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Quantitative Easing and its impact on the long-term yields of market-based and bank-based countries

Luís Carlos Rodrigues Carvalho

Master's Degree in Monetary and Financial Economics

Supervisor:
Professor Diptes Chandrakante Prabhudas Bhimjee,
Assistant Professor (Invited),
ISCTE - Instituto Universitário de Lisboa

June, 2024

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Department of Economic Politics

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Acknowledgements

This Dissertation wouldn’t be complete without the continuous support of a lot of people that have helped me throughout my journey in this Master’s degree.

First and foremost, I would like to thank my supervisor Diptes Chandrakante Prabhudas Bhimjee for the valuable help, advice and patience that has guided me during this path.

Second, I would like to thank my family, namely my parents Ana and Luís, for the motivation, belief and selflessness in helping me.

Third, I would like to thank Andreia, for all the love and constant nagging for me to submit this work in due time.

Fourth, I would like to thank my friends for all the teasing and provocation done to make me finish this.

And last but not least, I would like to thank my grandfather José who, despite not being able to cherish this moment together with me, will be celebrating inside my heart.

Resumo

A presente Dissertação aborda o Quantitative Easing, uma medida de política monetária não convencional adotada pelo Banco Central, de suporte aos mercados obrigacionistas. Pretende-se perceber o efeito deste instrumento nas taxas de juro a longo-prazo e comparar este com países de diferentes estruturas financeiras: uma estrutura *bank-based*, onde os agentes económicos financiam-se e investem através do banco; uma estrutura *market-based*, onde o financiamento e investimento é feito diretamente no mercado de capitais.

Para o efeito, são utilizadas duas regressões Pooled OLS para cada uma das estruturas financeiras em estudo. Com dados trimestrais, durante o período de 2015 a 2020, analisa-se o impacto do Quantitative Easing nas taxas de juro a dez anos de Portugal e Itália, países *bank-based*, e França e Países Baixos, países *market-based*, complementando as variáveis independentes com duas variáveis macroeconómicas, duas variáveis financeiras e duas variáveis de política monetária.

Conclui-se que o Quantitative Easing impacta significativamente ambas as estruturas financeiras, com um maior impacto para os países *bank-based*. Para estes, o Quantitative Easing transmite-se para a economia através de um canal de balanço de portefólio e de um canal de incerteza. Para os países *market-based*, o Quantitative Easing transmite-se adicionalmente por um canal de sinalização. Adicionalmente, compreende-se que uma combinação de Quantitative Easing com alteração das taxas de juro do Banco Central pode ser uma estratégia eficaz para países *bank-based*, de modo a combater pressões inflacionárias sem comprometer o risco de *default* do país.

Palavras-chave: Quantitative Easing, Taxas de juro a longo-prazo, *Bank-based*, *Market-based*.
Classificação JEL: E58 - Central Banks and Their Policies; G1 - General Financial Markets.

Abstract

This Dissertation focuses on Quantitative Easing, an unconventional monetary policy measure adopted by the Central Bank with the intent of supporting public debt markets. The main objective is to understand the impact of this instrument on long-term interest rates and to compare it with countries with different financial structures: a bank-based structure, where economic agents finance and invest through the bank; a market-based structure, where financing and investment is done directly in the capital market.

For this purpose, two Pooled OLS regressions are estimated, which are used for each of the financial structures under study. Utilizing quarterly data for the period from 2015 to 2020, the impact of Quantitative Easing on ten-year interest rates in Portugal and Italy (bank-based countries), and France and the Netherlands (market-based countries) is analyzed, complementing the independent variables with two macroeconomic variables, two financial variables and two monetary policy variables.

Quantitative Easing significantly impacts both financial structures, with a greater impact for bank-based countries. For these, Quantitative Easing is channeled to the economy through a portfolio balance channel and an uncertainty channel. For market-based countries, there is also evidence of a signaling channel. Additionally, it is understood that a combination of Quantitative Easing and changes to the Central Bank interest rate can be an effective strategy for bank-based countries, in order to combat inflationary pressures without compromising the country's default risk.

Keywords: Quantitative Easing, Long-term interest rates, Bank-based, Market-based.
JEL Classification: E58 - Central Banks and Their Policies; G1 - General Financial Markets.

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List of Abbreviations

QE - Quantitative easing

FED - Federal Reserve

ECB - European Central Bank

BoE - Bank of England

U.K. - United Kingdom

BoJ - Bank of Japan

LSAPs - Large-scale asset purchases

GDP - Gross Domestic Product

U.S. - United States

MBS - Mortgage-backed securities

VAR - Vector Autoregression

PCE - Personal Consumption Expenditures

CPI - Consumer Price Index

EU - European Union

OLS - Ordinary least squares

1. Introduction

The global financial crisis of 2007-2008 was an economic event that was brewing for some time, prior to its onset. Consequent decreases in interest rates by Central Banks from 2000 to 2003, leading to lax credit lending by commercial banks and securitization of high-risk subprime loans marketed as low-risk financial instruments (the so called mortgage-backed securities (MBS)), all with the purpose of boosting the economy, ultimately led to this economic collapse. As interest rates started increasing in 2004, house mortgages increased and home prices started to cool down, leading subprime borrowers to eventually enter a state of default and, consequently, leading to a spillover effect into all segments of the financial markets worldwide, causing many banks to collapse (Kenton, 2021). To address the lack of trust that built up into the general public towards banks, Central Banks started to decrease interest rates. When these reached zero, unconventional monetary policy was introduced, namely Quantitative Easing (QE), which is a large-scale purchase of financial assets, namely bonds, in order to increase money supply in the market and decrease long-term yields, consequently promoting economic growth through more loans and investments.

This monetary policy stance was implemented around the world, mainly the Federal Reserve (FED), the European Central Bank (ECB), the Bank of England (BoE), the Bank of Japan (BoJ) and by the Swiss National Bank. However, countries have different financial systems that may boost (or restrain) QE effects into the economy, mainly in long-term yields. This Dissertation aims at answering the question of what is the impact of QE on the long-term yields of countries with different financial structures, differentiating financial systems into two broad types: (i) bank-based countries, where investment and financing decisions, both by individuals and by companies, are done mainly with a bank as an intermediary and (ii) market-based countries, where these decisions are mainly done by private individuals directly through the capital markets.

This research question is very relevant to the global economic and financial environment. The recent stagflationary crisis, caused by an increase in inflation and supply shocks due to the war raging between Russia and Ukraine, raises the question of the role that a Central Bank should play in such a situation: (i) either interest rates should be raised in order to cope with inflation (emphasizing, on the other hand, the economic recession), or (ii) interest rates should be lowered in order to allow for a speedy economic recovery (consequently aggravating the inflationary component). With the conservative behavior assumed by the global Central Bank's, namely the FED and the ECB, to increase the key interest rates, the

prices of Treasury Bonds decrease, causing a deficit in the financing of sovereign states and a growing debt trajectory, which could subsequently lead to a sovereign financial default.

QE emerges as a possible vehicle for solving the problem of sovereign debts, since it greatly stimulates the liquidity of public debt in the secondary market, through large scale acquisitions of government bonds. This, if combined with a conventional hawkish monetary policy, could lead to a solution to the stagflationary crisis, allowing for a reduction of the inflation rate, while mitigating the higher interest rate's impact on countries with a higher debt-to-GDP ratio.

There is an abundance of literature about the effects of QE on long-term yields. Joyce et al. (2010) conclude that purchases of bonds in the United Kingdom (U.K.) decreases the yields on medium and long-term sovereign and corporate bonds. Additionally, there are different channels through which QE transmits to the economy, as mentioned by Stefanski (2022). There is empirical evidence of a portfolio balance channel, through the rise of stock prices, and an uncertainty channel, via a decrease in stock market volatility. In the comparison between the heterogenous effects of QE in different countries, Burriel and Galesi (2016) reflect that a more robust banking system is more effective in QE transmission to the economy.

In this Dissertation, two panel data regressions will be used, namely Pooled Ordinary Least Squares (Pooled OLS) regressions, separating both regressions for each type of financial system under study. The dependent variable will be the ten-year bond yield (data from FRED), with the independent variables being the debt-to-GDP ratio (data from OECD), consumer price index (data from FRED), total share prices (data from FRED), volatility of stock price index (data from FRED), central bank rates (data from FRED) and the asset purchases by central bank (data from ECB). Quarterly data will be used, spanning from 2015 to 2020 and encompassing two bank-based countries (Portugal and Italy) and two market-based countries (France and The Netherlands).

With this research, QE is found to be statistically significant in reducing ten-year long-term yields in bank-based countries and market-based countries. However, this effect is stronger in bank-based countries, with about two times the impact of that associated with market-based countries, where for 100 billion euros of assets purchased by the ECB, the long-term yield in bank-based countries reduces by 0,35171%. The transmission channels are also different, where QE flows into bank-based countries' economy through a portfolio balance channel and an uncertainty channel, market-based countries additionally have a signaling channel. It is also evidenced that, due to the lack of statistically significance of the Central

Bank rates impacting long-term yields in bank-based countries, QE can help prevent the increase in default risk for bank-based countries when a rise in interest rates occurs, since long-term yields can be kept low with large asset purchase programs.

This Dissertation is structured as follows: Chapter 2 reviews the main academic literature; Chapter 3 describes the methodology and data; Chapter 4 presents the main empirical results; Chapter 5 presents the robustness tests; lastly, Chapter 6 concludes the Dissertation.

2. Literature review

2.1. Quantitative Easing and long-term yields

The study of Quantitative Easing (QE) monetary policy has been explored mainly following the global financial crisis of 2007-2008, due to the popularization of unconventional monetary policies by the Federal Reserve (FED), the European Central Bank (ECB), the Bank of England (BoE), the Bank of Japan (BoJ) and by the Swiss National Bank. These Central Banks applied this specific type of policy in order to decrease long-term interest rates (Joyce et al., 2010), with the main purposes being: (i) increasing economic activity and growth; (ii) increasing the amount of money lent; (iii) decreasing the costs of borrowing, and (iv) increasing inflation. This follows the conventional reasoning associated with Keynesian theory, where an increase in money supply will encourage lending and borrowing by economic agents, as banks have more deposits and will therefore increase the amount lent to clients. This will ultimately allow for a decrease in interest rates, stimulating the economy via more investment, which will ultimately cause greater economic growth and inflation.

Joyce et al. (2010) conducted an event-study method of QE announcements in the United Kingdom (U.K.), during 2009/2010, and its effects on gilt (government bonds in the U.K.), medium and long-term yields, with a decrease of about 100 basis points through a portfolio balance channel. As described in the research, "The portfolio balance channel reflects the direct impact on asset prices of investors rebalancing their portfolios in response to the BoE's QE-related asset purchases" (Joyce et al., 2010:p.117). So, a shock in gilt purchases will cause investors to choose other long-term assets with higher yields (provided that money is not a perfect substitute for gilts). They found that around QE announcements by the BoE:

- Corporate bonds' yields with higher rating decreased in 70 basis points;
- Corporate bonds' yields with lower rating decreased in 150 basis points;
- Equity prices rose sharply through 2009;
- Sterling exchange rate depreciated by 4 percent.

This portfolio balancing effect contributes to the objectives laid down by Central Banks related to the implementation of QE, as more investments in the real economy is done by investors selling bonds (as their yields decreased) and purchasing equities. This also causes a depreciation of the Sterling, since more money is poured into the economy by the Central Bank's QE program, leading to a higher inflation rate.

Similar conclusions were found in Gagnon et al. (2011) research on the effects of QE in the U.S., using both a time-series (to estimate the effects of changes in the private holding of

longer-term debt on the term premium) and an event-study methodology (about the QE announcements of the FED and the changes on the interest rates around these communications). Through these two different methods, they found that the FED's large-scale asset purchases (LSAPs) were effective in reducing the term premium of long-term interest rates.

As explained by the authors, long-term yields are composed by "the average level of short-term risk-free interest rates expected over the term to maturity of the asset and the risk premium" (Gagnon et al., 2011:p.6). With the implementation of the LSAPs, the FED intended to target the risk premium of long-term yields, as it did not even signal that short-term interest rates would remain low. As such, the reduction of long-term yields would be caused by a reduction in risk premium, meaning that the additional return that investors expect from holding out a long-term asset is lowered. The term premium is a component of the risk premium, corresponding to the "additional return investors require, over and above the average of expected future short-term interest rates, for accepting a fixed, long-term yield" (Gagnon et al., 2011:p.7).

The authors concluded that the LSAPs allowed to reduce the supply of assets with long duration (years needed for an investor to be reimbursed for their purchase by the asset's cash flows) and consequently:

- Reduced the term premium on ten-year Treasury yields by about 30 to 100 basis points;
- Reduced ten-year agency debt yield by about 156 basis points. This was due to providing higher liquidity to the market for this specific asset and by removing assets with high prepayment risk from private investors (risk arising due to the premature payment of mortgage loans, not allowing for lenders to benefit from interest payments);
- Reduced ten-year MBS (mortgage-backed securities) yields by about 113 basis points, for the same reasons as the agency debt.

These effects on long-term yields also appeared to have spread to other markets, such as corporate bonds and interest rate swaps. U.K. QE effects, detailed by Joyce et al. (2010), also appear to have been similar to these. On the other hand, Japanese government bonds that were purchased by the BoJ, in 2001, in order to fight deflation, were found to have small or insignificant effects on long-term yields. The reason pointed out for this lack of impact is due to the small dimension of this operation, as the bonds that were bought by the BoJ accounted for about 4 percent of the Gross Domestic Product (GDP) of Japan, relatively to the 12 percent

of LSAPs' weight on the United States (U.S.) GDP. It was possible to conclude that the portfolio balance channel was behind the lowering of risk premium in long-term Treasury, agency and MBS yields.

