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# Pricing EU Sovereign Debt Risk


**Supervisor**
Prof. Michael Donadelli

**Graduand**
Alberto Lucchetta
Matricolation number: 867909


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## Aknowledgements

The writing of the thesis is the final step of my Master's Degree. This is a Journey started after the high school that, now, is going to finish. During these 5 years I met a lot of people and friend that improved myself and made me who I am. I think that the final thesis is a consequence of all my final years of study.

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# Contents

# 1 Introduction

The aim of the analysis is to investigate if the risk of European government bonds is priced. The idea to investigate this topic rises by the interest to examine in depth the movements of the bond financial market. In particular, bonds became more interesting after the crisis. Suddenly, bonds were an important instrument used by investors to protect themselves from the volatility of the stock market. In addition, government bonds offered speculative opportunities to investors in some cases. The general framework in the last years reveals an increase in the use of fixed income securities and, consequently, an increase in the use of bonds among investors. Credit institutions started to issue a large multiplicity of financial instruments, such as perpetual bonds, that were not frequently used in the past. For example, Unicredit issued a perpetual bond AT1 on the 12 of March 2019. Moreover, the increase of government bonds issued is drastic: during the period of the crisis European countries frequently asked money to the financial market in order to be able to guarantee their solvability. Consequently, the bond market became more interesting than before for investors and became more attractive and dynamic than in the past.

The question that I asked myself was if bonds returns changes affect the decisions of investors and their asset allocation. More in detail, the specific question guiding this research is the following: "Is government bonds risk priced?". In order to answer this question, the research unfolds in three main paragraphs.

In the first part the characteristics of bonds are analyzed and the variables to take into account in order to understand the value of a bond are highlighted. The following features are presented: the relation between bond and interest rate, the difference between a long-term and a short-term bond, and some indicators, as the duration and the Yield curve, that help to interpret the real movements of a bond. All these aspects are fundamental in order to figure out the general framework in which the analysis is based and in order to better understand the meaning of the final results.

In particular, the information that the Yield curve provides to investors are explained; for example, the analysis of the inversion of the yield curve is one of the main signals of an imminent crisis. Moreover, the meaning of the spread and the information that this indicator provides are analyzed. The causes and the consequences of the Crisis of Sovereign Debt are studied with the aim to highlight the different economic positions of different countries in the Eurozone. Finally, there is an insight about some strategies of asset allocations commonly used during crisis period that directly affected the bond market.

In the Third paragraph, the empirical analysis is deployed. In order to understand if bond risk is priced, a cross sectional asset pricing test is implemented. The process to obtain the final result is composed by a two-step regression. The first regression consists of a time-series regression of the returns of some bond risk factors previously built on the return of some selected portfolios. The second regression is a cross-section regression between the ß obtained in the first regression and the mean of returns of the portfolio selected. The final results are the coefficient $\gamma$that are used in order to understand if bonds risk is priced. The regressions are done over the period between 01/01/2002 and 01/06/2019. In addition, the same analysis is run also with a specific focus on the crisis period, from 01/01/2011 to 01/01/2016. In this part some statistical insights are presented in order to explain all the steps done to obtain the final results. To complete the analysis, the third part ends with a paragraph in which the weaknesses of the model selected and of the variables used are exposed.

## 2 The Characteristics of a Bond

A bond is a fixed income security that represents a loan made by an investor to a borrower. Bonds are normally issued by corporates or governments in order to raise money to finance their operations. Bonds are considered a low-risk financial instrument. One of the principle indicators of their riskiness is their rating. Rating agencies constantly rate bonds according to their quality. The quality of the bond is principally linked with the risk of default of the issuer. So, the return of bonds is strictly linked with their riskiness. The riskier the instrument is, the more investors ask for higher returns.

The first classification that is possible to do is between corporate bonds and government bonds. The first one is issued by a corporate while the second by a Government. Corporate bonds are normally considered riskier than governments one, because it is more likely that a corporate may fail than a country. However, it is misleading to consider government bonds as risk-free, the 1998 Russia default and the 2001 Argentina default are two recent examples.

It is important not to confuse shares with bonds. The principle difference is that, when an investor buys a share, he is buying a part of the equity of the issuer, consequently, he bears the risk of the corporation: he becomes a shareholder. Conversely, when an investor buys a bond, he is simply a creditor of the issuer. So, the principle risk of bondholders is the default of the issuer. Normally, shares are considered riskier than bonds, shareholders face more uncertainty upon firms' performances and share values are more volatile. As a consequence, investors ask for higher returns from shares.

Bonds are an obligation by the bond issuer to pay money to the bondholder according to predetermined conditions specified at the moment the bond is issued. Bonds are composed by some common variables.

Firstly, the face value or principal, is the amount of money the issuer will pay to the bondholder at maturity.

Secondly, most bonds are composed by periodically coupon payments. The amount of the coupon is calculated using the coupon rate, the interest the issuer pays on the face value of the bond. In addition, the coupon dates are the dates in which the coupon is paid, and they are constant and fixed. The most usual coupons are annual, semiannual or monthly coupons.

In addition, the maturity date, the date in which the bond matures and the issuer pays the last coupon, and the face value to bondholders are always defined.

The last variable to take into account is the issue price. The issue price is the price at which the issuer sells the bond the first time. Bonds can be issued at the par; it means that the bond is issued at its face value. Consequently, the yield to maturity of the bond is equal to the coupon rate. Another possibility is to sell a bond at premium; it means that the price of the bond is higher than its face value. Consequently, the coupon rate is higher than its yield to maturity. Finally, a bond can be issued at discount, the price of the bond is lower than its face value. In the last case, the coupon rate is lower that the yield to maturity.

The relation between the price of the bond and the level of the yield to maturity and the coupon rate is showed in Figure 1.

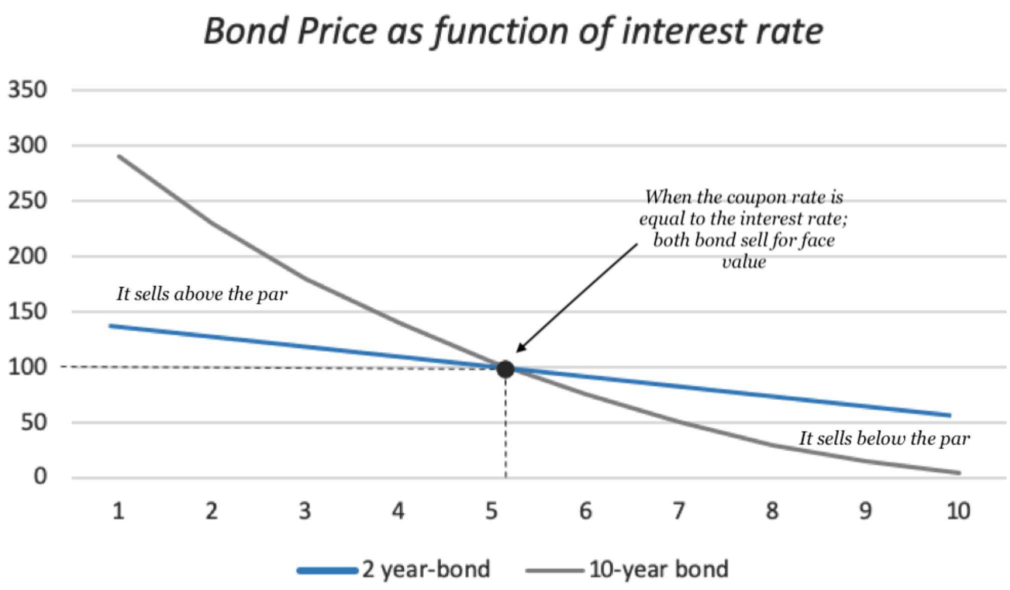


Figure 1: The Bond Prices as function of Interest Rate

## 2.1 The Yield to Maturity

The bond is composed by a series of payments, the coupons, and by the final payment of the principle.

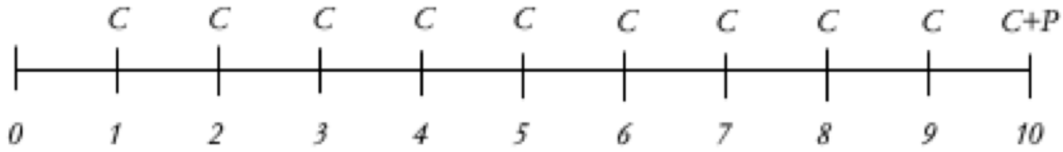


Figure 2: The Payments of a Coupon Bond

In Figure 2, it is possible to see an example of the stream of payments that characterize a 10 years coupon bond. At this point, it is fundamental to understand how to calculate the present value (PV) of the bond. The coupon bond can be valued as an annuity composed by several coupon payments and the final repayment of the principal. In Equation 1, it is expressed the general formula that is used to calculate the PV.

$$PV = \frac{Coupon_1}{(1+i)} + \frac{Coupon_2}{(1+i)^2} + ..... + \frac{Coupon_n + Principal}{(1+i)^n} \tag{1}$$

In addition, in order to calculate the present value, it is necessary to discount the payments using a consistent interest rate. For example, to calculate the PV of an Italian 3 years annual coupon bond, we must use the rate of returns offered by another government debt issues with the same time horizon and currency.
At this point is important to define what Yield to Maturity is. The YTM is the return investors earn if they hold the bond till maturity. The YTM is equal to the interest rate y, that allows to discount the payments that compose the bond in order to have the correct PV. Equation 2 represents the general formula used to obtain the YTM.

$$PV = \frac{Coupon_1}{(1+y)} + \frac{Coupon_2}{(1+y)^2} + ..... + \frac{Coupon_n + Principal}{(1+y)^n} \quad (2)$$

The YTM can be viewed as the internal rate of return of the bond at the current price. Moreover, it is easy to understand the link between the bond price and the interest rate. Bond prices and interest rates move in opposite directions: when the bond price increases, the interest rate decreases, when the bond price decreases, the interest rate increases. This relation is perfectly showed in Equation 1 and 2. In fact, the interest rate is the factor that discounts the value of the payments, consequently, it has an inverse relation with the PV.

In order to calculate the PV value of the bond, as it was analyzed before, it is possible to discount the cash payments by the Yield to maturity. The use of a single constant interest rate can be considered a good approximation, however, in this way, investors do not take into account that short-term interests and long-term interests could be different. To this regard, it is useful to use spot rates. The spot rate is the yield to maturity of a zero-coupon bond. Every coupon bond could be interpreted as a group of zero- coupon bonds. The process of using spot rates to discount the payments of a coupon bond is used to find out the correct price of the bond.

Only when the price of the bond is calculated it is possible to derive the yield to maturity. [1]

The law of one price states that identical commodities must sell at the same price under condition of free competition and price flexibility, also avoiding currency differences. So, all payments with similar characteristics and belonging to the same date, must be discounted at the same spot rate. In addition, spot rates are commonly used because comparing yield to maturity of two bonds with the same maturity, even if they are fairly priced, could be misleading. Investors have to take into account the so-called coupon effect, that is illustrated in Figure 3.

[1] Brealey R.A., Myers S.C., Allen F., Principle of Corporate Finance, 12th Edition, Chapter 3: Valuing Bonds, 54-59.

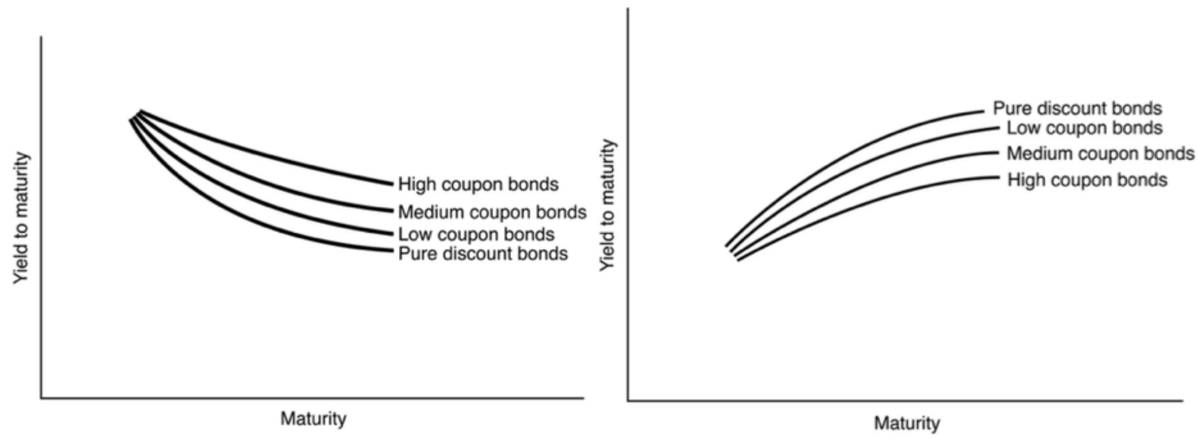


Figure 3: Elton et al. (2007), figures 21.5 and 21.6

However, the Yield Curve is an indicator that helps investors to forecast the economic performances in the future. The Yield curve is a graphical representation that plots interest rates of bonds with the same credit quality at a set point in time for a range of maturities. In particular, the shape of the curve is useful to predict future interest rates changes and economics performances. The Yield Curve can assume three principle shapes.
The first one, is called Normal Yield curve, it is an indicator of economic expansion. If the curve is upward sloping it means that bonds with longer maturity earn higher interest rates respect to bonds with shorter maturity. Longer term bonds mean greater risks, and bondholders want to be compensated for the higher level of risk. In particular, a steeper yield curve is a signal of an expanding economic period. Indeed, it means that the market expects that long term yields grow faster than short term yields: it is a signal of positive expectations on the future. The second one is the so-called Inverted Yield Curve. The shape of the curve is downward sloping, that means that long term Yields are lower than short term interests. The inverted shape is considered an indicator of an economic recession because it is a consequence of the perception of a decline of Yields in the future. One of the principle reasons that explain the changes in the shape of the curve is the prevision of a decline of inflation in the future.

