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The True Nature of the Portfolio Balance Channel of Quantitative Easing Policy

Jakub Jaki¹

Abstract: This paper analyses the effects of the ECB's Public sector purchase programme (PSPP) on portfolios of the Eurozone investors. The ECB claims that the PSPP works mainly through the portfolio balance channel when the conditions on the asset markets are changed by the presence of a bidding central bank and investors are under those conditions forced to reallocate their portfolio to the state that better corresponds to ECB-changed market conditions and their preferences. This paper incorporates counterfactual analysis approach rather than analysis of direct change of prices and yields of given assets and uses sectoral data regression analysis of asset holdings of different investors in the Eurozone. This study addresses questions regarding size and direction of investors' reallocations – what types of investors were acting as the main counterparts to the ECB on the market for government bonds and what asset classes were preferred and chosen as an alternative by investors in the Eurozone to reallocate their funds. The series of obtained regression estimates and counterfactual analysis graphic representation answers to questions mentioned above and identifies a nonnegligible effect of the PSPP on the rebalancing of government bond portfolios towards riskier corporate bonds and equities across investor types in major Eurozone countries.

Keywords: ECB, Portfolio Balance Channel, Public Sector Purchase Programme, Quantitative Easing

JEL Classification: E52, E61, G11, E65

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Introduction

Monetary policy of the main central banks around the world changed significantly after the late 2000s and early 2010s so-called Great Recession. The Federal Reserve System (FED), the European Central Bank (ECB), the Bank of England (BoE) and others followed the path of unconventional monetary policy in the form of asset purchases trying to affect prices and yields of purchased assets and reestablish proper functioning of dysfunctional markets in the short run and reach its main objectives of price stability in the long run. In the European Union (EU) followed the episode of European debt crisis since the end of 2009, when several Eurozone member states (Spain, Portugal, Ireland, Greece, and Cyprus) were unable to manage repayments of their government

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debt and to bail-out the domestic deeply indebted commercial banks. In the wake of these and following events, the ECB established several unconventional programmes dealing with emerged problems. Among other measures, that are mentioned in the next section of this paper, the ECB introduced its Public sector purchase programme (PSPP). The PSPP was officially introduced to help the ECB to achieve its primary objective of maintaining price stability.² It was designed to ease monetary and financial conditions in the Eurozone and to improve the borrowing conditions for non-financial corporations and households, supporting aggregate consumption and investment spending and ultimately contributing to return of inflation rates to desired levels close to the ECB's 2% goal.

While the officially presented goals of the PSPP and its implementation are clear, the academic debate still goes on about how the policy of quantitative easing (QE) works and what transmission mechanism stands behind it. ECB policymakers repeatedly emphasized the role of the so-called portfolio balance channel as the main transmission channel that leads from asset purchases to the ECB monetary policy final goal embodied in price stability, see e.g. Cœuré (2017). Many academic papers examine the portfolio balance channel indirectly by analyzing the effects of asset purchases on prices and yield changes of purchased assets rather than by analyzing direct portfolio reallocations of investors and other market participants. The goal of this paper is to disclose portfolio balance channel nature by focusing on the regression sectoral analysis of the various types of investors and to identify and estimate the strength of the possible effects of the ECB's asset purchases undergone via the PSPP on the real portfolio reallocations between different asset classes.

To what extent did different types of investors reallocated their portfolios as a reaction to ECB's bond purchases? What type of investor was the main counterpart to the ECB on the market for government bonds? Into what asset class did different types of investors in the Eurozone reallocated their funds while facing changes in bond markets caused by the ECB's purchases? Were portfolio changes induced by the PSPP towards more risky assets? These questions constitute the core questions tackled in this paper. This study follows the counterfactual analysis approach presented by Pesaran and Smith (2012) and uses the regression analysis of sectoral data of asset holdings provided by the ECB and the Eurostat. The study also incorporates the ex-ante and the ex-post impact measurement presented e.g. by Joyce, Liu and Tonks (2014) to investigate portfolio rebalances from the different perspective and in more detail and to tackle this issue using the counterfactual analysis that provides a more suitable way to access the PSPP. Counterfactual type of analysis is suitable in cases when one would need to know and evaluate what would otherwise have happened, for example in the no-QE scenario. Analysis carried out in this paper enriches the existing academic research by originally using tailored counterfactual sectoral analysis approach on portfolio changes in the Eurozone rather than using asset prices/yields changes and by including of the ex-ante and the ex-post analysis on the ECB's asset purchases answers the above-mentioned QE-related research questions.

² In that time the inflation was well below the target, under 1% whole 2014, reaching its low 0,3% in November.

The rest of this paper has the following structure: the second section introduces the asset purchase programmes (APP) of the ECB and the theoretical framework of the portfolio balance channel and explains why it could work as policymakers present it. The third section describes empirical methodology and data used in this analysis and its limitations followed by the fourth section presenting the results of the sectoral analysis of portfolio reallocations and their discussion.

Asset purchases and the Portfolio balance channel

The ECB's asset purchase programme

In the first wave of exceptional steps taken by the ECB in order to face economic and financial disturbances in 2009, there were undertaken liquidity-providing long-term refinancing operations (LTRO)³ and introduced the first Covered bond purchase programme (CBPP).⁴ The CBPP was the first program classified by the ECB in the so-called Asset purchase programmes (APPs), which is basically quantitative easing (QE) directed by the ECB representing only insignificant part of the ECB balance sheet till the introduction of the following APP in 2015. These measures already followed some preceding monetary policy tentative response measures taken already in 2008. In 2010 followed the Securities Markets Programme (SMP)⁵ and the second CBPP in 2011 (CBPP2).⁶ The second wave of measures taken in and after 2014 began with Targeted longer-term refinancing operations (TLTROs)⁷ in the segment of open market operations and the third CBPP (CBPP3)⁸ in the segment of Asset purchase programmes (APPs).

The Governing Council of the ECB decided on 22nd of January 2015 that undergoing asset purchases should be expanded by including a secondary market public sector bonds and introduced its expanded asset purchase programme. As a core programme was introduced the Public sector purchase programme (PSPP) aiming at sovereign Eurozone bonds, introduced in 4th March 2015, see ECB (2015). The PSPP is furthermore a central subject regarding this paper. Factors leading to the introduction of the PSPP, mentioned by the ECB, include lower than expected monetary stimulus from adopted monetary policy measures and a downward drift in actual and expected euro

³ For details of LTRO ECB decisions see decisions of the Governing Council of the European Central Bank from 7 May 2009 and 8 December 2011.

⁴ CBPP was aimed at euro-denominated covered bonds issued in the euro area. For details of CBPP ECB decisions see Decision (EU) 2009/522 of the European Central Bank of 4 March 2015 on the implementation of the covered bond purchase programme.

⁵ SMP was aimed at euro-area public and private debt securities markets to ensure its depth and liquidity. For details of SMP see Decision (EU) 2010/5 of the European Central Bank of 14 May 2010 on the establishing of a securities markets programme.

⁶ For details of CBPP2 see Decision (EU) 2011/744 of the European Central Bank of 3 November 2011 on the implementation of the second covered bond purchase programme.

⁷ For details of TLTRO ECB see Decision (EU) 2014/34 of the European Central Bank of 29 July 2014 on measures relating to targeted longer-term refinancing operations and Decision (EU) 2016/10 of the European Central Bank of 28 April 2016 on a second series of targeted longer-term refinancing operations.

