EFFECTS OF SOCIO-DEMOGRAPHIC FACTORS ON THE MATURITY STRUCTURE OF SOVEREIGN DEBT

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Abstract

The aim of this paper is to propose a model to analyze the effects of specific socio-demographic factors (age, income per capita by generation, gender and educational level) on the maturity structure of sovereign debt in Europe. Using panel data between 1980 and 2010,we obtain evidence that an increase in the age of the population as well as a higher level of income in the long-lived generation reduces the average maturity of sovereign debt. The number of graduates in the social sciences, business and law, which measures educational levels, shows a direct relationship with the average maturity.

Keywords: maturity structure, socio-demographic factors, debt maturity, sovereign debt market.

1. INTRODUCTION

Sovereign debt has been important object of study for economists, governmental authorities and researchers in recent years. The issue has gained greater importance because of the financial crisis that began in 2007 and its implications on public finances in euro zone countries such as Greece, Portugal and Ireland. In that sense, the aim of this paper is to deepen the maturity structure analysis of European sovereign debt. We propose a model that analyzes the effects of certain demographic factors (age, income per capita by generation, gender and educational level) on the maturity structure of sovereign debt in Europe between 1980 and 2010. We take into account the determinants that have traditionally been considered in the analysis of the average maturity of sovereign debt (debt/GDP ratio, inflation, GDP and interest rates on sovereign bonds). The aim is to analyze whether certain socio-demographic factors of the population of a state affects the average maturity of sovereign debt.

We also consider that there are different generations of investors coexisting at any moment in time that have different investment horizons (Guibaud et al., 2013). Younger investors have a longer-term investment horizon, while older investors seek

shorter-term investments. This combination of investors with different investment horizons can modify the structure of sovereign debt maturities and interest rates, modifying supply and demand (clientele effects). This idea links directly to the preferred habitat theory (Culbertson, 1957, Modigliani and Sutch, 1967), which establishes the existence of investors with different preferences of investment horizons.

This paper continues this line of research by attempting to contribute fresh insights to the study of the maturity structure of sovereign debt and its relationship to the socio-demographic attributes of investors. Specifically, it expands the number of variables included in Guibaud et al.'s (2013) model and, besides age, it includes proxies of income per capita by generation and variables for the effects of gender and educational level. To complete the study, we analyze the influence of the current financial crisis and the introduction of the euro as the single European currency on the maturity structure of sovereign debt.

Older age implies that potential investors' investment horizon is decreased, which leads to a reduction of the average maturity of sovereign debt. Similarly, a higher level of income for the younger generation implies a greater capacity for investment in a long-term horizon, increasing the average maturity of sovereign debt. For the older generation, the expected results from a higher level of income are the opposite. We also examine whether investors' gender affects the average maturity of sovereign debt. Many papers argue that women are more risk averse (Harris and Jenkins, 2006; Barnea et al., 2010 and Sachse et al., 2012, among others), so they seek safer investments and therefore shorter maturities. Regarding educational level, a better understanding of financial economics demonstrates a higher level of confidence, which can translate into the ability to take more risks (Paun et al., 2008) and therefore make more investments in longer maturities. To test these effects, we propose a model that includes a list of control variables (debt/GDP ratio, GDP, inflation and interest rates on sovereign bonds) and certain demographic factors (age, income per capita by generation, gender and educational level). The sample under study focuses on a group of countries in the Economic and Monetary Union, and the projection horizon extends from 1980-2010, inclusive.

The results show an inverse relationship between the average maturity of sovereign debt and the age of the population, which is consistent with the preferred habitat theory (Modigliani and Sutch, 1967). The results also confirm the conclusions of Guibaud et al. (2013) because as the age of the population increases, there is a greater preference for shorter-term investments, and therefore the average maturity of sovereign debt is reduced. The analysis also supports the conclusion that income per capita by generation influences the average maturity. This result shows that a higher level of revenue in the oldest generation reduces the average maturity of sovereign debt because the oldest generation's investment horizon is short term. However, the results are inconclusive regarding the effects of gender on the maturity structure of sovereign debt.

Overall, this work makes the following contributions to the literature:

- We propose a model to analize the effects of generations of investors on the average maturity of sovereign debt (clientele effects).
- We incorporate the following socio-demographic variables to analyze their effect on the average maturity of sovereign debt: age, gender, income per capita by generation and educational level.
- We conduct an empirical analysis using panel data on the influence of socio-demographic factors on the maturity structure of sovereign debt in Europe,

taking into account the current financial crisis and the introduction of the euro as the single European currency.

The paper is organized as follows. The following section provides a brief summary of the theoretical background. Next, we review the literature related to the maturity structure of sovereign debt. Section 4 proposes the hypotheses to be tested. Section 5 describes the data and methodology used in the analysis. Section 6 tests the hypotheses and discusses the results. Finally, the last section concludes.

