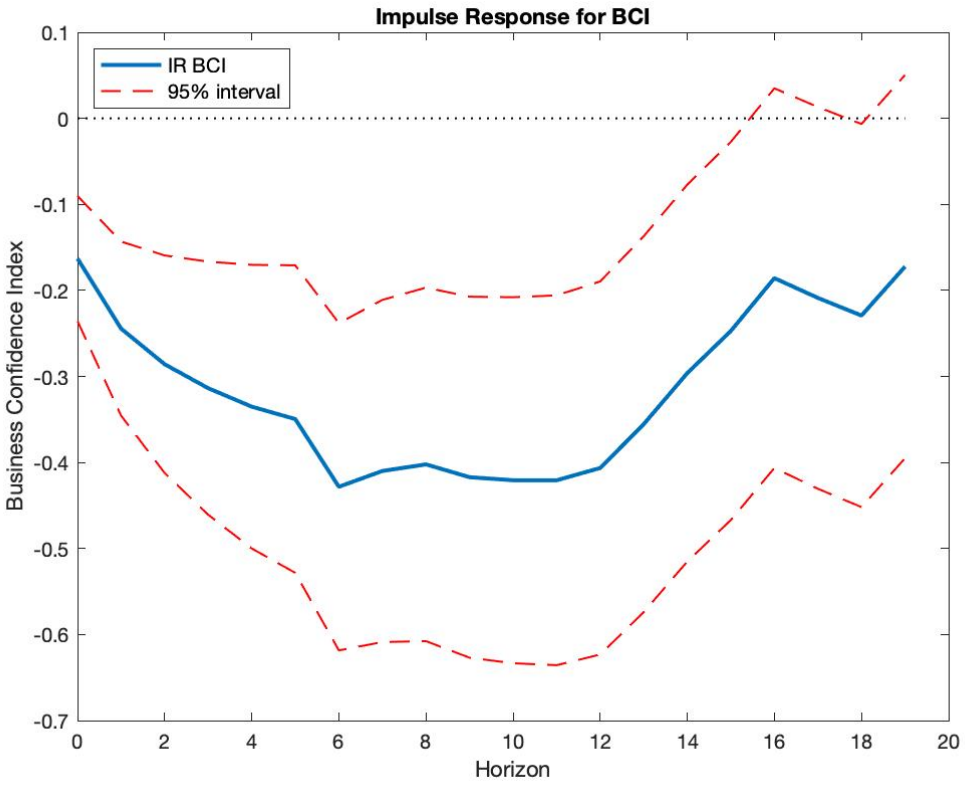
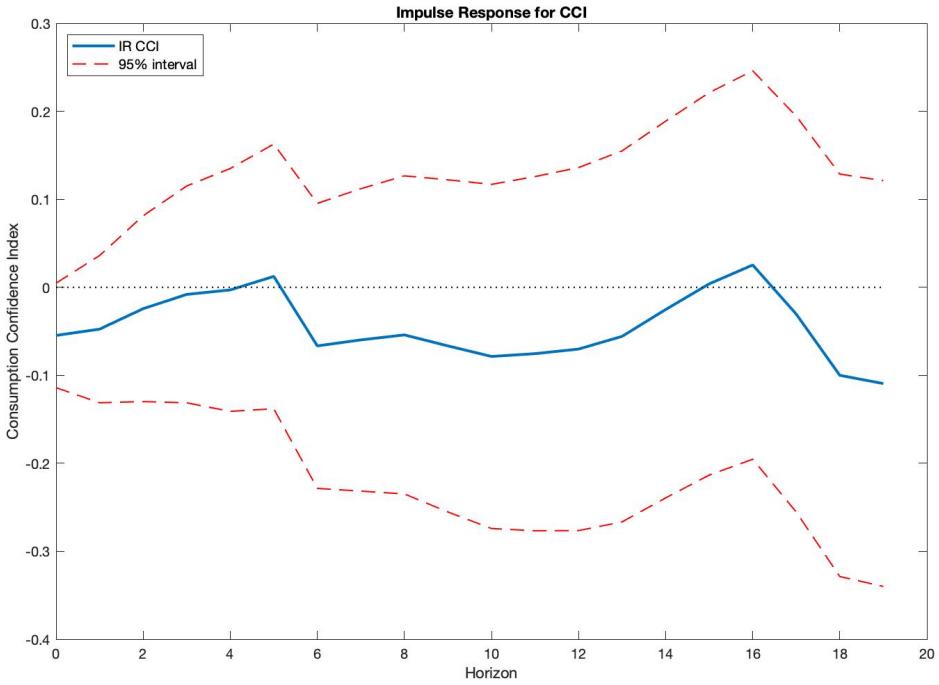


Figure 5: Local Projection Impulse Response CCI.
In this figure, the thick blue line reports the impulse response function of a financial instability shock on Consumption confidence index estimated with Jorda projection on an 20 periods horizon. The dot red line reports the 95%confidence interval. We find that a financial instability shock doesn't have a statistically significant effect on consumption confidence.



Part III

Unconventional monetary policy, bond prices and liquidity

Abstract

The paper aims at assessing the impact of the unconventional monetary policy undertaken by the European Central Bank (ECB) on European corporate bond prices and their liquidity. Using a difference-in-difference estimation technique, we find that the Corporate Sector Purchase Programme (CSPP) has significantly reduced both the yield and bid-ask spread of the purchased bonds. We also investigate whether the average treatment effect has changed over time during the implementation of the policy: the effect of the program on yield and prices has marginally abated, while the positive effect on liquidity is still present approximately nine months after the policy inception.

1 Introduction

This study presents an empirical analysis of the European corporate bonds market aimed at providing further evidence on how unconventional monetary policy affects asset prices and liquidity. Specifically, the analysis provides an estimate of the effect of the Corporate Sector Purchase Programme (CSPP), a part of the expanded Asset Purchase Programme (APP), implemented with the Decision (EU) 2016/948 of the 1st of June 2016, on the interest yield and bid-ask spread of the purchased bonds. In line with the theory, we find that the CSPP program has significantly reduced purchased bonds' yields and illiquidity. In particular, we estimate that the programme has reduced purchased assets' bid-ask spread by 7,22 basis points and returns by 0.237% with respect to a control group of bonds not purchased under the CSPP. We find also that the CSPP program has had a different effect over time: it had a persistent effect on liquidity up to 9 months after the implementation date, while the effect on returns (and thus on prices) vanished about 7 months after the announcement date.

This study differs from previous literature because it compares bonds purchased by ECB with a control group of non-purchased bonds in order to assess the effects generated by the CSPP on the bonds' liquidity and yields. The bonds purchased by the ECB were identified from the lists of corporate bonds portfolio holdings, updated to the second week of March, of the six National Central Banks (NCBs) in charge of buying the securities on behalf of the ECB. The ISIN codes of the securities bought under the CSPP at that point of time were employed to obtain respectively: ask prices, bid prices, mid-prices and yields of the 837 bonds for which they were available (i.e., almost the universe of all the purchased bonds).

Our sample spans approximately two years of daily observations (20/03/2015 − 22/03/2017), in order to observe the bonds both before the announcement date and before the start date of the programme. A control group of bonds not purchased by the NCBs was added to the dataset: this group was created filtering the bonds available on the Thom-

son Reuters Eikon databank according to the criteria that will be detailed in section 2.1, and it is composed by 125 corporate bonds. The construction of this control sample is important, because it allows us to perform difference-in-difference estimation. The reliability of the difference-in-difference approach depends on whether the holding of the parallel trend assumption is satisfied by the data, as this is a necessary condition for identification. This assumption requires the trends of the outcome variables to be similar in the pre-treatment era for both the control and treatment groups. The difference in difference estimation is used to perform two different analyses: the first one estimates variations in bonds' liquidity after the treatment; the second estimates the treatment effect on bond yields. The analysis is performed on a total of 396,210 observations for both the bid-ask spread and the yield. The liquidity proxy adopted in the research is the relative bid-ask spread, which is computed for all the bonds in the sample at a daily frequency. For both the spread and yields' difference-in-difference estimations, panel data are balanced, removing the bonds issued after the start date of the series. This procedure is adopted in order to account for the investors' preference for on-the-run securities, which can show systematic yield differences relative to similar seasoned bonds (for further information read section 2.3). In addition to the classical diff-in-diff estimation procedure, we estimate the magnitude of the average treatment effect in the days following the policy, following D'Acunto, Hoang and Weber (2016). We conclude by performing some robustness checks to examine how our estimated effects behave when the regression specification is modified by adding and removing regressors. We find that our results are robust with respect to different models and volatility measures.