Finally, the curve could be flat. The flat Yield curve means bonds with different maturities have more or less the same Yield. Normally, it happens when there is a transaction between a Normal Yield curve to an Inverted one or vice versa. Figure 4 plots an example of the three possible shapes of the Yield curve.

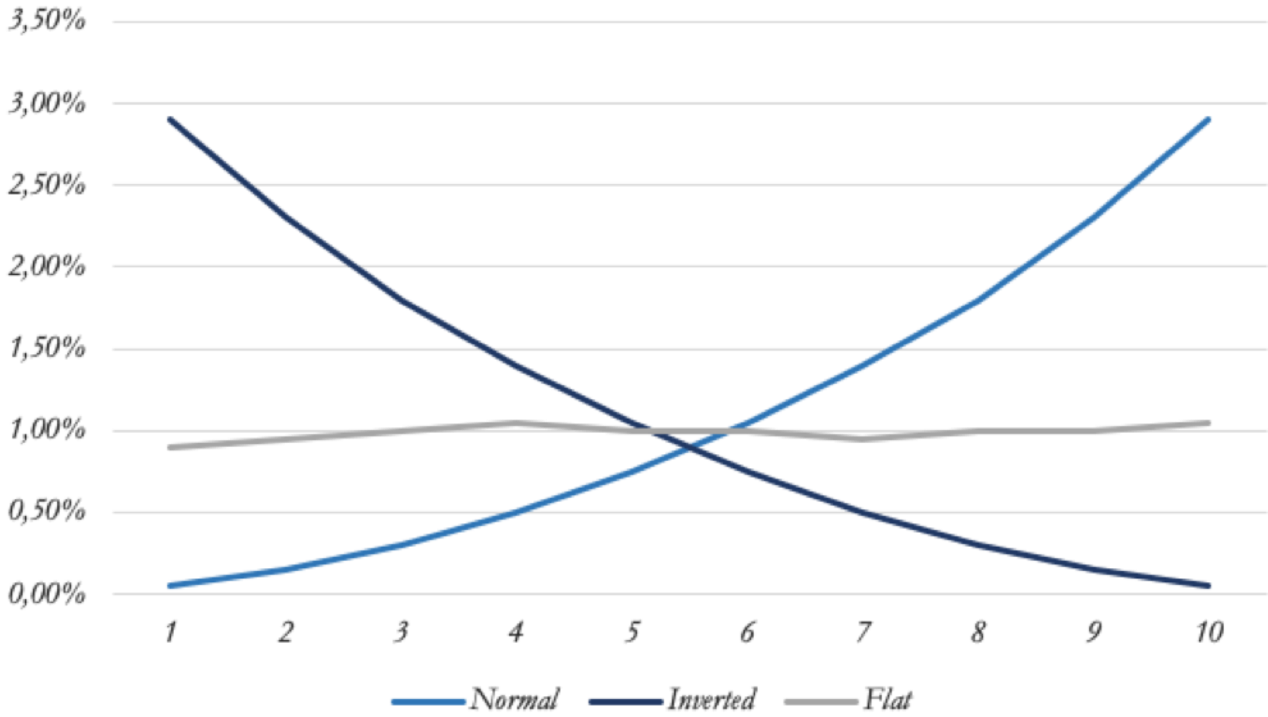


Figure 4: The different shapes of the Yield Curve

## 2.2 Duration

The duration of a fixed income instrument is the weighted average of the times that payments are made. Equation 4 shows the general formula in order to calculate the Duration.

$$Duration = \frac{t_0 PV_0}{(PV)} + \frac{t_1 PV_1}{(PV)} + ..... + \frac{t_n PV_n}{(PV)} \tag{3}$$

The time, t, indicates the years in which payments of coupons are done until the maturity date. The weight for each year is the PV of each cash payments at time t=1,2...,n divided by the total PV of the bond. The Duration is an average of the maturities of all the individual's payments. Consequently, it is a maturity measure and it is expressed in measure of time. A zero-coupon bond has always a duration equal to its maturity date, this is due to the fact that the bond is composed only by the final payment. Instead, coupon bonds must have a smaller duration than their maturity date. [2]

The duration is useful to understand the time horizon of investments and it gives a direct measure of interest rate sensitivity. It is a reliable instrument commonly used to compare different bonds. For example, bonds with the same maturity date and the same YTM but different coupon rates, do not have the same average effective maturity. In addition, changes in interest rates have a stronger effect on long-term bonds rather than on short-term bonds. So, investors are interested in the analysis of the effective maturity of each bond.

Moreover, to better investigate the effect that a change in interest rates has on the price of a bond, we could also use the so-called Modified Duration. Equation 4 illustrates the formula to calculate it.

$$ModifiedDuration = \frac{Duration}{(1 + yeld)} \tag{4}$$

The Modified Duration is particularly useful to measure the percentage change

[2] Bodie, Kane, Marcus, Investments,Tenth Edition, Chapter 16, McGraw-Hill

of bond price for a 1 percentage-point change in yield. So, it is useful to predict the exposure of each bond's price to fluctuations in interest rates.

## 2.3 Short-term vs Long-term Bonds

The price of the bond is strictly linked with the level of interest rates. When interest rates go up, the price of bonds go down, and, when interest rates go down the price of bonds go up. Bonds and interest rates are inversely related. So, the interest rate risk is the principal risks that bondholders need to take into account. However, bonds do not react equally to the movement of interest rates. In particular, longer maturities imply greater sensibility of the price to interest rates changes.

In particular, bondholders take advantage of a fall of interest rates because the price of their securities will increase. At the same time, they bear the risk of an increase of interest rates, because, as a consequence, the bond's price in the market decreases. In particular, long-term bonds bear more interest rate risk than short term bonds.

Firstly, this is due to the fact that there is a great probability that interest rates will rise in the future, negatively affecting the price of the bond. Moreover, it is easier to hold short term bond till maturity avoiding the interest rate risks. Interest rate fluctuations affect the price of bonds only if the bondholders decide to sell them before the maturity date. Otherwise, bonds are fixed income securities, so, they are not affected by changing of conditions in the market if investors hold them till maturity. Otherwise, long-term bonds offer also an opportunity cost for bondholders, when interest rates decrease, the price of the bond increase and bondholders can make a capital gain selling the financial instrument in the market.

Secondly, long term bonds normally have greater duration than short-term bonds, consequently, they are more vulnerable to a given interest rate change. The difference in the remaining coupon payments is the reason that explains the greater sensibility of long-term bond's price respect to short term bond's price.

Finally, long-term bonds are more affected by changes of the inflation level. The inflation is strongly difficult to predict in long terms; assumptions about the inflation level 20 years from now are not strongly reliable. Inflation does not change the level of payments directly, the bond's payments do not change, however, the purchasing power of investors could drastically decrease. This is the reason why bondholders want to be compensated more for the risk that they bear. Normally, bonds that are considered short-term mature in one to three years. Otherwise, bonds are considered long-term.

In Figure 5, it is possible to see the different movement of the bond price respect to the level of interest rates. The blue line plots the curve of a 2 years government bond, while, the grey one shows the curve of a 10 years government bond. It is possible to appreciate that the long-term bond is more sensitive to changes in interest rate respect to the short-term one.

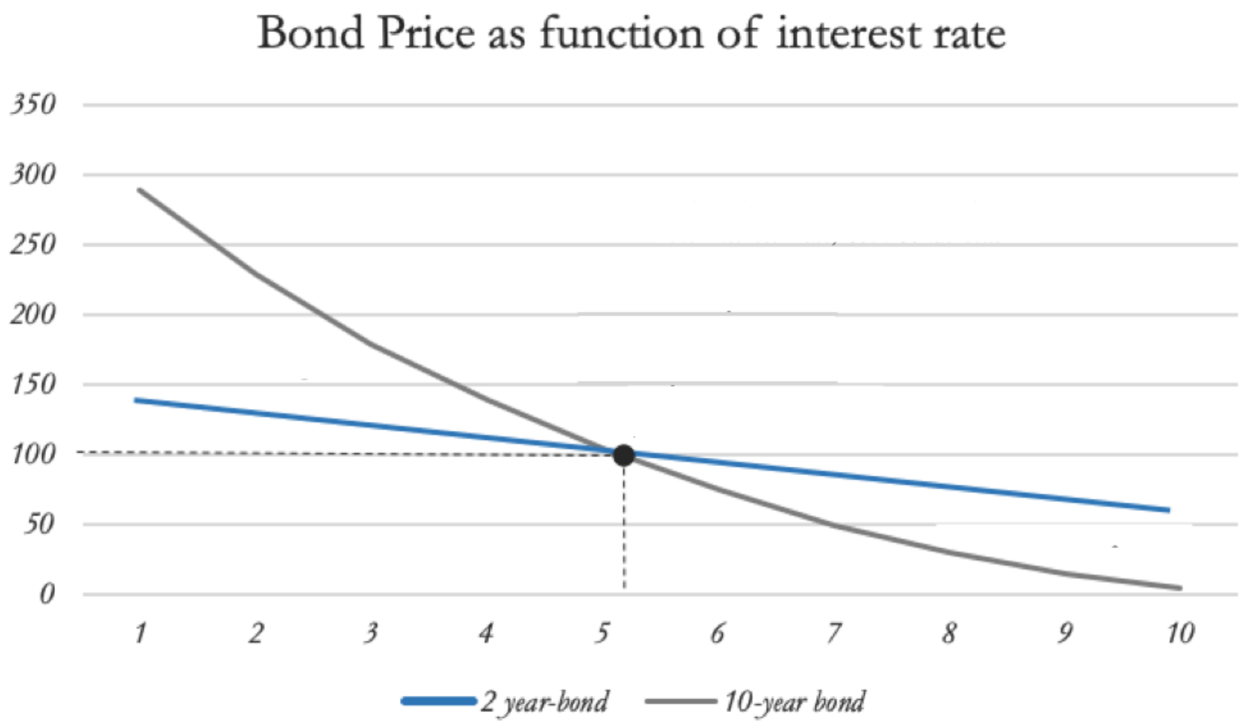


Figure 5: The price sensitivity to changes in Interest Rates

## 2.4 The Term Structure of Interest Rates

The term structure of interest rates is the relation between short- and long- term interest rates. In particular, the term structure of interest is composed by a series of spot rates. It is important to distinguish the yield curve from the term structure: the first one is composed by the yields to maturity, the second one is composed by spot rates. The term structure shows that interest rates for different times to maturity often differ. It can be described by three principal variables: the level factor, the slope factor and the curvature factor.

The first one is useful to capture parallel shifts of the curve. The parallel shifts mean a variation in the yields of all bonds. The level factor is particularly influenced by the economic growth, by the inflation and by the monetary policy. This is the reason why markets are particularly sensitive to the decision of BCE and of FED about the monetary policy of the country; these decisions have a strong impact on the value of bond markets. In addition, duration can be interpreted as a bond's exposure to the level factor. The level factor strongly influences the term structure because it is a systematic factor risk, and, fixed income securities are mostly influenced by this type of risk rather than by idiosyncratic risks factors, that, on the contrary, mostly influence equities.

The second variable, the slope, captures risk premiums for holding long-terms bonds that are riskier. The slope is mostly influenced by business cycle and it depends on macro factors. In addition, it is counter cyclical, it is possible to observe high slope during recession period and, on the contrary, low slope levels during economic expansion periods.

The curvature, the last factor to take into account, allows the middle of the yield curve to move independently of the level and term spread. [3] The term structure graphic can be used as an indicator about market expectations about the level of changes of interests and inflation rates.

[3] Ang, A. (2014): Asset Management: A Systematic Approach to Factor Investing. Oxford University Press, Chapter 9

In addition, the yield curve and the term structure have slightly different reactions to changes in interest rates. In particular, as analyzed in a Deutsche Bundesbank monthly report, if interest rates rise with the increasing of the maturity, this rise is underestimated by the Yield curve. The implication is that the term structure curve is slightly above the yield curve if the curve has a upward-sloping shape. On the contrary, with a downward sloping shape of the curves, the reaction of the two curves is exactly the opposite. The shapes of the two curves are described in figure 6. [4]

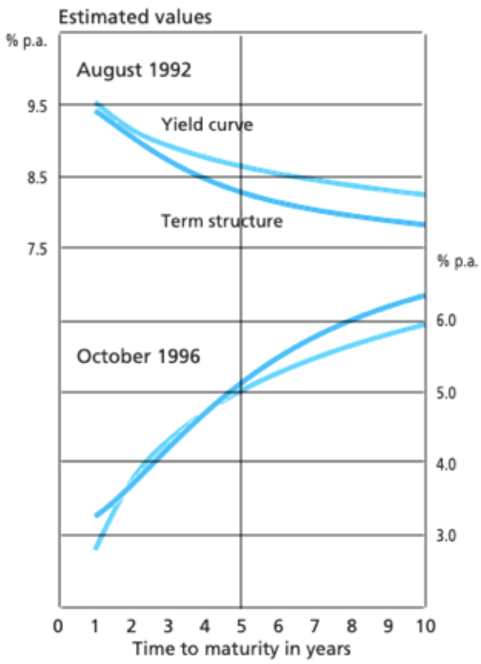


Figure 6: The difference between Term Structure and Yield curve
Source: Deutsche Bundesbank

Substantially, the term structure of interest rates enhances the quality of the expectations on the bond market improving the comparability of the data.

