LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER

MONETARY AND FINANCIAL ECONOMICS

MASTER´S FINAL WORK

DISSERTATION

QUANTITATIVE EASING IN THE EUROZONE: PORTFOLIO BALANCE CHANNEL AND PENSION FUNDS

MÁRIO JOSÉ FRANGANITO CASTELLANOS

NOVEMBER - 2020

LISBON SCHOOL OF ECONOMICS & MANAGEMENT
UNIVERSIDADE DE LISBOA

MASTER

MONETARY AND FINANCIAL ECONOMICS

MASTER´S FINAL WORK

DISSERTATION

QUANTITATIVE EASING IN THE EUROZONE: PORTFOLIO BALANCE CHANNEL AND PENSION FUNDS

MÁRIO JOSÉ FRANGANITO CASTELLANOS

SUPERVISION:

JOSÉ RICARDO BORGES ALVES

NOVEMBER - 2020

To my Grandmother

ABSTRACT

This dissertation assesses the effects of Quantitative Easing (QE) on the investment portfolios of the Pension Funds (PF) and the plausibility of the portfolio balance channel for the context of the Eurozone. We used a log-log econometric model and panel data to answer the questions 1) How did QE affect the investment portfolios of PFs; 2) If these changes are expected by the portfolio balance channel; 3) Are the effects consistent when we take into consideration countries with higher asset holdings by pension funds?

Our results suggests that QE had a positive effect on the stock of both corporate bonds and government bonds as well as cash and deposits. The increase in corporate bonds appear to be higher than that of private bonds so this seems to be in line with the hypothesis, since the relative amount of government bonds decreased. The results for bigger PF are not statistically significative for most cases.

KEYWORDS: Quantitative-Easing; Pension-Funds; Investment-Portfolios; Portfolio-Rebalancing Channel; Eurozone

JEL CODES: C23; D53; E22; E44; E51

TABLE OF CONTENTS

ACKNOWLEDGMENTS

Writing this dissertation has been a tremendous endeavor, both from a professional/academic level as well as from a personal level. But thanks to the knowledge, guidance and unwearying efforts of Professor José Alves, the path was not only manageable but pleasant. Without your help this would not be possible.

But to be in the position that I am today, is a privilege only possible due to the help of the people around me. For that, I would like to thank:

Felismina and Picareto, whose help and example are truly a blessing.

Elica and Jorge, for their continuous support, mentorship and example that push me to become better every day.

My friend Marco, for inspiring me to work hard; my friend Paulo, for our amazing dinners; my friend Manuel for our lunches.

My aunt Paula, for her patience and good spirits.

My parents, for all the sacrifices they have made, so that I could pursue this goal.

But more importantly, I have to thank Tita. This, and everything I do, is in your honor. Thank you for your love. Thank you for your food. Thank you for your example. Thank you for making me who I am.

I love you and I miss you.

QUANTITATIVE EASING IN THE EUROZONE: PORTFOLIO BALANCE CHANNEL AND PENSION FUNDS

By Mario Franganito

ABSTRACT

This dissertation assesses the effects of Quantitative Easing (QE) on the investment portfolios of the Pension Funds (PF) and the plausibility of the portfolio balance channel for the context of the Eurozone. We used a log-log econometric model and panel data to answer the questions 1) How did QE affect the investment portfolios of PFs; 2) If these changes are expected by the portfolio balance channel; 3) Are the effects consistent when we take into consideration countries with higher asset holdings by pension funds?

Our results suggests that QE had a positive effect on the stock of both corporate bonds and government bonds as well as cash and deposits. The increase in corporate bonds appear to be higher than that of private bonds so this seems to be in line with the hypothesis, since the relative amount of government bonds decreased. The results for bigger PF are not statistically significative for most cases.

1. INTRODUCTION

The COVID-19 pandemic brought not only a colossal public health crisis but also an equally devastating economic crisis, that we are only now begging to understand its full extent. Unlike in the 2008 economic crisis, central banks were much quicker to act this time around to supress the economic downturn. Such measures have ranged from lowering interest rates, to emergency credit lines, to new Quantitative Easing (QE)

programmes. For instance, the European Central Bank's (ECB) envelope for the pandemic emergency purchase programme (PEPP) is (as of September 2020) €1,350 billion, among a series of other measures to ease the effects of the pandemic. Similarly, the Bank of England announced a new QE program of £300 billion and the FED declared – after lowering their interest rates to 0 – it would buy $80 billion a month in Treasuries and $40 billion in residential and commercial mortgage-backed securities until further notice.

In the short run, these measures have a huge impact on the public debt of the countries and the balance sheet of their respective central banks. For instance, the Office for National Statistics announced in July 2020 that the UK's public debt reached a record £2,004.0 billion, as a result of the expansionary fiscal policy – £227.6 billion more than at the same point last year – which translates to around 100.5% of its GDP. On the other hand, a quick analysis of the FED's balance sheet shows that their total assets skyrocketed from roughly $4 trillion in the beginning of 2020 to approximately $7 trillion, as of September 2020. An increase of 75%, as a result of the large-scale purchase programmes.

The goal of QE is to lower the interest rates on government bonds. To do so, CBs carry out large-scale purchases of these titles which increases their prices in the secondary market and thus decrease their internal interest rates. This allows the government to issue new debt titles at lower interest rates, which in turn stimulates public spending.

The BoE's Monetary Policy Committee emphasised the role of the so-called *portfolio balance channel* as a key element in the transmission mechanism of the asset purchases to the rest of the economy. According to this mechanism, the purchase of treasuries by the central bank increases liquidity, leading investors to buy riskier assets, pushing their prices up. On the other hand, the lower interest rates reduce borrowing costs for

households and companies, also stimulating expenditure. Given that Pension Funds (PF) and insurance companies hold a significant amount of debt securities issued in the EU, the question of how QE affected their investment portfolios arises.

To assess how QE has affected the investment portfolios of PF and if the portfolio balance channel holds true for the context of the Eurozone, we used a log-log econometric model resorting to panel data from the eurozone countries across a time period of 18 years (from 2000 to 2018).