1.1 A brief description of the Asset Purchase Programme (APP)

On 10 March 2016, the Governing Council of the European Central Bank announced the Corporate Sector Purchase Programme (CSPP) as a part of the expanded Asset Purchase

Programme (APP). With the Decision (EU) 2016/948 of the 1st of June 2016, the European Central Bank published the procedures and the details of the implementation of the programme, which officially started on the 8th of June 2016. The APP had a target of euro 80 billion investments per month until the end of March 2017 and euro 60 billion since April 2017 and has been composed of the following programmes:

- Third covered bond purchase programme (CBPP3);
- Public sector purchase programme (PSPP);
- Asset-backed purchase programme (ABSPP);
- Corporate sector purchase programme (CSPP);

The CSPP is coordinated by the ECB but is performed by the following national central banks (NCBs): Banca d'Italia, Banco de Espana, Banque de France, Deutsche Bundesbank, Banque Nationale de Belgique, and Finlands Bank. Purchases of eligible corporate bonds can be performed both in the primary and in the secondary market and are subordinated to the respect of some minimal requirements. According to the EU Decision 2016/948 of June the 1st 2016 on the implementation of the corporate sector purchase programme (ECB/2016/16), corporate bonds have to meet the following requirements:

- be eligible as collateral for Euro system credit operations, based on the requirements defined in the Guideline on the implementation of the Euro system monetary policy framework (ECB/2014/60);
- be denominated in euro;
- fulfil a minimum first-best credit assessment of at least credit quality step 3 (rating of BBB- or equivalent) obtained from an external credit assessment institution according to Guideline ECB/2014/60;

- hold a minimum remaining maturity of six months and a maximum remaining maturity of 30 years at the time of purchase;
- be issued by a corporation established in the euro area, defined as the location of incorporation of the issuer. Corporate debt instruments issued by corporations incorporated in the euro area whose ultimate parent is not based in the euro area are also eligible for purchase under the CSPP, provided they fulfil all the other eligibility criteria;
- the issuer cannot be a credit institution or have a parent undertaking as defined in point (15) of Article 4(1) of Regulation (EU) No 575/2013 of the European Parliament and the Council that is also a credit institution defined in point (14) of the Article 2 of Guideline (EU) 2015/510 (ECB/2014/60);
- the issuer cannot have a parent company which is subject to banking supervision outside the euro area;
- the issuers cannot be an asset management vehicle (as defined in the Bank Recovery and Resolution Directive and Single Resolution Mechanism Regulation) or a national asset management and divestment fund established to support financial sector restructuring and/or resolution.

In addition to the previous requirements, the ECB ensures that:

- an issue share limit of 70% per international securities identification number (ISIN) on the basis of the outstanding amount will be applied to bonds purchases. However, in some cases this requirement can be flexible;
- market capitalisation provides a weighting for each of the jurisdictions of issuance within the benchmark. Issuer group limits will be based on the benchmark to ensure a diverse portfolio;

Figure 1 shows the CSPP total purchases distinguishing between primary and secondary market bonds and total holdings from the beginning to one year of the program.

[Insert Figure 1 about here]

Two main aspects emerge from the graph. First, the amount purchased on secondary market represent about 96% of the total value during the first month of operations while, has slowly decreased to 85% after one year. Second, the portfolio of corporate bonds has sharply increased during the last semester of 2016 and the first of 2017 from. Since the beginning of the program, the portfolio of corporate bonds, purchased under the CSPP, went from 6.39 billion euro at date of starting program to 89.83 billion euro on May 31st 2017 (ECB data). To give some more context, consider that the Bank of England's Corporate Bond Purchase Scheme (CBPS) has a target of £ 10[5] billion.

Given the relevance of this unconventional policy for the whole European corporate bond market, we empirically test the effect of the programme in addition to measuring its variation over time in order to evaluate the impact of the CSPP from a market microstructure point of view.

2 Empirical Strategy

In this section we present the identification strategy and the econometric technique used for the analysis. We begin with a brief discussion of the data.

[5]Data includes the CBPS' target as a part of the Bank of England Asset Purchase Facility Fund. For further details visit: https://www.bankofengland.co.uk/markets/quantitative-easing-and-the-asset-purchase-facility.

2.1 Data

In order to perform the analysis, the lists of the corporate bonds bought under the CSPP are collected from the websites of the six National Central Banks (NCBs) in charge of buying the securities on behalf of the ECB. These securities are available for lending for both repo and reverse repo operations in order to avoid phenomena of market distortion and to prevent settlement failures. These lists are employed to collect the ISIN codes of the securities bought under the CSPP at that point of time. Through the ISIN codes ask prices, bid prices, mid-prices and yields of the 837 bonds for which they are available, are collected. The sample includes observations from 20 March 2015 to 22 March the 2017, and therefore includes about one year of observations before the announcement of the programme. In addition to the universe of purchased bonds, a control group of non-purchased bonds is added to the dataset. The control group is built filtering the bonds available on the Thomson Reuters Eikon database with similar characteristics of the treatment group. Specifically, the bonds are filtered respectively for:

- their eligibility for European credit operations according to the part 4 of the Guideline (EU) 2015/510 of the European Central Bank (ECB/2014/60);
- the non-financial, non-investment nature of their business activity of the respective issuers;
- the absence of any parent company subject to banking supervision outside the euro-area;
- their euro-denomination;
- a maturity structure shorter than 30 years and 364 days;

- the corporate nature of the issuers, thus excluding sovereign debt, eligible to be purchased under the Public Sector Purchase Programme (PSPP).

Of the 125 bonds obtained as control group, some are issued by non-euro area headquartered companies, although they met all the other criteria listed above. Second, several of the bonds included in the control group could be eligible to be purchased under the Corporate Sector Purchase Programme conditional on having a parent company incorporated in the Eurozone, which is the case for most of them. Under these assumptions, we consider this sample as a valid control group for our analysis. This is also consistent with the fulfilment of the parallel trend assumption condition before the adoption of the policy, as will be shown in section 2.3.

Additional data were collected regarding: interest yields, amounts of the single issues and maturities. The first step pursued in order to perform the analysis of bonds' liquidity is to identify a liquidity proxy. Given the lack of data regarding volumes, turnovers and order flows' directions, the best possible measure to compute is the relative bid-ask spread. Accordingly, relative bid-ask spreads for all the bonds available in the sample are computed using daily bid, ask and midquotes. All the bonds for which either interest yields or any quotes necessary to compute the relative spread are unavailable, are eliminated from the sample.

Furthermore, in order to control for market volatility in the econometric analysis, daily observations of the CBOE Volatility index, Vix, were merged to the dataset and used as a control variable in our specification. The latter would control for a potential different impact of market volatility on treatment and control group which could mine consistency of results.

All the data collected to conduct the research are obtained from the Thomson Reuters Eikon database, except for the Vix, obtained from the FRED, Federal Reseve of St. Louis databank. Even though the access to more sophisticated databanks (Bloomberg Terminal)

was possible, no authorization for the usage of data was granted for publication. Finally, corporate bonds issued after the announcement date of the programme are excluded from the analysis in line with evidence suggesting that on-the-run securities usually trade at higher prices and liquidity with respect to similar but older bonds. The latter procedure implied the elimination of approximately 80,000 observations. We will discuss the effect of including on-the run bonds in next sections.

The following tables show summary statistics for the variables involved in the analysis divided by treatment and control group.

[Insert Table 1 about here]

Our sample includes 273,005 corporate bonds in the treatment group and 41,396 in the control one. The summary statistics show that the bid ask spread and yield are on average statistically lower in the treatment than in the control group. In addition, the treatment group presents a lower volatility of both yields and liquidity with respect to the control one. We underline some heterogeneity between the two groups with respect to the amount issued. On average, the amount of issued bonds in treatment group is slightly higher than control sample and the range, in absolute value, is larger in the former. Therefore, we decide to include amount as control in our models.

In table 2, we present summary statistics categorizing the corporate bonds by their maturity:

[Insert Table 2 about here]

The short term maturity group includes bonds with average maturities between 0 and

3.5 years; the mid-term maturity group includes bonds with average maturities between 3.5 and 7.5 years; the long-term group includes those with average maturities between 7.5 and 12.5 years; and the ultra-long term class, bonds with average maturities of more than 12.5 years. Looking at summary statistics, we state that our sample is homogenously distributed among the different maturity groups.

Finally, we check that our sample is homogenous with respect to geographic composition as selecting a sample focused on few countries would lead to inconsistent results because of selection endogeneity.

In the following table we report summary statistics for the bonds' yield, spread maturity and amount of the issue by country.

[Insert Table 3 about here]

As shown in Table 3, bonds composition is homogenous with respect to maturity and amount issued while there can exist a country effect on yields and liquidity. In particular, corporate portuguese bonds are on average more illiquid and riskier than other bonds. Therefore, we will include country fixed effect in our specification.

2.2 Identification assumption

The aim of this study is to test for the causal effect of unconventional monetary policy decisions, in this particular case, the Corporate Sector Purchase Programme (CSPP), on European corporate bonds' liquidity and yields. Given the characteristics of the treatment and control group, respectively, we have decided to perform an analysis using the difference in difference estimation both for the liquidity and for the yields' cases. This method makes use of panel data and needs the availability of observations of treated and untreated bonds before

and after the policy occurrence. Since we cannot observe counterfactual realizations for one of the two groups, we estimate consistently the average treatment effect in both analysis committing to an identification assumption. The latter is the parallel trend assumption: we assume the trends of the outcome variables to be parallel in the pre-treatment era both for the control and treatment groups. Note that this assumption does not imply that outcome variables must be at the same level before the treatment, but just that they follow a similar time pattern. Under this assumption, difference in difference estimation would produce a consistent estimate of the effect of the CSPP on the variables of our interest, after controlling for opportune covariates. The first correction that we have made to assess parallel trend assumption is to exclude 'on the run bonds'. We have underlined that 'on the run bonds' can mine the validity of our results leading to an inconsistent estimate of the average treatment effect. The reasons to exclude these bonds differ from yield and liquidity analysis.