[4]Estimating the term structure of interest rates, Deutsche Bundesbank monthly report, October 1997

# 3 The Consequences of the Financial Crisis

## 3.1 Yield Curve Inversion

The yield of a bond is a consequence of various variables. Some of these are macroeconomic, others are strictly linked with the quality of the fixed income securities. In particular, Yields are strongly linked with the rating of the bond issuer: the rating attached to a bond values the credit risk. As it was analyzed before, the maturity time of the bond is another element that influences the yield of the bond. Finally, also external economic conditions affect the bond's final return, for example, inflation changes have a great impact on the effective final return of the investment.[5]

The analysis of the yield curve is useful to investors to predict a period of crisis in the market, to forecast a recession time. In particular, it is fundamental to take into account the relationship between the yield of 10 years government bond and the yield of 3 months or 2 years government bond. Substantially, it is important to compare the level of yields of long-term bonds with short-term bonds. When yields of short-term bonds overcome yields of long-term bonds, it is a signal that a crisis period is approaching.

The fact that investors asks for more return for a longer investment show their optimism in the future. When there is an inversion of this perspective, it means that investors bear the future economic performance. Figure 7 shows the relation between yields of different maturities of US Treasury Bill: it is possible to appreciate the inversions of the Yield curve in the last 27 years.[6] Moreover, the graph of figure 7 allows to compare the level of yield offered by bonds with the same maturity during different periods; after the financial crisis the level of US government bonds yields is drastically lower than before, and this is a consequence of the unusual economic

[5] Assogestioni, La valutazione dei titoli obbligazionari, Metodologie di determinazione del valore dei titoli obbligazionari

[6] Neil Irwin, What's the Deal With That Inverted Yield Curve? A Sports Analogy Might Help, The New York Times

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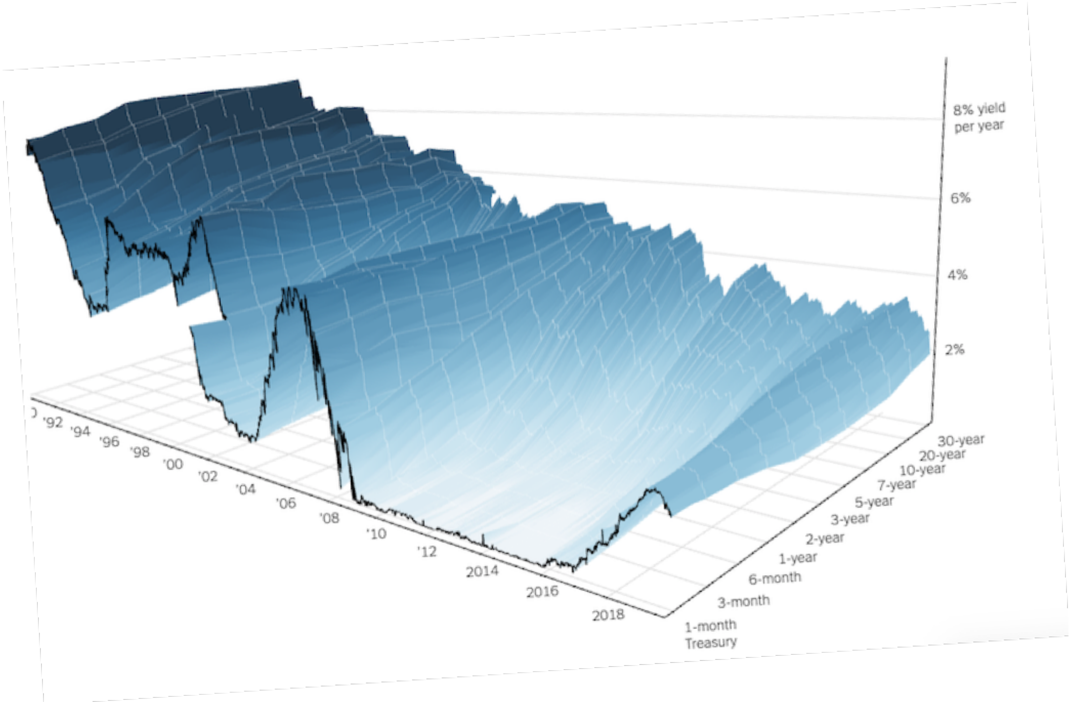


Figure 7: The inversion of the Yield curve

A recent article on Bloomberg[7] by L. Leatherby and K. Greifeld, in particular, shows that, on the 14 of August 2019, the yield curve was inverted the first time after the subprime financial crisis. The 10-year Treasury Yields fell below the rate on 2-year notes. However, the most interesting part of the article shows all the moments in which the inversion of the Yield curve has preceded past recessions.

In Figure 8 the blackline plots the 10-year yield while, the grey one the 3-month yield. The grey area evidences the recession period, while the red line the moment in which the inversion happened.

Figure 9 emphasizes the precise time period that elapses between the first inversion and the start of a recession phases.

[7]What the Yield Curve Says About When the Next Recession Could Happen By Lauren Leatherby and Katherine Greifeld

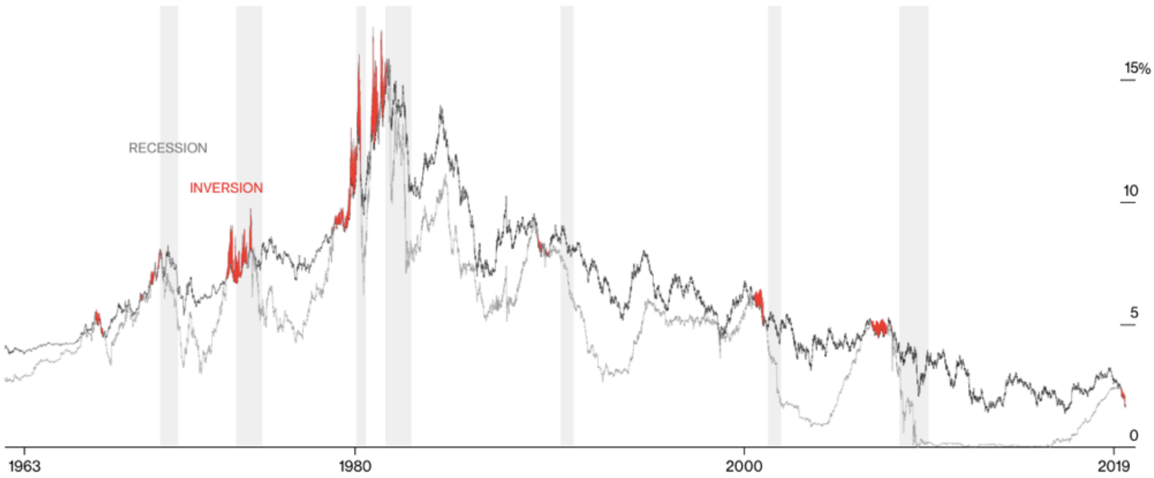


Figure 8: Inversion of the Yield curve
Sources: Bloomberg data, NBER

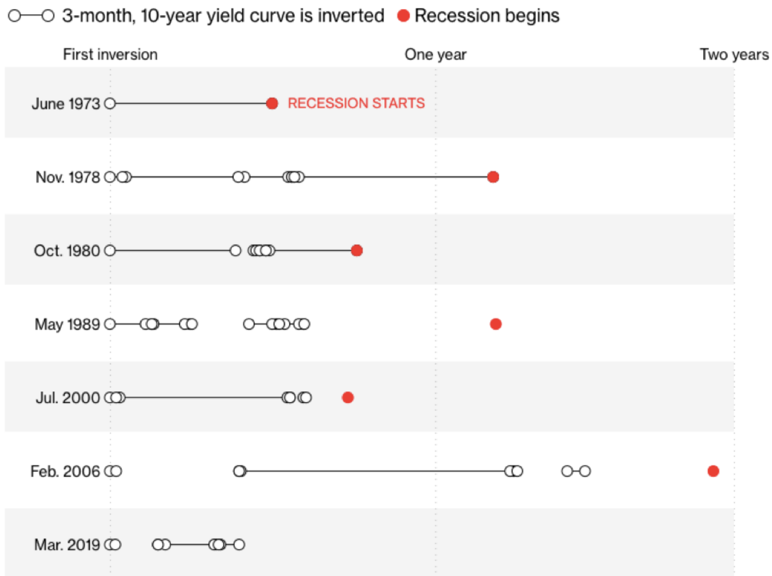


Figure 9: The time between inversion and economic recessions
Sources: Bloomberg data, NBER

The two Figures show how the inversion of the curve pointed out the coming of the 2007 financial crisis or of the 2000 dot-com bubble. The comparison of yield curves of bonds with different maturities is a reliable indicator that is frequently taken under control by investors and experts. The graphs above describe the relation between US government bonds yields, obviously, the same applies for all different countries. For example, in Italy, on 28th May 2019, there was a fast inversion of the yield curve, event that created an alert among investors. The last time in which the inversion of the yield curve happened was in 2011, the Italian 2 years bonds yields were 80 basis point higher than the 10 years bonds yields, as a consequence of the crisis of the sovereign debt [8]

## 3.2 The Spread

The spread generally is a measure that indicates the difference between two variables that have common characteristics. It was frequently used to analyze the performance of the yields of government bonds during the crisis of sovereign debt. In particular, in order to calculate a valuable spread, it is fundamental to have a proper benchmark. In Italy, the most important indicator is the spread with Germany. Generally, the spread is calculated between the Italian 10 years government bonds, BTp, and the German 10 years government bonds, Bund. In Europe, the benchmark used is Germany, however, the spread can be calculated between all the government bonds yield of all countries. The most important thing is to compare fixed income instruments with the same characteristics, at least with the same maturity and the same currency. It is generally expressed in basis points; one basis point is equal to 0,01 %. So, the difference in yields substantially values the credit risk. Investors ask for higher return from Italian government bonds because they consider a higher default risk of the country than the default risk of Germany. This measure is important for various reasons.

[8] Altro che spread! Per monitorare la crisi guardate la curva dei rendimenti di Vittorio Carlini e Vito Lops, 30 maggio 2018

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Figure 10: Spread BTp Italia - Bund 10 years
Sources: Il Sole 24 Ore, Mercati

Firstly, if the yield of a fixed income instrument of a specific country is higher than the one of another country, it means that for the first country it is more expensive to raise money from the market and it is more difficult to enhance their deficit.
Secondly, if investors loose confidence in the capacity of the Italian government to pay back the debt, the consequences could be dramatic and the possibility of default of the country become possible [9].
However, the interpretation of the spread could be misleading. Indeed, if the value of the Italian-Germany spread decreases, but this variation is caused by an increasing in the Yield of the Germany, this is not a signal of the decrease of the Italian country risk.

In Figure 10, the blue bold curve represents the Yield curve of Italian 10 years government bonds, while, the thin curve plots the Yield of 10 years German Bund. It is possible to see the difference in level of the two yields. The area between the two curves is the spread. On the left axis, values show the spread expressed in basis points.
Substantially, bond spread can be explained by three major causes; the differences

[9]Fabrizio Galimberti, Perché lo spread è molto importante, Il Sole 24 Ore

in the creditworthiness of the single national government, the liquidity situation of the domestic bond market and the risk premium in international financial market.[10]

## 3.3 The Crisis of Sovereign Debt

The Debt Sovereign crisis is strictly linked with the 2008 subprime financial crisis. Indeed, as a consequence of the 2007 crisis, banks all over the world, included in Europe, were helped by public intervention. Credit institutions in that period were suffering and in vulnerable positions, the consequence was a decrease of performances of all economics areas. For example, in Italy the GDP dropped of more or less 5 %, one of the worst results after World War II.[11]
Before the start of the Debt Sovereign crisis it is possible to note that European countries had substantial differences concerning domestic public finance conditions and growth rate. In particular, Germany had low level of public debt and strong economic performances, while PIIGS (Portugal, Italy, Ireland, Greece and Spain) were more vulnerable; high level of public debt accumulated over years, the continuous increasing of the countries deficit, bad expectations about the future growth of GDP, and, the efforts needed to save the credit institutions during the subprime crisis undermined the stability of these countries. In 2010 Eurozone benefited the economic recovery of the main countries, as Germany and USA. This is the principle moment in which the big difference in performance between Germany and the other countries of the Eurozone was created. Germany returned to grow with rates equal to the pre-crisis period, while the growth remained low in the other countries. The moment in which Greece showed its difficulties to repay or refinance its debt without the help of third institutions, the Sovereign Debt Crisis definitely started. At this point, rating agencies started to downgrade ratings of European countries government debt, and, consequently, investors started to ask for higher returns due to the higher default risk of the countries. The default risk is the principle variable

[10] Luciana Barbosa, Sonia Costa, Determinants of Sovereign Bond Yield Spreads in the Euro Area in the context of the economic and financial crisis

[11] CONSOB,la crisi del debito sovrano 2010-2011

that influenced the increase of interest rates of government bonds. In particular, if a government borrows in its own currency, there is a lower probability that the government will default. [12] Indeed, the government can always decide to print more money to pay back bondholders. However, the countries in the Eurozone do not have the possibility to print money in order to repay the debt. The European Central bank is the only institution that can decide to print Euro. This is one of the reasons why investors were scared about the real possibility of default of some European countries.

Banks suffered this situation because their business was strongly linked with public finance operations. The most negative consequence was the difficulty for private firms to obtain loans, in fact, the bank system strengthened the standards for granting loans.

In addition, Eurozone governments started an austerity period in which they tried to contain public spending through political maneuvers, such as the spending review in Italy. The difficulty for private firms to obtain funding and the austerity period reduced consumptions among the European population and increased the worries about the crisis. The logic consequence of this situation was the worsening of the economic conditions due to a stop in the growth of the GDP in almost all European countries. At this point, ECB started some expansive monetary political interventions. The most important one was the Quantitative Easing, a program in which ECB committed to buy private and government bonds in order to increase the liquidity in the market. The intervention of the ECB, during the years, obtained the objective to push the economic performance in Europe and improve positively the market sentiment of investors in the Eurozone.