Our research shows that there is statistical evidence that supports the hypothesis of the portfolio balance channel for PF in the context of the Eurozone.

In chapter 2 we consider the theorical framework of the topic at hand, its relevance and the approach followed to test the hypothesis. In chapter 3 we discuss the data used and the econometric model. In chapter 4 we present the results and debate their reasonableness and implications. Finally, in chapter 5, we conclude the dissertation by summarizing the results.

2. UNCONVENTIONAL MONETARY POLICY

CB generally have two main objectives, price stability and the stability of the financial system. To achieve this, CBs set their interest rates so that they can increase or decrease the aggregated demand and thereby, affect the economy (see, for instance, Fawley and Neely, 2013). More recently this tool has become less effective since, in most advanced economies, interest rates have approached or reached the *zero lower bound* (ZLB). This was particularly evident after the 2008 financial crisis. For instance, the main interest rate of the ECB has been lower than 1% since 2012 and for the BoE and the FED this is true since 2009.

Given the extent of the Great Recession combined with the ZLB, CB had to resort to the so-called *unconventional monetary policy.* Unconventional monetary policy is often defined as measures other than interest rate setting, adopted by CB to affect the economy. Such measures include alterations of the composition of the CB balance sheet (normally referred to as qualitative easing), large-scale asset purchases (commonly known as QE) and forward policy guiding (see, for instance, the reflections conducted on the different dimensions along which unconventional policy measures can be classified in Bernanke, Reinhart and Sack, 2004, and Meier, 2009, among others).

QE seeks to increase the liquidity of the economy. This is accomplished by large scale purchases of assets through *open market operations*, which are financed by electronically crediting banks reserve accounts in the CB. Monetary policy makers have often emphasized the role of the *portfolio balance channel* (see, for instance Bernanke, 2010 and Yellen, 2011, for the U.S and Bean, 2011, for the UK). We discuss such mechanisms in greater detail in section 2.1.

QE was first used in Japan in the early 2000s to combat their domestic deflation, after their interest rates reached the ZLB in 1999. This programme caused the reserves of the Bank of Japan to increase 5-fold, from 5 trillion yens to 25 trillion yens, with mixed results (see Schenkelberg and Watzka, 2013). Since then, quantitative and qualitative easing programs have occurred frequently in Japan and the world. More recently QE programmes have been used to counter the negative effects of the Great Recession and again during the 2020 pandemic.

Despite its increase in use, QE faces plenty of criticism. The negative effects on inequality (see, for instance, Mumtaz and Theophilopoulou, 2017, and Alves and Silva,

2020), the agency problem created between CB and government[1], the reluctancy on ending such programmes (for both cases, see Fisher, 2010) and the unfounded[2] claims of hyperinflation, are some of the most discussed topics.

2.1. Transmission mechanisms

There are a number of ways in which QE is believed to affect the real economy. Benford et al. (2009) and Joyce, Tong, and Woods (2011), among others, discuss in great detail how the mechanisms are thought to work and the importance of the liquidity in the economy created by the asset purchases. Here we only present the three main mechanisms:

1) *The portfolio balance channel* – Often associated with the work of Tobin (1958), which argues that when there's imperfect substitutability between financial assets, changes in asset supplies lead to changes in financial asset prices. So, when the CB buys assets, their price increases which leads to a correspondingly lower yield. This decreases the cost of borrowing which incentivises governments to spend and invest more (i.e., robust fiscal policies) as well as households and companies. Further, higher asset prices increase the wealth of asset holders, which boosts their spending.

   Investors that sold assets to the CB will have to choose between retaining the extra money or buying new riskier assets. If they do not consider the new extra money to be a perfect substitute for the assets sold, they will choose to buy new riskier

[1] The agency problem results from the fact that, while QE programmes are undergoing, governments have incentives to spend more due to the artificially low interest rates, thus, become less bounded to market discipline which creates incentives to maintain these programmes indefinitely.
[2] (McLeay, Radia, & Thomas, 2014) argue that new money is predominantly created by commercial banks and that new reserves do not translate to new loans, due to the constraint faced by the demand of new loans.

assets (such as corporate bonds) to rebalance their portfolio and thus drive up the prices of other assets. The second seller faces the same dilemma as the first, thus forming a cycle. Equilibrium is reached when investors are willing to hold the overall supplies of assets and money. When this happens asset prices as a whole are expected to have increased.

Higher asset prices also stimulate spending by increasing the wealth of asset holders[3].

2) *Liquidity premia* – Liquidity premium is the additional value investors demand for an asset that cannot be easily sold for its market value. When markets are dysfunctional, the number of transactions slows and assets become less liquid, so buyers ask for premiums, thereby decreasing prices in the market. When CB buy assets from the market, it is directly increasing liquidity to the asset holders but also encouraging trading since sellers will likely buy new assets to rebalance their portfolios. The increase in transactions, decreases the liquidity premium, thus increasing the prices. This effect may only persist while the CB is conducting asset purchases.

3) *Expectations* – As seen by the *"whatever it takes"* speech of former ECB president Mario Draghi – may play as much of a role in the economy as actions themselves. If market players expect QE to have real effects on inflation, the inflation goal of the monetary authority becomes credible. If expectations of inflation are credible then they will play a role in salary negotiations and thus costs