However, there are contrarian researches about the importance of this portfolio balance channel. Thornton (2014) uses interest rate and public debt supply measures to study the relationship between long-term yields and public holding of long-term debt, in the U.S. The public debt supply variables account for the public's holding of Treasury debt, less that held by the FED in the System Open Market Account. There wasn't a statistically significant relationship found between the public holding of long-term debt and the long-term yields, meaning a portfolio balance effect didn't impact bond yields. Baldacci and S. Kumar (2010) find different results, when using a panel data regression with fixed effects, to study the impact of fiscal deficits and public debt on long-term yields, in 31 emerging and developed economies. They find that an increase in fiscal deficits and public debt also increase the long-term yields, although this relationship is nonlinear. Fiscal deficits tend to raise public debt, which in turn raises long-term yields due to bond investors demanding higher yields to compensate the increased risk of default.

The channels through which QE impact is transmitted to the real economy have been subject to much investigation, and not reduced only to portfolio balancing channel. Krishnamurthy and Annette (2011) conducted an event-study analysis on the execution of QE policy, by the FED, during 2008/2009 and 2010/2011. They concluded that the transmission channels of QE to the economy vary with the type of assets bought, with the following having different QE channeling transmission mechanisms:

- Treasury purchases: a signaling channel, whereby the purchase of long-term assets is interpreted by the market as a commitment in keeping interest rates low; a long- term safety channel, explained by the existence of a specific group of clients that prefer assets with low risk; an inflation channel, where the expected inflation increases with QE effect.
- MBS purchases: a risk premium channel, through the pre-payment of mortgage credit; a default risk channel, where the probability of non-payment by companies goes down; a liquidity channel, as the purchase of more assets contributes to more money in the market.

In a different spectrum, Stefanski (2022) investigated the macroeconomic effects of QE in the U.S., as well as the transmission channels, through a Bayesian Vector Autoregression

(VAR) model. The main macroeconomic variables that were studied consisted of GDP, Personal Consumption Expenditures deflator (PCE) and unemployment.

The main findings, highlighted by the author, are that, during the period of 1966 to 2019 (which includes the effects of Operation Twist, implemented by the FED) are that:

- QE reduces unemployment, having no significant impact in GDP, PCE and in long-term rates;
- QE is channeled through the economy, mainly, by a rise in stock prices and a reduction in stock market volatility. The rise in stock prices causes a portfolio balancing effect, where investors transfer their capital to these financial products, while the reduction in stock market volatility, representing an uncertainty channel, allows investors to apply their capital more confidently into the real economy;
- QE effects in the economy are more uncertain than the effects of monetary conventional policy.

As such, the main transmission channel is through an uncertainty channel, centered around the volatility of the stock market, above the channel of portfolio balancing and signaling (represented by stock prices). This research points to a higher effectiveness of QE in its transmission to the real economy, through countries with more developed and prominent capital markets.

Similarly, Weale and Wieladek (2016) studied the impact of QE on the Consumer Price Index (CPI) and real GDP, both in the U.K. and the U.S., through a Bayesian VAR model, during the period of 2009 to 2014. Contrary to Stefanski (2022), they found that QE has a significant impact on real GDP and CPI, with a 1% impact of QE relatively to the nominal GDP, having an increase of:

- 0,62% real GDP and 0,58% CPI, in the U.S.;
- 0,25% real GDP and 0,32% CPI, in the U.K.

They also find that the impact on macroeconomic variables in the U.S. is caused by the decrease in long-term interest rates, referring to a portfolio balance channel. However, in the case of the U.K. there is no significant impact on the long-term interest rates.

The divergence between these two studies, both of which use the same methodology but branch out in the way QE impacts GDP and CPI (where Stefanski(2022) doesn't find any impact of QE on the macroeconomic variables, while Weale and Wieladek (2016) does) , comes down to the small number of variables on Weale and Wieladek (2016), as their model

only has five variables, causing it to probably suffer from omitted variable bias. For comparison, Stefanski (2022) contains fifteen variables.

Kumar et al. (2017) do find that a shock in market volatility leads to a reduction in the term premium of long-term yields. Through the use of time-varying VAR models on U.S. quarterly data from 1988 to 2019, they find that this impact on long-term yields is caused by a portfolio balancing effect, where an increase in stock market volatility turns investors from investing in equities to less riskier assets like bonds, thus lowering their yields.

2.2.Bank-based and market-based financial systems

According to Demirguc-Kunt and Levine (1999), financial systems can differ between bank-based and market-based. Bank-based financial systems can be described as one in which "…banks play a leading role in mobilizing savings, allocating capital, overseeing the investment decisions of corporate managers, and in providing risk management vehicles" (Demirguc-Kunt and Levine, 1999:p.2). Market-based systems consist of a financial structure according to which "…securities markets share center stage with banks in terms of getting society's savings to firms, exerting corporate control, and easing risk management" (Demirguc-Kunt and Levine, 1999:p.2).

Demirguc-Kunt and Levine (1999) address the financial structure of 150 countries, and they present stylized facts about the relationship between the financial structure, economic development and legal, regulatory, tax, and macroeconomic features of each country. The financial system of each country was determined by an index that is composed by the size, activity, and efficiency of banking sector development in relation to stock market development, thus leading to a classification of bank-based, market-based or underdeveloped financial structures (those below median values for bank and stock market development).

Regarding bank-based and market-based financial systems, the following facts were defined in Demirguc-Kunt and Levine (1999):

- In higher income countries, the domestic stock markets tend to be larger, more active and more efficient than domestic banks and, thus, with more market-based financial systems;
- Countries with a Common Law legal framework (which tend to have a bigger emphasis on the rights of minority shareholders), good accounting regulations, low corruption and no explicit deposit insurance are more market-based;
- Countries with a French Law legal framework (which tend to have less protection of shareholders' rights), with low creditors' rights, poor contract

enforcement, high levels of corruption, poor accounting regulations, restrictive banking regulations, and high inflation tend to have underdeveloped financial systems.

With these facts in mind, the authors then built a classification system of countries based on their economic development and their financial structure.

In a more recent study, Bijlsma et al. (2013) use a principal components analysis methodology to compare the financial structures of the countries from the European Union (EU), Japan and the U.S. The main findings point out to three groups with different types of financial systems:

- Eastern European countries (that have entered the EU recently);
- Market-based countries;
- Bank-based countries.

The Eastern European country group distinguishes itself from the other EU countries due to their relatively smaller banking and market sectors. Despite the market and bank-based countries having robust banking sectors, the former are more similar to the U.S. due to their larger stock market activity, investments from venture capital, and openness to foreign capital.

The bank-based countries have indicators that point out to more household assets being composed by household deposits, similar to Japan's profile. Banks also derive their income mainly from fees, rather than interest from other sources.

Due to Bijlsma et al. (2013) utilizing more recent data than Demirguc-Kunt and Levine (1999) and the thorough distinction that it does between the financial structure of EU countries, it will help answer the question of this Dissertation by providing the list of countries with market-based and bank-based systems, in order to compare the effects of QE between these two different systems.

2.3. Quantitative Easing in different financial systems

There is some literature that compares the effects of QE on countries that have different financial structures. Christensen and Rudebusch (2012) conducted an empirical study related to QE effects on the interest rates in the U.K. and in the U.S., confirming that bonds' yields decreased during this period. However, different channels were the principal culprit in the countries: in the U.K. the yields decreased due to a reduction in the term premiums (the added value required by the investors to bear the interest rate's risk until the maturity of the bond),

which points out to a portfolio balance channel contributing to this impact; whereas in the U.S. the main effect seems to have come from the QE announcement by the FED, which transmitted the lowering of federal funds rate via a signaling channel.

The authors point out the different communication policies and financial structures that led to this divergence between both countries. As the Federal Open Market Committee announced the commitments towards QE policies, the announcement would be made with the objective of providing forward guidance to investors and indicate the short-term actions of the FED to impact the economy. However, U.K. policy communication wasn't significantly impactful and didn't look to provide further guidance, as the operations of asset purchases were conducted in less than three months, while in the U.S. the operations were conducted over nine months, allowing for the signaling channel to fully work.

The financial structures' argument explains that U.S. bond markets are more liquid than those of the U.K., reflecting that it is a more market-based country. As such, there is less impact of risk on the premium of a bond, due to a more liquid market, which leads to less risk. When QE impacts the economy, it will impact a more illiquid market, caused by a stronger portfolio balance channel. Burriel and Galesi (2016) investigated the heterogeneous effects of unconventional monetary policy, by the ECB, on the members of the Eurozone during 2007 to 2015. On the aggregate view of the monetary union, GDP, inflation and equity prices increased with the unconventional monetary policy's shocks, with no impact in inflation expectations, which doesn't suggest the effect of a signaling channel. The rise of equity prices supports the existence of a portfolio balance channel. The real effective exchange rate also depreciated with these shocks.

On the disaggregated view, most of the euro countries benefit from the unconventional monetary shocks, however there is a certain degree of heterogeneity among countries. For example, Estonia has witnessed the biggest increases in inflation, while the smallest impact was in Cyprus. The reasons for this heterogeneity are: (i) spillover effects, these being the impacts of unconventional monetary policy in a country, which can indirectly impact other economies of other members; and (ii) the robustness of the banking system of a country, meaning that a more capitalized banking system will reflect a more effective impact from unconventional monetary policies and transmission into the real economy.

In short, with the application of QE, the financial impact is defined as a decrease on long-term yields, impacting the assets that are part of the program (mainly sovereign bonds), as well as substitutes of these (corporate bonds, equities) and the exchange rate. There is also an observable impact on the main macroeconomic variables, with a typical reduction in

unemployment.

The transmission channels to which QE passes through to the economy are not consensual among authors. While the most notorious and significant one in many of the articles is the portfolio balance channel, there is also evidence that this transmission channel is not significant, with the signaling channel and the uncertainty channel replacing it.

Furthermore, the academic literature on this subject is also not clear on the difference of the effects of QE on countries with divergent financial structures. It is determined that more developed and prominent capital markets represent a higher effectiveness of QE (due to less stock market volatility, higher stock prices and more liquid bond markets); but also points out to stronger QE effects on countries with a more robust banking system (due to lower long-term interest rates, allowing for more loans from credit institutions to the real economy).

As such, the underlying question that this Dissertation answers is important to the main theme of QE as it allows us to compare the different impacts that asset purchases, made by the Central Banks, may have on financial and economic variables and whether different transmission channels are found for each financial structure, allowing to better understand where QE is more impactful.

Table 2-1 presents a summary of the most relevant information from the literature review chapter.

Table 2-1 - Summary of the relevant information from the literature review.

Author(s)	**Period and Countries**	**Independent variable(s)**	**Dependent variable(s)**	**Main findings**
The Financial Market Impact of Quantitative Easing in the United Kingdom.				
Joyce et al. (2010).	2009/2010; U.K.	Gilt purchases.	Gilt with medium and long-term yields; **(-)** Corporate bonds' yields with high rating; **(-)** Corporate bonds' yields with low rating; **(-)** Equity prices; **(+)** Sterling exchange rate. **(-)**	Portfolio balance channel responsible for the impact on the dependent variables.
The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases.				
Gagnon et al. (2011).	2008/2009; U.S.	LSAPs.	Ten-year long-term Treasury yields; **(-)** Ten-year agency debt yield; **(-)** Ten-year MBS yields. **(-)**	Portfolio balance channel responsible for the impact on the dependent variables.
QE: Is There a Portfolio Balance Effect?				
Thornton (2014).	1985/2007; U.S.	Public holding of long-term debt, without FED's holding in the System Open Market Account;	Ten-year long-term Treasury yields. **(n.s.s.)**	Portfolio balance effect didn't impact bond yields.
Fiscal Deficits, Public Debt, and Sovereign Bond Yields.				
Baldacci and S. Kumar (2010).	1980/2008; 31 advanced and emerging economies.	Fiscal balance in percent of GDP; General government debt in percent of GDP	Ten-year yields for government bonds. **(-) for fiscal balance; (+) for general government debt.**	Portfolio balance effect impacted bond yields.
The effects of Quantitative Easing on interest rates: channels and implications for policy.				
Krishnamurthy and Annette (2011).	2008/2011; U.S.	Treasury purchases; MBS purchases.	Ten-year long-term Treasury yields; **(-)** Ten-year agency debt yields; **(-)** Ten-year MBS yields; **(-)** Corporate bonds' yields. **(-)**	Transmission channels of QE vary with the type of assets bought.
Macroeconomic effects and transmission channels of quantitative easing.				
Stefanski (2022).	1966/2019; U.S.	Fed Funds rate; Treasury purchases; MBS Purchases; Operation Twist.	GDP; **(n.s.s.)** PCE deflator; **(n.s.s.)** Unemployment; **(-)** Ten-year long-term Treasury yields; **(n.s.s.)** S&P 500; **(+)** Stock market volatility. **(-);** Nominal Effective Exchange Rate **(n.s.s.)** Bank credit. **(n.s.s.)**	No effect of QE on long-term yields. Stock prices reflect portfolio balance channel and market volatility reflect uncertainty channel. QE more effective in developed and prominent capital market.