In Figure 11, it is possible to see the total amount of government Debt in the Eurozone. It shows that it started to increase intensively from 2007, as a consequence of the financial crisis. The total amount strongly increased from 2007 to 2013, then

[12] Brealey R.A., Myers S.C., Allen F., Principle of Corporate Finance, 12th Edition, Chapter 3: Valuing Bonds

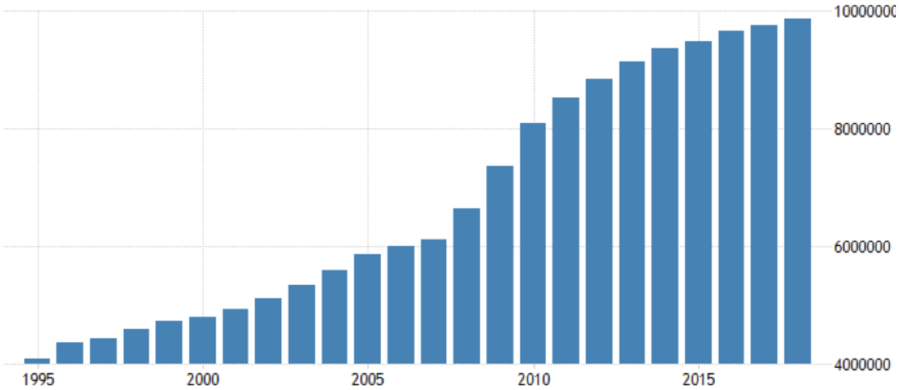


Figure 11: The amount of Debt in the Eurozone
Sources: Tradingeconomics.com, Eurostat

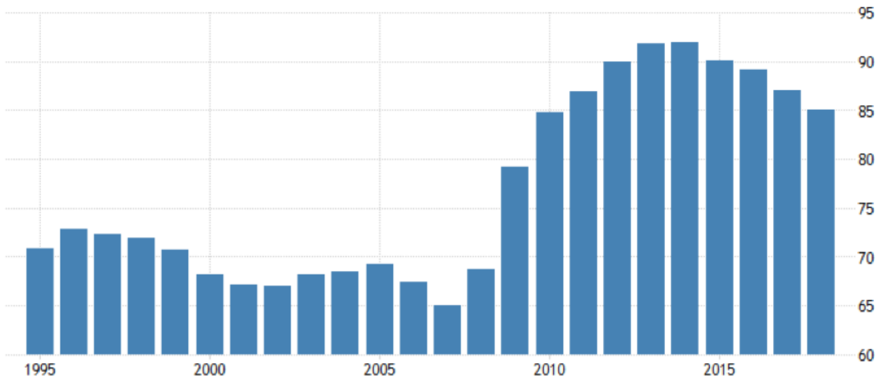


Figure 12: The level of debt in percentage of GDP
Sources: Tradingeconomics.com, Eurostat

it continued to increase but more slowly than before. However, the total level of the government debt it is not a meaningful data if it is not compared with other indicators of economic performances.

In Figure 12, it is possible to appreciate the level of the debt in percentage of the GDP. In particular, from 2014 the percentage decreases, the reason is the economic recovery and the faster growth of GDP respect to the total amount of debt. Substantially, the graph shows that the level of debt started to become sustainable in relation to the level of the GDP growth.

Finally, Table 1 illustrates the debt to GDP percentage at the end of 2009, 2014 and 2018 of a range of European countries. The graph of Figure 13 highlights the general trend of the debt in percentage to GDP; the level of debt increased strongly

Table 1: Debt to GDP Percentage
Source: Tradingeconomics.com, Eurostat

| Country | % 31/12/2009 | % 31/12/2014 | % 31/12/2018 |
|---|---|---|---|
| *Greece* | 126, 7 | 178, 9 | 181, 10 |
| *Italy* | 112, 5 | 131, 8 | 132, 20 |
| *Portugal* | 83, 6 | 130, 6 | 121, 50 |
| *Cyprus* | 54, 3 | 108 | 102, 50 |
| *Belgium* | 99, 5 | 107, 5 | 102, 00 |
| *France* | 83 | 94, 9 | 98, 40 |
| *Spain* | 52, 8 | 100, 4 | 97, 10 |
| *EuroArea* | 79, 2 | 92 | 85, 10 |
| *UnitedKingdom* | 49, 9 | 80, 2 | 84, 70 |
| *Germany* | 72, 6 | 75, 3 | 60, 90 |

h

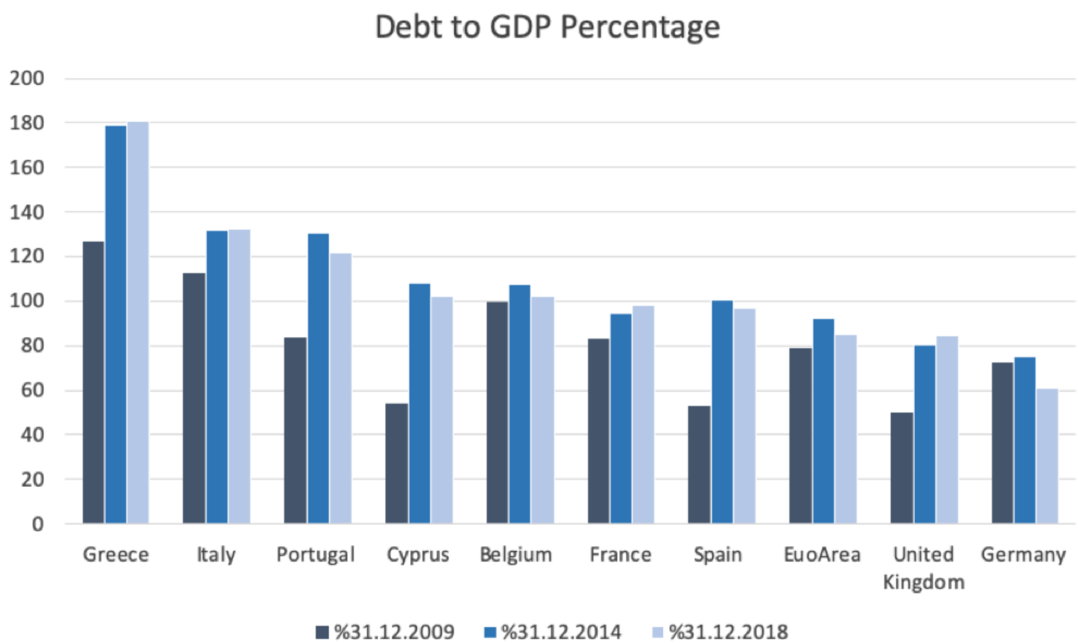


Figure 13: Debt to GDP percentage country by country
Sources: Tradingeconomics.com, Eurostat

in Eurozone countries after 2009.

This was a consequence of the financial crisis. In addition, the data shows that the intervention of ECB to alleviate the crisis between 2009 and 2014 were not particularly successful, instead, ECB politics after 2014 probably helped to invert the negative trend. However, as explained before, it is possible to note that data about Germany are totally different respect to the general trend of the other European countries. Finally, the label"EuroArea" that can be found in the table represents the mean of all the 28 European countries.

## 3.4 Flight to Quality Strategies

The 2007 financial crisis started in USA, however it affected all the world. In addition, it did not influence only financial institutions but also the real economy of almost all countries in the world. The global financial crisis spread worldwide also because of global interconnection of banks and financial markets.[13] In 2008, as a consequence of the failure of a large number of financial institutions, for example the most emblematic one was the failure of Lehman Brothers, stock markets, both in USA, Asia and Europe, drastically dropped. Figure 14 shows the level of performance of the stock market and it highlights the drop during the period of the crisis.

Investors, during crisis period change their asset allocations and their behaviours. The financial subprime crisis and then the crisis of Sovereign Debt strongly alarmed investors. The average daily returns fell significantly to negative levels and the volatility exploded during the crisis. [14] Substantially, PIIGS were forced to offer higher Yield in order to be able to raise funds from the market, and, at the same time, for solid countries government bonds yields declined. During the period of the crisis, the stock market experienced high volatility, this is the reason why investors normally shift their investments from stocks to bond in order to reduce the risk

[13] OECD Insights: Economic Globalisation, The 2008 financial crisis – A crisis of globalisation?

[14] Mo Chaundry, How Did the Financial Crisis Affect Daily Stock Returns?, The Journal of Investing

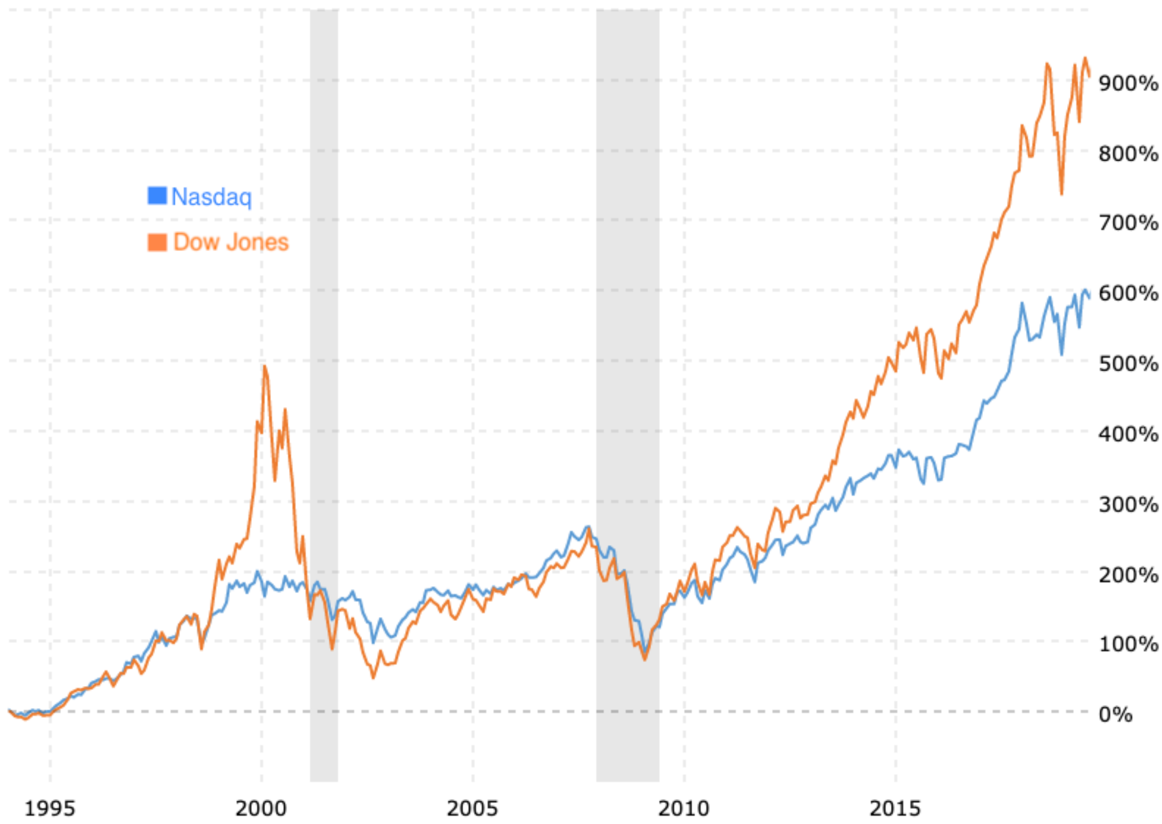

Figure 14: Percentage return Nasdaq vs Dow Jones
Sources: Macrotrends

of losses during the crisis period. This strategy is commonly defined as Flight to quality: it is a sudden change in investment behaviours. Investors start to buy bonds that are considered financial instruments that are safer respect to shares. So, investors start to put in their portfolios short-term financial instruments, to increase the diversification of their portfolios, and to buy only financial instruments with high rating, as AAA or AA; they prefer to obtain lower return in favour of a decrease of the risk that they bear. However, the Debt Sovereign crisis caused an increasing of the default risk of a great number of countries in Europe. Obviously, the preferences of investors go to safer countries. As a consequence, investors preferred government bonds of solid countries like Germany and USA, this is the reason why a drop in the level of the yield in strong economies happened while, at the same time, difficulties in the other countries intensified. So, for example, the crisis originated in Greece strongly affected all the PIIGS and less Germany and USA. [15]

In Figure 15 and 16, it is possible to appreciate the differences in the movements of bonds yields among different countries starting from the financial Subprime crisis. It is possible to appreciate the opposite movements of the Yield curve of Germany and USA respect to the movements of the Yields curve of Italy and Spain government bonds. In the second graph, the green line shows the curve of Greece, the values are much higher because the Mediterranean country was really close to Default.