Empirical evidence by Amihud and Mendelson (1991) and Krishnamurthy (2002) suggests that there exists an "on the run" phenomenon so that most recently issued bonds with similar characterises to seasoned ones usually trade at premium. In particular, Krishnamurthy "documents the profits on a trading strategy characterized by long position on 30-year Treasury bond and short one on the new 30-year Treasury bond rolled over 5 years auction cycles from 1995 to 1999". The author estimates an average CP-Bills [6] spread in an auction cycle varying between 0.083 to 0.099 at 5% level of significance. Hence, it would lead to a violation of parallel assumption because of the systematic yield premium of part of the bonds which is not quantifiable in magnitude. In support of our assumption, figure 2 provides graphical evidence that the identification assumption holds in our case. We plot the average yield of treated and control group at daily and monthly frequency. Empirical evidence shows that economic policies have an impact on yields at the announcement date.

[6]Spread between 3-month commercial paper and 3-month Treasury Bills.

[Insert Figure 2 about here]

Looking at the monthly plot, we observe that control and treatment bonds share the same trend up to the announcement date (grey vertical line) while after, we document a slight divergence. Following the same procedure, the identification assumption check is performed for the liquidity estimation.

Strebulaev (2002) claims that the liquidity difference off/on the run bills is significantly larger that pricing difference. In the same direction Amihud and Mendelson (1991) state that off/on the run yield difference is mostly due to liquidity phenomena. Goldreich, Hanke and Nath (2003) show that the price premia of more liquid securities depend on their future liquidity rather than their current liquidity. Pasquariello and Vega (2009) conclude the discussion on the topic stating that: "In spite of the debate on the extent of off/on the run yield differentials and the relative importance of liquidity as an explanatory factor, there is little or no disagreement in the literature that off/on the run liquidity differential are both economically and statistically significant". For this reason, we exclude on the run observations from the liquidity analysis as well. Figure 3 provides evidence in support of the identification assumption for the bid-ask spread at the announcement date.

[Insert Figure 3 about here]

Figure 3 shows the average pattern of bid-ask spreads of both the groups of bonds at daily frequencies over the observed time frame. The grey (dotted) vertical line represents the announcement date of the policy. After the policy the trend of the treated bonds series becomes clearly decreasing, meaning that bid-ask spreads of treated bonds declined after the announcement of quantitative easing, a result perfectly in line with the theoretical predic-

tions. Note that monthly averages of daily observations for both bid-ask spreads and interest yields are obtained and plotted for the purpose of a less noisy graphical representation. In this regard, we provide several evidences in support of our assumption, both for the liquidity and for the yields analyses.

2.3 Empirical estimation

This method makes use of panel data and needs the availability of observations of treated and untreated bonds before and after the policy occurrence. The diff-in-diff methodology yields estimate of the average treatment effect for both bid-ask spreads and interest yields, namely:

$$\beta_{Yield} = (Yield_{treated,post} - Yield_{treated,pre}) - (Yield_{control,post} - Yield_{control,pre})$$

$$\beta_{Spread} = (Spread_{treated,post} - Spread_{treated,pre}) - (Spread_{control,post} - Spread_{control,pre})$$

where $Spread_{treated,post}$ is the treatment group average bid-ask spread after the starting date of the purchases, $Spread_{treated,pre}$ the treatment group average bid-ask in the pre-treatment era,$Spread_{control,post}$ the control group average bid-ask spread after the starting date of the purchases and $Spread_{control,pre}$ the control group average bid-ask in the pre-treatment era and similarly for the second equation.

The difference in difference identification strategy allows for the elimination of both the individual and group specific fixed effects, as well as common macro trends, thanks to the double differencing. As already specified, two different analyses are performed in parallel: one over bonds liquidity and one over bonds interest yields. In practice to implement the difference-in-difference approach, we estimate the following specification for the bid-ask

spread and the yield regressions, respectively. The regression equations are:

$$Bidask_{i,t} = \alpha'_{i,t} + \beta_{spread}(Announcement * Treatment) + \epsilon_{i,t} \quad (1)$$

$$Yield_{i,t} = \alpha_{i,t} + \beta_{yield}(Announcement * Treatment) + \eta_{i,t} \quad (2)$$

where the variables: *Announcement* is a dummy variable which takes value 0 before the announcement date of the programme (on March 10, 2016) and 1 afterward; *Treatment* is a dummy variable which takes value 1 if the observations belong to the treated group and 0 otherwise. Therefore, the interaction term in that specification capture exactly the average treatment effect for bid-ask spread (β_{Spread}) and yield (β_{Yield}). Under the parallel trend assumption, equation (1) and (2) consistently estimate the impact of the CSPP program on liquidity and yields. Nevertheless, our results may be undermined by the presence of covariates that differently affect treated and control group. In this case the results would be inconsistently estimated because of endogeneity problems. In order to avoid such problems, we introduce in our specification a set of control variables. Thus, for studying the impact of the CSPP on bonds' interest yields the panel data diff-in-diff regression are formulated as follows:

$$Bidask_{i,t} = \alpha_{i,t} + \beta' Fixed + \beta_{spread}(Announcement * Treatment) + \gamma' X + \epsilon_{i,t} \quad (3)$$

$$Yield_{i,t} = \alpha_{i,t} + \beta Fixed + \beta_{yield}(Announcement * Treatment) + \gamma X + \eta_{i,t} \quad (4)$$

where *Fixed* controls for fixed effects that may arise from different country characteristics (note that in the regression there are 22 different country variables); X is a set of variables that controls for macro and micro characteristics. In detail, X includes dummy variables to control, respectively, for the start date of the programme (StartProgram), announcement

date (Announcement) and treatment group (Treatment). The variable *StartProgram* is a dummy, which takes value 1 after the effective start date of the programme, i.e., after June 8 2016. The variable *Announcement* is a dummy which takes value 0 until March the 8th 2016, i.e., the date of announcement of the CSPP from the ECB, and 1 afterwards. The variable *Treatment* is a dummy which discriminates between treated and non-treated bonds. Again, as equations (1) and (2), the interaction between the group indicator and the Treatment dummy serves to estimate the diff-in-diff coefficient. Following the literature, we control for other macroeconomic variables. Taking inspiration from Schlepper, Hofer, Riordan and Schrimpf (2017), who conduct a study of government bonds liquidity and interest yields both at intra-day and daily level, to investigate the effects of the Public Sector Purchase Programme (PSPP), we introduce controls for general market volatility and risk, end of the month effects and maturity. Volatility is proxied via daily observations of the Vix index. Further, a variable *End effect* allows to control for end of the month effects, also called turn of the month effects, whose existence is supported by extensive research evidence[7]. To control for this effect, we have created a dummy variable taking value 1 for the first two days of the month and the last two of the previous month. The matrix X then includes a set of microeconomic variables to control for differences in bonds characteristics. We control for: amount issued, maturity and yields/liquidity. The variable *Amount* is included with the idea of controlling for the magnitude of bond issues and it takes values in millions of euro. To control for maturity, residual maturities are averaged for every single bond. Securities are grouped into four different categories as made by Schlepper, Hofer, Riordan and Schrimpf (2017): bonds with average residual maturity of less than 3,5 years are classified as short-term, bonds with maturities between 3,5 and 7,5 years are classified as mid-term securities, bonds with maturities between 7,5 and 12,5 years as long-term, and bonds with residual

[7]For further information, see Thaler (1987), Lakonishok, Smidt (1988), Ritter and Chopra (1989), Ogden (1990) and Cadsby and Ratner (1992), among the others.

maturities in excess of 12,5 years are classified as ultra-long-term. Finally, in equation (3) and (4) we control respectively for liquidity and yields.

As regards the interaction term, according to the efficient market hypothesis (EMH) which supports the thesis of instantaneous information incorporation in asset prices and consequently yields, the rational choice would be to refer to the announcement date of the programme rather than to the effective date to estimate the difference-in-difference. However, s second variant of the model which considers the effective start date of the program as the reference date is estimated as a robustness check. As for the yield's model, we conjecture that market participants are going to change their behaviour in correspondence to the announcement date of the policy. The idea is that that dealers anticipate the effect of the policy adjusting their inventories in line with projected future demand. The conjectured assumption is tested as a robustness check and the results are summarized in table 8.

2.4 Results

In this section we report and discuss the results obtained. Table 4 shows the estimates of the models used to interpret the interest yields reaction to the CSPP.