What are the macroeconomic effects of asset purchases?				
Weale and Wieladek (2016)	2009/2014; U.K. and U.S.	Asset purchases divided by nominal GDP;	Log of CPI; **(+)** Log of real GDP; **(+)** Ten-year yields for government bonds; **(-)** Log of real equity prices. **(+)**	Portfolio balance effect impacted bond yields.
Market volatility, monetary policy and the term premium.				
Kumar et al. (2017).	1988/2019; U.S.	Equity volatility (VIX); Bond market volatility (MOVE).	GDP; **(-)** CPI; **(-)** FED's shadow rate; **(-)** U.S. term premium; **(-) for equity volatility; (+) through bond volatility.**	Portfolio balance effect impacted bond yields through equity volatility.
Bank-based and market-based financial systems: cross-country comparisons				
Demirguc-Kunt and Levine (1999).	1999; 150 countries.			Higher income countries are more market-based. Market-based countries have a better regulatory environment, while bank-based do not.
The changing landscape of financial markets in Europe, the United States and Japan.				
Bijlsma et al. (2013)	2013. 27 EU Countries, Japan, U.S.			Countries are divided into Eastern European, market-based and bank-based. Market and bank-based with more robust banking sector, but larger stock market in the former.
The Response of Interest Rates to U.S. and U.K. Quantitative Easing.				
Christensen and Rudebusch (2012).	2009/2011. U.K. and U.S.	QE announcements.	Ten-year yields for government bonds. **(-)**	Portfolio balance channel in the U.K., due to more illiquid bond markets. Signaling channel in the U.S., through providing forward guidance.
Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries.				
Burriel and Galesi (2016)	2007/2015. 19 Eurozone Countries.	Year-on-year rate of growth of ECB's total assets;	GDP; **(+)** Harmonized Index of Consumer Prices; **(+)** Real equity prices; **(+)** Bank lending operations to non-financial corporations; **(n.s.s)** Real effective exchange rate; **(-)**	Portfolio balance channel through equity prices. Heterogeneity between countries of QE impacts due to spillovers. More robust banking system means more effective QE transmission.

Source: Author's elaboration.

3. Methodology and data

3.1. Methodology

Previous academic literature has studied the impact of QE on long-term yields using:

- Event-study methodology, which focuses on observing the impact of QE announcements within a one-day or two-day timeframe in bond yields and other variables in order to identify the transmission channels of QE to the economy;
- Vector Autoregression Models, among them Global VARs, Bayesian VARs and Structural VARs, which aim at capturing the relationship between a large number of variables both endogenous and exogenous, among multiple time frames and countries, by regressing a system of equations to its lagged values.

In this research, two data panel regressions are estimated, one for bank-based countries and the other for market-based countries, in order to pinpoint the differences between both financial structures. The use of this distinct methodology in comparison to previous studies is one of the innovations of this research, and it will aim at studying QE's impact with particular insight in capturing unobserved heterogeneity between bank-based countries and market-based countries. This is done using a fixed effects, a random effects and a pooled OLS model, in order to find previously unfounded impacts of this monetary policy or at corroborating previous studies.

Brooks (2008) describes the data panel regression model as

$$y_{it} = \alpha + \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + u_{it}$$

where,

i represents the country, with $i = 1, \ldots, N$;

t represents the period, with $t = 1, \ldots, T$;

y represents the dependent variable;

α represents the intercept term, a constant for all countries in all periods;

β represents the slope term, measuring the impact of the independent variables on the dependent one;

x represents the value of the independent variable;

k represents which independent variable is impacting $k = 1, \ldots, K$;

u represents the error term, accounting for all the unobservable variables.

Through this method, we can observe the impact of the independent variables on the dependent one, across multiple countries and periods, and the relationship between the independent variables themselves. This may help identifying problems of multicollinearity between independent variables, rather than if time series regressions were done for each country

or period.

Three regression models are going to be estimated, for each financial system (Wooldridge, 2013):

- Pooled ordinary least squares (Pooled OLS): minimizes the sum of the of squared residuals, applied to panel data.
- Fixed effects: aimed at capturing unobserved, time constant effects that impact the dependent variable;
- Random effects: aimed at capturing unobserved effects that impact the dependent variable and are uncorrelated with the independent variables;

The independent and dependent variables are detailed in Annexes A and B and graphically represented in Annexes CC to II.

The dependent variable is composed by:

  - Ten-year bond yield to measure long-term interest rates;

The independent variables are divided as follows:

- Two macroeconomic variables:
  - Debt-to-GDP ratio to measure the impact of the risk premium reduction in the long-term yield;
  - CPI to measure inflation channel;
- Two financial variables:
  - Total share prices to measure a portfolio balancing channel;
  - Volatility of stock price index as a measure of an uncertainty channel.
- Two monetary policy variables:
  - Conventional monetary policy (represented by the variable Central Bank rates);
  - Unconventional monetary policy (represented by the variable asset purchases by Central Bank).

3.2.Data

The data chosen for this Dissertation has a quarterly frequency, starting from the 1st quarter of 2015 to the 4th quarter of 2020, totaling 24 observations for each country. This period coincides with the recovery of the recession marked by the Sovereign Debt Crisis in Europe, as well as the start of QE done by the ECB, and it finishes with the start of the economic recovery from the Covid-19 pandemic (as per the Business Cycle Clock by Eurostat).

This research will also focus on four countries, classified based on their financial system

according to Bijlsma et al. (2013): (i) two bank-based countries, Portugal and Italy; and (ii) two market-based countries, France and The Netherlands.

In the below table, we can observe the descriptive statistics of the variables in study:

Table 3-1 - Descriptive statistics of Bank-based and Market-based countries.

Variables	Observations		Minimum		Maximum		Average		Median		Standard Deviation	
	Bank-Based	Market-Based	Bank-Based	Market-Based	Bank-Based	Market-Based	Bank-Based	Market-Based	Bank-Based	Market-Based	Bank-Based	Market-Based
Ten-year bond yield	48	48	0,09%	-0,54%	3,99%	1,04%	1,89%	0,37%	1,87%	0,49%	0,91	0,42
Debt-to-GDP ratio	48	48	135,6 %	62,30 %	183,3 %	145,50 %	151,1 %	98,60 %	150,2 %	100,15 %	12,02	28,82
Consumer Price Index	48	48	98,88	98,86	104,15	108,23	101,76	102,71	102,02	102,11	1,42	2,54
Total share prices	48	48	79,97	90,09	134,22	120,52	106,25	106,52	103,87	107,94	13,79	8,57
Volatility of stock price index	48	48	10,64 %	10,72 %	29,90 %	24,91%	19,84 %	17,47 %	20,85 %	16,91%	5,78	4,71
Central Bank rates	48	48	0,25%	0,25%	0,30%	0,30%	0,26%	0,26%	0,25%	0,25%	0,01	0,01
Asset purchases by Central Bank	48	48	-2 088B €	-2 088B €	255 508B €	255 508B €	125 671B €	125 671B €	105 174B €	105 174B €	79 125	79 125

Source: Author's elaboration using R Studio results.

There's a higher standard deviation in the bank-based countries in all variables, excluding CPI. This can be explained by the impact of the European Sovereign Debt Crisis, which mainly affected countries with a high Debt-to-GDP ratio due to a perceived credit default risk by investors, which caused a higher volatility in the economy and in the bond's market (Ullah and Ahmed, 2014).

The correlation between variables can be seen below:

Table 3-2 - Correlation between variables in Bank-based countries.

	Debt-to-GDP ratio	Consumer Price Index	Ten-year bond yield	Total share prices	Volatility of stock price index	Central Bank rates	Asset purchases by Central Bank
Debt-to-GDP ratio	1,0000						
Consumer Price Index	-0,0506	1,0000					
Ten-year bond yield	0,0199	0,1187	1,0000				
Total share prices	-0,0981	0,2443	-0,3517	1,0000			
Volatility of stock price index	0,6990	-0,1719	-0,1359	-0,2740	1,0000		
Central Bank rates	0,0580	-0,1713	-0,1266	0,0858	-0,0536	1,0000	
Asset purchases by Central Bank	-0,2942	-0,2013	-0,1829	-0,1030	-0,3543	0,3478	1,0000

Source: Author's elaboration using R Studio results.

Table 3-3 - Correlation between variables in Market-based countries.

Market-Based countries	Debt-to-GDP ratio	Consumer Price Index	Ten-year bond yield	Total share prices	Volatility of stock price index	Central Bank rates	Asset purchases by Central Bank
Debt-to-GDP ratio	1,0000						
Consumer Price Index	-0,1470	1,0000					
Ten-year bond yield	-0,0322	0,1036	1,0000				
Total share prices	-0,2910	0,2734	-0,1344	1,0000			
Volatility of stock price index	0,7212	-0,3157	-0,3948	-0,2604	1,0000		
Central Bank rates	0,0116	-0,1904	0,1149	0,0113	-0,0409	1,0000	
Asset purchases by Central Bank	-0,2700	-0,0859	-0,0709	-0,1249	-0,3353	0,3478	1,0000

Source: Author's elaboration using R Studio results

In general, correlations between variables in bank-based countries and market-based countries seem to be very similar and not very significant, with:

- The most positive correlation being between the volatility of stock price index with the debt-to-GDP ratio, with 69,9% correlation in bank-based countries and 72,12% in

market-based;

- The most negative correlation, in the bank-based countries, being between the asset purchases by Central Bank and the volatility of the corresponding stock price index, with -35,43% correlation and in the market-based being between the volatility of stock price index with the ten-year bond yield, with -39,48% correlation.

It is in the negative correlation that a major difference arises between bank-based and market-based countries. In the bank-based countries, the total share prices have a relatively significant negative correlation with the ten-year bond yield (-35,17% *versus* -13,44% in market-based), while the volatility of stock price index doesn't (-13,59% *versus* -39,48% in market-based). According to Stefanski (2022), the bank-based country's correlation seems to be the cause of a portfolio balancing channel, where investors transfer their capital from the bond market to invest in shares. This effect, higher in bank-based countries, could be explained by the higher risk bonds that these countries had during the European Sovereign Debt Crisis, which in turn caused investors to invest their capital in shares. The market-based country's correlation is due to an uncertainty channel, where a reduction in the stock market volatility causes a higher investment in these financial instruments. This stronger negative correlation in the market-based countries is explained by the more developed capital markets that these regions have, where more economic agents rely on these to gather and lend capital to other economic agents. A lower volatility will lead investors to apply their capital directly into the real economy.

4. Empirical results

First and foremost, tests to detect unit roots were computed, identifying whether the different variables were stationary (or not). The tests used were Levin-Lin-Chu, Maddala-Wu and Hadri.

Table 4-1 - Stationarity tests for the variables.

	Bank-Based countries			Market-Based countries		
	Levin-Lin-Chu (H0: Non-stationarity)	Maddala-Wu (H0: Non-stationarity)	Hadri (H0: Stationarity)	Levin-Lin-Chu (H0: Non-stationarity)	Maddala-Wu H0: Non-stationarity)	Hadri (H0: Stationarity)
Debt-to-GDP ratio	0,9769	0,7864	4,29E-06	0,5504	0,8167	2,00E-17
Consumer Price Index	**0,03789**	0,1846	2,20E-16	0,2635	0,912	2,00E-17
Ten-year bond yield	0,7934	0,8995	2,20E-16	0,8771	0,9817	2,00E-17
Total share prices	0,08155	0,1945	2,20E-16	0,1495	0,4861	2,00E-17
Volatility of stock price index	0,5475	0,6377	2,82E-05	0,6859	0,7397	0,01576
Central Bank rates	**0,04729**	0,1902	2,20E-16	**0,04729**	0,1902	2,00E-17
Asset purchases by Central Bank	0,6353	0,7999	2,20E-16	0,6353	0,7999	2,00E-17

Source: Author's elaboration using R Studio results.

As table 4-1 demonstrates, our data is not stationary for a confidence interval of 5%, except for the variables CPI and Central Bank rates, in the bank-based countries, and only the variable Central Bank rates in the market-based countries, both for the test Levin-Lin-Chu. First differences were then applied to the variables, in order to make them stationary:

Table 4-2 - Stationarity tests for the first differenced variables.

	Bank-Based countries			Market-Based countries		
	Levin-Lin-Chu (H0: Non-stationarity)	Maddala-Wu H0: Non-stationarity)	Hadri (H0: Stationarity)	Levin-Lin-Chu (H0: Non-stationarity)	Maddala-Wu H0: Non-stationarity)	Hadri (H0: Stationarity)
Debt-to-GDP ratio	**0,04861**	**0,0004549**	**0,1421**	**1,30E-09**	**3,87E-09**	**0,2391**
Consumer Price Index	0,3738	**0,0009103**	**0,7854**	**0,01005**	**1,15E-06**	**0,705**
Ten-year bond yield	**9,29E-05**	**7,90E-06**	**0,5186**	**8,59E-09**	**2,55E-10**	**0,7808**
Total share prices	**1,74E-05**	**3,01E-07**	**0,8445**	**4,10E-06**	**9,05E-07**	**0,7811**
Volatility of stock price index	**1,62E-08**	**2,08E-08**	**0,5467**	**1,28E-08**	**1,04E-08**	**0,567**
Central Bank rates	**4,45E-06**	**1,27E-05**	**0,2689**	**4,45E-06**	**2,71E-03**	**0,2689**
Asset purchases by Central Bank	**3,00E-06**	**8,26E-06**	**0,08013**	**3,00E-06**	**8,26E-06**	**0,08013**

Source: Author's elaboration using R Studio results.

After the first differences, we can see that all variables, apart from the CPI in the Levin-

Lin-Chu Test, are all stationary. As two tests point to stationarity in this variable, against one that does not, we can assess that this variable is stationary due to the majority of the tests pointing it out.

With stationarity of the variables achieved, the panel regression models were estimated. The results can be synthetized in table 4-3, while the original output from R Studio can be found in annexes C to H:

Table 4-3 – P-value of the panel data regressions.