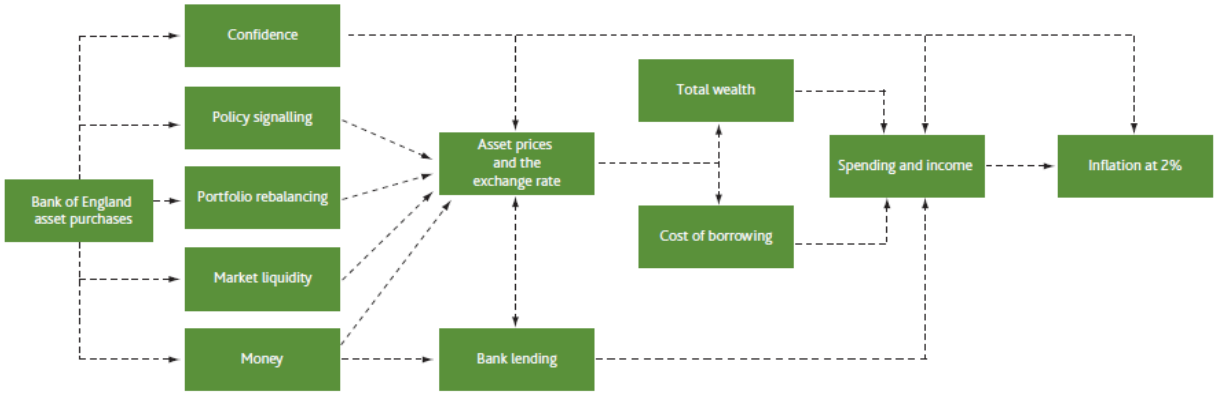
[3] The wealth effect is a behavioural economic theory that states that an increase in wealth increases spending due to a sense of financial security. This effect is not as strong as an income effect, since people tend to prefer a smooth path of consumption, thus, an increase in wealth is distributed over time and its effect in consumption dissipated.

of production. This means that prices will increase due to increases in costs and an aggregated demand increase.

The markets interpreted Mr Mario Draghi's speech as credible, thus, expected the actions of the ECB to be effective, which caused their inflation expectations to be anchored to the target.

In figure 1 we can see a stylised representation of the effects aforementioned for the British economy. A similar process is thought to play in the eurozone. The general idea is that by buying assets, CBs increase asset prices, decrease the long-term yield, thus boosting aggregated demand, thereby increasing inflation.

Figure 1 – QE Transmission channels



Source: Joyce, Tong and Woods (2011), pp. 93

Authors such as Woodford (2012) dispute the claims of the portfolio balance channel on the basis that such mechanism does not hold true for a modern, general-equilibrium theory of asset prices. He argues that, under such circumstances, assets are thought to be valued for their state-contingent payoffs and investors should be able to correctly anticipate the consequences portfolio choices today, have on their future wealth, to the extent that financial markets are effectively frictionless. Furthermore, Eggertsson and

Woodford (2003) find that, under the context of a representative-household model, asset purchases by central banks through open-market operations have no impact on asset prices, no matter the asset bought. The authors argue that when CB assume the real-state risk onto their own balance sheet, this does not mean that it disappears from the economy, since, in the scenario of a default, CB will have lower earnings, which then translates to lower earnings distributed to the treasury and thus, higher taxes. In the end, the after-tax income will be just as dependant on the real-state risk as it was before.

2.2 Pension funds' portfolio allocation

A PF's final goal is to save the contributions made by workers during their working life and pay them pensions when they retire. Since workers have little incentives to withdrawal their funds while still active – because doing so implies paying huge premiums in the form of taxes – this means that pension funds face most of their liabilities, on average, after the average retirement age of their pensioners. To be able to face their liabilities, PFs must do asset-liability matching, that is, match their future asset sales and income streams to their future expenses (i.e., pensions). Another important factor that influences portfolio allocation by pension funds is legislation and regulation[4]. PF must also encompass the risk preferences of all their stakeholders (asset managers, trustees, and pensioners), which each have their own interests. Furthermore, these allocations are not static and might suffer alterations in the short-term to take advantage of changes in the market (see Brennan, Schwartz and Lagnado, 1997).

[4] Examples of this range from accounting standards such as the FRS 17 or the IAS19, to regulation 2019/1238, that regulates the pan-European Personal Pension Products (PEPP) and may enforce some type of liquidity requirement (such as a determined percentage of cash) or even restrictions related to holding junk level assets. See Amir, Guan and Oswald (2010) for further details on how legislation may influence portfolio allocation for PFs.

Another important aspect that affects portfolio allocation is the size of the pension funds. Larger pension funds tend to be actively managed in contrast with smaller pension funds, that tend to be passively managed, due to the fixed cost often associated with this practice. The size of pension funds is directly related to the different methods of funding retirement plans, that are practiced in each country. Commonly, there are 3 pillars of pension funds provision: 1) A state run pension scheme that provides a basic income; 2) An occupational pension plan that accepts contributions by individuals and employers; 3) Private savings plans (including savings accounts). The relative importance of each of these pillars will then shape the size of pension funds. Countries like Portugal rely heavily on pillar 1, thus, pension funds are few and small. On the other hand, countries like Netherlands rely more heavily on pillars 2 and 3, which create room for these institutions to flourish. We would expect that the effects of QE would be stronger in countries whose pension plans tend to lean on pillar number 2 and therefore create bigger pension funds that tend to be managed actively.

2.3. ECB and the Asset Purchase Program

The approaches followed by the BoE and the ECB are different – perhaps due to the nature of their underlying economies. When the BoE first introduced its *large-scale asset purchase program*, its main take was that institutional investors (pension funds and insurance companies) would have a detrimental role in the transmission mechanism of QE (Fisher and Paul, 2010)[5]. Hence why they targeted specific long-term gilts with

[5] As Fisher explains in his speech: "That "portfolio rebalancing" [of the non-bank sector] channel is thought to have been largely absent in Japan, where most of the Japanese government bonds purchased were held by the banks, which in turn used the proceeds to directly de-leverage without obviously increasing the demand for other assets (although the purchases may have had an impact through other channels)."

residual maturities ranging from 5 to 25 years, typically held by these investors (see Joyce, Liu, and Tonks, 2014). Their reasoning was that, if the asset purchases were aimed at banks, these would simply de-leverage themselves without increasing the demand for other assets. What they believe to have happened in Japan.

In 2009 the ECB launched its first large-scale asset purchase programme, the Covered Bond Purchase Programme (CBPP) which was terminated, as expected, in 2010 when it totalled €60 billion. Since then, other programmes, under the umbrella of the Asset Purchase Programme (APP), were launched (and terminated).

In Table 1 we can see a breakdown of the current asset holdings by ongoing programmes. The PSPP is by far the most significant programme totalling around 80% of the current holdings. The CBPP3 and the CSPP trail behind with similar holdings and finally there is the ABSPP, which accounts for only 1% of the holdings.