[Insert Table 4 about here]

Model (1) reports the estimated coefficient of equation (1) where we regress liquidity on country fixed effects, announcement and treatment. In model (2) and (3) we add respectively macro events and micro characteristics as controls. Here, the main result of the analysis is the estimate of the *didBidask* coefficient. The latter is estimated to be -0.00072 with a 99% confidence level in the last specification. This means that the average bid-ask spread for treated bonds is on average 0.072% lower than for the control group as a consequence of

the Corporate Sector Purchase Programme. For a better understanding of the magnitude of this result, the average treatment effect estimated through the 'didBidask' coefficient is translated in relative terms. In particular, the coefficient is added to the mean of bid-ask spreads of treated bonds after the treatment and divided by the same mean to obtain a measure of the average percentage variation of the relative bid-ask spreads with respect to a hypothetical no-policy scenario:

$$Spread_{policy/nopolicy} = \frac{Spread_{treated,post} + \beta_{spread}}{Spread_{treated,post}} - 1 = -15.44\%$$

The average spread for treated bonds, if not purchased, would have been 15.44% higher. Or equivalently, the average spread for the sample of treated bonds is 0.4663%. Therefore the effect of the corporate sector purchase programme has been to reduce the spread by 7.20 basis points, to an average of 0.3943%. Note that all the covariates used to realize the different controls are all significant at a 99% confidence level. The variable StartProgram is significant at a 95% confidence level. Table 5 shows the estimates of the models used to interpret the interest yields reaction to the CSPP

[Insert Table 5 about here]

In column (1), we report the estimated results of equation (2). We also add country fixed effect, announcement and treatment as control variables. The estimated coefficient of variable *didYield* quantifies the average impact of the purchases program on yields' bonds on the one year interval after the program announcement. After controlling for micro characteristics and macro events (model 4), the complete results of our estimations suggest that the CSPP has had a considerable impact on corporate bonds yields and thus prices. The model attributes to the policy an average reduction of 2.36% for treated bonds yields with a confidence level of

95%. The control variables are significant at a 99% confidence level except for the Vix, which is significant at a 95% confidence level, End-effect, which proxies for the turn of the month effect, and Brexit which are not statistically significant. In addition to the classical diff-in-diff estimation procedure, we perform a further step, taking as reference the methodology used by D'Acunto, Hoang and Weber (2016). We run a set of regressions on our sample before and after the announcement of the CSPP program to estimate the average treatment effect over time in equation (3) and (4). We set the reference month to March 2015, and we change the end month m across regressions.

We estimate the following specifications:

$$Bidask_{i,03/2015\rightarrow m} = \alpha + \beta' Fixed + \beta_{spread,m}(Announcement * Treatment) + \gamma' X_{i,03/2015\rightarrow m} + \epsilon_{i,t} \quad (5)$$

$$Yield_{i,03/2015\rightarrow m} = \alpha_{i,t} + \beta Fixed + \beta_{yield,m}(Announcement * Treatment) + \gamma X_{i,03/2015\rightarrow m} + \eta_{i,t} \quad (6)$$

where $Bidask_{i,03/2015\rightarrow m}$ and $Yield_{i,03/2015\rightarrow m}$ are the vectors of observation for liquidity index and yields from the beginning of the sample to time m; $X_{i,03/2015\rightarrow m}$ is a matrix that includes set of controls specified in section 2.3. *Announcement*Treatment* is the interaction term between the two variables; $\beta_{spread,m}$ and $\beta_{yield,m}$ capture respectively the cumulative effect on liquidity and yields of CSPP after m periods following the announcement of the policy. Figure 4 shows the average treatment effect over time of CSPP on liquidity following the announcement day (solid line) and the error bands at 90% confidence interval (dash lines).

[Insert Figure 4 about here]

From the announcement date to the effective start date of the program (dash-dot line), the effect on liquidity is statistically close to zero, while at the beginning of the program liquidity on purchased bonds falls by 0.01% relative to the control group until it reaches a cumulative effect of 5 and 7 basis point after, respectively, 150 and 260 days from the announcement. Furthermore, the figure shows that the effect of the policy is persistent over time but marginally decreasing, that is, the effect has been larger during the first months after the implementation of the program than the following days. However, our results suggest that, approximately nine months from the beginning of the programme (i.e., March 2017), average bid-ask spreads for treated bonds are lower and decreasing with respect to spreads of non-treated ones, as a consequence of the policy implementation. The same analysis is performed on bonds' yield then. We find different but interesting results in line with the literature. Figure 5 shows the average treatment effect for yields.

[Insert Figure 5 about here]

Interesting is the path of ATE over time of CSPP on yields. Despite the error band 90%, we claim that the CSPP program has had a positive effect on prices (or negative effect yields) at the day of the announcement but the marginal effect on yields is zero afterwards. As the policy is announced, on average, yields on treated bonds fall to a new level (i.e., -0.01 lower than control group). Moreover, for the whole period, the point estimate is negative and slightly increasing (more negative) and the cumulative effect results to be statistically different from zeros only 200 days after the announcement. This can be due to the composition of the dataset, which counts more observation in treated than control group and to the possibility that the estimated cumulative variation few days from the announcement is quite small compared to the cumulative effect after several month. Regardless, empirical

evidence and literature suggest that most of the effect should be at the time of the announcement while it should marginally decrease over time and that is exactly what the path (solid line) suggest. In particular, the cumulative effect from the date of announcement is always negative and marginally decreasing to reach a peak of -2.36% after 250 days.

2.5 Robustness tests

Our analysis shows and quantifies the impact of the CSPP on liquidity and yields' purchased corporate bonds through a difference in difference estimation approach. As pointed out in the previous sections, our results are based on some assumptions in line with empirical and theoretical literature. In this section we verify that our results are robust to the following variations. We propose an alternative model for both the analyses performed assuming that the effect of the program begins in correspondence of effective start date of the program, rather than the announcement one. For the yields study, even if there is strong evidence suggesting that prices adjust as information becomes available to investors, we perform a meticulous robustness check considering the effective start date of the program. Thus, we estimate the following regressions:

$$Yield_{i,t} = \alpha_{i,t} + \beta Fixed + \beta_{yield}(StartProgram * Treatment) + \gamma X + \eta_{i,t} \quad (7)$$

$$Bidask_{i,t} = \alpha_{i,t} + \beta' Fixed + \beta_{spread}(StartProgram * Treatment) + \gamma' X + \epsilon_{i,t} \quad (8)$$

where, StartProgram*Treatment is the interaction term between two dummies, 'StartProgram' and 'Treatment', while X and 'Fixed' are usual controls. For the yield case, this specification implies that prices move once the policy actually starts and are not affected by previous announcements. In other words investors don't anticipate expected future events. However, this kind of phenomena is rejected by the literature. For the liquidity case, un-

der the specified model in equation (6), market makers don't anticipate market demand for corporate bonds and consequently the effect on liquidity arise only after the purchases take place. The following specification is not rejected by the literature, thus it serves as alternative model in our analysis. For this reason, we add the following regression as a robustness check. Our findings are summarized in Table 6:

[Insert Table 6 about here]

where,'didProgram' here captures the effect of the policy on liquidity and yields under the latter model. In column 1, we report the estimation of equation (5). Under the assumption that investors are naive with respect to the announcement, treated bonds still present an average yield lower than the control group of 0.0215 as consequence of CSPP, and the result are statistically significant. Compared to the results of our specification, this model predicts a lower effect on yields of 0.21 basis points. Hence, we conclude that our analysis on yield is robust to a different specification where the effects of the policy starts from the program starting date. In column 2 of Table 6, we report the results of the regression as in equation (6). Under the assumption that market makers don't anticipate market demand, we estimate an effect on treated bonds liquidity of -0.000887. That is, because of CSPP, during the whole period treated bonds show lower bid ask spread of 0.0887% than control group. Compared to the results of specification as in equation (4), this model predicts a bigger effect on liquidity of 0.0167 basis points. Therefore, we claim that our results on liquidity are robust to the same test as well. A second assumption made during our analysis is that market volatility maybe affected differently the treatment and control group. We proxy market volatility with Vix index. The idea is that, since in our sample are present both European bonds and non EU, volatility index better capture the instability phenomena that can arise inside the Europe and

overseas. However, as further robustness check, we also control for Vstoox (i.e., volatility index for the European stock market) instead of Vix. The results are strongly robust to this check, in line with empirical evidence suggesting a 93% correlation between the Vstoxx and the Vix series at a monthly frequency from 2004 to 2017. Further robustness checks are then performed. We check that our results are robust when controlling for unexpected values: first, we apply a technique of tail trimming, eliminating both the upper and lower tails at 1% and 99% of the yields' distributions. The resulting did-yield coefficient is larger in magnitude (-0.0442) and still statistically significant, suggesting that our previous result could be deflated by yields' outliers. In addition, we create a filter for liquidity, trimming the yields observations for bonds characterized by very high illiquidity (again the upper and lower tails at 1% and 99% of bid-ask spreads). In this case the yield β coefficient decreases to -0.021 at a 10% significance level. In the light of our checks we believe that our findings are robust and significantly different from zero.

2.6 Conclusion

This research focuses on estimating the effect of the Corporate Sector Purchase Programme (CSPP) on both Eurozone corporate bonds' yields and liquidity. Our contribution to the existing literature is twofold:

1. We provide further evidence for the effects of unconventional monetary policy from a market microstructure perspective for the European corporate bond market.

2. We use a difference-in-difference technique to perform the analyses, comparing the effect of the policy on a treated and a control group.

The flexibility of the CSPP, which considers a wide range of eligible bonds from many countries and with many different characteristics, contributes to empower the effective impact

of the purchases on both market liquidity and yields. The results found in this analysis are in contrast with evidences from the public sector purchase programme presented by Schlepper, Hofer, Riordan and Schrimpf (2017). The authors claim that the ECB purchases have implied bunds' scarcity, lowering their liquidity, as proxied by the bid-ask spread. However their results are limited to the market for Bunds. However, we estimate an impact of the policy implemented by the ECB to be -0.0720% for relative bid-ask spreads with a 99% confidence level, and -0.237% for interest yields, with a 95% confidence level. Furthermore, as a consequence of the potential presence of spillover effects concerning the control group of bonds (due to the ease of circulation of capital flows among different asset markets and world's regions), the actual average treatment effect for both the bid-ask spreads and interest yields could have been underestimated, which would strengthen our findings.