Dependent variable / **Independent variable**	**Ten-year bond yield**					
	Bank-Based countries			Market-Based countries		
	Pooled OLS	Fixed effects	Random effects	Pooled OLS	Fixed effects	Random effects
Debt-to-GDP ratio	0,083839 (0,054574)	0,083079 (0,055522)	0,083839 (0,054574)	***0,10189**** ***(0,041565)***	***0,11588**** ***(0,044285)***	***0,10189**** ***(0,041565)***
Consumer Price Index	0,051412 (0,072351)	0,051571 (0,073242)	0,051412 (0,072351)	-0,014553 (0,054598)	-0,025889 (0,056041)	-0,014553 (0,054598)
Total share prices	***-0,033934**** ***(0,0086253)***	***-0,033825**** ***(0,0087669)***	***-0,033934**** ***(0,0086253)***	***-0,010598**** ***(0,0049426)***	***-0,010272**** ***(0,0049635)***	***-0,010598**** ***(0,0049426)***
Volatility of stock price index	***-0,30946**** ***(0,10293)***	***-0,30846**** ***(0,10445)***	***-0,30946**** ***(0,10293)***	**-0,26647*** **(0,054868)**	***-0,28095**** ***(0,057136)***	***-0,26647**** ***(0,054868)***
Central Bank rates	0,53681 (6,95159)	0,54182 (7,0003)	0,53681 (6,9159)	5,1996 (3,4535)	4,974 (3,4680)	5,1996 (3,4535)
Asset purchases by Central Bank	***-0,0000035171**** ***(-0,0000015344)***	***-0,0000035157**** ***(-0,0000015531)***	***-0,0000035171**** ***(0,0000015344)***	***-0,0000019615**** ***(0,00000075482)***	***-0,000001955**** ***(0,00000075614)***	***0,0000019615*** ****(-0,00000075482)***
R-squared:	0,351	0,3481	0,35101	0,4263	0,43834	0,42626
Adjusted R-squared:	0,256	0,23402	0,25603	0,3423	0,34005	0,3423

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'. H_0: Variable not statistically significant to impact the dependent variable.*

We can see that the R-squared and adjusted R-squared of the regressions, metrics that determine the amount of the dependent variable that is explained by the model's independent variables, are very similar among all regressions. In order to confirm which is the best to explain the variance of our dependent variable, the following tests will be done:

- **F Test for individual effects**

This test allows us to determine if we have individual or fixed effects in our observations,

this is, if it's preferable to use a fixed effects model or a pooled OLS model.

- **Breusch Pagan Lagrange Multiplier test**

This test allows us to determine whether we have individual or random effects in our observations, this is, whether it is preferable to use a random effects model or a pooled OLS model.

- **Hausman test**

This test allows us to determine whether we use a fixed or random effects variant in our model applications.

Table 4-4 and Annexes I to N shows the p-value for these tests:

Table 4-4 - P-values for model determination tests.

	Bank-Based countries	Market-Based countries
F Test for individual effects (H_0:Pooled OLS preferred)	0,8927	0,3592
•Breusch Pagan Lagrange Multiplier test (H_0:Pooled OLS preferred)	0,3123	0,5643
Hausman test (H_0:Random effects preferred)	1	0,9909

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'*

Between the Pooled OLS, fixed effects and random effects models, the former is the preferred model, according to the tests done. As such, the Pooled OLS model is the one that we will be analyzing.

With the model chosen, we can proceed with tests to check whether the data that we have fulfills the assumptions needed for the Pooled OLS model to produce reliable results. As such, testing is needed for:

- Cross-sectional dependence – verifies whether cross-sectional units of a model are correlated or not. In a well fitted Pooled OLS model, there shouldn't be cross-sectional dependence. In Table 4-5 (annexes O and S), we can confirm the existence of cross-sectional dependence.

Table 4-5 - Breusch-Pagan LM test for cross-sectional dependence in panels.

	Pooled OLS for bank-based countries	Pooled OLS for market-based countries
Breusch-Pagan LM test for cross-sectional dependence in panels (H_0:Cross-sectional independence)	0,009983	0,00006744

Source: Author's elaboration using R Studio results.

The existence of cross-sectional dependence seems to be due to common events between the countries under study, an event that might impact them in similar way. The 2020 Covid-19 pandemic is very likely to be the reason for this cross-sectional dependence.

- Multicollinearity – verifies whether two or more independent variables are highly correlated between each other. In a well fitted Pooled OLS model, there shouldn't be multicollinearity. In Table 4-6 and 4-7 (annexes P and T), we can confirm the inexistence of significant multicollinearity.

Table 4-6 - Variance Inflation Factor for bank-based countries.

	Pooled OLS for bank-based countries					
	Debt-to-GDP ratio	Consumer Price Index	Total share prices	Volatility of stock price index	Central Bank rates	Asset purchases by Central Bank
Variance Inflation Factor (*VIF* = 1: No multicollinearity; 1 < *VIF* < 5: Non-significant multicollinearity; *VIF* > 5: Significant multicollinearity)	2,057497	1,174624	1,214717	2,397524	1,227425	1,467045

Source: Author's elaboration using R Studio results.

Table 4-7 - Variance Inflation Factor for market-based countries.

	Pooled OLS for market-based countries					
	Debt-to-GDP ratio	Consumer Price Index	Total share prices	Volatility of stock price index	Central Bank rates	Asset purchases by Central Bank
Variance Inflation Factor (*VIF* = 1: No multicollinearity; 1 < *VIF* < 5: Non-significant multicollinearity; *VIF* > 5: Significant multicollinearity)	2,233709	1,269398	1,237287	2,487435	1,20931	1,402705

Source: Author's elaboration using R Studio results.

- Serial correlation – verifies whether a variable is highly correlated with its lagged values. In a well fitted Pooled OLS model, there shouldn't be serial correlation. In Table 4-8 (Annexes Q and U), we can confirm the inexistence of serial correlation.

Table 4-8 - Breusch-Godfrey/Wooldridge test for serial correlation in panel models.

	Pooled OLS for bank-based countries	**Pooled OLS for market-based countries**
Breusch-Godfrey/Wooldridge test for serial correlation in panel models (H_0: No serial correlation in idiosyncratic errors)	0,2998	0,2299

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'*

- Heteroskedasticity – verifies whether the variance of the residuals of the model are constant or not over a range of values. In Table 4-9 (Annexes R and V), we can confirm the inexistence of heteroskedasticity.

Table 4-9 - Studentized Breusch-Pagan test.

	Pooled OLS for bank-based countries	**Pooled OLS for market-based countries**
Studentized Breusch-Pagan test (H_0: Homoscedasticity is present)	0,9419	0,2299

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'*

- Normality – verifies whether the residuals of the model follow a normal distribution. In Figure 4-1, we can confirm a normal distribution for the residuals.

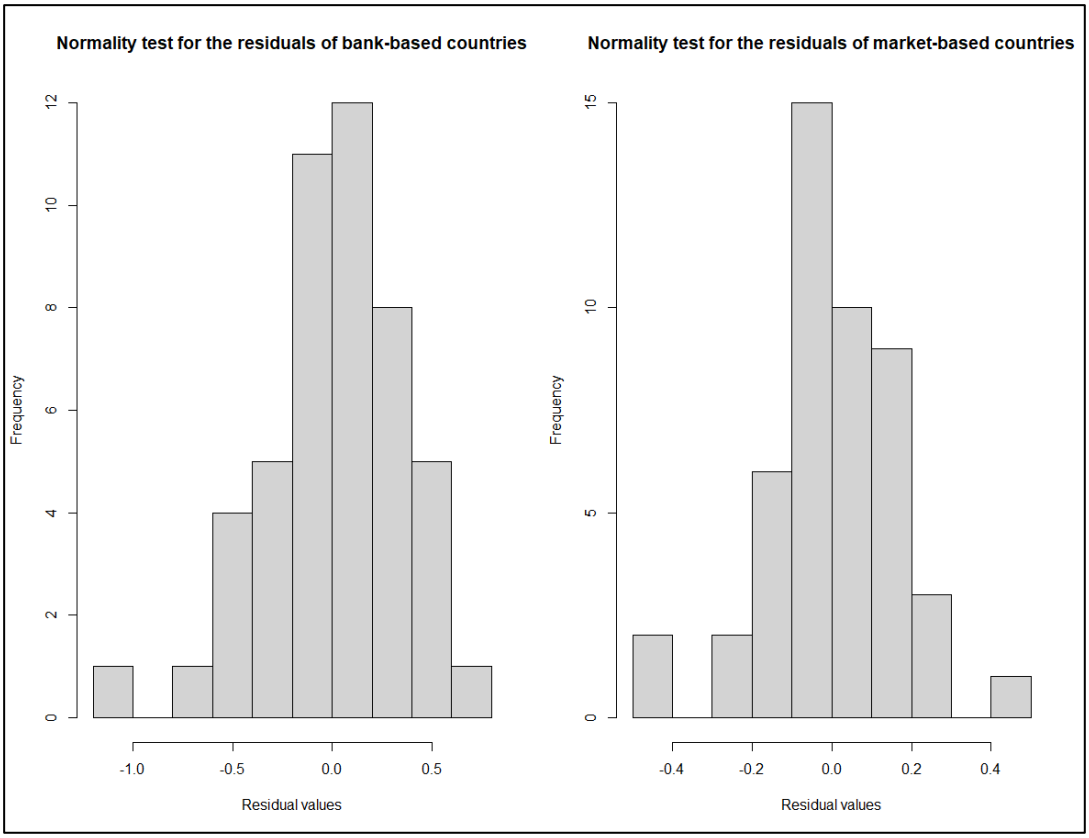


Figure 4-1 - Normality test for the residuals of bank-based and market-based countries. Source: R Studio.

With the tests for the model's assumptions made, we confirm that four of the five criteria were met. In order to solve the cross-sectional dependence, the estimation of a robust covariance matrix of parameters is needed, according to Driscoll and Kraay (1998). In Table 4-10 (Annex W and X), this transformation has been done, with the re-estimation of the p-values for the independent variables:

Table 4-10 – P-value of the Pooled OLS regression after robust covariance matrix transformation.

Dependent variable / Independent variables	Ten-year bond yield	
	Bank-Based countries	Market-Based countries
	Pooled OLS	Pooled OLS
Debt-to-GDP ratio	***0,083839** ***(0,038138)***	***0,10189***** ***(0,017300)***
Consumer Price Index	0,051412 (0,054908)	-0,014553 (0,067394)
Total share prices	***-0,033934***** ***(0,0048703)***	***-0,010598*** ***(0,0048784)***
Volatility of stock price index	***-0,30946***** ***(0,069544)***	***-0,26647***** ***(0,036225)***
Central Bank rates	0,53681 (3,1505)	***5,1996**** ***(1,7169)***
Asset purchases by Central Bank	***-0,0000035171***** ***(0,00000080445)***	***-0,0000019615**** ***(0,00000068374)***

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'. H_0: Variable not statistically significant to impact the dependent variable.*

We can observe that we have four statistically significant variables for bank-based countries, for a confidence interval of 5%: (i) the Debt-to-GDP ratio; (ii) the total share prices; (iii) the volatility of stock price index; and (iv) the asset purchases by the corresponding Central Bank. We have the same for the market-based countries, with the addition of the Central Bank rates.

For Debt-to-GDP ratio, a 1% increase will cause rise of 0,083839% on long-term yields in bank-based countries, while in market-based countries the rise will be higher, with an impact of 0,10189%. This positive impact, in both groups of countries, of the long-term yields, caused by the positive shock on the Debt-to-GDP ratio goes in line with what Baldacci and S. Kumar (2010) have stated previously. There is an interesting difference between the two financial structures, where there seems to be a higher effect of Debt-to-GDP ratio in market-based countries. Gruber and Kamin (2010) do find similar results for OECD countries, where the G-7 (U.S., Germany, U.K., Japan, Italy, Canada and France) have an impact of 0,15% on long-term yields with a variation of 1% from the Debt-to-GDP ratio, while non G-7 countries have half of that. The explanation for this higher effect of public debt on the yields of market-based countries may be due to the fact that bonds are more market-driven, where the worsening of

macroeconomic conditions is reflected more strongly in the bond's market.

There seems to be no statistically significant impact of the CPI in the long-term yields, which goes against what Krishnamurthy and Annette (2011) found about the transmission of QE through an inflation channel.

Total share prices have a negative impact on long-term yields in both financial structures, with an increase of 1% of the prices causing a 0,033934% reduction on yields in bank-based countries, and a 0,010598% reduction in market-based countries. As stated by Joyce et al. (2010) and Stefanski (2022), this increase of stock prices caused by a decrease in long-term yields reflects a portfolio-balancing channel, where investors turn their attention into more profitable assets when long-term yields are lower. We can also observe that there is a stronger impact in bank-based countries. Christensen and Rudebusch (2012) mention that a stronger portfolio balance channel will be felt in more illiquid bond markets, due to a higher impact of the liquidity risk in the premium of a bond. I.C. Cabral et al. (2019) corroborate this view, with a study in euro area countries focusing on the relationship between equities and sovereign bonds, finding that during the sovereign debt crisis, bonds with higher credit and liquidity risk had their yields increased, leading also to a downward trend in equity indices due to companies in these countries being perceived as having higher borrowing costs and lower demand. As such, these views can explain the stronger impact on countries with this financial structure.

The volatility of the stock price index follows a similar effect to the total share prices, but with a higher impact on long-term yields, with a decrease of 0,30946% in bank-based countries and a decrease of 0,26647% in market-based countries. This follows what the literature has written about in this subject, mainly Stefanski (2022) and Kumar et al. (2017), where this effect is attributed to an uncertainty channel by the former, and to a portfolio balance channel by the latter, as when there is an increase in volatility in the stock market, the investors turn away from these riskier assets, and in turn invest in safer assets like bonds, consequently causing long-term yields to fall. Like with the total share prices, there is a higher impact on the long-term yields of bank-based countries, due to the relative lack of liquidity of the bond market, when compared to market-based countries.

The main difference between bank-based and market-based countries resides in the Central Bank rates' impact on the long-term yields. Indeed, while there is no statistical significance of the impact in the former, there is a statistic significant impact in the latter, with a variation of 1% of the rates causing an increase in the long-term yields of market-based countries around 5,1996%. It's well studied and known in the literature that an increase of Central Bank rates will impact short term rates, causing investors to divert their funds to bank deposits, which in

turn lowers bond prices and increases their long-term yields. The lack of impact in long-term yields in bank-based countries can be explained with the study conducted by Leombroni et al. (2021). They find that, during the sovereign debt crisis, while core countries in Europe (like Germany and France) had their yields significantly lowered after communications about conventional monetary policy from the ECB (effectively confirming a signaling channel), peripheral countries (like Italy and Spain) were immune to these changes. This immunity was caused by an increase in credit risk premium, which offset the dovish attitude from the ECB.