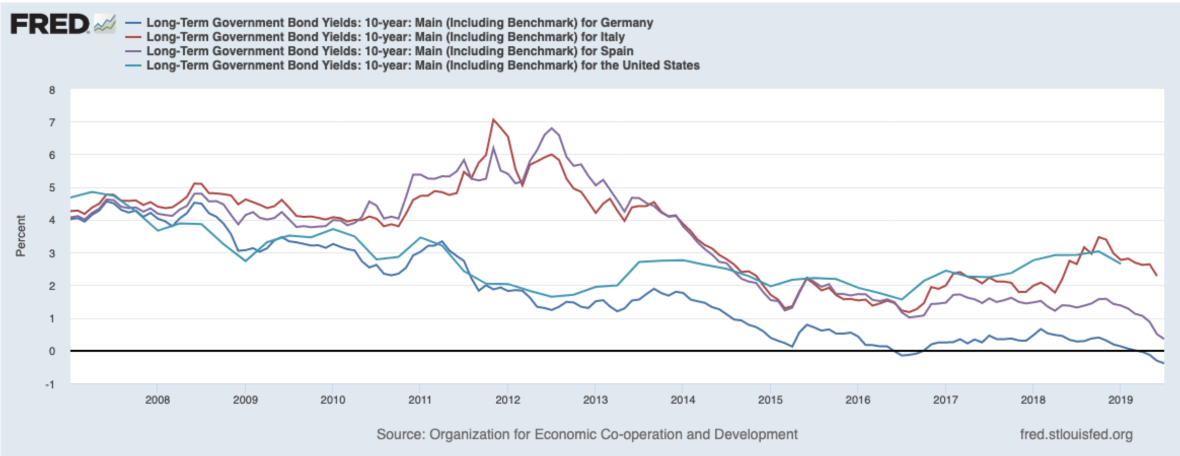


Figure 15: Long Term government Bond Yields
Source: Fred, Organization for Economic Co-operation and Development

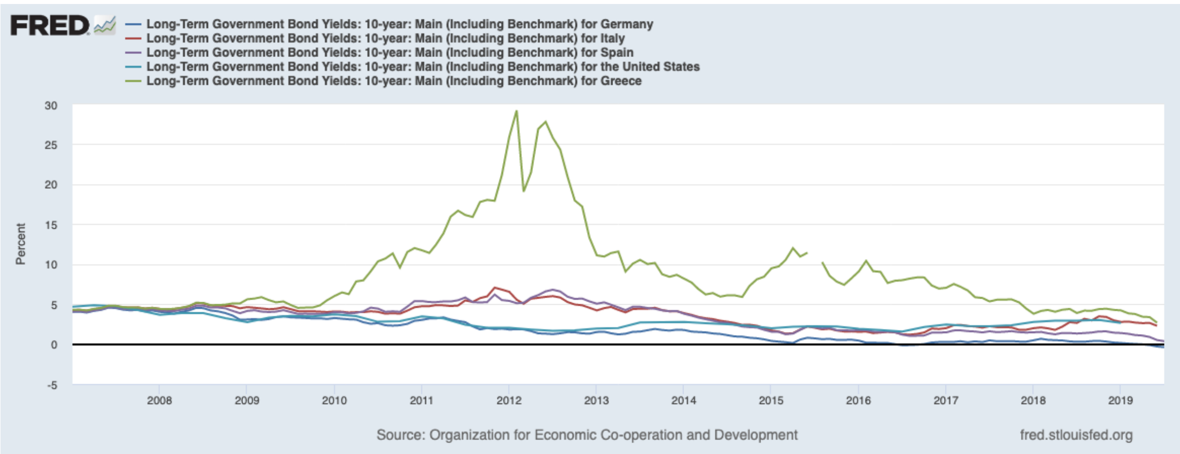


Figure 16: Long Term government Bond Yields
Source: Fred, Organization for Economic Co-operation and Development

[15] Canhui Hong, Flight-to-Quality Debt Crises, 2018, Society for Economic Dynamics

Another investment strategy strongly used during crisis period is the so-called flight to liquidity. The flight to quality consists in changes in investors behaviours toward safer assets, while, the flight to liquidity consists in reallocating portfolios in order to improve the liquidity of assets. This behaviour is a consequence of the uncertainty that characterizes financial markets. If investors are worried about market performances, they try to adjust their portfolio adding liquid financial instruments. Investors start to view illiquid assets as riskier; they want to increase the possibility to sell their financial instruments quickly in order to protect themselves from a decline in the value of the financial market. This is the reason why they try to move to liquid assets. The equities market can be considered an example of a liquid market. In particular, stocks with high market capitalization and large numbers of shares are considered liquid instruments. However, shares, during crisis period, can be considered too risky respect to other types of investments. Another example of liquid financial instrument used in crisis period are corporate and governments short-term bonds. They are considered liquid because normally there is a great amount of government bonds present in the market, so, it is easier to find out someone to sell them to. In addition, if investors hold bonds till maturity, they are not influenced by market conditions, unlike shares.

# 4 The Process to Price Sovereign Debt Risk

In the previous part of the paper the characteristics of bonds were analysed. The focus is on the variables that affect the value of a bond. Interest rates directly affect the price of a bond. Secondly, bonds react differently to changes of market variables, according with their characteristics: the type of the bond, i.e. short vs long- term bonds, the effective duration and the shape of the yield curve explain these differences.
In addition, the environment in which bonds work was analysed. The financial subprime crisis and the crisis of Sovereign debt strongly affected the economic performances and investors behaviours. In particular, two meaningful indicators, the spread and the Yield curve, that are used to predict and forecast market trends, were studied.
The financial environment, after 2007, changed drastically and investors adapted their portfolios in order to protect themselves from the volatility of the market. This situation led to changes in investment behaviours; the so-called flight to quality and the flight to liquidity strategies affect the composition of investors' portfolios worldwide.
At this point, once the large use of debt instruments in the market and the changes that characterized the financial market after the crisis have been highlighted, the aim of the thesis is to investigate if bonds risk is priced.

## 4.1 Methodology

The analysis investigates the relation of bond returns on stock returns. In order to find out some evidences of this phenomena a cross section asset pricing model is used. At this point, the general framework and the formulas used to compute the final results will be explained; then, in the following paragraphs, the passages to obtain the results and the variables used step by step will be analysed.The process of asset pricing used refers to the one introduced by Fama and MacBeth (1973) [16]. The process involves a two-steps procedure.

The first step consists in a time series regression;

$$R_t{}^i = \alpha + B^i F_t{}^i + \epsilon_t \tag{5}$$

Firstly, Rt is the vector of Nx1 excess returns of stocks while Ft is the vector of Nx1 bonds returns that influences the performance of the first vector. So, Rt is considered the y variable, the dependent one, while Ft the x variable, the independent one. Having these two vectors, it is possible to estimate ß, that is a measure that explain the change of the variable Ft according to a change of 1 in variable Rt. It is possible to find out ß values using OLS. The second step of the analysis consists in a cross-sectional regression.

$$E[R_t{}^i] = \alpha + B\gamma + \mu \tag{6}$$

Rt is the average return of stock portfolios that are considered in the analysis. B is the vector formed by the ß computed in the first regression. So, it is important not to confuse the Vector B with γ. In this equation Rt is the dependent variable while B is the independent one. In order to compute γ, it is possible to use OLS. The values of γvariable is the final result that allows to understand if bonds risk is priced; indeed, the coefficient γexplains the influence of ß on the average return of the sample of stocks. The first step consists in a time series regression, the second one in a cross-section regression.

Time series data are data collected about one phenomenon over time. In particular, the model considered is a static model. A static model is used to analyze data in which variable x influence variable y, at time t, immediately. Normally, it is used to observe the trade-off between two variables. On the contrary, cross section data are data that are collected about different elements in one precise time or period.

[16] EF Fama, JD MacBeth, Journal of political economy, 1973

Moreover, the OLS, ordinary least square, is the method that will be used to derive the values of betas first, and the values of γthen. OLS is a commonly used method to find out the unknown variable in a linear regression model. It is a statistical method that allows to estimate the relationship between the independent variable of a linear regression and the dependent one. In particular, the final result plots a line that minimizes the distance between all the data considered.

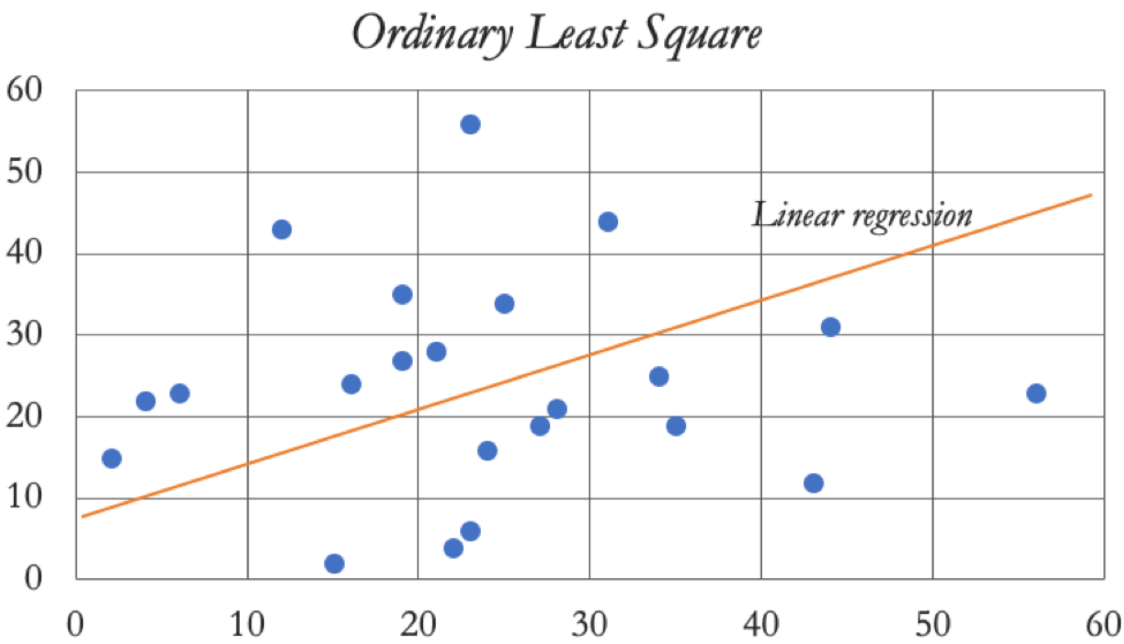


Figure 17: Ordinary Least Square represnetation

As it is possible to see from Fig. 17, the result of the OLS is the line that passes through all the observation of the data set. In order to calculate OLS a statistical software, Gretl, which allows to directly obtain the results, is used.
However, it is important to understand the process used to calculate the values of the coefficients. The starting point is a linear regression.

$$y = ßx + \epsilon \tag{7}$$

The linear regression is a statistical method that explain the relation between a dependent variable, in this case y, and an independent one, in the example x, that explains and influences the first one. In equation 8, it is possible to appreciate the formula to compute the coefficient ß using ordinary least square.

$$ß = \frac{\sum_{i=1}^{n}(x_t - E(x))(y_t - E(y))}{\sum_{i=1}^{n}(x_t - E(x))^2} \tag{8}$$

The numerator is composed by the sum of the multiplication of the difference between variable x and the mean of variable x at time t, and the difference between variable y and the mean of variable y at time t, of all observations. The denominator is the sum of the difference of the variable x with the mean of variable x at time t elevated at the power of two of all observations. The division between numerator and denominator permits to calculate ß, that is the slope of the line of OLS. Moreover, it is possible to derive the formula to compute OLS; it is exactly the division between the covariance of X and Y and the variance of X.

$$Variance(X) = \frac{\sum_{i=1}^{n}(x_t - E(x))^2}{n} \tag{9}$$

$$Covariance(X, Y) = \frac{\sum_{i=1}^{n}(x_t - E(x))(y_t - E(y))}{n} \tag{10}$$

In the formula (9), the variance is the value of the standard deviation at the power of two. The standard deviation is a measure that allows to understand the level of dispersion of the data that composes the sample, and the same information is reported by the variance. So, variance is a measure of concentration, the higher the value of the variance, the higher the presence of the values of the data near the mean value of the data sample. At the same time, the covariance, is a measure that helps to understand the contemporaneous variability of two variables taken into consideration. In the presence of a positive covariance, it is expected that, as a consequence of the positive variation of the first variable, also the second one changes positively; on the contrary, in the presence of a negative covariance, the movements of the variables are opposite. However, the results of the covariance are strongly affected by the unit of measure used, leading to possible difficulties in the interpretation of the results. In order to have a measure that is not influenced by the unit measure used and to better understand the covariance of two variables, it is useful to use the Formula of Pearson correlation; it is the result of the covariance divided by the multiplication of the standard deviation of the two variables.

$$\rho(X,Y) = \frac{Cov(X,Y)}{\sigma x \sigma y} \tag{11}$$

In particular, this indicator helps to understand the link between two series of variables. More in detail, the value of Pearson correlation lies from -1 to 1; when the value is above zero, there is a positive correlation, on the contrary, the link between the variables is negative. Finally, if the value is equal to zero, the variables are independent. However, it is important not to confuse correlation with causation; if variables are strongly correlated it does not mean that there is a direct causation link between the first and the second element [17] . So, the variance is a measure of the variability of the values of the variable X with respect to the mean of the values that compose the vector X. The covariance measures the joint variability of two variables. Dividing the two elements explained, as result, the formula of the OLS is obtained. In this way, it is possible to derive the value of the coefficient ß. Consequently, ß shows the joint variability of variable Y and X related to the variability of only the variable X. When ß has a positive sign, if the first variable increases, also the second does the same, when the value of ß is negative, if the first variable grows the second decreases.