⁸ For details of the CBPP2 see Decision (EU) 2014/40 of the European Central Bank of 15 October 2014 on the implementation of the third covered bond purchase programme.

area inflation. In March 2015, the Eurosystem member banks initiated purchases of eligible assets on secondary markets, and by the end of 2018, the total Eurosystem holdings were over two trillion EUR.⁹ The pace of the monthly PSPP purchases and the length¹⁰ of the program were changed several times when the original monthly pace was €60 billion from March 2015 until March 2016, €80 billion from April 2016 until March 2017, once again €60 billion from April 2017 to December 2017 and €30 billion since January 2018 till the December 2018.¹¹ In 2016 the ECB also introduced the Corporate sector purchase programme (CSPP) aimed this time at a corporate bond issued by the Eurozone non-financial corporations, see ECB (2016) for details.

While all figures mentioned above sum the PSPP together with other programmes under APP, mainly CBPP3 and CSPP, the PSPP accounts by far for the greatest share of monthly purchases always exceeding 80% of all purchases. The ECB uses the capital key for purchases among the member states of the EMU, which implies that large, economically significant countries with lower debt to GDP ratio and high population (Germany for instance) have the relatively highest ratio of the ECB-bought assets to the total government debt. Eligibility criteria requirements were set to a rating of BBB or better with the remaining maturity from 2 to 30 years. Another condition imposed in December 2016 was that yield to maturity of purchased bonds must exceed deposit lending rate of the ECB. There was also the limit of 33% on the outstanding issued debt of a sovereign and 25% on a particular issuance.

Transmission of monetary policy asset purchases

In recent academic papers, there are mentioned many possible channels through which the unconventional policy of QE could work however with connection to asset purchase programmes of the FED, BoE or ECB the channel of portfolio balance reallocation is always emphasized by policymakers and is being given leading role over the others.¹² The portfolio balance channel is formally described in many papers e.g. in D'Amico and King (2010), Hamilton and Wu (2011) or Gagnon et al (2011) and abundantly mentioned by central banks representatives e.g. Bernanke (2010).¹³ Transmission of the

⁹ Intended allocations were roughly 90% of the total purchases to the government bonds and recognized agencies, and 10% to securities issued by international organizations and multilateral development banks.

¹⁰ Originally planned for 18 months, extended in December 2015 to March 2017, in August 2016 extended to December 2017 and finally extended in October 2017 until the end 2018. For details see amending decisions of the ECB 2015/33, 2015/48, 2016/8 and 2017/1.

¹¹ With further intentions “...to continue reinvesting, in full, the principal payments from maturing securities purchased under the APP for an extended period of time past the date when it starts raising the key ECB interest rates, and in any case for as long as necessary to maintain favourable liquidity conditions and an ample degree of monetary accommodation.” See ECB (2018).

¹² Among other transmission channels are mainly important signaling channel and liquidity channel – both described e.g. in Krishnamurthy and Vissing-Jorgensen (2011).

¹³ *I see the evidence as most favorable to the view that such purchases work, primarily through the so-called portfolio balance channel, which relies on the presumption that different financial assets are not perfect substitutes in investors' portfolios. For example, some investors who sold MBS to the Fed may have replaced them in their portfolios with longer-term, high quality corporate bonds, depressing the yields on those assets as well.* – Ben S. Bernanke, Jackson Hole, August 27, 2010.

portfolio balance channel is going through relative changes in asset prices with respect to the prices of its investments alternatives. When the ECB buys government bonds from investors in the Eurozone, preferably from non-bank private investors, it comes with an increase of broad money holdings in the economy and upward pressure on prices of purchased assets.

At the beginning of this process investors have portfolios that correspond to their own holding preferences in the given time – the composition of assets, the portfolio duration, its liquidity, the riskiness of assets held, its yield, regulatory framework, tax regime and other characteristics and this state is eventually affected by the ECB asset purchases and must inevitably lead to transformation of these portfolios given the changed conditions. The state of the world for investors is different than it was before the beginning of the ECB purchases. The ECB counterparts sell long-term, profit-yielding assets with limited liquidity for the short-term, high-liquid asset that yields no profit. Investors are not forced to sell any assets to the ECB, but they are highly motivated to do so by the prospect of short-term profit gains stemming from the fact that prices of the assets bought under the APP are on the rise. This in turn naturally leads to a rebalancing process when the investors who initially sold part of their holdings of government bonds to the ECB stand before the question of where to put their money.¹⁴ The money they received from the bond sale in the environment of different types of available investment opportunities characterized in the first place by different level or riskiness, duration, and yield they bear. The programmes of the ECB as the PSPP and later the ECB's Corporate sector purchase programme (CSPP) are designed to lower yields on government and prime corporate bonds and consequently lower credit premia required by investors in the segments of less attractive alternative investment assets. This mechanism could consequently lower the funding costs for small and medium-sized enterprises (SMEs) and households (which is directly intended by ECB) and for less sound governments (not officially admitted by the ECB)¹⁵ and other subjects in the Eurozone. Together with the rise of asset prices, the net wealth of asset holders rises as well. Thus, both mentioned effects then stimulate the real economic activity and consequently lead to upward pressure on inflation.

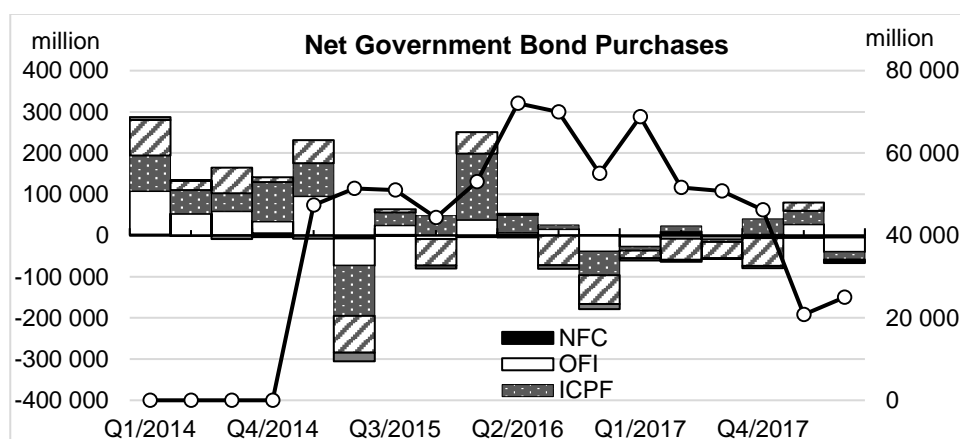
The portfolio balance channel can in theory, under certain circumstances, work in several different ways – for instance in the environment of efficient markets the announcement of APP itself would induce an instantaneous reaction in the bond markets when the price would rise up to the level that corresponds to expectations of future availability, respectively prices of ECB-targeted assets. The price through the time afterward would be linearly moving upwards, which would be caused by the prospect of the future ECB purchases and the necessity for the asset holders to be rewarded for their willingness to hold the asset just for a time till it is bought by the ECB, see D'Amico and King (2010) for detailed view. Through price increase in the benchmark portfolio

¹⁴ Under the condition that money is not being seen as the perfect substitute to investment assets that could be bought during portfolio rebalancing.