We also have a decrease in the long-term yields with the asset purchases by the ECB. For 100 billion euros of assets purchased, there is a decrease on long-term yields of 0,35171% in bank-based countries, while it's about half of that value for market-based countries, with an impact of 0,19615%. The stronger effect in bank-based countries can be explained by the added liquidity to the bond market, which causes a diminishing of the liquidity risk and, consequently, of the long-term yields. This uncertainty channel allows investors to feel safe when investing in the sovereign debt of a bank-based country, due to the prospect of QE programs' large asset purchases of these.

With these results, we can find that QE effects are stronger in the ten-year long-term yields of bank-based countries. The transmission to the real economy for this financial system is mainly done through a portfolio balance channel and an uncertainty channel (through the impact of total share prices and in stock market volatility), while for market-based countries we additionally have a signaling channel present (through the central bank rates impact). In neither of them we have an inflation channel.

We can also conclude that, in bank-based countries, a combination of conventional monetary policy, mainly interest rates, with QE, can help prevent the effects of rising inflation and the consequent default risk due to the rise in yields, as the large asset purchases done by the Central Bank will keep long-term yields low while the interest rates rise. This can be a potential strategy to be adopted for countries with this financial system, in order to prevent a sovereign debt crisis, like the one that has happened in Europe, in the past decade.

5. Robustness tests

In the Pooled OLS model, the dependent variable used to answer the question proposed by this Dissertation is the ten-year long-term yield. For the robustness tests, yields of medium/long-term with different maturities will be used. Five-year bond yields and twenty-year bond yields will be used in order to infer whether the effects on the ten-year bond yield will be similar to those of other maturities.

In Table 5-1 (Annexes Y to BB), we can find the results for these different maturities:

Table 5-1 - P-value of the Pooled OLS regression after robust covariance matrix transformation for five and twenty-year bond yields.

Dependent variable / **Independent variables**	**5-year bond yield**		**20-year bond yield**	
	Bank-Based countries	Market-Based countries	Bank-Based countries	Market-Based countries
	Pooled OLS	Pooled OLS	Pooled OLS	Pooled OLS
Debt-to-GDP ratio	***0,099926**** ***(0,046001)***	***0,083005***** ***(0,014455)***	*0,089497* *(0,062376)*	***0,1407***** ***(0,037993)***
Consumer Price Index	*-0,051839* *(0,080985)*	*-0,024369* *(0,049624)*	*0,08931* *(0,14027)*	*0,066403* *(0,13567)*
Total share prices	*-0,00018565* *(0,0076435)*	*0,0047019* *(0,0036959)*	*-0,0028257* *(0,011075)*	*-0,0010278* *(-0,0096867)*
Volatility of stock price index	***-0,25079**** ***(0,086242)***	***-0,20142***** ***(0,021514)***	***-0,23679**** ***(0,11014)***	***-0,34756***** ***(0,091992)***
Central Bank rates	*-1,5635* *(3,6760)*	***6,3493***** ***(0,92658)***	*4,8356* *(5,7047)*	***17,231***** ***(3,6388)***
Asset purchases by Central Bank	***-0,000005115***** ***(0,0000011262)***	***-0,0000021144***** ***(0,00000046698)***	***-0,0000055606**** ***(0,0000020186)***	***-0,0000045268**** ***(-0,0000015814)***

*Source: Author's elaboration using R Studio results. Caption: p-value < 0,001 '***'; p-value < 0,01 '**'; p-value < 0,05 '*'. H_0: Variable not statistically significant to impact the dependent variable.*

There are differences found with yields of different maturities.

- Debt-to-GDP ratio has no statistical significance on the twenty-year yield in bank-based countries. This may be due to the lack of liquidity of the twenty-year yield, added to the less market-driven financial structure, which contributed to less trading activity and, therefore, less impact on this specific maturity, where mainly institution investors and pension funds typically hold them until their maturity;
- Total share prices have no statistical significance in these maturities. The portfolio balance channel seems to not be a contributing transmission channel of QE to the five-year and twenty-year yields;

- Central Bank rates have a much more considerable impact in twenty-year long-term yields, in market-based countries, accounting for a change in 17,231%. As the rates increase, holders of twenty-year bond yields have a stronger incentive to divert their funds to bank deposits, in order to receive a higher return on their investment and avoid the term premium associated with the long-term bond yields.
- There's a higher impact of QE on five-year and twenty-year bonds, compared to ten-year bond yields. This can be explained by a stronger impact of the added liquidity in these two maturities, as they are less liquid than the ten-year yield.

With these heterogeneous behaviors, we can ascertain that QE still remains stronger in bank-based countries, rather than market-based countries. This appears to be more significant for the five-year and twenty-year yields. There seems to be a smaller role of the portfolio balance channel acting in these maturities.

6. Conclusion

QE has been an important part of the monetary policy of Central Banks around the world for the last two decades. The large asset purchases done under this program had the objective of decreasing long-term yields and improving lending and borrowing by economic agents, serving as a way to circulate even more money into the economy when interest rates reach zero. As countries have different economic and financial systems, it is important to know whether QE plays a distinct role in these. This research aims at answering this specific question, which is understanding whether QE is more effective and how it transmits to the economy in countries that have a financial system that is more bank-based (where the bank plays a leading role in finance and investment allocation for private agents) or market-based (where private agents go primarily to the capital markets to look for financing and investment). The importance of this question is a very relevant topic in today's global economy. A rise in inflation above the 2% threshold established by the Central Banks enforces them to raise the lending rates in an effort to restrain the circulation of money in the economy. However, this provokes a more strenuous relationship between the economy and its debt sector, as more interest will have to be paid as a consequence of a rate's rise. QE can indirectly alleviate this impact in the economy by providing targeted liquidity for creditors, mainly countries, by buying bonds and debt instruments in order to prevent default risk taking over their financing in the market, as it nearly happened throughout the European sovereign debt crisis.

For this Dissertation, two panel data regressions were used, namely two Pooled OLS regressions, one to account for bank-based countries and the other one for market-based countries. Quarterly data was extracted from 2015 to 2020, accounting for the recuperation from the European sovereign debt crisis until the start of the recuperation from the economic recession caused by the Covid-19 pandemic. The ten-year long-term yield was used as the dependent variable, while for the independent variables two macroeconomic variables (Debt-to-GDP ratio and CPI), two financial variables (total share prices and volatility of the stock price index) and two monetary policy variables (Central Bank rates and asset purchases by the Central Bank) were used. The independent variables were not only used to observe their impact on the long-term yield, but also to identify the transmission channels for QE for each financial system.

The empirical results obtained with this research show that QE has a statistically significant impact in ten-year long-term yields in both bank-based and market-based countries, with an impact of -0,35171% in the first and -0,19615% in the second, for 100 billion euros of asset purchases. This reveals that QE has about double the impact in bank-based countries, than

market-based countries, revealing a higher effectiveness in lowering long-term yields in financial systems where banks play a bigger role in transferring wealth from creditors to debtors The explanation for this difference is related to the more impact of the added liquidity in the bond market that QE provides, which causes a more significant decrease in liquidity risk in countries that have a smaller volume of market activity for these products. It has also shown that, for both financial systems, the impact is transmitted to the economy via a portfolio balance channel, through an increase in stock prices, which reflects the transfer of investors' capital from long-term yields to the stock market, and through an uncertainty channel, where investors turn their capital to less risky assets, like bonds, when market volatility increases. In both these channels, there is a higher impact in the ten-year long-term yield for bank-based countries, with an increase of 1% in stock prices causing a decrease of 0,033934% in the ten-year long-term yield (0,010598% for market-based countries) and an increase of 1% in stock market volatility causing a decrease of 0,30946% in the ten-year long-term yield (0,26647%) for market-based countries. Additionally, there is a signaling channel only statistically significant for market-based countries, identified through a positive impact of Central Bank rates in long-term yields, amounting to 5,1996%. This channel works through communication of the Central Banks of an interest rate decrease, which in turn causes investors to turn their funds from bank deposits to long-term yields, expecting future economic growth from this conventional monetary policy. Robustness tests using five-year and twenty-year long-term yields also confirm the impact of QE in these, with a stronger impact than in the ten-year long-term yield and with different transmission channels.

This research provides a new insight into a relatively unexplored topic such as QE's impact into different financial systems, demonstrating an important breakthrough about the use of conventional monetary policy mixed with unconventional monetary policy. It shows that, for bank-based countries, inflationary forces that pressure the Central Bank to raise interest rates and, therefore, increase long-term yields, can be attenuated with QE activity, which will decrease the yields and allow countries to then mitigate default risk.

There are some limitations in this paper. Although the countries were chosen according to Bijlsma et al. (2013)'s definition of bank-based and market-based countries, the number used in the research can be increased in order to obtain confirmation about QE's impact on long-term yields. The QE period frame is also relatively recent, where the ECB's only starts since 2015, not allowing for an observation during the peak of the global financial crisis and the European sovereign debt crisis.

Further studies in this field can expand this comparison between QE in different financial

systems by including: (i) more bank-based and market-based countries in the Eurozone; (ii) comparing different bank-based and market-based countries with their own Central Bank's QE program in order to evaluate if the impact in long-term yields is different based on the Central Bank and (iii) discerning and identifying the impact in long-term yields by the type of assets purchased in the QE program, like MBS, corporate bonds, agency debt, in countries with different financial systems.

As economic growth stagnates around Europe and inflation rises due to geopolitical tensions that escalate to wars, the ECB has an increasing demand from member countries and its citizens to not only curb inflationary pressure, but also alleviate private and public institutions in the interest rate's growth. QE can play an important role in this scenario. As Bernanke (2012) disclosed in his speech about monetary policy and its impact since the start of the global financial crisis, about QE:

> "Large-scale asset purchases can influence financial conditions and the broader economy through other channels as well … During stressful periods, asset purchases may also improve the functioning of financial markets, thereby easing credit conditions in some sectors.".

7. References

Baldacci, E. and Kumar, M.S., 2010. Fiscal Deficits, Public Debt, and Sovereign Bond Yields. *IMF* [Online]. WP/10/184 [viewed 22 February 2024]. Available on: Fiscal Deficits, Public Debt, and Sovereign Bond Yields (imf.org).

Bernanke, B.S., 2012. *Monetary Policy since the Onset of the Crisis.* [Online]. [viewed 29 June 2024]. Available on: Speech by Chairman Bernanke on monetary policy since the onset of the crisis - Federal Reserve Board

Bijlsma, Michiel J., Zwart, Gijsbert T. J. 2013. The changing landscape of financial markets in Europe, the United States and Japan. *Bruegel* [Online]. No. 2013/02 [viewed 18 November 2023]. Available on: EconStor: The changing landscape of financial markets in Europe, the United States and Japan

Brooks, C., 2008. *Introductory Econometrics for Finance*. 2nd ed. New York: Cambridge University Press.

Burriel, P. and Galesi, A., 2016. Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries. *Bank of Spain* [Online]. No. 1631 [viewed 21 November 2023]. Available on: Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries - ScienceDirect

Cabral, I.C., Ribeiro, P.P. and Nicolau, J., 2019. Tracking the relationship between euro area equities and sovereign bonds. *Int. J. Monetary Economics and Finance* [Online]. Volume 12 (No. 6), 511–537 [viewed 23 March 2024]. Available on: Tracking the relationship between euro area equities and sovereign bonds (utl.pt).

Christensen, J.H.E. and Rudebusch, G.D., 2012. The Response of Interest Rates to US and UK Quantitative Easing. *Federal Reserve Bank Of San Francisco* [Online]. No. 2012-06 [viewed 7 August 2013]. Available on: The Response of Interest Rates to U.S. and U.K. Quantitative Easing (frbsf.org)

Demirguc-Kunt, A. and Levine, R., 1999. Bank-based and market-based financial systems: cross-country comparisons. *Policy Research* [Online]. No. 2143 [viewed 7 June 2023]. Available on: Bank-Based and Market-Based Financial Systems: Cross-Country Comparisons by Asli Demirgüç-Kunt, Ross Levine :: SSRN

Driscoll, J.C. and Kraay, A.C., 1998. Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *The Review of Economics and Statistics* [Online]. Volume 80 (No. 4), 549-560 [viewed 22 February 2024]. Available on: (PDF)

Consistent covariance matrix estimation with spatially dependent data (researchgate.net).

Duguid, K. and Smith, C., 2022. *'The market is just dead': Investors steer clear of 20-year Treasuries.* [Online] [viewed 6 April 2024]. Available on: 'The market is just dead': Investors steer clear of 20-year Treasuries (ft.com).

Eurostat, 2024. *Business Cycle Clock.* [Online]. [viewed 13 March 2023] Available on: Business Cycle Clock (europa.eu).

Gagnon, J., Raskin, M., Remache, J., and Sack, B., 2011 The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases. *International Journal of Central Banking* [Online]. Volume 7 No. 1 [viewed 4 August 2023]. Available on: The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases (ijcb.org)

Gruber, J.W. and Kamin, S.B., 2010. Fiscal Positions and Government Bond Yields in OECD Countries. *International Finance Discussion Papers* [Online]. No. 1011 [viewed 4 May 2024]. Available on: FRB: Fiscal Positions and Government Bond Yields in OECD Countries (federalreserve.gov).

Joyce, M., Lasaosa, A., Stevens, I., and Tong, M., 2010. The financial market impact of quantitative easing. *Bank of England* [Online]. No. 393 [viewed 14 March 2023]. Available on: The financial market impact of quantitative easing | Bank of England

Kenton, W., 2021. *European Sovereign Debt Crisis: Eurozone Crisis Causes, Impacts*. [Online]. [viewed 29 March 2024]. Available on: European Sovereign Debt Crisis: Eurozone Crisis Causes, Impacts (investopedia.com).