## 4.2 Bond Risk Factors, FF Portfolios and First Regression

The first step in order to compute ß is to define the variables that are used to run the first regression. Firstly, Equation 6 is considered. At this point we need to build the regressor, the vector Ft. The choice is to use some variables that are

[17] Movements and Co-Movements Across European Asset Classes: Portfolio Allocation and Policy Implications

expected to influence the dependent variable. It is decided to build some bond risk factors. Bond risk factors will be the regressors of the equation. It is decided to form various portfolios composed by different types of government and corporate bonds. In particular, the data used are bonds total return indexes. The time period considered is from 01/01/2002 to 01/06/2019. Twelve bond risk factors are built. The first bond risk factor is composed by 10 years government bond total return index of different European countries. In particular, the following variables were used: UK BENCHMARK 10 YEAR DS GOVT. INDEX, IT BENCHMARK 10 YEAR DS GOVT. INDEX, BD BENCHMARK 10 YEAR DS GOVT. INDEX, FR BENCHMARK 10 YEAR DS GOVT. INDEX, PT BENCHMARK 10 YEAR DS GOVT. INDEX, ES BENCH- MARK 10 YEAR DS GOVT. INDEX, SD BENCHMARK 10 YEAR DS GOVT. INDEX, DK BENCHMARK 10 YEAR DS GOVT. INDEX, BG BENCHMARK 10 YEAR DS GOVT. INDEX, GR BENCHMARK 10 YEAR DS GOVT. INDEX, NL BENCHMARK 10 YEAR DS GOVT. INDEX, OE BENCHMARK 10 YEAR DS GOVT. INDEX. All these variables show the indexed price of 10 years government bond of different countries; specifically, United Kingdom, Italy, Germany, France, Portugal, Spain, Sweden, Denmark, Belgium, Greece, Netherlands and Austria. Different countries of the Eurozone are selected in order to build a portfolio that expresses the general trend of European government bonds. This portfolio is called ALL10 in the rest of the paper. At the same time, other two portfolios using previous data are built; the MED10, in which the 10 years government bonds total return index of Mediterranean countries are present: Italy, Portugal, Spain and Greece. Equally, the same process is used to build the NOR10 portfolio, which is composed by 10 years government bonds total return index of Nordic countries: Sweden, Denmark, Belgium and Netherlands. The choice to build three different portfolios with the same term but formed by different countries is done in order to have the possibility to compare the results and to analyze the different influence of bond returns of different regions on the stock market. The same process is used in order to build other six portfolios; the same countries but different maturities of government bonds are used. Precisely, 5 years government bond total return indexes and the 2 years government bond indexes are taken into consideration. So, the following six portfolios are built: ALL5, MED5, NOR5, ALL2, MED2, and NOR 2. The ratio of this choice is to have the possibility to compare the influence of bonds with different terms on the stock market; as it is previously analyzed, the behaviours of short and long-term bond are strongly different, so, it is expected that bonds with different maturities have a different influence on the dependent variable. In order to improve the analysis, another two portfolios composed by corporate AAA bonds are built. In particular, to build the first one, ICE BofAML 7-10 Year AAA Euro Corporate Index is used; it is a portfolio composed by corporate long-term bond; it is formed by different AAA bonds of different corporates weighted by the data provider. The second one is a portfolio composed by short-term AAA corporate bonds; in particular, the data used are the ICE BofAML 1-3 Year AAA Euro Corporate Index. Again, long-term and short-term corporate bonds are considered to have the possibility to compare the effects on stocks returns of different term structure bonds with the same characteristics. The final portfolio that is used in the analyses is the portfolio composed by the market risk premiums; the portfolio is composed by the returns obtained by subtracting the market returns with the return of a risk-free asset. The data of the last portfolio are downloaded by the FF database, the source of the previous data is DataStream by Thomson Reuters. The second step is the computation of the mean of the price of bonds that compose every single portfolio. So, it is computed the mean of prices of each monthly observation of every portfolio illustrated before. However, in order to run the regression, it is necessary to use returns and not prices of the monthly observations. The following formula to compute returns is applied.

$$R_t = \frac{Index_t - Index_{t-1}}{Index_{t-1}} \tag{12}$$

The formula allows to calculate returns of every single monthly observation of every portfolio. In addition, using total return indexes, the returns calculated also express the values of the coupon within.

| NAME | IT 10 YEAR DS GOVT. INDEX | PT 10 YEAR DS GOVT. INDEX | ES 10 YEAR DS GOVT. INDEX | GR 10 YEAR DS GOVT. INDEX | MED10 | |
|---|---|---|---|---|---|---|
| CURRENCY | € | € | € | € | Mean | Return % |
| 01/01/02 | 100 | 100 | 100 | 100 | 100,00 | |
| 01/02/02 | 99,972 | 100,219 | 100,57 | 100,417 | 100,29 | 0,294 |
| 01/03/02 | 99,867 | 99,379 | 99,615 | 99,65 | 99,63 | -0,665 |
| 01/04/02 | 97,803 | 97,939 | 97,934 | 98,157 | 97,96 | -1,676 |
| 01/05/02 | 98,738 | 98,719 | 98,787 | 99,101 | 98,84 | 0,896 |
| 01/06/02 | 98,547 | 98,427 | 98,539 | 98,924 | 98,61 | -0,230 |
| 01/07/02 | 99,845 | 99,666 | 99,853 | 100,07 | 99,86 | 1,267 |
| 01/08/02 | 101,911 | 101,728 | 102,486 | 102,146 | 102,07 | 2,212 |
| 01/09/02 | 103,506 | 103,376 | 104,126 | 103,691 | 103,67 | 1,574 |
| 01/10/02 | 104,929 | 104,974 | 105,721 | 105,262 | 105,22 | 1,492 |
| 01/11/02 | 103,229 | 103,429 | 104,198 | 103,639 | 103,62 | -1,518 |
| 01/12/02 | 103,881 | 104,092 | 104,735 | 104,254 | 104,24 | 0,595 |
| 01/01/03 | 106,416 | 106,738 | 107,266 | 106,785 | 106,80 | 2,457 |
| 01/02/03 | 107,621 | 107,94 | 108,495 | 108,024 | 108,02 | 1,141 |
| 01/03/03 | 109,434 | 109,65 | 110,282 | 109,809 | 109,79 | 1,642 |
| 01/04/03 | 108,128 | 108,44 | 109 | 108,695 | 108,57 | -1,118 |
| 01/05/03 | 107,816 | 108,228 | 108,737 | 108,45 | 108,31 | -0,238 |
| ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| 01/11/18 | 138,784 | 160,851 | 159,566 | 88,263 | 136,87 | -0,280 |
| 01/12/18 | 141,687 | 161,81 | 160,908 | 87,94 | 138,09 | 0,892 |
| 01/01/19 | 146,283 | 163,046 | 162,016 | 86,629 | 139,49 | 1,019 |
| 01/02/19 | 146,473 | 166,278 | 164,79 | 91,674 | 142,30 | 2,015 |
| 01/03/19 | 146,689 | 168,762 | 165,216 | 94,17 | 143,71 | 0,988 |
| 01/04/19 | 149,47 | 172,021 | 167,979 | 95,595 | 146,27 | 1,779 |
| 01/05/19 | 150,703 | 174,46 | 170,108 | 96,494 | 147,94 | 1,145 |
| 01/06/19 | 150,626 | 180,103 | 175,046 | 98,704 | 151,12 | 2,148 |

Figure 18: Bond Risk Factors

In figure 18, the table illustrates an example of the building of a bond risk factor; the graph shows the MED10 bond risk factor and the process to compute each monthly return. In the same way, the 12 bond risk factors returns that are used as regressor of the Equation 6 are obtained.

Now, showed the regressors of the equation, it is fundamental to explain the choice of the dependent variable. It is decided to use different equity portfolios formed and sorted by Fama & French; data are downloaded by the Kenneth R. French data library. In particular, the following are considered: 17 INDUSTRY PORTFOLIO, 25 PORTFO- LIOS FORMED ON SIZE AND BOOK TO MARKET, 25 PORTFOLIOS FORMED ON SIZE AND OPERATING PROFITABILITY, 25 PORTFOLIOS FORMED ON SIZE AND INVESTMENTS, 25 PORTFOLIOS FORMED ON BOOK TO MAR- KET AND OPERATING PROFITABILITY, 25 PORTFOLIOS FORMED ON BOOK TO MARKET AND INVESTMENTS, 25 PORTFOLIO FORMED ON OPERATING PROFITABILITY AND INVESTMENT, 25 PORTFOLIOS FORMED ON SIZE AND MOMENTUM, 25 PORTFOLIO FORMED ON SIZE AND SHORT TERM REVERSAL, 25 PORTFOLIOS FORMED ON SIZE AND LONG TERM REVERSAL, 25 PORTFOLIOS FORMED ON ACCRUALS, 25 PORTFOLIOS FORMED ON MARKET BETA, 25 PORTFOLIOS FORMED ON VARIANCE, 25 PORTFOLIOS FORMED ON RESIDUAL VARIANCE, 25 EUROPEAN PORT- FOLIOS FORMED ON SIZE AND BOOK TO MARKET, 25 EUROPEAN PORT- FOLIOS FORMED ON SIZE AND OPERATING PROFITABILITY, 25 EURO- PEAN PORTFOLIOS FORMED ON SIZE AND INVESTMENTS, 25 EUROPEAN PORTFOLIOS FORMED ON SIZE AND MOMENTUM. All these portfolios report monthly observation of returns from 01/02/2002 to 01/06/2019. The choice is to use a large number of portfolios with different characteristics; for example, the presence of the industry portfolios is important in order to observe the possible differences in the effect of the regressors with the other portfolios sorted by financial characteristics. In addition, portfolios composed by only European stocks are considered in order to compare and analyze the discrepancy of the influence of bond risk factors on portfolios formed by stocks of all over the world and portfolios formed by only European stocks. Figure 19 illustrates the composition of the 17-industry portfolio, the table shows the values of returns in %.

At this point, once the dependent and the independent variables are obtained, it is possible to compute the value of ß. In particular, equation 5 is a time series regression and OLS method is used in order to obtain ß. The regression is between

| 17 Industry Portfolio | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Data*** | ***Food*** | ***Mines*** | ***Oil*** | ***Clths*** | ***Durbl*** | ***Chems*** | ***Cnsum*** | ***Cnstr*** | ***Steel*** | ***FabPr*** | ***Machn*** | ***Cars*** | ***Trans*** | ***Utils*** | ***Rtail*** | ***Finan*** | ***Other*** |
| 01/01/02 | 0,76 | -0,13 | -2,92 | 5,23 | 2,10 | -1,11 | -0,37 | -0,56 | -0,21 | 0,08 | 4,37 | 2,42 | 6,62 | -4,07 | 3,57 | -1,33 | -5,76 |
| 01/02/02 | 3,79 | 3,13 | 5,22 | -0,19 | 4,79 | 4,29 | 1,14 | 1,51 | -0,01 | 7,42 | -13,27 | 2,31 | 4,56 | -0,25 | 0,51 | -1,12 | -4,25 |
| 01/03/02 | 3,56 | 9,27 | 7,77 | 4,59 | 5,43 | 5,16 | -0,08 | -1,06 | 6,02 | 9,46 | 9,86 | 7,61 | 3,17 | 10,04 | 2,44 | 6,50 | 2,85 |
| 01/04/02 | 3,15 | -0,31 | -4,38 | 2,24 | 2,42 | -5,38 | -6,54 | -0,44 | -7,04 | 3,71 | -7,20 | 1,26 | -3,05 | -0,56 | -1,67 | -1,34 | -10,67 |
| 01/05/02 | 1,16 | 6,64 | -0,63 | -1,45 | -0,73 | 1,24 | -1,21 | -3,72 | 0,28 | -2,77 | -3,28 | 1,57 | 0,04 | -6,47 | -0,38 | -0,21 | -1,33 |
| 01/06/02 | -2,29 | -7,87 | -0,39 | -1,95 | -5,28 | -1,47 | -9,69 | -5,53 | -5,28 | -2,51 | -16,09 | -8,11 | 0,55 | -5,36 | -4,22 | -4,70 | -9,10 |
| 01/07/02 | -8,38 | -14,78 | -11,77 | -11,35 | -10,15 | -9,52 | -1,75 | -13,22 | -20,34 | -13,66 | -9,37 | -12,14 | -6,43 | -12,30 | -11,15 | -7,35 | -7,65 |
| 01/08/02 | 1,15 | 6,83 | 0,48 | -2,14 | 3,69 | 1,79 | 2,58 | 2,64 | -4,95 | 3,13 | -3,43 | -0,36 | -4,43 | 3,38 | 0,66 | 2,02 | 0,26 |
| 01/09/02 | -5,08 | -7,92 | -8,11 | -5,75 | -11,21 | -10,54 | -7,69 | -12,09 | -18,49 | -7,97 | -16,52 | -10,15 | -5,86 | -10,86 | -9,40 | -10,85 | -10,53 |
| 01/10/02 | 5,19 | -5,82 | 3,26 | 8,41 | 3,68 | 5,52 | 6,92 | 5,03 | 6,66 | 2,61 | 14,46 | -4,61 | 0,27 | -0,68 | 5,60 | 7,58 | 12,10 |
| 01/11/02 | -1,61 | 5,72 | 3,09 | 5,34 | 9,59 | 9,71 | 1,96 | -0,73 | 18,28 | 5,66 | 19,32 | 11,01 | 4,07 | 1,62 | 4,33 | 3,52 | 8,84 |
| 01/12/02 | -0,58 | 9,62 | 0,67 | -4,73 | -4,74 | -4,58 | -3,04 | -4,79 | -10,40 | -2,90 | -14,63 | -8,45 | -0,87 | 3,85 | -7,72 | -4,49 | -7,68 |
| 01/01/03 | -5,72 | -4,09 | -2,29 | -3,83 | -4,88 | -5,97 | -1,27 | -6,87 | -5,06 | -6,81 | -2,40 | -3,65 | -5,23 | -3,17 | -4,22 | -1,34 | -2,51 |
| 01/02/03 | -3,88 | -3,37 | 1,87 | -2,50 | -1,13 | -4,09 | -2,65 | 5,09 | 2,28 | -1,16 | 4,00 | -5,30 | -5,78 | -3,92 | -2,59 | -3,05 | -2,18 |
| 01/03/03 | -0,23 | -4,13 | 1,21 | 5,65 | 0,64 | 3,94 | 2,99 | 2,60 | -3,26 | -0,63 | -2,70 | -2,01 | 0,62 | 4,35 | 5,92 | 0,01 | 0,85 |
| 01/04/03 | 4,33 | 5,87 | -0,59 | 7,62 | 6,88 | 9,97 | 3,85 | 9,93 | 10,36 | 8,10 | 11,47 | 16,94 | 9,66 | 7,44 | 8,95 | 11,24 | 8,79 |
| 01/05/03 | 6,93 | 14,75 | 8,77 | 4,22 | 4,21 | 0,97 | 4,06 | 10,25 | 13,01 | 2,43 | 12,07 | 2,34 | 5,43 | 10,11 | 1,98 | 5,69 | 5,74 |
| 01/06/03 | 0,65 | 4,36 | -1,23 | -0,86 | -1,55 | -1,52 | 5,00 | 0,67 | 2,21 | 0,75 | -0,02 | 1,16 | 2,53 | 0,66 | 3,57 | 0,58 | 1,45 |
| 01/07/03 | -1,42 | 6,49 | -2,60 | 4,07 | 2,88 | 7,84 | -3,28 | -0,18 | 6,90 | 6,51 | 9,17 | 7,17 | 2,67 | -5,25 | 4,39 | 4,52 | 2,06 |
| 01/08/03 | -0,02 | 8,07 | 6,27 | 5,66 | 4,62 | 1,88 | -2,45 | 6,05 | 4,65 | 4,26 | 7,95 | 7,92 | 3,27 | 1,91 | 7,35 | -0,75 | 2,83 |
| 01/09/03 | 0,70 | 0,32 | -2,31 | -1,07 | -5,51 | -6,12 | 2,16 | -1,12 | -3,31 | -2,96 | -4,06 | -4,23 | -3,39 | 3,90 | -5,67 | 0,66 | -1,35 |
| 01/10/03 | 4,22 | 13,74 | 1,45 | 10,54 | 8,02 | 6,58 | 1,46 | 12,79 | 19,24 | 11,39 | 13,14 | 7,01 | 9,94 | 1,58 | 8,89 | 7,08 | 3,98 |
| 01/11/03 | 3,00 | 9,90 | 0,60 | 3,01 | 0,54 | 2,96 | 1,86 | 1,94 | 3,54 | 4,75 | 3,65 | 2,79 | -0,51 | 0,94 | -0,07 | 0,70 | 1,06 |
| 01/12/03 | 3,36 | 7,79 | 13,45 | 0,94 | 2,17 | 9,67 | 5,51 | 0,36 | 10,86 | 7,08 | 0,51 | 11,74 | 5,17 | 5,81 | -3,00 | 4,26 | 5,78 |
| 01/01/04 | -0,18 | -8,98 | 0,55 | -1,08 | 3,66 | -1,44 | 1,70 | -1,75 | -0,16 | -1,36 | 2,77 | -2,14 | -1,87 | 1,92 | 0,22 | 3,31 | 3,49 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 01/10/18 | 0,03 | -9,45 | -12,06 | -11,00 | -12,24 | -13,04 | -2,83 | -13,97 | -11,61 | -11,81 | -11,24 | -0,93 | -10,01 | -0,06 | -7,98 | -5,45 | -7,87 |
| 01/11/18 | 3,25 | -1,84 | -2,41 | -0,81 | 3,38 | 4,42 | 4,28 | 2,98 | -3,00 | 6,63 | 2,93 | 4,87 | 3,89 | 3,27 | 2,26 | 2,89 | 0,56 |
| 01/12/18 | -9,65 | -7,21 | -13,28 | -7,42 | -11,76 | -7,97 | -8,05 | -6,81 | -14,78 | -10,82 | -8,57 | -9,05 | -13,40 | -4,75 | -9,58 | -11,44 | -8,35 |
| 01/01/19 | 5,71 | 8,76 | 10,42 | 12,16 | 11,93 | 5,65 | 4,54 | 8,66 | 17,11 | 12,56 | 8,99 | 7,50 | 11,93 | 5,41 | 8,78 | 9,69 | 8,43 |
| 01/02/19 | -1,42 | 5,92 | 2,49 | 5,57 | 7,27 | 3,80 | 4,46 | 3,49 | 2,27 | 6,27 | 7,14 | 4,63 | 6,61 | 3,62 | -0,23 | 2,97 | 3,50 |
| 01/03/19 | 3,78 | 4,65 | 2,09 | -0,65 | -0,49 | -1,77 | 2,44 | 2,46 | -4,66 | -0,12 | 1,93 | -2,62 | -3,09 | 3,32 | 3,88 | -2,33 | 2,22 |
| 01/04/19 | 4,55 | -0,98 | 0,01 | 4,97 | 4,12 | 5,56 | -1,80 | 6,35 | -2,64 | 4,88 | 5,42 | 2,67 | 4,70 | 1,02 | 4,65 | 7,07 | 4,86 |
| 01/05/19 | -3,33 | -8,72 | -11,88 | -10,66 | -7,25 | -13,62 | -4,04 | -8,61 | -15,46 | -6,53 | -12,02 | -10,24 | -8,40 | -1,54 | -5,75 | -5,44 | -6,29 |
| 01/06/19 | 4,68 | 14,04 | 8,92 | 9,08 | 9,73 | 2,09 | 5,86 | 9,39 | 16,03 | 10,03 | 11,18 | 10,20 | 7,15 | 3,64 | 6,86 | 6,24 | 6,92 |