¹⁵ In fact, that was probably the main reason, why the capital outflow from Italy and Spain reached its maximum, it was most likely caused by the purchases carried out by Banco de España and Banca d'Italia. These purchases would be a part of capital outflows accounted for in the balance of payments and would also be transferred through the local central banks' purchases to the ECB as their uncovered liability in TARGET 2.

bonds bought by the ECB and the reduction of availability of these bonds on secondary markets, this would lead to higher investors' willingness to buy other riskier bonds on the secondary markets or a higher demand for newly issued government and corporate debt securities and consequently lowering the funding costs of their issuers. Substitution for other assets caused by asset purchases done by the central bank and other real effects are covered in Krishnamurthy and Vissing-Jorgensen (2011). In reality, however, the notoriously slow adjusting of portfolios of institutional investors, the novelty of APPs at the beginning and the lack of details about eligible bonds and possible tapering options or future parameter changes of purchase programmes moved the theory incorporating market efficiency miles away from praxis. A revaluation of bond prices was undoubtedly present in the time of the PSPP announcements, but this mixture of signals about QE, the future path of conventional rate-setting monetary policy and liquidity-providing programmes to commercial banks didn't really cause that much movement which would imply the theory mentioned above. Reality working differently and with more complexity allows us to use an analysis based on regressions over sectoral asset holdings data. Quarterly net changes in portfolio holdings for the main types of investors and the ECB net purchases since 2014/Q1 are depicted in Figure 1 below for illustration.

Figure 1: Quarterly PSPP and investors' net bond purchases [in Millions EUR]



Source: ECB, own calculations; NFC stands for Non-Financial Corporation, ICPF stands for Insurance Corporations and Pension Funds, HH stands for Households, OFI stands for Other Financial Institutions, MFI stands for Monetary Financial Institutions and PSPP stands for the Public sector purchase programme.

The reasons that repricing of purchased assets is not instantaneous and rather slow, dependent on persistent ECB's purchases, is that markets are far from being perfectly efficient, asset holders are slowly changing its portfolio of assets, and economic subjects other than the central bank (CB) must be necessarily convinced about the CB's intentions. The lack of information about the ECB purchases and the presence of information asymmetry between the Eurosystem member banks undertaking the APPs and investors regarding frequency of purchases, timing, and structure of purchases leads

to slower repricing as well. The central bank is in fact by its decisions to undertake its QE policy signaling its future intended rate path and under the Ricardo-de Viti-Barro equivalence, the QE could be effective only by convincing the public.

Academic research and publications on asset purchases

Theory incorporating relevance of the asset supply side is developed in the preferred habitat investors model presented in Modigliani and Sutch (1966), Vayanos and Vila (2009), Greenwood and Vayanos (2014) or Christensen and Krogstrup (2016). The instantaneous part of the asset QE-induced price changes of targeted assets can be assigned to the signalling channel, described e.g. in Krishnamurthy and Vissing-Jorgensen (2011), D'Amico and King (2013), Gagnon et al (2011), Glick and Leduc (2011) or Bauer and Rudebusch (2014), rather than the portfolio-balance channel.

A working mechanism and empirical evidence of the portfolio balance channel is mentioned by policymaker's speeches e.g. in Bernanke (2012) or in working papers e.g. in Haldane et al (2016) or Gambeti and Musso (2017) and in variety of academic papers with a focus on different aspects of this channel. Christensen and Rudebusch (2012) for instance analyzed the direct instantaneous impact of the QE announcements of the FED and the BoE on government bond yields. Joyce et al. (2011) analyzed the UK asset price changes induced by the BoE asset purchases and found significant evidence for the portfolio balance channel.¹⁶ Altavila et al. (2015) found that the impact of the ECB's asset purchases had a sizeable impact on asset prices. Using extended term structure model with bond supply effects and model-based predictions for cross-asset price movements associated with the transmission channels their estimated results indicate sizeable impact on long-term sovereign bonds, with yields declining by about 30-50 bp at the 10-year maturity for the implied euro area term structure, and by roughly twice as much in higher yield member countries such as Italy and Spain. Moreover, considering the non-targeted corporate bonds, they found a sizeable spill-over effect when corporate-sovereign spreads have declined by about 20 bp for both euro area financial and non-financial corporations.

The majority of other studies and those mentioned above examine the impact of asset purchases on prices or yields of asset classes rather than the direct impact on investment portfolios of important investors which are the key movers in the whole transmission mechanism of this monetary policy. Some of the latest are Arrata and Nguyen (2017) or Schlepper et al. (2017). Arrata and Nguyen (2017) tested on daily security-level data the impact of the PSPP on bond returns of French sovereign bonds. Their results showed that having purchased 10% of a bond outstanding correlates with a decrease in the yield of about 13 bp to 26 bp on average in the first year of PSPP implementation. They, however, did not find any significant supplemental effect from flows of purchases. Schlepper et al. (2017) matched the high-frequency ECB QE purchase data with high-frequency inter-dealer data on German government bonds and found economically significant price impacts at high (minute-by-minute) and low (daily) frequencies, highlighting the relevance of scarcity effects in bond markets. They argue that induced

¹⁶ APP of the BoE have depressed medium to long-term government bond yields by about 100 basis points by the 02/2010, with the largest part of the impact coming through a portfolio balance effect.

scarcity harms market liquidity conditions as measured by bid-ask spreads and inter-dealer order book depth.

Many existing studies dealing with portfolio allocations analyze different economies than the Eurozone, e.g., Joyce, Liu and Tonks (2014) for the UK, Carpenter et al. (2013) and (2015) for the US or Hogen and Saito (2015) for Japan. Joyce, Liu, and Tonks (2014) examined how the BoE asset purchase programme affected via the portfolio balance channel the investment behavior of insurance companies and pension funds. Their counterfactual analysis is based on explanation of portfolio allocations by variables invariant to the QE monetary policy and their results suggest that QE of the BoE led institutional investors to shift their portfolios away from government bonds towards corporate bonds. Carpenter et al (2013) and (2015) examined the Federal Reserve's asset purchase programme and on the flow of funds data assessed the types of investors that were selling assets to the FED and their portfolio adjustments after these sales. Their goal was to uncover possible effects described by the preferred habitat theory and the transmission of unconventional monetary policy across asset markets. Their findings were that the FED was buying from only a handful of investor types, primarily households, with a different reaction to changes in the FED holdings of longer-term versus shorter-term assets and that the key participants were rebalancing their portfolios toward more risky assets.

Other studies analyze the ECB's asset purchases impact on specific market segment, e.g. Albertazzi, Becker, Boucinha (2018) analyzing 25 largest euro area commercial banks, providing evidence of an active portfolio rebalancing channel. They argue that search-for yield mechanism is an important part of the transmission of purchase programmes, as it implies that the monetary stimulus is passed-through onto sectors which do not hold nor issue eligible securities and therefore do not directly benefit from the programme itself. The results of their study indicate that *"in more vulnerable countries, where macroeconomic unbalances and relatively high risk premia remain, APP was mostly reflected into a rebalancing towards riskier securities. In less vulnerable countries, where constraints on loan demand and supply are less significant, the rebalancing was observed mostly in terms of bank loans."* A different perspective than this study followed Koijen et al (2018) or Bua and Dunne (2017) focusing on quantifying changes in risk concentration by investor type across countries in the Eurozone using data on security-level portfolio holdings by investor type across the Eurozone countries. Their instrumental variables estimator showed that the average impact on bonds decreased yields about 13 bp. Moreover, they did not find large portfolio shifts towards other assets such as corporate bonds or equities in the euro area.