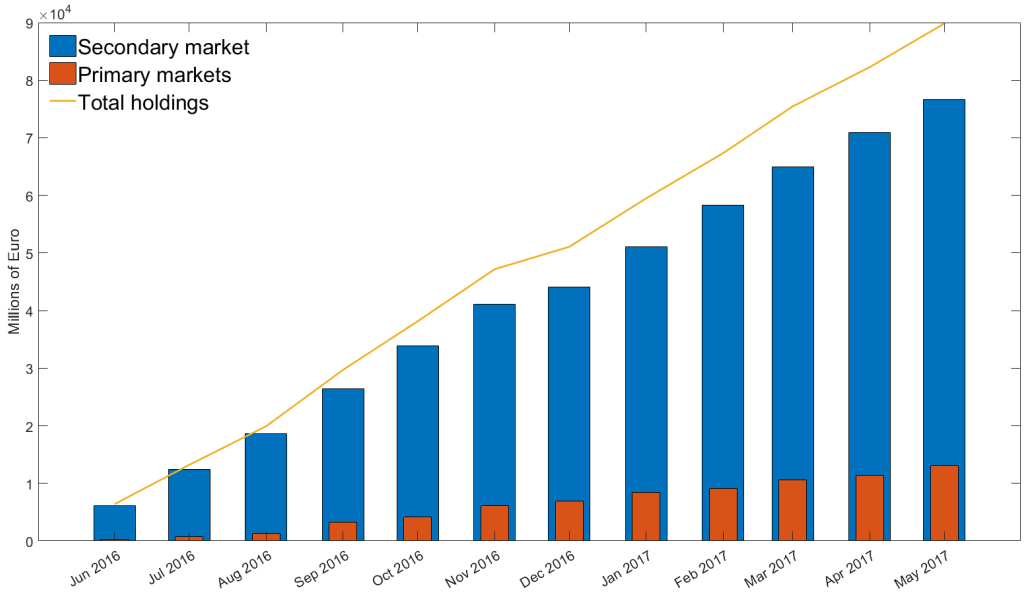
In light of the robustness of our findings, we believe that our estimates are reliable and add value to the literature on the effects of unconventional monetary policies. It would be interesting to continue to monitor the effect of the CSPP until the end and after the end of the program. This would allow to consider the overall effect of the policy after the tapering process, and eventually, to evaluate the ECB exit strategy.

Further, the access to richer databases for collecting the data could allow to perform a more complete analysis taking into account market depth and order flow directions. In addition, the analyses could be repeated using high frequency intraday observations and amounts of the single bond purchases by the ECB. However, this analysis is suggested for future research, since it is outside of the purpose of this work.

Appendix

Figure 1: CSPP program cumulative purchases.

In Figure 1, we plot the value of cumulative purchases of corporate bonds purchased by ECB from July 2016 to March 2017. In blue, we report the value of purchases on secondary market, in orange the total value on primary markets, while the line summarize the total holdings of ECB throughout the year. The portfolio of corporate bonds has sharply increased during the last semester of 2016 and the first of 2017 from. Since the beginning of the program, the portfolio of corporate bonds, purchased under the CSPP, went from 6.398 billion euro at date of starting program to 89.83 billion euro on May 31st 2017. Regard the composition, the amount purchased on secondary market represents most of the purchases made during the entire year.



Source: ECB data

Table 1. Yield summary statistics:

This table reports basic summary statistics for the Bid-Ask spread of the treatment and control groups. The treatment group includes 273,005 corporate bonds while the control group 41,396. We report that the average bid-ask spread for treated bonds is significantly lower and also less volatile than the average spread for non-treated ones.

	Treatment Group				Control Group			
Variables	Mean	Sd	Min	Max	Mean	Sd	Min	Max
Yield	2.820	1.158	0.485	7.087	2.975	1.182	0.477	6.6
Bid-Ask Spread	0.004663	0.00341	0.00001	0.079	0.006935	0.006231	0.00008	0.6074
Maturity	22563.8	1081.317	20909	26992	23222.89	2039.142	20982	31072
Amount	730361.1	357658.8	150000	2500000	504945	382328.7	15000	1750000
Volatility Index	15.682	4.323	10.58	40.74				
Group Maturity	1.991	0.775	1.0000	4.0000	2.255	0.880	1	4
Eurozone	0.992	0.087	0.0000	1.0000	0.278	0.448	0	1
Observations	273,005				41,396			

Table 2. Yield and Bid-Ask spread summary statistics by maturity.

This table reports the summary statistics tabulated by maturity for the interest Yield. The sample includes observations from March the 20th 2015 to March the 22nd 2017. In our sample, short-term maturity bonds show on average higher yields and standard deviations than the mid, long and ultra-long term maturity bonds. These characteristics are valid for both the treatment and control groups, even though the former are part of the bond purchase program. As in the previous table, we report the summary statistics by maturity for the Bid-ask spread. The average bid-ask spreads are increasing in maturity, meaning that, the longer is the bonds' maturity, the lower is their liquidity. In addition, the standard deviation of bonds' liquidity is increasing in their maturity.

Maturity	Variable	N	Mean	Std.Dev.	Min	Max
Short term Maturity	Bid-ask treated	78.257	0,3151%	0,2957%	0,0009%	31109%
	Bid-ask control	9.559	0,3996%	0,4047%	0,0089%	27977%
	Yield treated	77.991	32457%	14520%	0,1239%	70016%
	Yield control	9.559	31711%	14983%	0,1248%	59984%
Mid term Maturity	Bid-ask treated	16.165	0,5115%	0,3500%	0,0009%	79658%
	Bid-ask control	22.295	0,5851%	0,4572%	0,0081%	77444%
	Yield treated	161.509	24454%	11366%	0,1238%	70869%
	Yield control	22.295	24212%	12502%	0,248%	55857%
Long term Maturity	Bid-ask treated	93.388	0,5858%	0,3073%	0,0009%	34907%
	Bid-ask control	15.951	0,7957%	0,6982%	0,0083%	60745%
	Yield treated	93.388	20029%	0,8463%	0,2494%	44172%
	Yield control	15.951	25989%	12092%	0,4042%	66004%
Ultra long term Maturity	Bid-ask treated	11.507	0,7328%	0,3823%	0,0008%	38754%
	Bid-ask control	4.001	12221%	0,7190%	0,0375%	49451%
	Yield treated	11.507	2.60%	0.93%	0.84%	50946%
	Yield control	4.01	27488%	0,6725%	1.52%	43355%

Table 3. Summary statistics by issued countries

This table reports the summary statistics tabulated by countries for the yield, bid-ask spread, maturity and amount issued. The sample includes observations from March the 20th 2015 to March the 22nd 2017 for 20 countries.

Country	Yield	Bid-Ask spread	Maturity	Amount
AT	2.999	.0067029	22658.43	415869.6
BE	2.834	.0072025	24052.57	392042.9
CZ	3.579	.005258	22551.2	570000
DE	2.161	.0046278	22426.77	676666.7
DK	2.271	.0052857	23187.5	825000
EE	4.215	.0022243	21377	225000
ES	3.416	.0042401	22604.36	727087.6
FI	2.743	.0059255	22286	360000
FR	2.752	.0045767	22684.16	812716.9
GB	2.631	.0056549	22320.27	780000
IE	2.907	.0050258	22300.33	766666.7
IT	3.231	.0031206	22491	839337.1
LU	2.827	.0059856	22253.75	591500
NA	3.994	.0023969	20920.25	625000
NL	2.786	.0048291	22573.51	760017.2
NO	2.216	.0062254	23177.67	941666.7
PT	4.514	.0110206	22691	400000
SE	3.132	.006657	22841.93	387925.9
SI	3.055	.0043047	21724	265000
SK	2.868	.0081531	22407.33	376666.7

Figure 2: Monthly yields parallel trend assumption check.

Figure 2 provides graphical evidence of the parallel trend assumption. Our identification strategy is based on the assumption that on the announcement date of the policy, there are no differences in the behaviour of control and treated bonds. In this figure we provide graphical evidence that the 'parallel trend assumption' is verified for yields, i.e. before the announcement control and treated bonds follow the same trend. The graph above shows the average pattern of yields of both bonds' groups at daily frequencies over the observed time-frame, while in the second row we plot the monthly average pattern of the same variable. The vertical axis is positioned in correspondence of the announcement date of the CSPP. The black line report the average yields of treated bonds while in grey the average yield of control group at different time frequencies. The figure clearly shows that before the announcement, there are not significant differences between the two groups while straight after, yields are sharply decreasing for both groups.