Table 1 – Breakdown of current holdings by APP from the ECB

	Holdings in millions of euros
Corporate Sector Purchase Programme (CSPP)	236,349
Public Sector Purchase Programme (PSPP)	2,290,140
Asset-Backed Securities Purchase Programme (ABSPP)	29,112
Third Covered Bond Purchase Programme (CBPP3)	286,852

Source: ECB (2020)

In graph 1, we have the cumulative net purchases by programme. We can observe a sharp increase between 2015 and 2018, and subsequent stagnation between the years of 2018, and 2020. In 2020 there is another increase caused by the measures taken to mitigate

the effects of the pandemic. As of the end of October 2020, the stock of Eurosystem APP bonds stood at €2,999 billion.

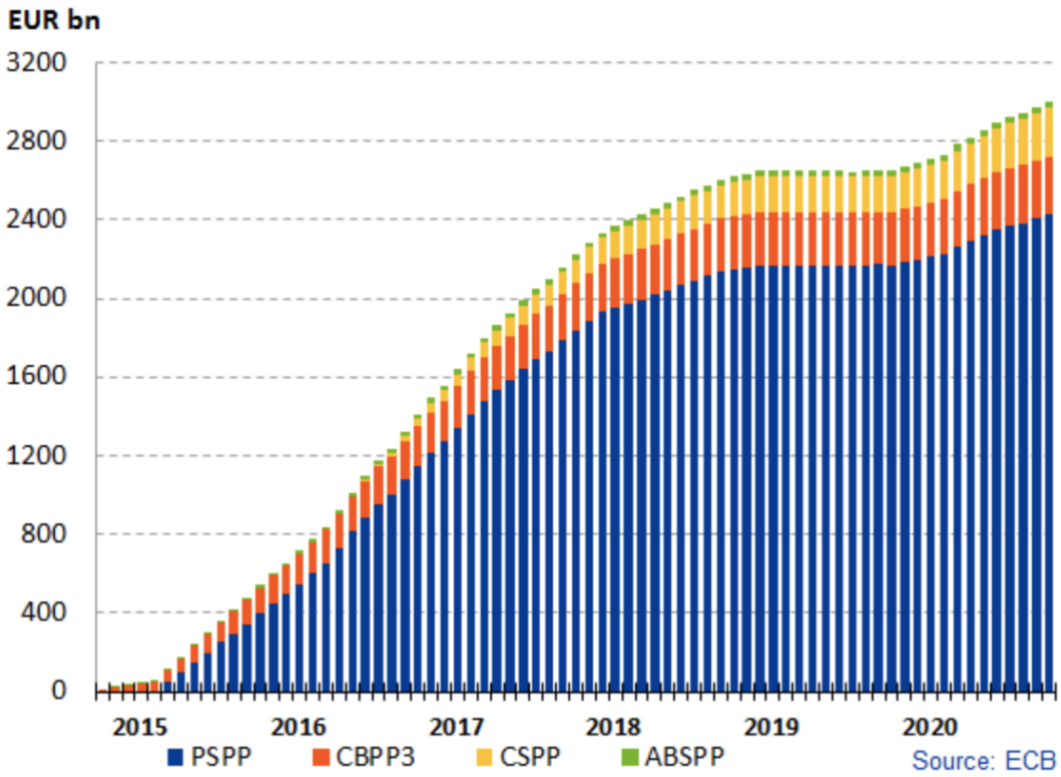


Figure 1 – APP cumulative net purchases, by programme

Source: ECB (2020)

Given the emphasis that the portfolio balance channel was given by the BoE, our goal is to assess whether this mechanism holds true for the context of the Eurozone. For this reason, we want to understand 1) How did QE affect the investment portfolios of PF; 2) If these changes are expected under the portfolio balance channel hypothesis; 3) If the effects are consistent when we take into consideration countries with higher asset holdings by pension funds.

3. METHODOLOGY AND DATA

In order to assess if the hypothesis of the portfolio balance channel holds true for the context of the Eurozone and answer the questions aforementioned, we will use a similar approach to that of Pesaran and Smith (2014) and Pesaran and Smith (2016) – and used by Joyce, Liu and Tonks (2017). They argue that to identify policy effects, a conditional model with parameters that are invariant to the policy being studied, is sufficient. This means that, under the assumption of rational expectations, a fully structural DSGE model is not necessary. Instead, what is needed is a model with parameters invariant to the policy being studied (in this case, QE). With this in mind we have estimated the following regression model:

$$\mathrm{Asset}_{i,t} = \alpha + \beta.\,\mathrm{PSPP}_{i,t-1} + \gamma.\,\mathrm{spread}_{i,t-1} + \delta.\,\mathrm{debt}_{i,t-1} + \eta.\,\mathrm{vix}_{i,t-1} + \zeta.\,\mathrm{GDPpc}_{i,t-1} + \varepsilon_t \qquad (1)$$

The dependent variable, $\mathrm{Asset}_{i,t}$, represents the logarithm of each asset type in country i in year t. We chose to use bonds – divided between corporate bonds and government bonds – equity, and cash and deposits, since these are the most representative types of assets held by pension funds. We also used the total stock of investment assets held by PFs to understand how QE affected their total investment decisions. $\mathrm{PSPP}_{i,t-1}$, represents the logarithm of the purchases of securities under the PSPP (measured in € millions and taken directly from the ECB) during the period of 2015-2018, lagged one period. As control variables, we have $\mathrm{spread}_{i,t-1}$, which represents the difference between the long-term real interest rates of German government debt and country i (both taken from the AMECO database), measured in % and lagged one period; $\mathrm{debt}_{i,t-1}$, which represent the deb-to-GDP ratio in country i, measured in % and taken from OECD

database, lagged one period; $GDPpc_{i,t-1}$, that is, the logarithm of the GDPpc measured in € thousands, lagged one period and taken from the AMECO database; $vix_{i,t-1}$, is an index that measures the expected volatility of the S&P 500, and often used as a proxy of the market volatility, also and lagged one year. The S&P 500 Low Volatility Index[6] was taken from the S&P Global and we used the value from the first trading day each year.