Kumar, A., Mallick, S., Mohanty, M.S. and Zampolli, F., 2017. Market volatility, monetary policy and the term premium. *BIS* [Online]. No. 606 [viewed 16 September 2023]. Available on: Market Volatility, Monetary Policy and the Term Premium by Sushanta Mallick, Madhusudan S. Mohanty, Fabrizio Zampolli :: SSRN.

Krishnamurthy, A. and Annette, V. J., 2011. The effects of Quantitative Easing on interest rates: channels and implications for policy. *NBER* [Online]. No. 17555 [viewed 10 November 2022]. Available on: The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy | NBER

Leombroni, M., Vedolin, A.,Venter, G. and Whelan, P., 2021. Central Bank Communication and the Yield Curve. *Journal of Financial Economics* [Online]. Volume 141 [viewed 2 April 2024]. Available on: Central Bank Communication

and the Yield Curve by Matteo Leombroni, Andrea Vedolin, Gyuri Venter, Paul Whelan :: SSRN

Singh, M., 2023. *The 2007–2008 Financial Crisis in Review*. [Online]. [viewed 28 June 2024]. Available on: The 2007–2008 Financial Crisis in Review (investopedia.com).

Stefanski, M., 2022. Macroeconomic effects and transmission channels of quantitative easing. *Economic Modelling* [Online]. Volume 114 [viewed 15 September 2022]. Available on: Macroeconomic effects and transmission channels of quantitative easing - ScienceDirect

Thornton, D., 2014. QE: Is There a Portfolio Balance Effect? *Federal Reserve Bank of St. Louis Review* [Online]. No. 96 [viewed 4 July 2023]. Available on: QE: Is There a Portfolio Balance Effect? - Review - St. Louis Fed (stlouisfed.org)

Ullah, G.M.W. and Ahmed, S.P., 2014. A review of European sovereign debt crisis: Causes and consequences. *International Journal of Business and Economics Research* [Online]. Volume 3, No. 2 [viewed 14 July 2023]. Available on: (PDF) A review of European sovereign debt crisis: Causes and consequences (researchgate.net)

Weale, M. and Wieladek, T., 2016. What are the macroeconomic effects of asset purchases? *Journal of Monetary Economics* [Online]. Volume 79, 81-93 [viewed 25 October 2023]. Available on: What are the macroeconomic effects of asset purchases? - ScienceDirect

Woodford, M., 2016. Quantitative easing and financial stability. *NBER* [Online]. No. 22285 [viewed 14 October 2023]. Available on: Quantitative Easing and Financial Stability | NBER

Wooldridge, J. M., 2009. *Introductory Econometrics: A Modern Approach*. 5th ed. South-Western: Cengage Learning.

8. Annexes

Dependent variable	Code	Unit of measure	Description	Related articles	Source
Ten-year bond yield	**yield**	Percentage	Quarterly values of the Ten-year bond yields of each country.	Joyce et al. (2010), Gagnon et al. (2011), Thornton (2014), Baldacci and S. Kumar (2010), Krishnamurthy and Annette (2011), Stefanski (2022), Weale and Wieladek (2016), Christensen and Rudebusch (2012).	FRED.

Annex A - Dependent variable description.

Source: Author's elaboration.

Independent variables	Code	Unit of measure	Description	Related articles	Source	Predicted impact
Debt-to-GDP ratio	**debt**	Percentage	Quarterly values of the general government gross debt-to-GDP ratio of each country.	Baldacci and S. Kumar (2010).	OECD.	**(+)** impact on dependent variable.
Consumer Price Index	**cpi**	Index	Quarterly values of the CPI of each country.	Weale and Wieladek (2016), Kumar et al. (2017).	FRED.	**(-)** impact on dependent variable.
Total share prices	**shares**	Index	Quarterly values of all share prices for all	Joyce et al. (2010), Stefanski (2022), Weale	FRED.	**(-)** impact on dependent variable.

			shares of each country.	and Wieladek (2016), Kumar et al. (2017), Burriel and Galesi (2016).		
Volatility of stock price index	**volat**	Percentage	Quarterly values of the volatility of the stock price index of each country.	Stefanski (2022), Kumar et al. (2017).	FRED.	**(-)** impact on dependent variable.
Central bank rates	**cbrates**	Percentage	Quarterly rate of the Marginal Lending Facility rate for the ECB	Stefanski (2022), Kumar et al. (2017).	FRED	**(+)** impact on dependent variable.
Asset purchases by central bank	**cbpurch**	Millions of Euros	Quarterly values of assets bought under the ECB's asset purchase programme.	Joyce et al. (2010), Gagnon et al. (2011), Krishnamurthy and Annette (2011), Stefanski (2022).	ECB.	**(-)** impact on dependent variable.

Annex B - Independent variable description.

Source: Author's elaboration. Caption: (+) positive impact; (-) negative impact.

```
Pooling Model

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = bnkdf, model = "pooling", index = c("Countries",
    "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-1.082260 -0.175530  0.054111  0.205523  0.689744

Coefficients:
               Estimate  Std. Error t-value  Pr(>|t|)
(Intercept) -6.3245e-02  5.6248e-02 -1.1244 0.2673853
debt         8.3839e-02  5.4574e-02  1.5362 0.1321620
cpi          5.1412e-02  7.2351e-02  0.7106 0.4813633
shares      -3.3934e-02  8.6253e-03 -3.9342 0.0003154 ***
volat       -3.0946e-01  1.0293e-01 -3.0065 0.0044978 **
cbrates      5.3681e-01  6.9159e+00  0.0776 0.9385080
cbpurch     -3.5171e-06  1.5344e-06 -2.2922 0.0271019 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    8.2258
Residual Sum of Squares: 5.3385
R-Squared:      0.35101
Adj. R-Squared: 0.25603
F-statistic: 3.69579 on 6 and 41 DF, p-value: 0.0050036
```

Annex C - Pooled OLS model for bank-based countries.

Source: R Studio.

```
Oneway (individual) effect Within Model

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = bnkdf, model = "within", index = c("Countries",
    "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-1.089613 -0.181403  0.053402  0.207188  0.682274

Coefficients:
           Estimate  Std. Error t-value  Pr(>|t|)
debt     8.3079e-02  5.5522e-02  1.4963 0.1424188
cpi      5.1571e-02  7.3242e-02  0.7041 0.4854416
shares  -3.3825e-02  8.7669e-03 -3.8583 0.0004065 ***
volat   -3.0846e-01  1.0445e-01 -2.9532 0.0052439 **
cbrates  5.4182e-01  7.0003e+00  0.0774 0.9386912
cbpurch -3.5157e-06  1.5531e-06 -2.2636 0.0290936 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    8.1854
Residual Sum of Squares: 5.3361
R-Squared:      0.3481
Adj. R-Squared: 0.23402
F-statistic: 3.55991 on 6 and 40 DF, p-value: 0.0064185
```

Annex D - Fixed effects model for bank-based countries.

Source: R Studio.

```
Oneway (individual) effect Random Effect Model
   (Wallace-Hussain's transformation)

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = bnkdf, model = "random", random.method = "walhus",
    index = c("Countries", "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Effects:
                 var std.dev share
idiosyncratic 0.1160  0.3406     1
individual    0.0000  0.0000     0
theta: 0

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-1.082260 -0.175530  0.054111  0.205523  0.689744

Coefficients:
               Estimate  Std. Error z-value  Pr(>|z|)
(Intercept) -6.3245e-02  5.6248e-02 -1.1244  0.260845
debt         8.3839e-02  5.4574e-02  1.5362  0.124480
cpi          5.1412e-02  7.2351e-02  0.7106  0.477341
shares      -3.3934e-02  8.6253e-03 -3.9342 8.347e-05 ***
volat       -3.0946e-01  1.0293e-01 -3.0065  0.002643 **
cbrates      5.3681e-01  6.9159e+00  0.0776  0.938130
cbpurch     -3.5171e-06  1.5344e-06 -2.2922  0.021896 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    8.2258
Residual Sum of Squares: 5.3385
R-Squared:      0.35101
Adj. R-Squared: 0.25603
Chisq: 22.1748 on 6 DF, p-value: 0.0011257
```

Annex E - Random effects model for bank-based countries.

Source: R Studio.

```
Pooling Model

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = mktdf, model = "pooling", index = c("Countries",
    "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.4437031 -0.0739853 -0.0017236  0.1099221  0.4589983

Coefficients:
               Estimate  Std. Error t-value  Pr(>|t|)
(Intercept) -1.6824e-02  3.1472e-02 -0.5346   0.59583
debt         1.0189e-01  4.1565e-02  2.4514   0.01858 *
cpi         -1.4553e-02  5.4598e-02 -0.2665   0.79116
shares      -1.0598e-02  4.9426e-03 -2.1442   0.03799 *
volat       -2.6647e-01  5.4868e-02 -4.8567 1.777e-05 ***
cbrates      5.1996e+00  3.4535e+00  1.5056   0.13984
cbpurch     -1.9615e-06  7.5482e-07 -2.5987   0.01294 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    2.355
Residual Sum of Squares: 1.3512
R-Squared:      0.42626
Adj. R-Squared: 0.3423
F-statistic: 5.07691 on 6 and 41 DF, p-value: 0.00056319
```

Annex F - Pooled OLS model for market-based countries.

Source: R Studio.

```
Oneway (individual) effect Within Model

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = mktdf, model = "within", index = c("Countries",
    "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-0.426663 -0.097891  0.004986  0.085290  0.481918

Coefficients:
           Estimate  Std. Error t-value Pr(>|t|)
debt     1.1588e-01  4.4285e-02  2.6168  0.01247 *
cpi     -2.5889e-02  5.6041e-02 -0.4620  0.64661
shares  -1.0272e-02  4.9635e-03 -2.0696  0.04499 *
volat   -2.8095e-01  5.7136e-02 -4.9173 1.54e-05 ***
cbrates  4.9740e+00  3.4680e+00  1.4343  0.15927
cbpurch -1.9550e-06  7.5614e-07 -2.5854  0.01348 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    2.355
Residual Sum of Squares: 1.3227
R-Squared:      0.43834
Adj. R-Squared: 0.34005
F-statistic: 5.20287 on 6 and 40 DF, p-value: 0.00048919
```

Annex G - Fixed effects model for market-based countries.

Source: R Studio.

```
Oneway (individual) effect Random Effect Model
   (Wallace-Hussain's transformation)

Call:
plm(formula = yield ~ debt + cpi + shares + volat + cbrates +
    cbpurch, data = mktdf, model = "random", random.method = "walhus",
    index = c("Countries", "Quarters"), test = "adf")

Balanced Panel: n = 2, T = 24, N = 48

Effects:
                  var std.dev share
idiosyncratic 0.02884 0.16982     1
individual    0.00000 0.00000     0
theta: 0

Residuals:
      Min.    1st Qu.     Median    3rd Qu.       Max.
-0.4437031 -0.0739853 -0.0017236  0.1099221  0.4589983

Coefficients:
               Estimate  Std. Error z-value  Pr(>|z|)
(Intercept) -1.6824e-02  3.1472e-02 -0.5346  0.592939
debt         1.0189e-01  4.1565e-02  2.4514  0.014231 *
cpi         -1.4553e-02  5.4598e-02 -0.2665  0.789821
shares      -1.0598e-02  4.9426e-03 -2.1442  0.032014 *
volat       -2.6647e-01  5.4868e-02 -4.8567 1.194e-06 ***
cbrates      5.1996e+00  3.4535e+00  1.5056  0.132171
cbpurch     -1.9615e-06  7.5482e-07 -2.5987  0.009358 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    2.355
Residual Sum of Squares: 1.3512
R-Squared:      0.42626
Adj. R-Squared: 0.3423
Chisq: 30.4615 on 6 DF, p-value: 3.2112e-05
```

Annex H - Random effects model for market-based countries.

Source: R Studio.

```
        F test for individual effects

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
F = 0.018417, df1 = 1, df2 = 40, p-value = 0.8927
alternative hypothesis: significant effects
```

Annex I - F Test for bank-based countries.

Source: R Studio.

```
        Lagrange Multiplier Test - (Breusch-Pagan)

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 1.021, df = 1, p-value = 0.3123
alternative hypothesis: significant effects
```

Annex J - Breusch-Pagan Lagrange Multiplier Test for bank-based countries.

Source: R Studio.

```
        Hausman Test

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 0.0080255, df = 6, p-value = 1
alternative hypothesis: one model is inconsistent
```

Annex K - Hausman test for bank-based countries.

Source: R Studio.

```
        F test for individual effects

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
F = 0.86024, df1 = 1, df2 = 40, p-value = 0.3592
alternative hypothesis: significant effects
```

Annex L - F Test for market-based countries.

Source: R Studio.

```
        Lagrange Multiplier Test - (Breusch-Pagan)

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 0.33228, df = 1, p-value = 0.5643
alternative hypothesis: significant effects
```

Annex M - Breusch-Pagan Lagrange Multiplier Test for market-based countries.

Source: R Studio.

```
        Hausman Test

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 0.84226, df = 6, p-value = 0.9909
alternative hypothesis: one model is inconsistent
```

Annex N - Hausman test for market-based countries.

Source: R Studio.

```
        Breusch-Pagan LM test for cross-sectional dependence in panels

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 6.638, df = 1, p-value = 0.009983
alternative hypothesis: cross-sectional dependence
```

Annex O - Breusch-Pagan LM test for cross-sectional dependence in panels for bank-based countries.

Source: R Studio.

```
    debt      cpi   shares    volat  cbrates  cbpurch
2.057497 1.174624 1.214717 2.397524 1.227425 1.467045
```

Annex P - Variance Inflation Factor for bank-based countries.