Figure 19: 17 Industry Portfolio

the vector composed by all the return computed of the bond risk factors and the vector of the returns of the single portfolios composing the FF portfolios. The regression is run with Gretl. Figure 20 shows the result of one regression, the value under the coefficient label and near the name of the bond risk factor, in the example MktRF, is the final estimation of the ß.

At this point, a matrix is built; it is possible to appreciate the value of betas associated at the linked risk factors and portfolios typologies. For example, in figure 21, it is possible to appreciate the matrix with the results of ß obtained for the 17-

```
Modello 1: OLS, usando le osservazioni 2002:02-2019:06 (T = 209)
Variabile dipendente: Food

             coefficiente   errore std.   rapporto t   p-value
  ------------------------------------------------------------
  const        0,403054      0,155388        2,594     0,0102    **
  MktRF        0,553291      0,0366813      15,08      3,56e-35 ***

Media var. dipendente   0,763541   SQM var. dipendente     3,208222
Somma quadr. residui    1019,890   E.S. della regressione  2,219686
R-quadro                0,523611   R-quadro corretto       0,521310
F(1, 207)               227,5192   P-value(F)              3,56e-35
Log-verosimiglianza    -462,2028   Criterio di Akaike      928,4056
Criterio di Schwarz     935,0902   Hannan-Quinn            931,1082
rho                    -0,108123   Durbin-Watson           2,194775
Note: SQM = scarto quadratico medio; E.S. = errore standard
```

Figure 20: The computation of the coefficient ß

industry portfolio. This process is done for all portfolios; 5304 regressions are run in order to obtain all the ß values necessary for the analysis. The coefficient ß shows the level of change of the dependent variable associated with a change of 1 unit of the dependent one. It is an indicator of the level of risk exposure of the independent variable to movements of returns of the equity market.[18]

[18] Aswath Damodaran, Applied Corporate Finance 4th Wiley (2014), Chapter 3

| The computation of ß | | 17 Industry Portfolio | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Food | Mines | Oil | Clths | Durbl | Chems | Cnsum | Cnstr | Steel | FabPr | Machn | Cars | Trans | Utils | Rtail | Finan | Other |
| Bond Risk Factors | Mkt-RF | 0,553 | 1,231 | 0,941 | 1,083 | 1,262 | 1,247 | 0,618 | 1,171 | 1,708 | 1,113 | 1,358 | 1,287 | 1,029 | 0,528 | 0,831 | 1,168 | 1,038 |
| | ALL10 | 0,036 | 0,454 | 0,355 | 0,318 | 0,351 | 0,323 | 0,222 | 0,378 | 0,269 | 0,226 | 0,210 | 0,031 | 0,145 | -0,136 | 0,132 | 0,185 | 0,189 |
| | MED10 | -0,081 | 0,017 | 0,124 | 0,130 | 0,113 | 0,038 | 0,006 | 0,015 | 0,146 | 0,086 | 0,012 | 0,026 | 0,023 | -0,106 | -0,042 | 0,138 | 0,015 |
| | NOR10 | 0,100 | 0,540 | 0,347 | 0,305 | 0,333 | 0,373 | 0,276 | 0,434 | 0,219 | 0,197 | 0,265 | 0,028 | 0,147 | -0,108 | 0,184 | 0,133 | 0,212 |
| | ALL5 | -0,096 | -0,088 | -0,096 | -0,025 | -0,213 | -0,124 | -0,006 | 0,151 | -0,378 | -0,219 | -0,160 | -0,374 | -0,183 | -0,340 | -0,126 | -0,140 | -0,053 |
| | MED5 | -0,155 | -0,192 | 0,012 | 0,028 | -0,025 | -0,121 | -0,083 | -0,159 | -0,066 | -0,011 | -0,056 | -0,029 | -0,126 | -0,181 | -0,169 | 0,013 | -0,069 |
| | NOR5 | -0,036 | -0,208 | 0,015 | 0,284 | 0,051 | -0,155 | 0,312 | 0,332 | -0,628 | -0,224 | 0,054 | -0,361 | -0,323 | -0,444 | 0,081 | -0,215 | 0,015 |
| | ALL2 | -0,210 | -2,641 | -1,058 | -1,373 | -1,466 | -0,979 | 0,015 | -1,358 | -1,763 | -1,267 | -0,627 | -1,898 | -1,525 | -0,984 | -0,982 | -0,965 | -0,382 |
| | MED2 | 0,092 | -0,572 | -0,137 | -0,235 | -0,163 | 0,049 | 0,095 | -0,290 | -0,060 | -0,091 | 0,004 | -0,282 | -0,195 | -0,111 | -0,191 | 0,055 | 0,105 |
| | NOR2 | -1,282 | -4,225 | -2,350 | -2,292 | -3,199 | -2,861 | -0,556 | -2,254 | -4,793 | -3,293 | -1,836 | -3,676 | -3,167 | -2,474 | -1,550 | -3,222 | -1,793 |
| | EUCOR7-10 | 0,142 | 0,255 | 0,229 | 0,356 | 0,353 | 0,158 | 0,192 | 0,329 | 0,129 | 0,278 | 0,141 | 0,129 | 0,118 | -0,099 | 0,319 | 0,224 | 0,181 |
| | EUCOR1-3 | 0,223 | 0,073 | 0,224 | 0,116 | 0,139 | -0,003 | 0,143 | 0,159 | 0,140 | 0,160 | 0,162 | 0,179 | 0,094 | 0,147 | 0,050 | 0,239 | 0,169 |

Figure 21: The ß value for the 17-industry Portfolio

## 4.3 The Second Regression and the Computation of $\gamma$

Equation 6 is used in order to obtain the values of Gamma.

More in detail, R, is the vector composed by the mean returns of the different portfolios present in the FF portfolios considered. So, the mean of returns of every single portfolio is calculated, and the vector composed by the mean of every portfolios is used as dependent variable.

The coefficient B is the vector composed by the values obtained in the previous regression. Each value of ß represents the result of the regression between the return of the bond risk factor and the return of each portfolios. At this point, the regression is run using OLS. The values of $\gamma$are summarized in Figure 22.

Firstly, it is possible to analyze only values that are statistically significant. In the table, they are highlighted using block characters. Values of gamma could be both positive and negative. In the presence of a negative value of gamma, investors do not ask for higher return from bonds as a consequence of a variation of the return of stocks. On the contrary, a positive value of gamma shows that investors ask for higher returns as a consequence of a change of stocks returns.

Most of the results that are obtained are negative. However, it is interesting to note that there are some positive values of $\gamma$. In particular, the 10 years Mediterranean bond risk is positively priced in two circumstances. Positive values of $\gamma$are related only to portfolios composed by only European stocks.

Probably, these results are affected by the conditions of the economic environment; investors, during the crisis, wanted to hold liquid and less risky assets. So, long-term government bonds of European countries that were strongly affected by the crisis, Greece was near default, and the position of Italy, Spain and Portugal was not stable, were not appetible for them. Consequently, they asked to be compensated in order to hold these types of financial instruments.