Our model is constructed resorting to panel data techniques. The equation is estimated using the Generalised Least Squares (GLS) method, since it tends to estimate coefficients with higher efficiency than when such regressions are estimated through the classical OLS. Moreover, the higher efficiency arises from the fact that GLS allows some correlation between the residuals of the aforementioned equation. Additionally, we ran Hausman tests to identify whether or not we had to employ a fixed effects estimation.

To account for the different types of pension provision policy in the eurozone, their effect on PF size and consequent effect on the type of portfolio management (active vs passive), we decided to run equation (1) for the subset of 6 countries where pension funds had, on average, the biggest stock of investment assets over the period studied. These countries are Netherlands with €800,000 million, Germany with €139,000 million, Finland with €104,000 million, Spain with €80,000 million, Ireland with €79,000 million and Italy with €73,000 million.

We tried to use other variables that track market conditions such as the yearly return of the S&P 500 or the 10-year treasury yields of the USA, but these brought issues related to collinearity and had almost no explanation power in our model, so we decided to drop them. Other variables that can influence asset allocation decisions, such as regulation, are

[6] This index dates to April 2011, however, earlier readings are based upon the same methodology used on the launch day.

extremely difficult to account for since the implementation of these measures take a long time to apply and the behaviour of the investors might change in advance, so we decided to not model their effect.

We have gathered data for 16 of the 19 member states of the Eurozone[7] for a period ranging between 2000 and 2018. This data has been treated with panel data techniques following the remarks of Park (2011).

In table 2 you can find the basic descriptive statistics for each of the variables previously mentioned.

Table 2 – Descriptive statistics of the variables used for our database.

Variable	Mean	Std. Dev.	Max.	Min.	Median	Skewness	Kurtosis	Obs.
invest	92973.32	218116.40	1360152.00	0.00	16283.53	3.90	18.82	273
cash	3161.70	6138.05	44524.00	0.00	1163.18	4.01	22.14	237
public	25901.30	60397.46	377439.00	0.00	3374.17	3.81	19.52	168
private	16881.14	41215.96	242745.00	0.00	2006.76	3.65	17.23	164
equity	23860.84	66173.76	430157.00	0.00	1375.77	4.03	20.02	240
PSPP	30302.08	46060.71	188321.00	-58.00	7887.00	1.80	5.24	64
debt	67.92	37.05	156.85	6.65	66.11	0.33	2.29	304
vix	11489.56	3651.35	17938.48	6855.39	11210.00	0.30	1.84	144
GDPpc	27.64	17.39	98.64	2.90	26.66	1.54	6.38	304
spread	0.00	3.36	23.11	-14.73	0.00	1.17	13.58	292

Note: *invest* represent total investment assets held by PFs; *cash* represents the stocks of cash and deposits held by PFs; *public* represents the stock of government bonds PFs hold; *private* represents the stock of corporate bonds held by PFs; *equity* represents the total amount of stocks PFs hold.

[7] We chose to exclude Cyprus and Malta due to insufficient data and their materiality in respect of the total PSPP. Greece was not part of the PSPP programme.

4. RESULTS

In this section, we present and discuss the results obtained by regressing equation (1) on different types of assets commonly held by pension funds. As previously mentioned, our results include a split that consists of the 6 biggest countries by PF asset holdings during the period of analysis. In theory, we would expect that the effects predicted by the portfolio balance channel are stronger in these cases since their portfolio management would be more active.

In table 3 we can see the results of our regression for corporate bonds. Here we assess how asset purchases affected the stock of corporate bonds held by PF during the period between 2000 and 2018, for the population as a whole and for the 6 countries with the highest asset holdings by PFs. PSPP is statistically significant at the level of 1% when we take into consideration all the countries and use all the control variables. Furthermore, on average, other things equal, a 1% change in asset purchases by the ECB is associated with a 0.194% change in the stock of corporate bonds held by PFs in the Eurozone. This result is line with the expected outcome of QE, since it shows that it influences positively the amount of corporate bonds PF bought over the period in which PSPP is being studied. Other control variables such as the spread, debt and GDPpc have a positive effect on this outcome and are also statistically significant. For instance, GDPpc has the biggest effect (1.13%) and is in line with economic theory since an increase in GDPpc is a good proxy of a positive economic outlook which positively affects investment decision in the economy. For the case of countries with the biggest pension fund holdings, we have no statistical evidence that suggests a positive effect of asset purchases on the stock of this asset.

Table 3 – Regression results for the stock of corporate bonds (*private*) held by PF, 2000-2018.

	All countries				Subset of countries w/ large pension funds			
	GLS-RE	GLS-RE	GLS-RE	GLS-RE	GLS-FE	GLS-RE	GLS-FE	GLS-FE
spread	-0.028	-0.130***	-0.013	-0.114***	-0.058	0.339	0.099**	0.070
	(0.032)	(0.027)	(0.035)	(0.039)	(0.055)	(0.416)	(0.038)	(0.096)
debt	0.006	0.014**	0.000	0.018***	0.006	-0.006	-0.019***	-0.014
	(0.005)	(0.007)	(0.004)	(0.006)	(0.005)	(0.010)	(0.003)	(0.018)
GDPpc	2.603***	0.822		1.132**	2.498***	3.589***		-0.558
	(0.399)	(0.581)		(0.520)	(0.868)	(1.356)		(3.446)
PSPP		0.163***		0.194***		-1.015*		0.246
		(0.047)		(0.051)		(0.573)		(0.189)
vix			0.000***	0.000			0.000***	0.000
			(0.000)	(0.000)			(0.000)	(0.000)
Constant	-1.552	2.380	6.251***	0.284	1.306	9.779	10.113***	11.140
	(1.367)	(2.844)	(0.765)	(2.573)	(3.026)	(9.800)	(0.217)	(12.583)
Observations	162	35	88	35	54	10	25	10
R-squared	0.223	0.667	0.274	0.652	0.167	0.420	0.836	0.941

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively.