Source: R Studio.

```
        Breusch-Godfrey/Wooldridge test for serial correlation in panel models

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 27.101, df = 24, p-value = 0.2998
alternative hypothesis: serial correlation in idiosyncratic errors
```

Annex Q - Breusch-Godfrey/Wooldridge test for serial correlation in panel models for bank-based countries.

Source: R Studio.

```
        studentized Breusch-Pagan test

data:  bnkolsp
BP = 1.7413, df = 6, p-value = 0.9419
```

Annex R - Studentized Breusch-Pagan test for bank-based countries.

Source: R Studio.

```
        Breusch-Pagan LM test for cross-sectional dependence in panels

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 15.881, df = 1, p-value = 6.744e-05
alternative hypothesis: cross-sectional dependence
```

Annex S - Annex 15 - Breusch-Pagan LM test for cross-sectional dependence in panels for market-based countries.

Source: R Studio.

```
    debt      cpi   shares    volat  cbrates  cbpurch
2.233709 1.269398 1.237287 2.487435 1.209310 1.402705
```

Annex T - Variance Inflation Factor for market-based countries.

Source: R Studio.

```
        Breusch-Godfrey/Wooldridge test for serial correlation in panel models

data:  yield ~ debt + cpi + shares + volat + cbrates + cbpurch
chisq = 28.744, df = 24, p-value = 0.2299
alternative hypothesis: serial correlation in idiosyncratic errors
```

Annex U - Breusch-Godfrey/Wooldridge test for serial correlation in panel models for market-based countries.

Source: R Studio.

```
        studentized Breusch-Pagan test

data:  mktolsp
BP = 1.6863, df = 6, p-value = 0.9462
```

Annex V - Studentized Breusch-Pagan test for market-based countries.

Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value  Pr(>|t|)
(Intercept) -6.3245e-02  6.4919e-02 -0.9742   0.33567
debt         8.3839e-02  3.8138e-02  2.1983   0.03363 *
cpi          5.1412e-02  5.4908e-02  0.9363   0.35459
shares      -3.3934e-02  4.8703e-03 -6.9675 1.832e-08 ***
volat       -3.0946e-01  6.9544e-02 -4.4499 6.448e-05 ***
cbrates      5.3681e-01  3.1505e+00  0.1704   0.86554
cbpurch     -3.5171e-06  8.0445e-07 -4.3720 8.225e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Annex W - Robust Covariance Matrix Estimator for bank-based countries.

Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value  Pr(>|t|)
(Intercept) -1.6824e-02  2.3521e-02 -0.7153  0.478478
debt         1.0189e-01  1.7300e-02  5.8896 6.210e-07 ***
cpi         -1.4553e-02  6.7394e-02 -0.2159  0.830109
shares      -1.0598e-02  4.8784e-03 -2.1724  0.035659 *
volat       -2.6647e-01  3.6225e-02 -7.3560 5.204e-09 ***
cbrates      5.1996e+00  1.7169e+00  3.0284  0.004240 **
cbpurch     -1.9615e-06  6.8374e-07 -2.8689  0.006483 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Annex X - Robust Covariance Matrix Estimator for market-based countries.

Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value Pr(>|t|)
(Intercept) -7.0084e-02  7.1978e-02 -0.9737 0.335924
debt         9.9926e-02  4.6001e-02  2.1723 0.035671 *
cpi         -5.1839e-02  8.0985e-02 -0.6401 0.525666
shares      -1.8565e-04  7.6435e-03 -0.0243 0.980740
volat       -2.5079e-01  8.6242e-02 -2.9080 0.005848 **
cbrates     -1.5635e+00  3.6760e+00 -0.4253 0.672832
cbpurch     -5.1150e-06  1.1262e-06 -4.5418 4.83e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Annex Y - Robust Covariance Matrix Estimator for bank-based countries with five-year bond yields.

Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value  Pr(>|t|)
(Intercept) -8.5771e-03  2.1925e-02 -0.3912    0.6977
debt         8.3005e-02  1.4455e-02  5.7421 1.006e-06 ***
cpi         -2.4369e-02  4.9624e-02 -0.4911    0.6260
shares       4.7019e-03  3.6959e-03  1.2722    0.2105
volat       -2.0142e-01  2.1514e-02 -9.3619 9.797e-12 ***
cbrates      6.3493e+00  9.2658e-01  6.8524 2.664e-08 ***
cbpurch     -2.1144e-06  4.6698e-07 -4.5279 5.047e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Annex Z - Robust Covariance Matrix Estimator for market-based countries with five-year bond yields.

Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value Pr(>|t|)
(Intercept) -1.1897e-01  8.8916e-02 -1.3380 0.188257
debt         8.9497e-02  6.2376e-02  1.4348 0.158932
cpi          8.9310e-02  1.4027e-01  0.6367 0.527866
shares      -2.8257e-03  1.1075e-02 -0.2551 0.799891
volat       -2.3679e-01  1.1014e-01 -2.1498 0.037518 *
cbrates      4.8356e+00  5.7047e+00  0.8477 0.401550
cbpurch     -5.5606e-06  2.0186e-06 -2.7547 0.008721 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Annex AA - Robust Covariance Matrix Estimator for bank-based countries with twenty-year bond yields.