An alternative view on asset purchases of central banks raise moral hazard concerns about a possible reduction of incentives to restructure the banking sector and to make reforms of fiscal policy to hold it self-sustainable in the long term. Cúrdia and Woodford (2011) express the concerns about the incentives to investors to take higher risks by switching to riskier assets and to take high leverage. Brunnermeier and Sannikov (2014) or Coimbra and Ray (2019) describe the possible mechanisms of these negative phenomena that could accompany the QE policy. Coimbra and Ray for instance claim that when monetary policy rates are low, a further stimulus can increase aggregate risk while inducing a fall in the risk premium – there could be a trade-off between stimulating the economy and financial stability.

Empirical methodology and data

Regression model

The core of the portfolio balance process of an individual investor, his portfolio changes and asset flows among different asset classes for the whole sector is a simple utility optimization of economic agents. Mathematic interpretation is basically the maximization of the value of the expected utility function tomorrow with respect to portfolio asset allocations that are being made today. Formally written as:

$$\max E[U(x_{1,T+1}, \dots, x_{n,T+1}, L_{T+1})|T] \quad (1)$$

Where $(x_{1,T}, \dots, x_{n,T})$ represent the market value of agent's available assets with different characteristics, that can be chosen in the portfolio decision making in given time and space. Every asset type $x_{i,t}(c_1, c_2, \dots, c_n)$ has its own unique characteristics c_1, \dots, c_n that represents e.g. duration, liquidity, riskiness, yield, regulatory framework, tax regime etc. L represents the sum of liabilities of the same agent (market value of investor's debt owed to other subjects). L can be also decomposed to different types of liabilities with its own unique characteristics as it is for different assets.

Constraints of this optimization problem are as given:

$$E(\sum_{i=1}^n x_{i,T+1}|T) = \sum_{i=1}^n x_{i,T} R_{i,T} \quad (2)$$

Representing the expected market value of the sum of the whole portfolio holdings, where $x_{i,T}$ is the value of i -th asset held in time T and $R_{i,T}$ is the forthcoming return of i -th asset over one period.

Expected market value of the debt for given portfolio holdings is then:

$$E(L_{T+1}|T) = L_T E_T(R_{T+1}^L) \quad (3)$$

Where $E_T(R_{T+1}^L)$ is the expected liability growth ration over one period incorporating expected return – expected liability in time T+1 will then be equal to liabilities in time T multiplied by this ratio and finally:

$$E(\sum_{i=1}^n x_{i,T+1}|T) - E(L_{T+1}|T) \geq C_{T+1}|T \quad (4)$$

Where $C_{T+1}|T$ represents required capital C in time T+1 derived from the value of capital C known in time T and required yield from own capital for period t . Together, it gives us reasonable initial assumptions about funding sources at the beginning of this decision-making process. The simplified solution of this optimization problem, when we assume not risk-loving agent and optimized relation of assets and liabilities among periods (balanced funding / same market value of assets and liabilities), gives us optimal demand function:

$$f_T^* = f^*(R_T, v_T, \Sigma_T^x, \kappa_T) \quad (5)$$

Where v_T is the vector of values of the whole portfolio, Σ_T^x is the variance covariance matrix of the asset returns for each investment asset and κ_T is the vector of higher-order moments.

This solution of utility optimizing problem would allow us to construct a structural model upon consumer theory to derive the portfolio reallocation model incorporating the demand function for investment assets. Non-linearity and dynamics in such a model would be difficult to construct correctly and to interpret accurately – this paper, therefore, follows a different approach of the counterfactual analysis advocated in Pesaran and Smith (2012).

The counterfactual analysis is based on the conditional model incorporating parameters which are invariant to the change in the monetary policy decision being studied, e.g., the ECB decisions about asset purchases in this case. The baseline model for explaining investors' behavior as a reaction to the PSPP purchases on the sectoral level is defined as:

$$y_t^i = \alpha^i + \beta_p^i p_t + \beta_{w1}^i w_{1,t} + \dots + \beta_{wn}^i w_{n,t} + \epsilon_t^i \quad (6)$$

Where the dependent variable y_t^i stands for the net acquisition of asset i held by the given investor in time t and regressors include p_t that represents the central bank policy (in this case the net acquisition of government bonds) over time period t and the invariant variables w_1, \dots, w_n that in the first place affect the dependent variable and on the other hand are to some extent invariant to the policy change captured in the first regressor. A problem-specific form of the equation (6) for the given problem of this paper is therefore given as:

$$y_{I,t}^i = \alpha_i^i + \beta_{I,p}^i p_t + \beta_{I,iss.}^i issuance_t + \beta_{I,i.r.}^i inv.regressors_t + \epsilon_t^i \quad (7)$$

which is the regression equation for the portfolio of investor I, asset i , over time t with the specific invariant regressors that include government bonds issuance and other invariant regressors. The list of invariant regressors includes issuance of the given type of purchased asset (in this case the PSPP-eligible government bonds denominated in EUR), the US treasury 10Y benchmark yield, the US government-corporate high yield spread¹⁷, the S&P 500 total return index and the US Economic policy uncertainty index (EPU).¹⁸ All these variables on the list are fairly invariant to the monetary policy changes in the Eurozone, on the other hand the expected invariance would not be absolute due to advanced globalization and worldwide character of portfolio investment opportunities.

The second set of data used in this study is compiled from several Eurozone holdings statistics provided in monthly and quarterly frequency by the ECB and the Eurostat. Namely: the MFI holdings of securities statistics¹⁹, the Securities holding statistics

¹⁷ Stands for spread between the US treasury 10Y benchmark yield and the US government-corporate high yield represented by the Bloomberg Barclays US Corporate High Yield Total Return Index.

¹⁸ The Economic Policy Uncertainty Index represents the measurement of policy-related economic uncertainty constructed from three types of underlying components: newspaper coverage of policy-related economic uncertainty, number of federal tax code provisions set to expire in future years and disagreement among economic forecasters as a proxy for uncertainty. Sectoral classification is based on the ESA 2010.

¹⁹ The MFI holdings of securities statistics contains monthly data about the holdings of debt securities, equity and non-MMF investment fund shares of MFIs in the Eurozone excluding the

(SHS)²⁰ and the Integrated euro area economic and financial accounts²¹. The Securities holding statistics is a valuable source of information about the structure of debt security holdings across the Eurozone countries and different types of investors, collected on a security-by-security basis and broken down by instrument type, issuer country, and further classifications. Asset segments analyzed within the framework of this paper are governmental bonds issued in the Eurozone – both in EUR and non-EUR currencies, government bonds issued outside the Eurozone held by investors with the Eurozone domicile, corporate bonds issued in the Eurozone, corporate bonds issued outside the Eurozone held by investors with the Eurozone domicile and listed equity shares and investment fund shares held by investors with the Eurozone domicile.²² All the above mentioned statistics provide a firm set of data about asset allocations of various types of investors in the Eurozone and allow us to cover estimated sectoral regressions with the sufficient set of data.