In table 4 we can observe the results for government bonds. In this case, the PSPP is statistically significative for countries where pension funds present higher asset holdings, and the coefficient is negative. This is coherent with the hypothesis of the portfolio balance channel, that predicts that PF will sell their government bonds to the CB – in this case the ECB – and buy riskier assets such as corporate bonds. On average, all other things the same, an increase of 1% in asset purchases by the ECB is associated with a decrease of the stock of governments bonds held by PF funds of approximately 0.18%. This result is very similar to that of Joyce, Liu, and Tonks (2017). They estimated that for every £1 of gilts purchased by the Bank, ICPFs reduced their net inflows into government bonds by £0.12.

The control variables used also feature interesting results. Spread has a negative effect on the stock of government bonds. The reasoning for this could be that other things equal, the increase in profit associated with an increase of the spread (i.e., an increase in risk), is not satisfactory enough for PF to buy this asset. The most significant effect appears to be that of GDPpc, which has a coefficient of -3.17%. This result is consistent with economic theory since an increase of GDPpc is associated with economic prosperity and bonds are a financial product more sought-after during periods of crisis, due to their relatively lower risk when compared with other assets such as equity.

When we take into consideration all the countries in our data, the PSPP coefficient is not negative. However, it is lower than the coefficient for private bonds, which means that, even though our data shows that the PSPP increased the stock of public bonds held by PFs, the effect was not as strong as it was for the case of corporate bonds so, as a result, the relative percentage of public bonds held decreased, which is also in line with the portfolio balance channel hypothesis.

Table 4 – Regression results for the stock of government bonds (*public*) held by PF, 2000-2018.

	All countries				Subset of countries w/ large pension funds			
	GLS-RE	GLS-FE	GLS-RE	GLS-FE	GLS-FE	GLS-RE	GLS-FE	GLS-FE
spread	0.110**	-0.091***	0.011	-0.079***	0.074**	0.045	0.071	0.031
	(0.049)	(0.023)	(0.029)	(0.026)	(0.036)	(0.214)	(0.076)	(0.030)
debt	0.001	-0.024**	0.010***	-0.022**	0.000	-0.013**	-0.026***	-0.027**
	(0.007)	(0.009)	(0.003)	(0.009)	(0.003)	(0.005)	(0.006)	(0.006)
GDPpc	3.523***	-3.166***		-3.169***	1.917***	3.563***		0.663
	(0.527)	(0.825)		(0.822)	(0.560)	(0.697)		(1.089)
PSPP		0.164***		0.171***		0.097		-0.182*
		(0.055)		(0.055)		(0.295)		(0.060)
vix			0.000***	0.000			0.000***	-0.000**
			(0.000)	(0.000)			(0.000)	(0.000)
Constant	-3.530**	19.590***	6.591***	19.006***	4.305**	-0.610	12.466***	15.154*
	(1.735)	(3.997)	(0.710)	(4.025)	(1.954)	(5.036)	(0.430)	(3.978)
Observations	168	35	88	35	54	10	25	10
R-squared	0.271	0.952	0.240	0.955	0.474	0.946	0.479	0.999

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively.

In table 5 we can observe the results of the model, now for the case of stocks. The results for this regression, when we look at the entire population, are not as statistically significant as they are for the previous asset types, however, we can see that for both cases, there's statistical evidence that suggest that asset purchases had a negative effect on the stock of equity assets. Equity is often less attractive for pension funds since it is riskier in case of solvency and do not provide cyclical dividends[8], that are important to pay current liabilities such as ongoing pensions or expenses related to running the fund[9]. Other effects vary largely if we consider all the countries or just the subset with bigger

[8] Stocks may pay dividends, but it's not mandatory.
[9] Such expenses often range between actuary fees, legal fees, and consultancy fees.

PF asset holdings and are not very statistically significant (see GDPpc) or have a small impact (see debt-to-GDP ratio and spread).

Table 5 – Regression results for the stock of equity (*equity*) held by PF, 2000-2018

	All countries				Subset of countries w/ large pension funds			
	GLS-RE	GLS-RE	GLS-RE	GLS-RE	GLS-FE	GLS-RE	GLS-FE	GLS-RE
spread	-0.028	0.002	-0.015	0.012	0.000	0.066	-0.008	-0.001
	(0.021)	(0.037)	(0.036)	(0.034)	(0.026)	(0.055)	(0.036)	(0.473)
debt	0.017***	0.013***	0.006	0.011***	0.010***	0.026*	0.005	-0.067***
	(0.004)	(0.005)	(0.005)	(0.004)	(0.003)	(0.015)	(0.004)	(0.025)
GDPpc	0.765***	0.638***		0.707***	1.374***	2.782		-6.775*
	(0.289)	(0.158)		(0.148)	(0.373)	(2.821)		(3.563)
PSPP		-0.209***		-0.121*		-0.198**		-1.626***
		(0.055)		(0.063)		(0.091)		(0.612)
vix			0.000***	0.000**			0.000***	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
Constant	3.362***	5.803***	5.021***	3.719**	2.241*	-2.781	6.092***	58.466***
	(0.917)	(1.190)	(1.044)	(1.448)	(1.275)	(12.189)	(0.327)	(19.204)
Observations	232	44	110	44	102	20	50	20
R-squared	0.148	0.589	0.290	0.667	0.331	0.725	0.448	0.004

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively.

In table 6, our results are for the case of cash and deposits. When we use all the data, the PSPP is statistically significant at the level of 1% and, on average, all other things being equal, a 1% increase in the asset purchases is associated with a 0.16% increase in the stock of cash and deposits. As expected, PSPP increases liquidity for the PF, but not by much, since the coefficient for GDPpc is substantially bigger and equally statistically significant. The debt-to-GDP ratio appears to have a negative effect on the holdings of these assets, but its effect is almost negligible. When running the regression

only for countries with big pension funds, the effect of the PSPP is not statistically significative, however, the effects of the debt-to-GDP ratio maintain both the significance and sign – when we don't take into consideration the control variable *vix*.