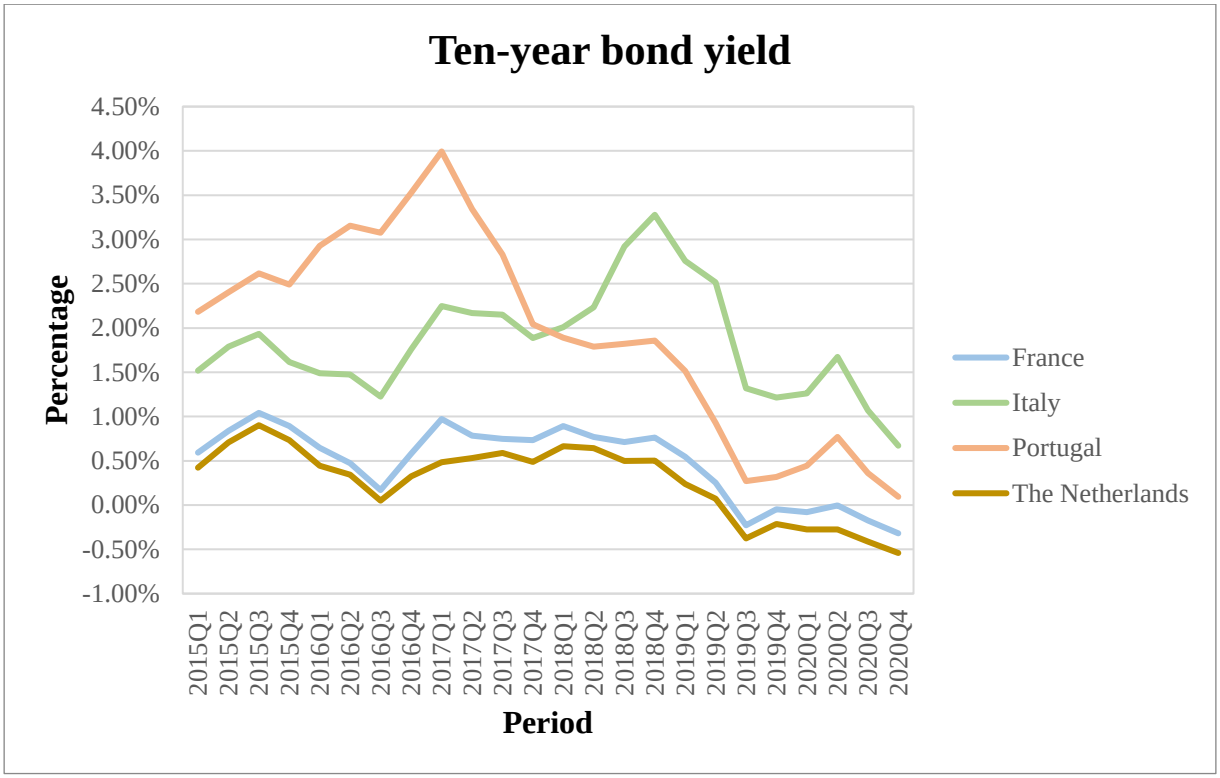
Source: R Studio.

```
t test of coefficients:

               Estimate  Std. Error t value  Pr(>|t|)
(Intercept) -2.6158e-02  4.1923e-02 -0.6239 0.5361230
debt         1.4070e-01  3.7993e-02  3.7033 0.0006281 ***
cpi          6.6403e-02  1.3567e-01  0.4895 0.6271267
shares      -1.0278e-03  9.6867e-03 -0.1061 0.9160196
volat       -3.4756e-01  9.1992e-02 -3.7782 0.0005032 ***
cbrates      1.7231e+01  3.6388e+00  4.7354 2.616e-05 ***
cbpurch     -4.5268e-06  1.5814e-06 -2.8625 0.0065926 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

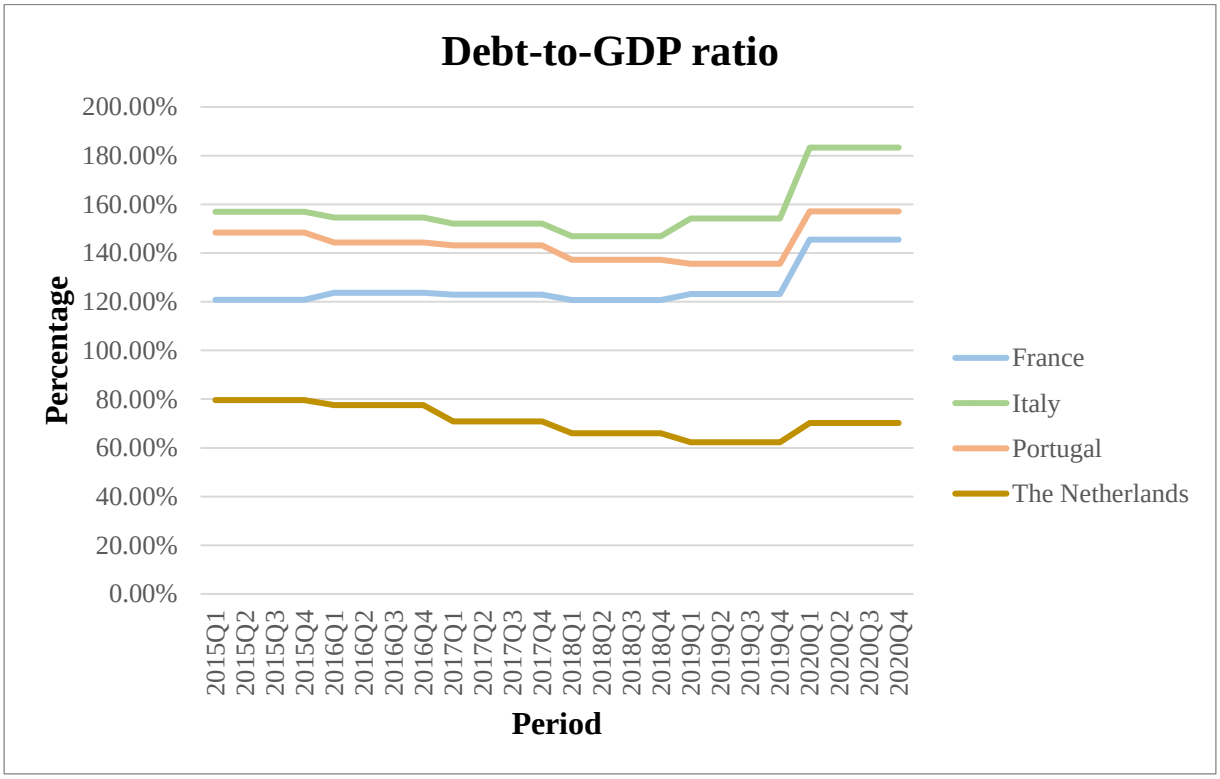
Annex BB - Robust Covariance Matrix Estimator for market-based countries with twenty-year bond yields.

Source: R Studio.



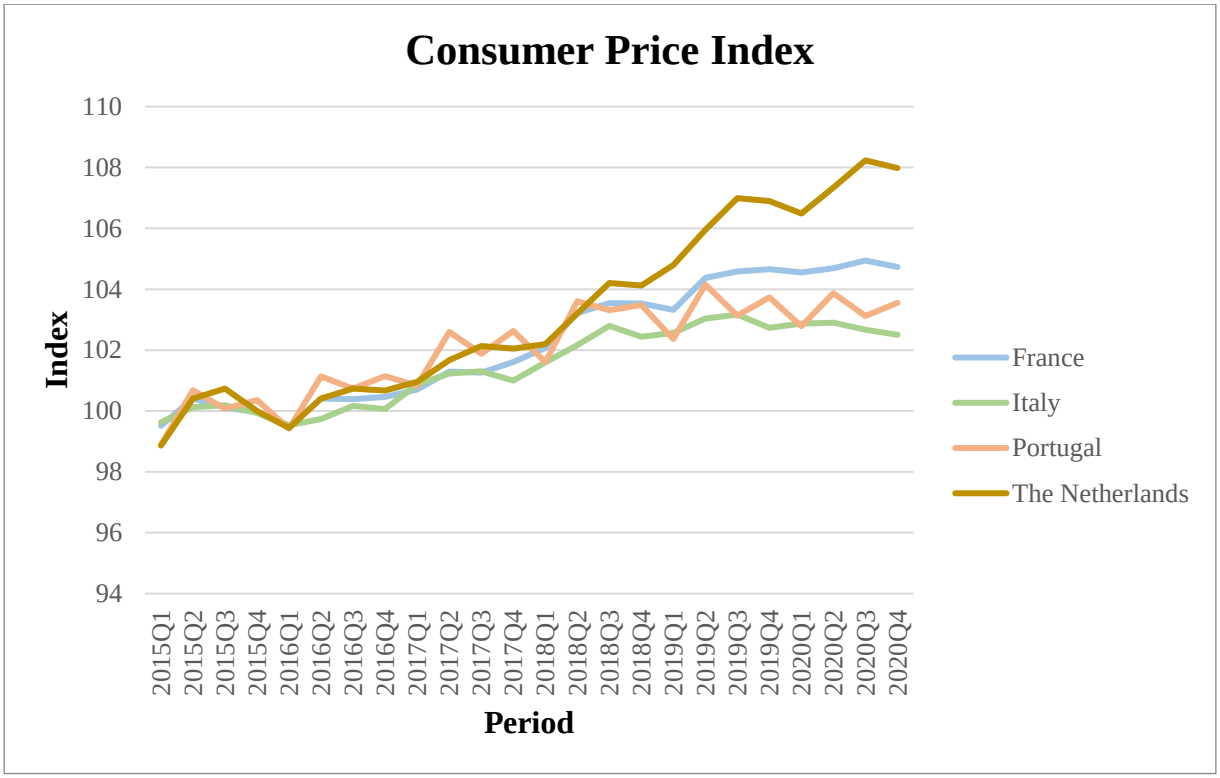
Annex CC - Ten-year bond yield for bank-based and market-based countries.

Source:Author's elaboration.



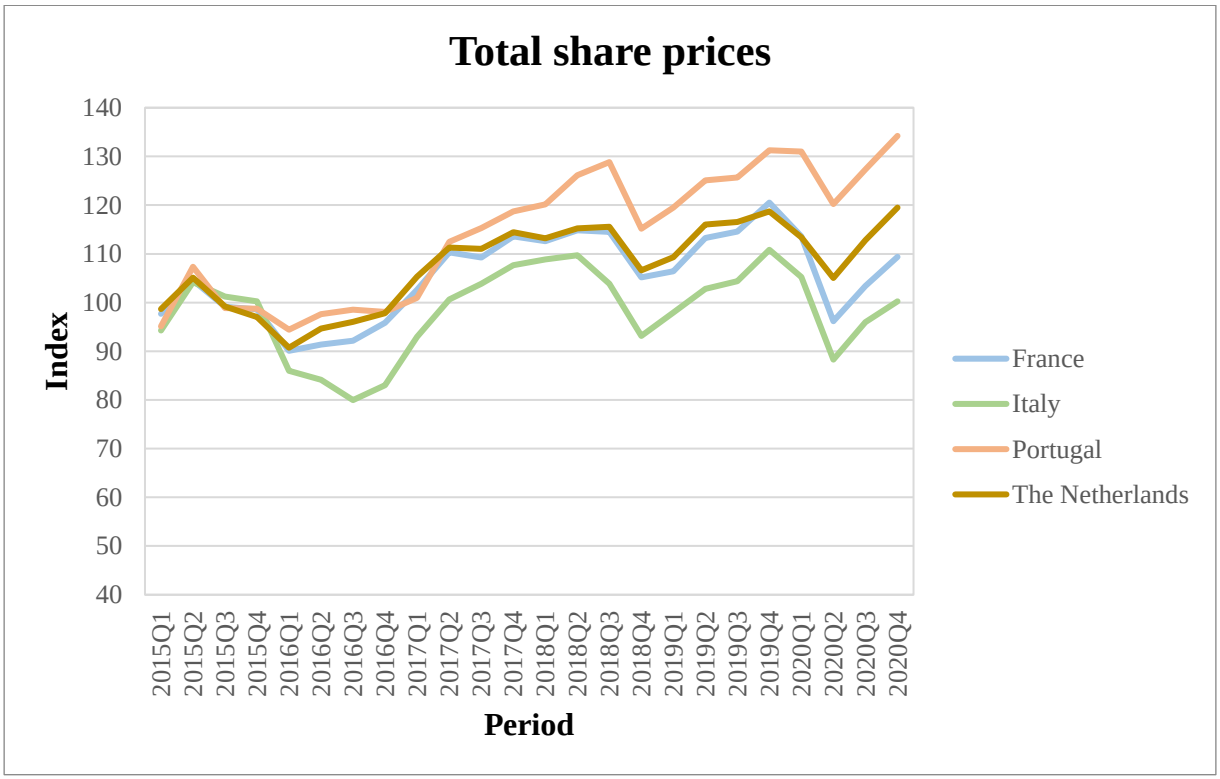
Annex DD – Debt-to-GDP ratio for bank-based and market-based countries.

Source:Author's elaboration.



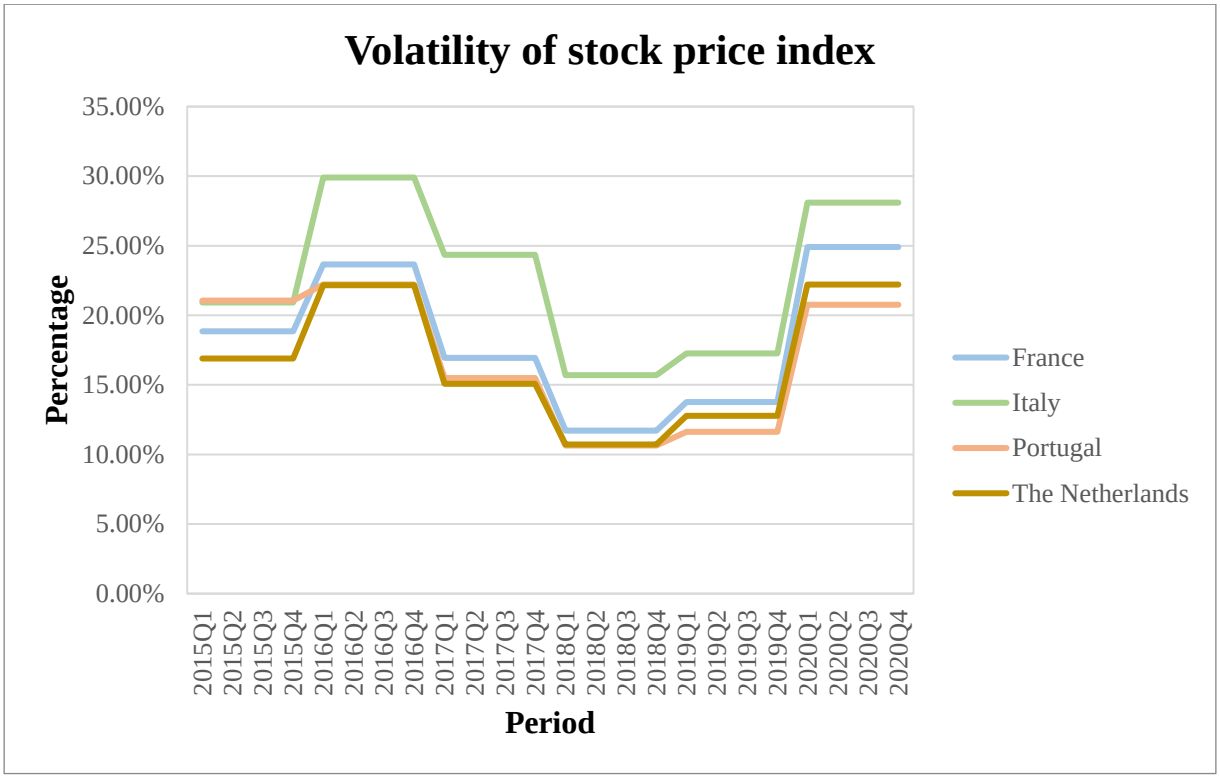
Annex EE – Consumer Price Index for bank-based and market-based countries.

Source:Author's elaboration.



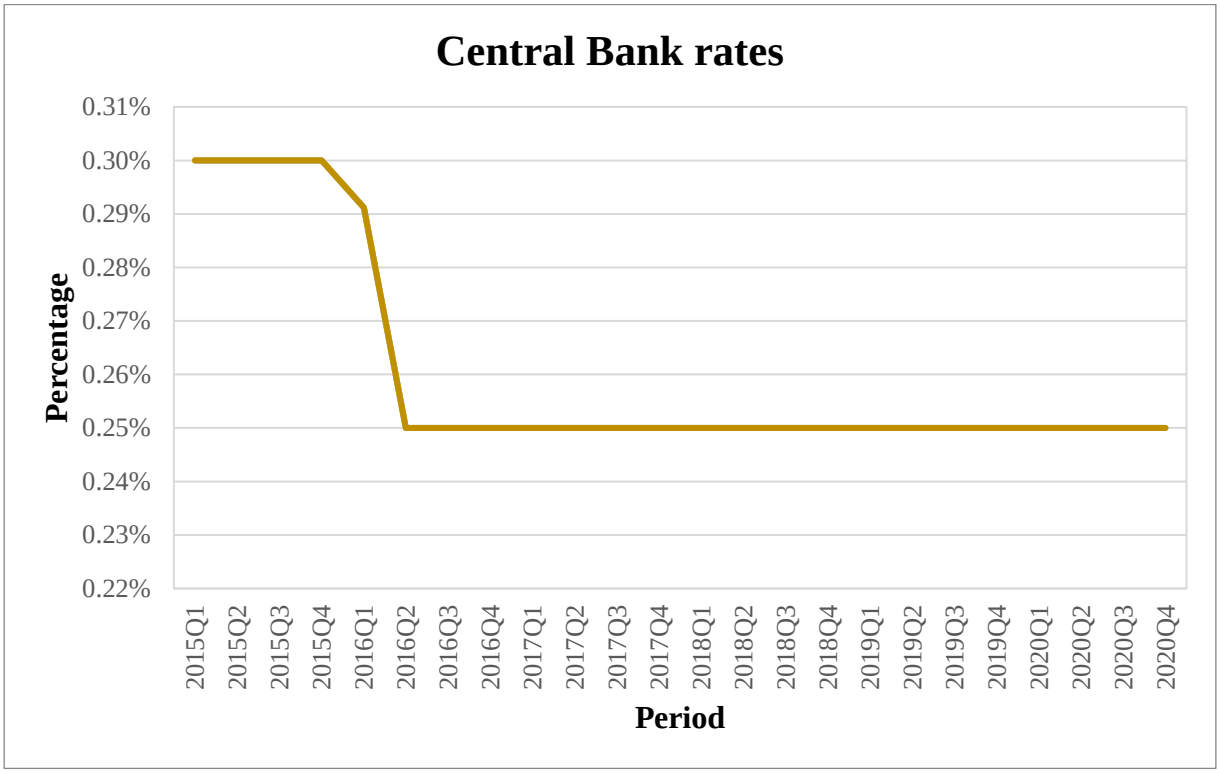
Annex FF- Total share prices for bank-based and market-based countries.

Source:Author's elaboration.



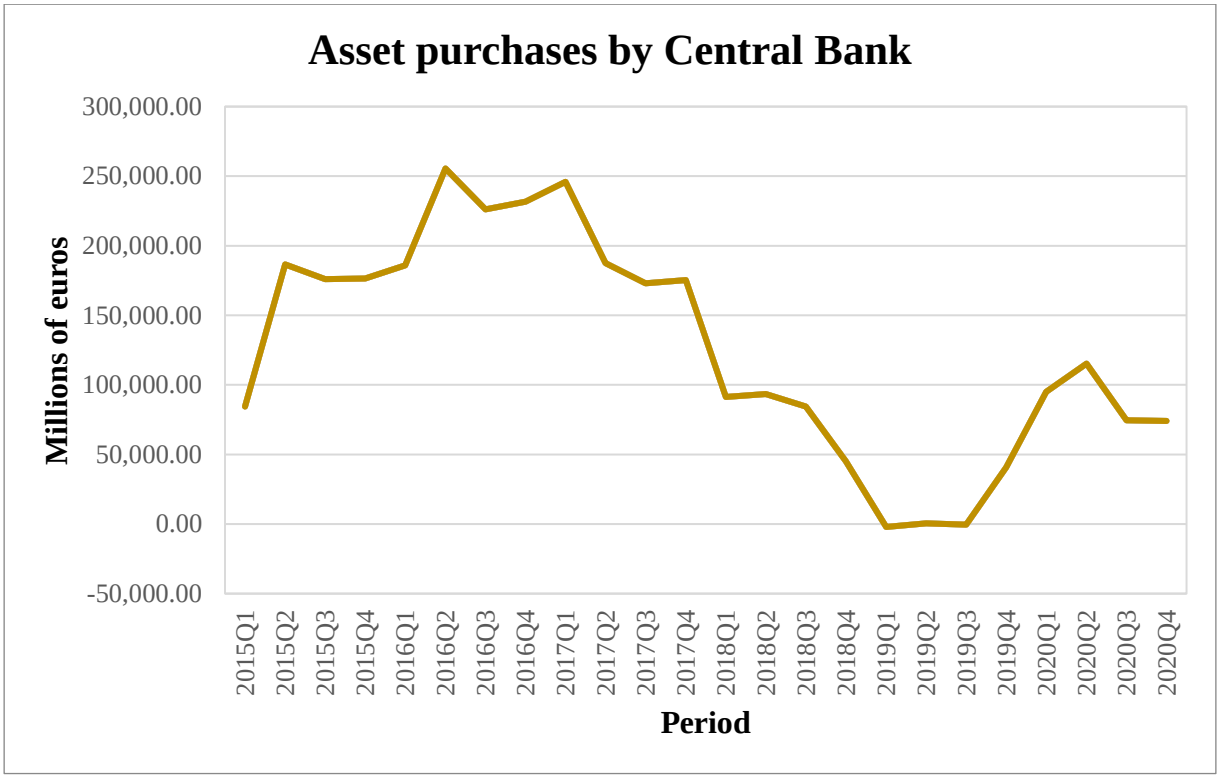
Annex GG – Volatility of stock price index for bank-based and market-based countries.

Source:Author's elaboration.



Annex HH – Central Bank rates for bank-based and market-based countries.

Source:Author's elaboration.



Annex II – Assets purchases by the Central Bank for bank-based and market-based countries.

Source:Author's elaboration.