Invariant variables allow us to control for variety of possible factors that may have some impact on portfolio reallocations – sovereign PSPP-eligible bond issuance covers supply side on primary market; US treasury 10Y benchmark yield covers possible effects of unsynchronized monetary policy of the ECB and the FED and investment tendencies between US federal and sovereign Eurozone bonds; S&P 500 total return index covers development on equity markets and its inverse relationship to bond markets; and the Economic policy uncertainty index covers policy-related economic uncertainty on markets. All time series used in this paper are in the form of net change between periods in given units – millions of EUR as for series representing the PSPP purchases and asset holdings, in basis points change for time series representing yield changes and in index point changes in case of the S&P and the EPU. By focusing solely on net asset holdings changes it is more straightforward and problems with the passive recomposition of holdings due to valuation changes can be omitted. Time series data are not additionally adjusted for the possible impact of valuation effects, while it is being considered to be implicitly contained in investors' decisions that are well aware of all elements that have some impact on the yield of their portfolio and take this impact into account in the decision process. Unfortunately, it is not possible to separate in an easy way (other than by comprehensive questionnaire) the elements of their decision-making and to access them per se.

The expected results of the equation (7) according to the economic theory would suggest following beta values for government bond holdings of private investors: $\beta_{I,p}^i < 0$, which would mean that asset purchases of the central bank of given asset (p_t) caused rebalancing of investors' portfolios towards other types of assets; $\beta_{I,iss.}^i > 0$, which

Eurosystem. Classification of this statistics is based on the ESA 2010. Data cover of this statistics is in range 09/1997-8/2018.

²⁰ The Securities holding statistics contains detailed quarterly data about the holdings of debt securities of different holders in the Eurozone. Data cover of this statistics is in range 12/2013-6/2018.

²¹ The integrated euro area economic and financial accounts contain monthly sectoral data of the opening and closing balance sheets of financial assets and liabilities of the individual sectors of the Eurozone economy. Data cover of this statistics is in range 06/1999-6/2018.

²² Issuance variables of government bonds include all types of bonds – nominal and inflation-linked issuances.

would mean that positive net issuance of government bonds ($issuance_t$) causes increase of investors' government bond holdings, however, this effect should be smaller compared to pre-QE times due to smaller share of government bonds on the secondary markets available to private investors; and individual elements (betas) of matrix $\beta_{i,i.r.}^i$ should be either >0 or <0 depending on the nature of the particular invariant regressor ($inv.regressor_t$) – e.g. for the net change of value of the S&P500 Index the expected estimation of beta should be <0 , because equity indexes are negatively correlated with the price of the government bonds since the late 1990s, see e.g. Baz et al (2018). It is also reasonable to assume that the sum of estimated beta parameters of all investor types for government bonds would be close to -1 ($\sum_{i=1}^n \beta_{i,p}^{gov.bond} \approx -1$). It can be claimed intuitively that for each unit of government bonds purchased by the ECB, there should be one unit sold by other market participants to the ECB.²³ Beta values should be different for the investors' corporate bond holdings and equity holdings: $\beta_{i,p}^{corp.bonds} > 0$ and $\beta_{i,p}^{equity} > 0$, which would mean that government bond purchases of the central bank (p_t) caused rebalancing of investors' portfolios towards other types of assets (corporate bonds, equities and possibly other asset types that are not involved in this study).

Counterfactual analysis

Counterfactual graphic analysis of ex-ante and ex-post impacts²⁴ of the PSPP that follows the regression results in section 4 is formally defined in the following equations (8) and (9). For ex-ante approach as:

$$PSPP_{ex.a.T+l} = E(y_{T+l}|y_T, p_{T+l}, issuance_{T+l}, inv.regressors_{T+l}, \Omega_{full.sample}) - E(y_{T+l}|y_T, p_{T+l} = 0, issuance_{T+l}, inv.regressors_{T+l}, \Omega_{full.sample}) \quad (8)$$

where the ex-ante impact of the PSPP is derived from the difference between the expected outcome of variable y_{T+l} estimated according to equation (7) and the same variable in the no-PSPP scenario with $p_{T+l} = 0$, both estimated over the full sample starting in the time T (Q1/2015). Graphic representation of ex-ante impact therefore starts on Figures 2, 3 and 4 in time of the beginning of the PSPP.

The ex-post approach is formally defined as:

$$PSPP_{ex.p.T+l} = y_{T+l} - E(y_{T+l}|y_T, p_{T+l} = 0, issuance_{T+l}, inv.reg.T+l, \Omega_{sub.sample}) \quad (9)$$

which is the difference between the reality and the no-PSPP scenario estimated from the same equation (7) over the sub-sample data ending by the time of the PSPP beginning in Q1/2015.

Methods used in this paper, theoretically described above, by its nature does not allow to control for all other possible factors that may have had been nonnegligible and may

²³ This assumption fully holds under the condition of zero net issuance of government bonds and in case of net issuance $0 < / > 0$ deviates accordingly.

²⁴ For similar use of this analysis of asset purchases in the United Kingdom see Joyce (2014).

have some impact on the portfolio rebalancing phenomenon. It would be over-complicated and uneasy to develop and to interpret a system of linear regression equations incorporating for example slow-changing preferences of investors together with the wide investor-based perception of the relative safety of sovereign bonds of different European countries and external factors. One of the known external factor is e.g. sale of China's public sector debt holdings in the same period corresponding to this analysis. It would probably not yield better results and control for explicitly mentioned factors in this analysis seems to be convenient for its goals.

Sectoral analysis of portfolio reallocations

Detailed regression results estimated upon equation (7) for Monetary Financial Institutions (MFIs), the crucial counterpart of the ECB and representative of investors, are reported below in Table 1. This model is based on the monthly Integrated euro area economic and financial accounts data and the MFI holdings of securities statistics described in the preceding section. Each column in Table 1 represents one regression outputs estimated on variables stated in the first column and corresponding asset type stated in the first row. Each regression estimate in Table 1 includes variables described in predeceasing section – the PSPP variable representing the ECB purchases, issuance variable representing net issuance of given underlying bonds (relevant to a given type of dependent variable → changing in some regressions), invariant variables described in the previous section and the lagged dependent variable (LDV) to capture possible dynamic effects.²⁵ All models presented below in this study were estimated by OLS, while standard errors (SE) and t-statistic of all coefficients are based on Newey-West robust estimation of the covariance matrix.²⁶ to overcome possible autocorrelation and heteroskedasticity in the error terms in the presented models. N-W kernel function heteroskedasticity- and autocorrelation-consistent (HAC) estimators of the variance-covariance matrix can bypass the issue of serially correlated error term ϵ_t^i . Kernel choice is based on Andrews (1991), where he finds a HAC that minimizes the average root mean square error (AMSE) of the “long-run variances” (LRV). Regressions presented in Table 1 were also estimated with respect to findings of Keele and Kelly (2006) – they argue that under certain conditions it is viable to use OLS (GLS) with corrected standard errors with autocorrelated data and that the LDV can provide estimates that are superior to the other models or estimators. Inclusion of LDV is appropriate so long as the stationarity condition holds for the dependent variable, which holds for our model (dependent variables are stationary). The Nature of the models in this study however does not imply direction between variables and presented regression estimates are merely directionless and based upon the spread of data points from the regression line (curve). Therefore, only possible relations supported by the relevant economic theory are mentioned in the following discussion of model results.

Statistically significant results from estimated regressions are presented in Table 1, showing that reactions of MFIs to the ECB PSPP purchases are negative – one unit bought by the ECB was accompanied by the decrease of MFIs holdings of government bonds (denominated in EUR) by 0.25-unit. The different pattern applies for corporate

²⁵ LDV was not included in regressions presented in Table 2 and Table 3.