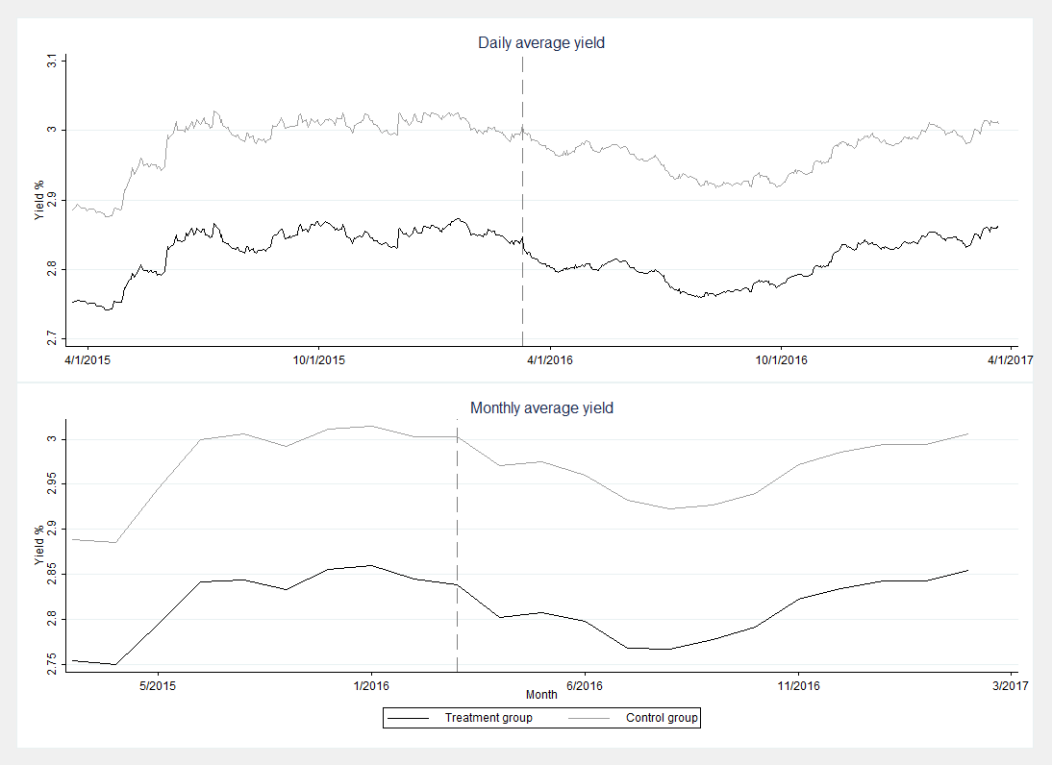


Figure 3: Monthly Bid-ask parallel trend assumption check.

Figure 3 provides graphical evidence of the parallel trend assumption for liquidity. The graph above shows the average pattern of bid-ask spread of both bonds' groups at daily (first row) and monthly (second row) frequencies over the observed time-frame. Whereas for the yields' regression analysis the reference date was the announcement one, the literature suggest that policy announcements are less relevant for the case of market liquidity. Therefore, we fix the reference date in correspondence of the effective start date of the policy (vertical grey line). As before, the black line report the average bid ask of treated bonds while in grey the average bid ask of control group at different time frequencies. Even in this case, before the programme, control and treated bonds follow the same path while after the policy the average bid ask spread significantly decreases for the treated group compared to the control one. After the policy announcement the trend of the treated bonds' series becomes clearly decreasing, meaning that bid-ask spreads of treated bonds declined probably as a consequence of quantitative easing, in line with theoretical predictions.

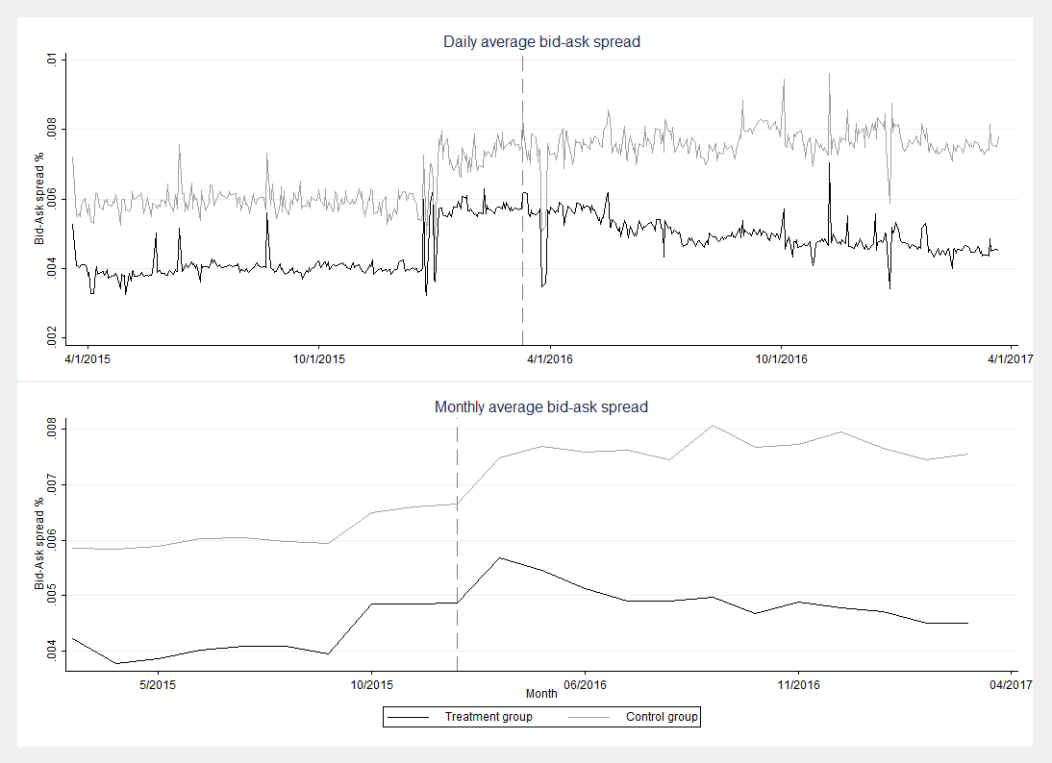


Table 4. Regression Liquidity model, sample 'without on the run'

In table 4 we report OLS regression output for liquidity's diff-in-diff estimation. All models are estimated including country fixed effects. In model (1), we regress variable Bid-ask on 'Annoucement', 'Treatment' and interaction term 'didBidask'. In model (2) and (3) we control respectively for macro events and micro effects. Finally, model (4) reports the estimated coefficients including both groups of controls. The estimated effect of didBidask capture the effect of CSPP program on market liquidity. The model, attributes to the policy an average reduction of 0.0720% for treated bonds' liquidity with a confidence level of 99% after including all controls.

	(1)	(2)	(3)	(4)
Bid-ask	Basic model	Macro cont.	Micro cont.	Complete model
didBidask	-0.000815***	-0.000801***	-0.000734***	-0.000720***
	(-20.68)	(-20.00)	(-19.59)	(-18.93)
Announcement	0.00143***	0.00205***	0.00168***	0.00219***
	(39.04)	(49.76)	(48.11)	(55.73)
Treatment	-0.00298***	-0.00299***	-0.00216***	-0.00217***
	(-67.72)	(-66.91)	(-50.90)	(-50.39)
Brexit		-0.000188		-0.000398***
		(-1.22)		(-2.72)
Eurozone		0.00238***		0.00255***
		(12.57)		(14.07)
Vix		0.0000599***		0.0000660***
		(33.79)		(39.17)
StartProgram		-0.000515***		-0.000334***
		(-23.17)		(-15.79)
EndEffect		-0.0000522***		-0.0000467***
		(-2.98)		(-2.80)
Yield			-0.0000396***	-0.0000412***
			(-6.65)	(-6.82)
Amount			-6.96e-10***	-6.96e-10***
			(-35.93)	(-35.41)
GroupMaturity			0.00147***	0.00146***
			(170.80)	(167.43)
_cons	0.00488***	0.00352***	0.00275***	0.000539***
	(28.91)	(38.81)	(16.78)	(5.86)
N	314400	303600	314400	303600
adj. R^2	0.115	0.121	0.202	0.207

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Regression Yield model, sample 'without on the run'

In table 5 we report OLS regression output for yield's diff-in-diff estimation. All models are estimated including country fixed effects. In model (1), we regress variable Yield on 'Annoucement', 'Treatment' and interaction term 'didYield'. In model (2) and (3) we control respectively for macro events and micro differences. Finally, model (4) reports the estimated coefficients including both groups of controls. The estimated effect of didYield capture the effect of CSPP program on market yields. The model, attributes to the policy an average reduction of 0.236% for treated bonds' yield with a confidence level of 95% after including all controls.

	(1)	(2)	(3)	(4)
Yield	Basic model	Macro cont.	Micro cont.	Complete model
didYield	-0.00238	-0.00245	-0.0235**	-0.0236**
	(-0.20)	(-0.21)	(-2.09)	(-2.07)
Announcement	-0.0219**	-0.0140	-0.0718***	-0.0360***
	(-2.01)	(-1.14)	(-6.84)	(-3.04)
Treatment	-0.248***	-0.248***	-0.537***	-0.537***
	(-19.07)	(-18.73)	(-42.27)	(-41.58)
Brexit		-0.0361		0.00997
		(-0.79)		(0.23)
Eurozone		1.034***		1.286***
		(18.38)		(23.70)
Vix		0.00226***		0.00114**
		(4.28)		(2.25)
StartProgram		0.00127		-0.0413***
		(0.19)		(-6.50)
EndEffect		-0.00115		-0.00259
		(-0.22)		(-0.52)
Bidask			0	-3.714***
			(.)	(-6.82)
Amount			0.000000476***	0.000000476***
			(82.83)	(81.33)
GroupMaturity			-0.328***	-0.329***
			(-124.67)	(-122.62)
_cons	4.477***	2.243***	5.030***	2.681***
	(89.47)	(83.28)	(104.35)	(98.75)
N	314400	303600	314400	303600
adj. R^2	0.095	0.095	0.166	0.166

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 4: Average Treatment Effect over time of CSPP program on liquidity.