Table 6 – Regression results for the stock of cash and deposits assets (*cash*) held by PF in the Eurozone, 2000-2018.

	All countries				Subset of countries w/ large pension funds			
	GLS-RE	GLS-RE	GLS-RE	GLS-RE	GLS-FE	GLS-RE	GLS-FE	GLS-RE
spread	0.037	-0.031	0.016	-0.040	0.015	0.047	-0.051*	-0.136
	(0.030)	(0.031)	(0.021)	(0.030)	(0.024)	(0.037)	(0.027)	(0.313)
debt	0.012**	-0.013***	-0.008***	-0.012***	0.005*	-0.003	-0.000	-0.047***
	(0.005)	(0.004)	(0.003)	(0.004)	(0.003)	(0.010)	(0.003)	(0.016)
GDPpc	2.423***	0.915***		0.865***	2.144***	-0.595		-3.356
	(0.354)	(0.144)		(0.141)	(0.364)	(1.894)		(2.356)
PSPP		0.218***		0.157***		0.273***		-0.346
		(0.051)		(0.060)		(0.061)		(0.404)
vix			0.000***	-0.000*			-0.000	-0.000
			(0.000)	(0.000)			(0.000)	(0.000)
Constant	-1.931*	3.354***	7.153***	4.813***	-0.218	7.094	7.748***	28.834**
	(1.151)	(0.935)	(0.574)	(1.250)	(1.247)	(8.183)	(0.244)	(12.696)
Observations	237	45	116	45	99	20	50	20
R-squared	0.237	0.743	0.125	0.798	0.373	0.788	0.097	0.236

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively.

Finally, in table 7 we have the results of the regression in respect of the stock of investment assets. Again, our data shows statistical significance for the PSPP and its effect is positive. The control variables GDPpc and debt-to-GDP ratio have positive effects, are statistically significant and are in line with economic theory, since, as per table 3, these variables are often proxies of a positive a positive economic outlook which positively influences investors decisions. For the case of countries with big pension funds,

PSPP is not statistically significant. The variable debt-to-GDP ratio appears to have a negative effect on the stock of investment for PFs. The debt-to-GDP ratio, up to a certain threshold – literature tends to agree on around 90% – positively affects economic growth. After this threshold, increasing this ratio hinders economics growth, which is consistent with the obtained coefficient for *debt* (see Herndon, Ash and Pollin, 2014).

Table 7 – Regression results for the stock of investment assets (*invest*) held by PF in the Eurozone, 2000-2018.

	All countries				Subset of countries w/ large pension funds			
	GLS-FE	GLS-RE	GLS-RE	GLS-RE	GLS-FE	GLS-FE	GLS-RE	GLS-RE
spread1	0.030	-0.021*	0.001	-0.023*	0.041**	0.002	-0.027	-0.261
	(0.028)	(0.012)	(0.012)	(0.012)	(0.020)	(0.013)	(0.021)	(0.284)
debt1	0.022***	-0.012***	0.001	-0.012***	0.006***	-0.007*	0.002	-0.064***
	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.002)	(0.015)
GDPpc1	2.158***	0.384***		0.370***	1.692***	-0.413		-3.447
	(0.376)	(0.059)		(0.058)	(0.288)	(0.732)		(2.138)
PSPP1		0.243***		0.225***		0.273***		-0.125
		(0.020)		(0.024)		(0.022)		(0.367)
vix1			0.000***	-0.000			0.000**	0.000
			(0.000)	(0.000)			(0.000)	(0.000)
Constant	0.842	7.634***	9.139***	8.067***	3.753***	9.895**	9.923***	29.680***
	(1.176)	(0.584)	(0.555)	(0.682)	(0.983)	(3.139)	(0.809)	(11.520)
Observations	263	48	124	48	110	20	50	20
R-squared	0.276	0.890	0.358	0.896	0.468	0.962	0.251	0.006

Notes: *, ** and *** represent statistical significance at levels of 10%, 5% and 1% respectively.

With these results we can answer the questions asked earlier, namely, how QE affected the investment portfolios of PFs. QE appears to have a positive effect on the holdings of corporate bonds, government bonds and cash and deposits, and a negative effect on the

holdings of equity asset - when analyzing the entire population; Moreover, we have asked if these changes in line with the hypothesis of the portfolio balance channel. In fact, our findings suggest that this mechanism is true for the context of the Eurozone, despite having a positive effect on the amount government bonds, this effect appears to be weaker than that of corporate bonds, so the relative amount of government bonds increases. Lastly, we proposed to analyze the effects for the countries with higher asset holdings by PF. The overall results do not have statistical significance for most assets, however, we found that the asset purchases had a negative effect on the stock of government bonds, as expected by the portfolio balance channel.

5. CONCLUSION

The LZB has been a problem faced by many developed countries over the past decade. To mitigate the negative effects of the Great Recession and more recently the covid-19 pandemic, CB had to resort to unconventional monetary policy, namely QE. One of the most important mechanisms of QE is the portfolio balance channel that occurs predominantly in non-banking institutions such as PF and insurance companies. The literature suggests that this effect has occurred in the UK but was absent in Japan. To understand if this hypothesis holds true for the context of the Eurozone, we decided to use an econometric GLS regression based on panel data for a group of 16 of the 19 countries that are part of this group, over a period of 18 years.

Our results are consistent with the hypothesis of the portfolio balance channel for PFs within the Eurozone. When analysing the entire population, PSPP is statistically significant for most cases, and with an expected sign. When analysing the subset of

countries where pension funds hold a bigger amount of investment assets, we do not find statistical significance for PSPP except for the regression in respect of government bonds. Here we can see that the effect is negative, which is in line with the results presented by Joyce, Liu and Tonks (2017) and supports the portfolio balance channel.

Our results suggest that, on average, all other things the same, an increase of 1% in PSPP leads to a 0.19% increase in the stock of corporate bonds held by PF. This is once again predicted by the model, since pension funds with the added liquidity, are expected to buy riskier assets such as corporate bonds.