²⁶ Appropriate truncation lags for Newey-West are based on the AIC automated selection rule.

bonds (denominated in EUR), where one unit bought by the ECB was accompanied by an increase in MFIs holdings of about 0.26-unit / 0.19-unit and in equity holdings, where 0.12-unit increase could have been caused.

The overall picture shows that the ECB purchases could have caused MFIs to reduce government bond holdings and reallocate own portfolios towards corporate bond and equity holdings. The relative increase was smaller for corporate bonds and equities compared to the decrease in government bond holdings. The results are not statistically significant for bond holdings denominated in non-EUR currencies.

Table 1: MFIs' net acquisitions of assets regression results (sample period 10/1997-8/2018)

	Gov.bond s EUR	Gov.bond s non- EUR	Gov.bond s non- EUR	Corp.bond s EUR	Corp.bond s EUR	Corp.bond s non-EUR	Corp.bond s non-EUR	Equity
Constant	2994 (-1.3)	195 (-1.32)	134 (-1.02)	6375** (-2.35)	1157 (-0.63)	625** (-2.1)	747*** (-2.41)	2801 (-1.56)
ECB PSPP	-0.25*** (-4.05)	-0.001 (-1.14)	-0.003 (-0.73)	0.26** (-2.25)	0.19* (-1.74)	-0.005 (-0.35)	-0.004 (-0.32)	0.12*** (-2.9)
Issuance Gov. EUR	0.06 (-0.88)	-0.004 (-1.13)		-0.04 (-0.41)		0.01 (-1.1)		0.08* (-1.69)
Issuance Gov. non- EUR			-0.14* (-1.76)					
Issuance Corp. EUR					0.32*** (-6.32)			
Issuance Corp. non- EUR							0.025 (-1.13)	
US Gov. 10y Yield	-135.13** (-1.93)	-2.56 (-0.54)	-3.87 (-0.79)	-135.6** (-2.12)	-114.56* (-1.88)	36.7* (-1.73)	34.55* (-1.68)	29.18 (-0.3)
US Gov.- Corp. Spread	-68.59*** (-3.22)	-3.06** (-2.05)	-3.21** (-2.22)	-16.9 (-0.46)	-5.53 (-0.31)	6.66 (-1.53)	6.57 (-1.5)	-23.75 (-1.26)
S&P500	-28.39* (-1.66)	-5.14*** (-2.61)	-4.57** (-2.3)	-32.42 (-1.3)	-17.73 (-0.84)	-6.34 (-1.48)	-7.05* (-1.64)	69.22** * (-3.43)
US EPU Index	-46.77 (-0.55)	11.49** (-2.05)	13.1** (-2.3)	-208.25* (-1.72)	-180.89* (-1.6)	-37.08** (-2.17)	-38.77 (-2.38)	-16.37 (-0.29)
LDV	-0.02 (-0.35)	-0.12 (-1.14)	-0.12 (-1.04)	0.27*** (-2.97)	0.12* (-1.69)	-0.16*** (-2.85)	-0.17*** (-2.85)	0.04 (-0.86)

Note: T-statistics reported in parentheses are based on the Newey-West heteroskedasticity consistent standard errors. *, **, *** indicates significance at the 90%, 95% and 99% level, respectively. Number of observations: 249.

Source: own calculations.

In the second set of estimated regressions presented in Table 2, there are presented all major private investor types. Investor types included in Table 2 are as follow: Monetary Financial Institutions (MFI), Insurance Corporations and Pension Funds (ICPF), Other Financial Institutions (OFI), Non-Financial Corporation (NFC), Households (HH) and Non-Residents. Local and central governments from the Eurozone were excluded from all analysis in this paper to focus solely on the private sector. Model results presented in Table 2 are based on the quarterly Securities holding statistics data. Each row in Table 2 represents estimated regression results for one type of investor with changing the dependent variable (portfolio asset class) stated in the first row of each column. Each regression estimate was constructed on the same set of explanatory variables as it was in Table 1 (except the LDV), but in this case, only constant C and the estimates for variable representing the issuance of government bonds and the PSPP-variable coefficients are presented for better result clarity.

Statistically significant results in Table 2 show that reactions across all types of investors to the ECB PSPP purchases are the same – accompanied by reduction of own holdings of government bonds and increase of holdings of different types of assets. The strongest possible reactions to the ECB bond purchases are present in the estimated parameters for foreign holders (-0.66), MFIs (-0,36), OFI (-0,32) and through a weaker reaction of ICPF (-0,17) to almost invariant HH (-0,02) and statistically insignificant NFC. One unit bought via the PSPP could have caused the majority of investors to shift its holdings of government bonds to corporate bonds, equities and possibly other kinds of assets that are difficult to trace and are not analyzed within this study (e.g. precious metals, real estate or intangibles).

Significant are especially portfolio reallocations of MFIs in corporate bonds segment (domestic and worldwide) and equities (investment fund shares, and listed shares), where one unit of the PSPP purchases was accompanied by a net increase of 0,21 unit in corporate bonds and 0,03 in equities. These results are in line with preceding results presented in Table 1, estimated on a different set of data. The same pattern of reallocations from government bonds applies for corporate bond holdings of non-residents, also the very important counterpart of the ECB. For other types of investors, the portfolio reallocations towards corporate bonds and equity are not so unambiguous – they mostly exhibit similar, though not that significant, pattern with the exception of household's equity holdings that exhibit the decrease rather than the increase. Decrease of household's equity holdings could be the result of locking in the equity profit arising from the increase in equity prices. This could be the consequence of the ECB asset purchases as well and it's not necessarily against the model expectations. The segment of foreign investors cannot be analyzed in equity holding segment due to lack of data on their asset holdings and unknown structure of assets abroad. Worldwide holdings of Eurozone-located investors show no strong pattern in relation to ECB's purchases with some possible tendencies to shift portfolios more towards non-EU government and corporate bonds.

Coefficients estimated in Table 2 for the possible PSPP-induced changes in government bonds segment sum up together number slightly higher than 1, which would be against intuition using the perfect model (someone would have to always buy what others sell) but is slightly overestimated given the model and data imperfections.

Table 2: Investment portfolio reallocations regression results (sample period 3/1999-6/2018)