| *The values of λ* | *Mkt-RF* | *ALL10* | *MED10* | *NOR10* | *ALL5* | *MED5* | *NOR5* | *ALL2* | *MED2* | *NOR2* | *EUCOR7-10* | *EUCOR1-3* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *17 industries portfolio* | -0,0165 | 0,2037 | -0,0916 | 0,2332 | 0,3270 | -0,2064 | 0,1236 | -0,0491 | -0,3023 | 0,0048 | 0,3710 | **-1,2254** |
| *Size and book to market* | -0,2205 | 0,0754 | -0,3119 | 0,5104 | 0,2753 | -0,4285 | 0,0590 | -0,1205 | **-0,6885** | -0,0038 | 1,0976 | -0,2062 |
| *Size and operating profitbility* | -0,2264 | -0,1449 | **-1,6202** | 0,0918 | -0,0832 | **-1,2193** | -0,1142 | **-0,3079** | **-1,1551** | -0,0908 | 0,7380 | 0,7264 |
| *Size and Investment* | 0,2571 | -0,2734 | -0,5719 | -0,2305 | **-0,8795** | **-1,0824** | **-0,3905** | **-0,2575** | **-0,9899** | **-0,1601** | 0,7239 | 0,0464 |
| *Book to market and operating profitability* | -0,1664 | 0,1652 | 0,2440 | 0,1440 | 0,1151 | 0,4248 | 0,0225 | -0,0081 | -0,2346 | 0,0433 | 0,0493 | **-0,9415** |
| *Book to market and investment* | -0,2252 | -0,3804 | -0,2815 | -0,4779 | -0,1907 | -0,0998 | -0,0041 | 0,0523 | 0,5744 | 0,0000 | -0,0448 | **-0,9416** |
| *Operating profitability and investment* | **-0,4107** | 0,0061 | -0,9359 | 0,0599 | 0,0950 | -0,5126 | 0,1196 | 0,0064 | -0,3443 | 0,0240 | 0,4987 | -0,1389 |
| *Size and Momentum* | **-0,3441** | **-0,4484** | **-1,0872** | **-0,4363** | -0,1893 | **-0,9120** | **-0,3369** | -0,0555 | -0,3439 | 0,0423 | 0,2428 | 0,0850 |
| *Size and Short term reversal* | 0,1924 | 0,3315 | -1,2161 | 0,3934 | -0,2348 | **-2,1965** | 0,1275 | **-0,1837** | **-0,7933** | -0,0054 | **1,3924** | 0,6745 |
| *Size and Long term reversal* | 0,1447 | -0,5471 | **-1,4765** | -0,4398 | **-0,7237** | **-1,2433** | **-0,4357** | **-0,2038** | **-0,6562** | **-0,1617** | 0,0908 | **0,6795** |
| *Size and accruals* | 0,2389 | -0,0393 | -0,2701 | -0,0302 | -0,2689 | **-0,8565** | -0,1855 | **-0,1579** | **-0,7562** | **-0,0733** | 0,4596 | 0,1413 |
| *Size and market beta* | -0,0132 | -0,3202 | -0,7395 | -0,1660 | **-0,6514** | **-1,2157** | **-0,4056** | **-0,2289** | **-0,7982** | **-0,0976** | 0,0756 | -0,0419 |
| *Size and Variance* | **-0,2425** | **-0,6463** | -0,8769 | **-0,7507** | 0,4220 | -0,1702 | -0,5671 | -0,0178 | -0,3846 | 0,0533 | **1,6188** | **1,0724** |
| *Size and residual variance* | **-0,3091** | **-0,8697** | **-1,8785** | **-0,9541** | -0,1013 | **-1,8355** | -0,4526 | -0,1502 | **-0,9304** | 0,0456 | 2,1389 | **1,5583** |
| *European size and book to market* | -0,1068 | 0,4121 | **1,3300** | 0,2409 | **1,0315** | **0,9107** | 0,0504 | 0,2199 | 0,5809 | -0,0048 | 0,2972 | 0,0980 |
| *European size and operating profitability* | **-0,9191** | **-1,0967** | -0,4189 | **-1,0329** | -0,8039 | 0,7194 | **-0,5705** | -0,3466 | 0,1629 | **-0,2901** | -0,4953 | -1,2403 |
| *European size and Investment* | **-0,6203** | 0,2176 | **3,6221** | -0,1294 | **1,5063** | **1,8541** | -0,0819 | **0,3982** | **1,0789** | 0,0673 | -0,3270 | -0,1619 |
| *European size and Momentum* | **-1,4030** | **-1,7714** | **-4,3954** | **-1,4617** | 0,6676 | -0,9438 | **-0,6705** | -0,3535 | -1,0290 | **-0,4174** | -1,1349 | **-3,0847** |

Figure 22: The computation of $\gamma$

Moreover, both ALL5, MED5, ALL2 and MED2 bond risk seems to be priced in some circumstances. However, there are not positive values of $\gamma$among government bonds composed by bonds of Nordic European country. Finally, European corporate bonds risk, EUCOR7-10 and EUCOR1-3, seems to be positively priced by portfolios composed by stocks of all over the world and sorted by characteristics, conversely than bond risk factors composed by government bonds.

## 4.4 Focus on the Period of the Crisis

At this point of the analysis, the period from 01/01/2002 to 02/06/2019 was considered. However, this period is very long, and within the period occurred both the 2007 subprime financial crisis, and the crisis of sovereign debt. Obviously, these two events affected the values of stocks and the behaviours of investors. So, it is interesting to strengthen the period of the analysis on the period of the Sovereign crisis, in order to investigate the possible influence of bonds during that period. So, the previous analysis is carried out again, but the time horizon analyzed is from 01/01/2011 to 01/01/2016; the period in which the crisis of sovereign debt was stronger. The regression is run only on some of the previous portfolios. In particular, it is decided to use as dependent variables the following data: 17 INDUSTRY PORTFOLIO, 25 PORTFOLIOS FORMED ON SIZE AND BOOK TO MARKET and 25 EUROPEAN PORTFOLIOS FORMED ON SIZE AND OPERATING PROFITABILITY. The reason is to analyze both a portfolio formed by worldwide stocks and a portfolio formed only by European stocks. The regressors remains the same of the first part; so, 12 bond risk factors are used as regressor. Just like before, the OLS is run to find out the values of ß. Then, the mean of returns of the portfolio considered for the new time horizon is computed. The new vector is used as dependent variable of the regression and the vector of ß just obtained as regressor. Again, using OLS, the values of $\gamma$reported in the table below are found out.

| The values of ß | | 17 Portfolio industries | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Food | Mines | Oil | Clths | Durbl | Chems | Cnsum | Cnstr | Steel | FabPr | Machn | Cars | Trans | Utils | Rtail | Finan | Other |
| Bond Risk Factors | Mkt-RF | 0,558 | 1,362 | 1,225 | 0,824 | 1,309 | 1,472 | 0,703 | 1,205 | 1,511 | 1,192 | 1,183 | 1,290 | 0,987 | 0,331 | 0,718 | 1,232 | 0,988 |
| | ALL10 | -0,117 | 1,159 | 0,531 | -0,168 | 0,285 | 0,647 | -0,121 | 0,350 | 0,628 | 0,331 | 0,387 | 0,403 | 0,147 | -0,489 | -0,107 | 0,313 | 0,154 |
| | MED10 | -0,169 | -0,044 | -0,044 | -0,023 | 0,061 | 0,015 | -0,168 | -0,080 | 0,181 | 0,095 | 0,008 | 0,234 | -0,027 | -0,222 | -0,193 | 0,070 | -0,066 |
| | NOR10 | 0,062 | 1,425 | 0,528 | -0,057 | 0,307 | 0,771 | 0,063 | 0,502 | 0,578 | 0,320 | 0,499 | 0,292 | 0,228 | -0,304 | 0,124 | 0,330 | 0,291 |
| | ALL5 | -0,137 | 0,475 | -0,116 | -0,216 | -0,141 | 0,140 | -0,333 | 0,334 | 0,086 | -0,118 | -0,091 | 0,009 | 0,026 | -0,454 | -0,191 | 0,070 | -0,057 |
| | MED5 | -0,208 | -0,092 | 0,033 | 0,000 | 0,080 | -0,103 | -0,246 | -0,118 | 0,169 | 0,084 | -0,026 | 0,254 | -0,097 | -0,275 | -0,243 | 0,051 | -0,107 |
| | NOR5 | -0,070 | 2,117 | 0,414 | 0,214 | 0,773 | 1,053 | -0,090 | 1,016 | 0,626 | 0,256 | 0,929 | 0,709 | 0,291 | -0,744 | 0,352 | 0,640 | 0,399 |
| | ALL2 | 0,509 | 0,018 | -0,088 | -0,787 | 0,460 | 0,961 | 0,295 | 0,198 | 1,574 | 0,296 | 1,049 | 0,360 | 0,086 | -0,429 | -0,203 | 1,139 | 1,055 |
| | MED2 | 0,168 | -0,036 | 0,039 | -0,156 | 0,168 | 0,299 | 0,104 | 0,003 | 0,575 | 0,163 | 0,257 | 0,160 | 0,049 | -0,058 | -0,080 | 0,334 | 0,317 |
| | NOR2 | -0,243 | 2,001 | -1,041 | -0,647 | 0,745 | 0,423 | -0,278 | 1,774 | -1,021 | -1,031 | 2,114 | 0,369 | -0,194 | -1,651 | 0,941 | 1,286 | 0,596 |
| | EUCOR7-10 | 0,180 | 0,275 | 0,209 | 0,273 | 0,350 | 0,161 | 0,116 | 0,256 | 0,179 | 0,232 | 0,080 | 0,144 | 0,110 | -0,092 | 0,311 | 0,177 | 0,132 |
| | EUCOR1-3 | -0,879 | -0,646 | -1,809 | -0,922 | 0,113 | -2,831 | -1,136 | 0,706 | -3,223 | -0,328 | -0,248 | -0,874 | -1,146 | -1,671 | 0,211 | -0,779 | -0,885 |

| The values of λ | | Bond Risk Factors | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mkt-RF | ALL10 | MED10 | NOR10 | ALL5 | MED5 | NOR5 | ALL2 | MED2 | NOR2 | EUCOR7-10 | EUCOR1-3 |
| FF Portf. | 17 industries portfolio | **-1,2023** | **-1,5373** | -1,9354 | **-1,5852** | **-1,7628** | -1,5363 | **-0,7661** | -0,2706 | -0,9621 | -0,0698 | -0,5662 | **0,3176** |
| | Size and book to market | **-0,5631** | **-0,6237** | -0,4988 | **-1,1110** | **-0,6917** | -0,6429 | -0,2457 | **-0,1704** | **-0,6875** | -0,0616 | **1,3731** | -0,0554 |
| | European size and operating profitability | **-1,0129** | **-1,5550** | -0,2777 | **-1,3290** | 0,0092 | 0,0140 | **-0,6250** | -0,2170 | -0,4595 | **-0,1897** | -0,0051 | 0,0362 |

Figure 23: The computation of ß and γduring crisis period

Figure 23 plots the ß associated to the 17-industry portfolios and the final values of $\gamma$of all portfolios selected. It is interesting to observe that, again, the great majority of results are negative. So, mostly, investors do not require higher returns as consequences of a positive change in stock returns. The only positive data concern corporate bond, in particular, the short-term government bond risk seems to be positively priced by the portfolio sorted by industry typology. Previously, there were no positive items linked to the industry portfolio. It seems that the results are not strongly different from the previous analysis.

## 4.5 The Weaknesses of the Model

The results that are found out are ambiguous. In fact, it is possible to recognize that in some cases debt financial instruments risk is priced, however, results are affected by various variables that influence the final results. Firstly, it is decided to build some bond risk factors that are used to compute the ß. However, a linear regression is used, in which, variables need to be totally independent. However, the return of stocks and of bonds are affected both by the economic condition, so, they cannot be considered totally independent.

In addition, the linear regression is sensitive to the presence of outliers. An outlier is a data that is strongly different from the sample. In the case of the bond risk factors, there are some prices of bonds, in particular related to Mediterranean countries, that were strongly affected by the crisis and as a consequence collapsed at a certain moment. The presence of outliers, in addition, also negatively influence the quality of OLS output.

Moreover, the time horizon considered was previously affected from the financial crisis of 2007 and then by the crisis of sovereign debt; the consequences is that both stock returns and bond returns were strongly affected by these events and, consequently, these anomalies are reported within the sample considered.

Another weakness of the analysis is that the values of ß are strongly difficult to predict and forecast [19]. Moreover, ß values computed are not market values but they are estimated, consequently, the estimation results incorporate a certain error level within them.

The cross-section regression used gives results that are very difficult to read: in particular, results from a CSR do not help to find out a relation of cause and effect. In addition, the cross-section regression requires a large number of data to provide accuracy, it is only effective in the moment in which the variables represent the entire environment. So, the choice of the independent variable is fundamental, and the possible lack of some variables reduces the validity of the analysis.

[19] Barahona Ricardo, Driessen Joost, Frehen Rik, Can unpredictable risk exposure be priced? January, 2018

# 5 Conclusion

The general framework considered was strongly influenced by the crisis. Credit institutions and governments strongly suffered this situation and economic performances were negatively affected worldwide. At a certain point in time, bonds became attractive for investors for different reasons; in order to protect themselves from the volatility of the market or in order to gain through speculative behaviours. As viewed before, bonds returns are affected by various external elements: the interest rates, the inflation level, the monetary policy decisions. So, it is easy to think that the stock market, that is large and dynamic, could have some kind of influence on the bond market. Surely, investors behaviours change during period of crisis, or at least, there are various factors that affect the asset allocations of their portfolios. [20] So, it is very interesting to investigate if the risk of bonds is priced. The results obtained however are ambiguous. The great majority of the values of $\gamma$are negative. It means that investors do not require to be compensated as a consequence of a positive change of stock returns. In addition, the bond risk factors selected seem to be priced only by portfolios formed by European stocks. This is reasonable because the bond risk factors are composed only by European government Bonds. Normally investors have the possibility to diversify their portfolios without regional constraints, however, the general preference of investors to invest in domestic financial instruments, both equities and debt is certified The phenomenon is called home bias. [21] Results, in addition, show that the Nordic governments bonds risk seem not to be positively priced, on the contrary, there are some positive $\gamma$values linked with bond risk factors composed by all government bonds and Mediterranean governments bonds. Moreover, corporate bonds risk seems to be priced by some portfolios sorted by characteristics (Size and short-term reversal, Size and long-term reversal,

[20]Mehmet Islamoglu, Mehmet Apan, Adem Ayvali, Determination of Factors Affecting Individual Investor Behaviours: A Study on Bankers, International Journal of Economics and Financial Issues

[21]F. Balli, A.A. Basher, H. Hozer-Balli, From home bias to euro bias: Disentanglig the effects of Monetary union on the European Financial markets, Journal of Economics and Business, 2010, Elsevier

Size and Variance, Size and Residual Variance) and composed by stocks from all over the world.

The results of the analysis focused on the period of the crisis are ambiguous too. Again, the majority of the values of coefficient $\gamma$are negative. The only positive values are linked with corporate bonds. It seems results are not strongly different from the previous one.

In order to understand the reasons of this ambiguity, it is important to take into account the weaknesses of the model. Firstly, the computation of the value of ß is extremely difficult and results are not strongly reliable.

Secondly, the choice of the dependent and independent variables of the regression is fundamental, the presence of variables that are not totally independent between each other negatively affects the final result. The presence of outliers negatively affects the output of the linear regression and, finally, the lack of some explanatory variable in the model reduces the quality of the final result.

So, considered the final outcome obtained it is possible to affirm that bond risk seems to be priced in certain circumstances; however, in order to better investigate the topic and to obtain more reliable results, it is probably necessary to develop a different method to run the cross section asset pricing test or, at least, to improve the quality of the method used enhancing the quality of the variables selected.

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