In Figure 4, we plot the the β_{bidask} coefficient (solid line) of $Bidask_{i,03/2015\to m} = \alpha + \beta Fixed + \beta_{spread,m}(Announcement * Treatment) + \gamma X_{i,03/2015\to m} + \epsilon_{i,t}$ and 90% confidence interval (dashed line). The vertical line point the date of starting program. $Bidask_{i,03/2015\to m}$ is the vector of observation of liquidity index from the beginning of the sample to time m; $X_{i,03/2015\to m}$ is a matrix that include set of controls specified in section 2.3; 'Announcement*Treatment' in the interaction term between two variables; $\beta_{spread,m}$ captures the effect on liquidity of CSPP program after m periods after the announcement of the policy.

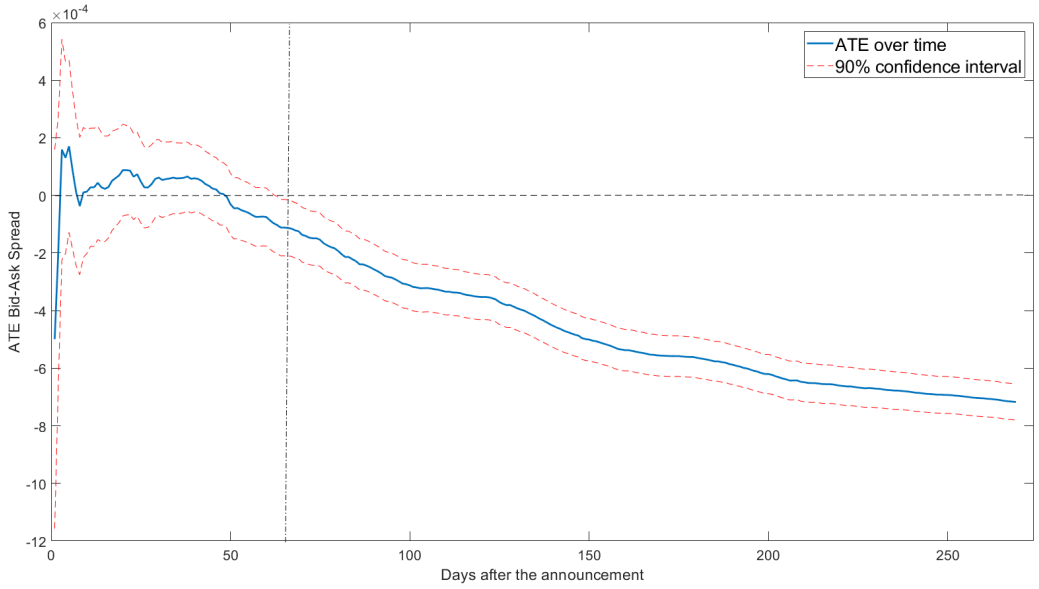


Figure 5: Average Treatment Effect over time of CSPP program on yields.

In Figure 5, we plot the the β_{yield} coefficient (solid line) of $Yield_{i,03/2015\rightarrow m} = \alpha' + \beta' Fixed + \beta_{yield,m}(Announcement * Treatment) + \gamma' X_{i,03/2015\rightarrow m} + \nu_{i,t}$ and 90% confidence interval (dashed line). The vertical line point the date of starting program. $Yield_{i,03/2015\rightarrow m}$ is the vector of observation of yields' bonds from the beginning of the sample to time m; $X_{i,03/2015\rightarrow m}$ is a matrix that include set of controls specified in section 2.3; 'Announcement*Treatment' in the interaction term between two variables; $\beta_{yield,m}$ captures the effect on liquidity of CSPP program after m periods after the announcement of the policy.

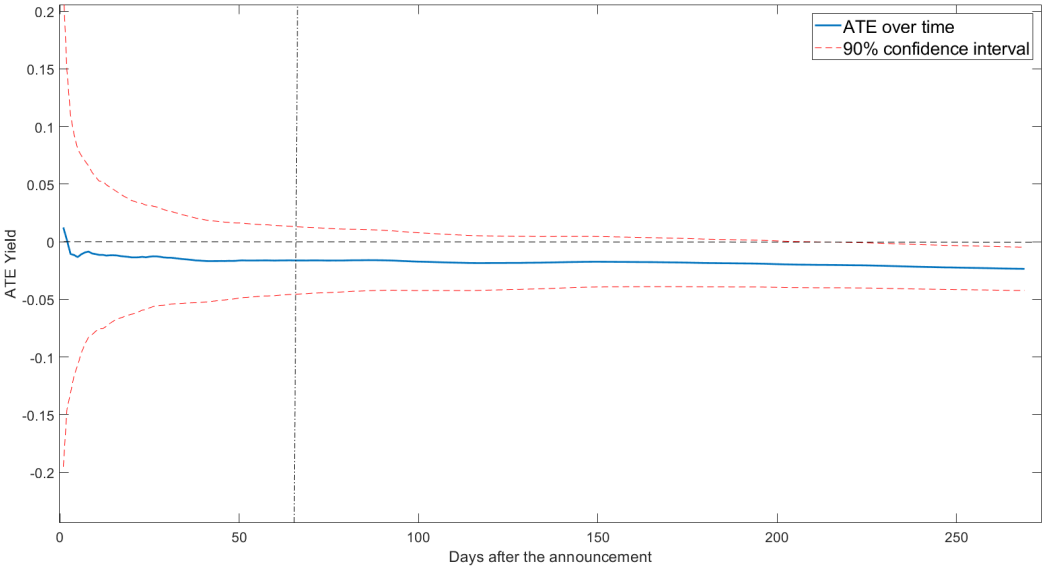


Table 8. Robustness check: regression model from starting program

In table 8 we report OLS regression output for yields (column 1) and liquidity (column 2) robustness check estimation. In column (1), we estimate the same specification as reported in table 4 assuming that CSPP has had an impact starting from the beginning of the program. Here, the interaction term between 'Program' and 'Announcement' (i.e. didProgram) capture the effect of CSPP on dependent variables. In column (2), we quote the same specification for Bid-Ask spread. Further, we control for country fixed effects and other variables as in table (4) and (5).

	(1) Yield	(2) Bidask
didProgram	-0.0215*	-0.000887***
	(-1.84)	(-22.80)
Announcement	-0.0565***	0.00156***
	(-8.79)	(73.63)
Treatment	-0.541***	-0.00219***
	(-43.67)	(-53.14)
Bidask	-3.717***	
	(-6.82)	
Amount	0.000000476***	-6.96e-10***
	(81.33)	(-35.43)
StartProgram	-0.0227*	0.000436***
	(-1.90)	(10.95)
EndEffect	-0.00259	-0.0000467***
	(-0.52)	(-2.80)
GroupMaturity	-0.329***	0.00146***
	(-122.62)	(167.38)
Brexit	0.00997	-0.000398***
	(0.23)	(-2.72)
Eurozone	1.286***	0.00255***
	(23.70)	(14.08)
Vix	0.00114**	0.0000660***
	(2.25)	(39.18)
Yield		-0.0000412***
		(-6.82)
_cons	2.685***	0.000560***
	(99.56)	(6.14)
N	303600	303600
adj. R^2	0.166	0.208

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

References

Acharya, V. V. and L. H. Pedersen (2005): "Asset pricing with liquidity risk," *Journal of financial Economics*, 77, 375–410.

Adrian, T. and H. S. Shin (2009): "Money, liquidity, and monetary policy," *American Economic Review*, 99, 600–605.

Albertazzi, U., B. Becker, and M. Boucinha (2018): "Portfolio rebalancing and the transmission of large-scale asset programmes: evidence from the euro area," .

Altavilla, C., F. Canova, and M. Ciccarelli (2016): "Mending the broken link: heterogeneous bank lending and monetary policy pass-through," .

Altavilla, C., G. Carboni, and R. Motto (2015): "Asset purchase programmes and financial markets: lessons from the euro area," .

Amihud, Y. (2002): "Illiquidity and stock returns: cross-section and time-series effects," *Journal of financial markets*, 5, 31–56.

Amihud, Y. and H. Mendelson (1986): "Asset pricing and the bid-ask spread," *Journal of financial Economics*, 17, 223–249.

——— (1991): "Liquidity, maturity, and the yields on US Treasury securities," *The Journal of Finance*, 46, 1411–1425.

Amihud, Y., H. Mendelson, and L. H. Pedersen (2012): *Market liquidity: asset pricing, risk, and crises*, Cambridge University Press.

Amihud, Y., H. Mendelson, L. H. Pedersen, et al. (2006): "Liquidity and asset prices," *Foundations and Trends® in Finance*, 1, 269–364.

Apostolakis, G. and A. P. Papadopoulos (2015): "Financial stress spillovers across the banking, securities and foreign exchange markets," *Journal of Financial Stability*, 19, 1–21.

Balakrishnan, R., S. Danninger, S. Elekdag, and I. Tytell (2011): "The transmission of financial stress from advanced to emerging economies," *Emerging Markets Finance and Trade*, 47, 40–68.