		Gov.Bonds [EMU]	Corp.Bonds [EMU]	Gov.Bonds [Worldwide]	Corp.Bonds [Worldwide]	Equity [Worldwide]
MFI	C	28346 (1.9)	-55803*** (-6.63)	6057** (2.4)	14.359*** (4.9)	-1005 (-1.1)
	Issuance	0.2 (1.4)	0.01 (0.1)	0.06*** (5.2)	-0.05*** (-2.9)	0.01 (0.3)
	PSPP	-0.36*** (-6.76)	0.21*** (4.37)	-0.04** (-2.2)	0.06** (-2.9)	0.03** (2.6)
ICPF	C	39125** (2.5)	4963 (0.9)	-2436 (-0.7)	6494 (9.7)	17063 (0.9)
	Issuance	-0.01 (-0.4)	-0.03 (-0.6)	0.04 (1.5)	0.02** (2.7)	0.4* (1.7)
	PSPP	-0.17** (-1.93)	-0.00 (-0.1)	0.02*** (2.8)	0.01 (1.3)	0.06 (1.5)
OFI	C	49671*** (4.8)	14861 (1.6)	2453 (0.55)	25293 (4.6)	27684 (1.4)
	Issuance	0.03 (0.4)	0.12 (2.1)	0.002 (0.1)	0.006 (0.1)	0.13 (1.0)
	PSPP	-0.32*** (-13.1)	-0.05 (-1.5)	0.08* (1.6)	-0.03 (-0.4)	-0.14 (-1.2)
NFC	C	671 (1.4)	-2087 (-0.8)	-169 (-1.2)	27 (0.2)	3071 (1.15)
	Issuance	-0.02 (-0.2)	-0.003 (-0.2)	-0.001 (-0.8)	0.004 (1.4)	0.02 (0.3)
	PSPP	-0.01 (-0.2)	0.01*** (3.2)	0.002 (1.5)	0.01*** (3.7)	-0.02 (-1.3)
HH	C	-3832*** (-5.9)	-31822 (-0.01)	25 (0.5)	-1388** (-2.35)	34806 (1.43)
	Issuance	0.01 (0.3)	0.002 (0.003)	0.0 (0.43)	-0.007 (-0.7)	0.17 (1.4)
	PSPP	-0.02*** (-4.8)	0.05 (0.01)	-0.001 (-0.4)	0.02*** (21.3)	-0.25* (-1.8)
Non-Residents	C	43783*** (3.2)	69946* (2.1)			
	Issuance	0.26 (1.2)	-0.46 (-1.4)			
	PSPP	-0.66*** (-4.9)	0.21* (2.2)			

Note: T-statistics reported in parentheses are based on the Newey-West heteroskedasticity consistent standard errors. *, **, *** indicates significance at the 90%, 95% and 99% level, respectively.

Source: own calculations.

Table 3 shows estimated regression results for local investors' bond reallocations in four selected Eurozone countries that represent the most important countries in the Eurozone as for nominal GDP and population – Germany (the sovereign debt benchmark country), France and countries that face publicly-known fiscal challenges, Spain and Italy. Selection of countries mentioned above is traditionally used in academic research, see e.g. Altavila et al (2015), and on the professional level, while their credit rating²⁷ differs from benchmarked Germany (AAA), through France (AA/Aa2), Spain (A-/Baa1) to relatively lowest-rated Italy (BBB/Baa3).

Model results presented in Table 3 are based on the quarterly Securities holding statistics (SHS) data described in the preceding section. For all countries, the PSPP purchases were undoubtedly accompanied by the decrease of local investors' sovereign bond holdings²⁸ – they were shifting portfolio from government bonds to other assets in this time period in relative terms. In Italy MFIs bought mainly corporate bonds and on the contrary in Germany the reaction was the opposite. German corporate debt segment

²⁷ Credit rating provided by Moody's, Fitch and S&P.

²⁸ For all statistically significant results.

is also being considered prime compared to other corporate debt in other EU countries and bears little yield. It was also targeted for the ECB CSPP purchases and investors (mainly MFIs) were probably not willing to face these conditions and reallocated towards other assets that were not directly targeted by any APP program. Eurozone investors are certainly not limited to invest only in assets within the Eurozone, there are plenty of investment opportunities abroad e.g. in emerging markets. There are no results for equity investments because the SHS does not provide country-specific holdings data for equities, therefore only the results for government and corporate bonds are presented below.

Table 3: Investors' bond portfolio reallocations by country (sample period 1/2014-9/2018)

		Germany	France	Italy	Spain
MFI	Gov. Bonds	-0.28*** (-6.98)	-0.21*** (-10.48)	-0.52** (-2.12)	-0.32*** (-2.77)
	Corp. Bonds	-0.27*** (-7.38)	0.15 (1.23)	0.36*** (3.2)	-0.03 (-0.24)
ICPF	Gov. Bonds	-0.11*** (-3.02)	-0.21** (-2.09)	-0.25 (-0.98)	-0.22*** (-2.97)
	Corp. Bonds	0.03*** (3.77)	-0.03 (-0.46)	0.03 (0.48)	-0.11** (-2.16)
OFI	Gov. Bonds	-0.14*** (-5.61)	-0.11 (-1.43)	-0.65*** (-4.01)	-0.39*** (-2.84)
	Corp. Bonds	0.02 (0.39)	-0.2** (-2.29)	-0.26* (-1.64)	-0.17 (-1.61)
NFC	Gov. Bonds	-0.002 (-0.36)	0.03 (0.59)	0.01 (0.22)	-0.05*** (-2.75)
	Corp. Bonds	-0.002 (-0.5)	0.01 (0.7)	0.02 (1.27)	-0.05 (-1.29)
HH	Gov. Bonds	-0.001 (-0.76)	-0.002 (-0.8)	-0.15*** (-11.9)	0.03 (0.8)
	Corp. Bonds	0.04*** (3.34)	0.02 (1.13)	0.04 (0.27)	0.06 (1.39)

Note: T-statistics reported in parentheses are based on the Newey-West heteroskedasticity consistent standard errors. *, **, *** indicates significance at the 90%, 95% and 99% level, respectively.

Source: own calculations.

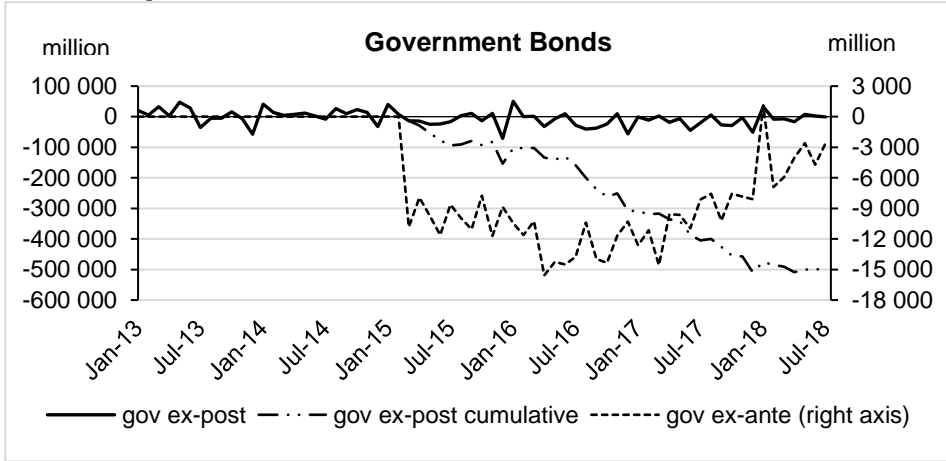
Following figures (Figure 2 – 4) contain the graphic representation of ex-ante and ex-post impact formally described in equations (8) and (9). Figures 2 – 4 depict the PSPP ex-ante and ex-post impacts in three main asset classes held by MFIs as a representative type of investors. For other important investor types, such as ICPF or OFI, the graphic representations of ex-ante and ex-post impact are similar to MFIs, therefore only MFIs figures are presented below. The ex-ante impact is being measured as a difference between the QE and the no-QE monetary policy scenario, in this particular case as the PSPP and the no-PSPP scenario described in equation (8). The calculation incorporates net investment differences into specific asset class over the full sample period in scenario with (see equation 7) and without the PSPP.²⁹

The ex-post impact is measured as a difference between the realized net investment flows and estimated no-PSPP counterfactual scenario formally defined in equation (9). Counterfactual scenario is estimated as a forecast from the out-of-sample data subset available before the implementation of the PSPP in 2015 (on data since Q4/1997). The

²⁹ There is no ex-ante impact till the beginning of the PSPP because there is no counterfactual.