For the case of equity assets, our results suggest a negative effect as a result of the asset purchases. Despite not being predicted by the model, these numbers might suggest a relocation to other forms of assets, such as corporate bonds. There's statistical evidence that suggests an increase in the stock of cash and deposits as a result of the asset purchases, which translates to an increase in liquidity, an important mechanism as explained by Benford et al (2009).

In this dissertation we have studied the hypothesis of portfolio allocation for the case of pension funds. However, other non-banking institutions such as insurance companies and hedge funds may also play a relevant role in the dissemination of the asset purchases throughout the economy, so future research on these institutions could be relevant to better understand such mechanism.

References

Alves, J., & Silva, T. (2020). An Empirical Assessment of Monetary Policy Channels on Income and Wealth Disparities. *Rem Working Paper Series*, 1-29.

Amir, E., Guan, Y., & Oswald , D. (2010). The effect of pension accounting on corporate pension asset allocation. *Review of Accounting Studies, 15*(2), 345–366.

Bean, C. (25 de February de 2011). *Lessons on unconventional monetary policy from the United Kingdom - speech by Charles Bean*. Obtido de Bank of Engalnd: https://www.bankofengland.co.uk/speech/2011/lessons-on-unconventional-monetary-policy-from-the-uk-speech-by-charles-bean

Benford, J., Berry, S., Nikolov, K., Young, C., & Robson, M. (2009). Quantitative easing. *Bank of England. Quarterly Bulletin, 49*(2), 90-100.

Bernanke, B. S. (2010, August 27). *The Economic Outlook and Monetary Policy*. Retrieved from Federal Reserve: https://www.federalreserve.gov/newsevents/speech/bernanke20100827a.htm

Bernanke, B. S., Reinhart, V. R., & Sack, B. P. (2004). Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment. *Brookings Papers on Economic Activity, 2004*(2), 1-100.

Brennan, M., Schwartz, E. S., & Lagnado, R. (1997). Strategic asset allocation. *Journal of Economic Dynamics and Control, 21*(8-9), 1377-1403.

Carpenter, S., Demiralp, S., Ihrig, J., & Klee , E. (2015). Analyzing Federal Reserve asset purchases: From whom does the Fed buy? *Journal of Banking & Finance, 52*, 230-244.

Dinenis, E., & Scott, A. (1993). What determines institutional investment? An examination of UK pension funds in the 1980s. *Oxford Economic Papers*, 292-310.

ECB. (15 de December de 2020). *Asset Purchase Programmes*. Obtido em 15 de December de 2020, de European Central Bank: https://www.ecb.europa.eu/mopo/implement/app/html/index.en.html

Eggertsson, G., & Woodford, M. (2003). The Zero Bound on Interest Rates and Optimal Monetary Policy. *Brookings papers on economic activity, 2003*(1), 139-233.

Fawley, B., & Neely, C. (2013). Four Stories of Quantitative Easing. *Federal Reserve Bank of St. Louis Review, 95*(1), 51-88.

Fisher, Paul. (11 de October de 2010). *An unconventional journey: The Bank of England's Asset Purchase Programme - speech by Paul Fisher*. Obtido de Bank of England: https://www.bankofengland.co.uk/speech/2010/the-bank-of-englands-asset-purchase-programme

Fisher, R. W. (8 de November de 2010). *Recent Decisions of the Federal Open Market Committee: A Bridge to Fiscal Sanity? (Acknowledging Henry B. Gonzalez and Winston Churchill)*. Obtido de Federal Reserve Bank of Dallas: https://www.dallasfed.org/news/speeches/fisher/2010/fs101108.cfm

Herndon, T., Ash, M., & Pollin, R. (2014). Does high public debt consistently stifle economic growth? A critique of Reinhart and Rogoff. *Cambridge Journal of Economics, 38*(2), 257-279.

Joyce, M. A., Liu, Z., & Tonks, I. (2017). Institutional Investors and the QE Portfolio Balance Channel. *Journal of Money, Credit and Banking, 49*(6), 1225-1246.

Joyce, M., Liu, Z., & Tonks, I. (2014). Institutional investor portfolio allocation, quantitative easing and the global financial crisis. *Bank of England Working Paper No. 510*, 1-46.

Joyce, M., Tong, M., & Woods, R. (2011). The United Kingdom's quantitative easing policy: design, operation and impact. *Bank of England Quarterly Bulletin*.

McLeay, M., Radia, A., & Thomas, R. (2014). Money creation in the modern economy. *Bank of England Quarterly Bulletin, Q1*.

Meier, A. (2009). Panacea, Curse, or Nonevent? Unconventional Monetary Policy in the United Kingdom. *IMF Working Papers*, 1-47.

Mumtaz, H., & Theophilopoulou, A. (2017). The Impact of Monetary Policy on Inequality in the UK. An Empirical Analysis. *European Economic Review, 98*, 410-423.

Park, H. M. (2011). Practical Guides To Panel Data Modeling: A Step by Step. *Public Management and Policy Analysis Program, Graduate School of International Relations, International University of Japan*, 1-52.

Pesaran, H., & Smith, R. (2014). Tests of Policy Ineffectiveness in Macroeconometrics. *Cambridge Working Papers in Economics*, 1-38.

Pesaran, M. H., & Smith, R. P. (2016). Counterfactual analysis in macroeconometrics: An empirical investigation into the effects of quantitative easing. *Reserch in Economics, 70*(2), 262-280.

Schenkelberg, H., & Watzka, S. (2013). Real effects of quantitative easing at the zero lower bound: Structural VAR-based evidence from Japan. *Journal of International Money and Finance, 33*, 327-357.

Tobin, J. (1958). Liquidity Preference as Behavior Towards Risk. *The Review of Economic Studies, 25*(2), 65-86.

Woodford, M. (16 de September de 2012). Methods of Policy Accommodation at the Interest-rate Lower. *Columbia University*.

Yellen, J. (25 de February de 2011). *Unconventional Monetary Policy and Central Bank Communications*. Obtido de Federal Reserve: https://www.federalreserve.gov/newsevents/speech/yellen20110225a.htm