Beckmann, J. and R. Czudaj (2017): "Exchange rate expectations and economic policy uncertainty," *European Journal of Political Economy*, 47, 148–162.

Billio, M. and L. Pelizzon (2003): "Volatility and shocks spillover before and after EMU in European stock markets," *Journal of Multinational Financial Management*, 13, 323–340.

Blinder, A. S., M. Ehrmann, M. Fratzscher, J. De Haan, and D.-J. Jansen (2008): "Central bank communication and monetary policy: A survey of theory and evidence," *Journal of Economic Literature*, 46, 910–45.

Borio, C. and P. Disyatat (2010): "Unconventional monetary policies: an appraisal," *The Manchester School*, 78, 53–89.

Brunnermeier, M. K. and L. H. Pedersen (2008): "Market liquidity and funding liquidity," *The review of financial studies*, 22, 2201–2238.

Chakraborty, I., I. Goldstein, and A. MacKinlay (2017): "Monetary stimulus and bank lending," .

Chen, L., D. A. Lesmond, and J. Wei (2007): "Corporate yield spreads and bond liquidity," *The Journal of Finance*, 62, 119–149.

Chordia, T., R. Roll, and A. Subrahmanyam (2001): "Market liquidity and trading activity," *The journal of finance*, 56, 501–530.

Chordia, T., A. Sarkar, and A. Subrahmanyam (2004): "An empirical analysis of stock and bond market liquidity," *The Review of Financial Studies*, 18, 85–129.

Christensen, J. H. and J. M. Gillan (2018): "Does quantitative easing affect market liquidity?" Federal Reserve Bank of San Francisco.

Christensen, J. H. and G. D. Rudebusch (2012): "The response of interest rates to US and UK quantitative easing," *The Economic Journal*, 122, F385–F414.

Christopoulos, A. G., J. Mylonakis, and C. Koromilas (2011): "Measuring the Impact of Financial Crisis on International Markets: An Application of the Financial Stress Index," *Review of European Studies*, 3, 22.

D' Acunto, F., D. Hoang, and M. Weber (2016): "Unconventional fiscal policy, inflation expectations, and consumption expenditure," .

D' Amico, S., R. Fan, and Y. Kitsul (2015): "The scarcity value of Treasury collateral: Repo market effects of security specific supply and demand factors," .

D' Amico, S. and T. B. King (2013): "Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply," *Journal of Financial Economics*, 108, 425–448.

D'Acunto, F., D. Hoang, and M. Weber (2015): "Inflation expectations and consumption expenditure," *Chicago Booth Global Markets Working Paper Series*.

Danthine, J.-P. and J. B. Donaldson (2014): *Intermediate financial theory*, academic press.

Dees, S., F. d. Mauro, M. H. Pesaran, and L. V. Smith (2007): "Exploring the international linkages of the euro area: a global VAR analysis," *Journal of applied econometrics*, 22, 1–38.

Drechsler, I., A. Savov, and P. Schnabl (2018): "A model of monetary policy and risk premia," *The Journal of Finance*, 73, 317–373.

El Ghourabi, M., A. Dridi, and M. Limam (2015): "A new financial stress index model based on support vector regression and control chart," *Journal of Applied Statistics*, 42, 775–788.

Eser, F. and B. Schwaab (2016): "Evaluating the impact of unconventional monetary policy measures: Empirical evidence from the ECB' s Securities Markets Programme," *Journal of Financial Economics*, 119, 147–167.

Foucault, T., M. Pagano, A. Roell, and A. Roell (2013): *Market liquidity: theory, evidence, and policy*, Oxford University Press.

Gagnon, J., M. Raskin, J. Remache, B. Sack, et al. (2011): "The financial market effects of the Federal Reserve's large-scale asset purchases," *international Journal of central Banking*, 7, 3–43.

Gaspar, V., F. Smets, and D. Vestin (2006): "Adaptive learning, persistence, and optimal monetary policy," *Journal of the European Economic Association*, 4, 376–385.

Georgiadis, G. and J. Gräb (2016): "Global financial market impact of the announcement of the ECB's asset purchase programme," *Journal of Financial Stability*, 26, 257–265.

Gilchrist, S. and E. Zakrajšek (2013): "The impact of the Federal Reserve's large-scale asset purchase programs on corporate credit risk," *Journal of Money, Credit and Banking*, 45, 29–57.

Glosten, L. R. and P. R. Milgrom (1985): "Bid, ask and transaction prices in a specialist market with heterogeneously informed traders," *Journal of financial economics*, 14, 71–100.

Hollo, D., M. Kremer, and M. Lo Duca (2012): "CISS-a composite indicator of systemic stress in the financial system," .

Illing, M., Y. Liu, et al. (2003): "An index of financial stress for Canada," .

Islam, T. U. (2016): "Consumer Confidence Index and economic growth," .

Joyce, M., A. Lasaosa, I. Stevens, and M. Tong (2010): "The financial market impact of quantitative easing," .

Joyce, M. A. and M. Tong (2012): "QE and the gilt market: a disaggregated analysis," *The Economic Journal*, 122, F348–F384.

Kandrac, J. and B. Schlusche (2017): "Quantitative easing and bank risk taking: evidence from lending," .

Kilic, E. and S. Cankaya (2016): "Consumer confidence and economic activity: a factor augmented VAR approach," *Applied Economics*, 48, 3062–3080.

Koellinger, P., M. Minniti, and C. Schade (2007): ""I think I can, I think I can": Overconfidence and entrepreneurial behavior," *Journal of economic psychology*, 28, 502–527.

Krishnamurthy, A. and A. Vissing-Jorgensen (2011): "The effects of quantitative easing on interest rates: channels and implications for policy," Tech. rep., National Bureau of Economic Research.

Kyle, A. S. (1985): "Continuous auctions and insider trading," *Econometrica: Journal of the Econometric Society*, 1315–1335.

Lall, M. S., M. R. Cardarelli, and S. Elekdag (2009): *Financial stress, downturns, and recoveries*, 9-100, International Monetary Fund.

Maggio, M. D., A. Kermani, and C. Palmer (2016): "How quantitative easing works: Evidence on the refinancing channel," Tech. rep., National Bureau of Economic Research.

Mallick, S. K. and R. M. Sousa (2013): "The real effects of financial stress in the Eurozone," *International Review of Financial Analysis*, 30, 1–17.

Manamperi, N. (2015): "A comparative analysis on US Financial stress indicators," *International journal of Economics and Financial issues*, 5, 613–623.

McLaren, N., R. N. Banerjee, and D. Latto (2014): "Using changes in auction maturity sectors to help identify the impact of QE on gilt yields," *The Economic Journal*, 124, 453–479.

Meinen, P. and O. Roehe (2017): "On measuring uncertainty and its impact on investment: cross-country evidence from the euro area," *European Economic Review*, 92, 161–179.

Milani, F. et al. (2008): "Learning about the Interdependence between the Macroeconomy and the Stock Market," *University of California-Irvine, Department of Economics Working Papers*, 70819.

Obstfeld, M., J. C. Shambaugh, and A. M. Taylor (2009): "Financial instability, reserves, and central bank swap lines in the panic of 2008," *american Economic review*, 99, 480–86.

——— (2010): "Financial stability, the trilemma, and international reserves," *American Economic Journal: Macroeconomics*, 2, 57–94.

Oet, M. V., R. Eiben, T. Bianco, D. Gramlich, and S. J. Ong (2011): "CFSI). The financial stress index: Identification of systemic risk conditions. Federal Reserve Bank of Cleveland Working Paper 11-30," .

Oguchi, M., T. Tasaki, I. Daigo, T. Cooper, C. Cole, and A. Gnanapragasam (2016): "Consumers' expectations for product lifetimes of consumer durables," in *Electronics Goes Green 2016+(EGG), 2016*, IEEE, 1–6.

Oosterloo, S. and J. de Haan (2004): "Central banks and financial stability: a survey," *Journal of Financial Stability*, 1, 257–273.

Park, C.-Y. and R. V. Mercado Jr (2014): "Determinants of financial stress in emerging market economies," *Journal of Banking & Finance*, 45, 199–224.

Pasquariello, P. and C. Vega (2009): "The on-the-run liquidity phenomenon," *Journal of Financial Economics*, 92, 1–24.

Peersman, G. (2011): "Macroeconomic effects of unconventional monetary policy in the euro area," .

Pelizzon, L., M. G. Subrahmanyam, D. Tomio, and J. Uno (2015): "Sovereign credit risk, liquidity, and ECB intervention: Deus ex machina?" .

Smets, F. et al. (2014): "Financial stability and monetary policy: How closely interlinked?" *International Journal of Central Banking*, 10, 263–300.

Vayanos, D. and J. Wang (2009): "Liquidity and asset prices: A unified framework," Tech. rep., National Bureau of Economic Research.

Vermeulen, R. and M. Hoeberichts (2015): "Financial stress indices and financial crises," *Open Economies Review*, 26, 383–406.

Wieland, V. (2009): "Quantitative easing: a rationale and some evidence from Japan," Tech. rep., National Bureau of Economic Research.

Wright, J. H. (2011): "Term premia and inflation uncertainty: Empirical evidence from an international panel dataset," *American Economic Review*, 101, 1514–34.