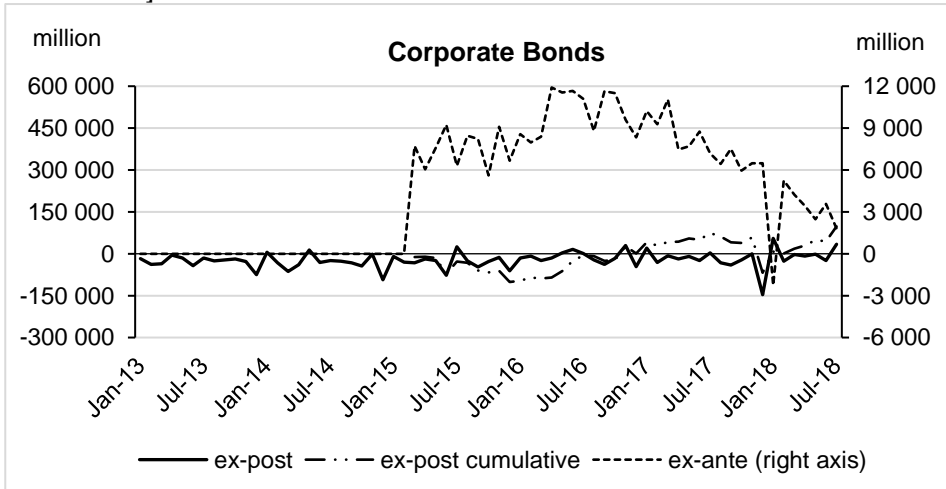
same approach of counterfactual analysis was originally used and formally described by Pesaran and Smith (2012) on analysis of the QE adopted by the Bank of England. For convenience and easier interpretation of ex-post impact, the cumulative curve of ex-post impact, since the beginning of the PSPP, was also added in figures below.

Figure 2: Ex-ante and ex-post effects of the PSPP on MFIs' government bond holdings [in Millions EUR]



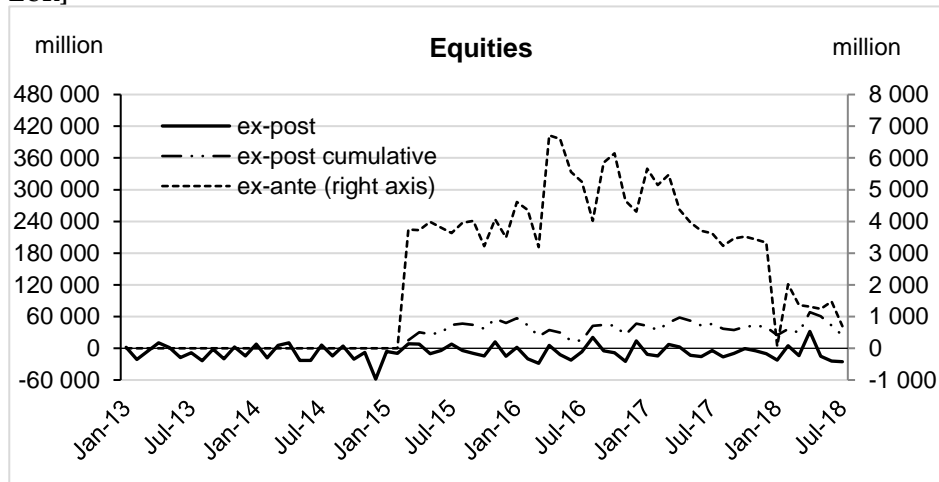
Source: own calculations

Figure 3: Ex-ante and ex-post effects of the PSPP on MFIs' corporate bond holdings [in Millions EUR]



Source: own calculations

Figure 4: Ex-ante and ex-post effects of the PSPP on MFIs' equity holdings [in Millions EUR]



Source: own calculations

It is clear from Figure 2 that for government bond holdings of MFIs the impact of the PSPP on their holdings was negative in both impact comparisons, ex-ante and ex-post. This fact suggests that the expected net investment flow of MFIs into government bonds was affected by the PSPP and would have been greater in the no-PSPP scenario. Figure 3 and Figure 4 both exhibit strong and positive ex-ante impact on corporate bonds and equity segments. At the same time, the cumulative ex-post impact in equities is a positive but rather small and ex-post impact in corporate bonds segment is ambiguous. This suggests that net investment flows of MFIs into corporate bonds and equities would have been weaker in the case of no-PSPP scenario.

Estimated counterfactual ex-ante and ex-post impacts in all three asset segments are in line with the regression results in Table 2 and possibly imply that the PSPP, had not negligible portfolio-reallocation effect that was intended in the first place by the ECB when the PSPP was put in place. Results anticipated according to the economic theory explained in section 3 are also in line with estimated results. Overall evidence of the counterfactual analysis shows that rebalancing of portfolios was significant towards corporate bonds and was accompanied by a reduction of allocation to conventional government bond portfolios.

Conclusions

In this paper, the regression models and the counterfactual analysis provide evidence about the nature of the so-called portfolio balance channel that is being so frequently mentioned by the ECB in connection to its unconventional monetary policy programmes. The evidence is mainly consistent with the picture that is being presented by the ECB – all types of investors reshuffled its portfolios, selling government bonds to the ECB and buying different types of assets, mostly corporate bonds and equities (listed shares) and equity funds shares. The ECB by its PSPP simply changed conditions

on the markets enough to motivate even portfolio notoriously slow-adjusting investors to undertake some steps in order to change own portfolios to make it correspond their own preferences and current market prices and yields of available investment assets. The analysis showed that investors are quite willing to sell government bonds, particularly foreign investors and MFIs. The closest alternative investment asset classes are corporate bonds and equities and were verifiably bought more than would be in the case of no-PSPP scenario. There is an exception for buying corporate bonds in Germany, which is most likely given by its exceptional position as a government and corporate bond benchmark country with the most high-rating issues in both government and private sectors. The PSPP led to portfolio reallocations towards riskier assets and it is an opened question whether the benefits of lower funding costs across the Eurozone, caused by the ECB asset purchases, is justifiable facing the higher risk exposure of investors in the Eurozone. There is also always the question of why the ECB did not use some alternatives to quantitative easing – e.g. more conventional policy affecting the euro exchange rate by direct or indirect interventions or rather more technical solution by considering some kind of lowering its monetary policy rates even further and the costs and the benefits of each variant.

There are several possible ways of how to enhance this paper by additional research – adding control for other possible acting factors, that are beyond the scope of this analysis, e.g. for regulatory environment factor or widening the portfolio of analyzed assets that are difficult to trace and are not analyzed within this study (e.g. precious metals, real estate or intangibles). The Security holdings statistics used in this study also does not provide country-specific holdings data for equity issuers, it would be enriching to fill in this data gap in the future. Better data frequency and more detailed security holdings statistics and the ECB statistics with longer history would provide better grounds for further research on the theme of portfolio purchase channel and other monetary policy channels that accompany unconventional monetary policy of quantitative easing. Nevertheless, the availability of data and the future APP tapering praxis of the ECB, characterized by a reduction of the ECB balance sheet, is needed to approach the ECB's asset purchases as a closed issue in any following research.

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