2. THEORETICAL BACKGROUND

This section presents a brief summary of the theories and arguments that justify our hypotheses. Traditional theories on the maturity structure of sovereign debt stem from corporate finance, including the contracting costs theory, the signaling theory and the tax theory[1]. In this paper, we propose a model that takes into account the effects of the clientele (clientele effects) on the maturity structure of debt (Guibaud et al., 2013), following the assumptions of the preferred habitat theory. This approach examines how the presence of different generations of investors can affect the average maturity of sovereign debt. We also include arguments from the field of behavioral finance related to the liquidity preference theory that serve to justify the inclusion of gender, educational level and crises as factors that influence the maturity structure of sovereign debt.

2.1. Clientele effects

As noted above, one of the objectives of this paper is to propose a model to analyze the effects of specific socio-demographic factors on the maturity structure of sovereign debt in Europe. Therefore, we expand the number of variables considered by Guibaud et al. (2013)[2], who analyze the effects of age on the interest rates and maturity structure of sovereign debt.

From a theoretical point of view, the Guibaud et al.'s (2013) model starts from the idea that the sovereign debt market is formed by different types of investors with different preferences and characteristics. We can distinguish between institutional investors with long-term (pension funds) and short-term (financial institutions) investment horizons, but individual investors also have different investment horizons. This idea links directly to the preferred habitat theory (Culbertson, Modigliani and Sutch, 1957 and 1967), which states that investors are more likely to invest in bonds with maturities that reflect their investment-horizon preferences. Thus, investors with short-term investment horizons demand shorter-term bonds than investors with a longer investment horizon.

The model considers three generations of individuals at different stages of the life cycle and assumes that there are no tax distortions, and there is an efficient allocation of risk between generations. These groups receive an endowment to invest in bonds of different maturities to reflect their preferred investment horizon. The model assumes that there are two generations of investors in each period: the young generation, which expects to invest for two periods and therefore may invest in bonds of

[1] See Bodnaruk (1999) on the main theories of corporate debt maturity and its transfer to the sovereign debt market.

[2] Also see papers by Vayanos and Vila (2009) and Vayanos (2012) on the effects of the clientele in the maturity structure.

two periods (long-term bonds), and the older generation, which expects to invest for only one period and therefore invests in bonds of a single period (short-term bonds). We assume the condition that the risk aversion coefficient is greater than one[3] and is equal across generations. Therefore, an increase in the generation that has the long-term investment horizon reduces the interest rate of long-term bonds because the increased demand for two-period bonds raises their price, and interest rates and bond prices maintain an inverse relationship. In this sense, a greater demand for long-term bonds increases the average maturity of sovereign debt.

According to these assumptions, the model considers a change in the income of the generations in a given period while keeping the total value constant. In this case, we assume that the aggregate demand function for two-period bonds in equilibrium with full market participation has a negative slope. That is, as the interest rate increases, the bond price decreases. This condition ensures that there is a unique equilibrium with full market participation. Following the above reasoning, an increase in the generation with a long-term investment horizon (young generation) generates an increase in the supply of two-period bonds, reduces the equilibrium interest rate of this type of instrument, and increases the average maturity of sovereign debt.

These hypotheses are also related to the characteristics of each state. Given the situation described, an increase in the size of the generation with a long-term investment horizon (young generation) causes a reduction in the interest rate of long-term bonds as demand increases, implying an increase in the supply of two-period bonds offered by the government, which seeks the optimal maturity structure. A revenue-maximizing government responds by increasing the supply to a point of equilibrium in which the interest rate of the two-period bond remains constant. However, a welfare-maximizing government allows the interest rate of the two-period bonds to decrease without limit, which does not fully cover the excess demand because the unlimited supply affects future generations, who take the risk of default. Therefore, the model also predicts that an increase in the generation with a longer investment horizon (young generation) induces a welfare-maximizing government to increase the average maturity of its debt structure, but to a lesser extent than a revenue-maximizing government.

In short, the approach of Guibaud et al. (2013) is a theoretical model of optimal maturity structure influenced by the demographic characteristics of investors. Specifically, the authors analyze the influence of the age of the population on the average maturity and on the slope of the interest rate curve according to the following regressions:

$$Slope_{it} = \alpha + \beta Dem_{it} + u_{it} + e_{it} \tag{1}$$

$$Maturity_{it} = \alpha + \beta Dem_{it} + v_{it} + f_{it} \tag{2}$$

where $Slope_{it}$[4] is the slope of the interest rate curve, and $Maturity_{it}$ is the average maturity of the sovereign debt. Dem_{it} is the median age of the population, u_{it} and v_{it} are country effects, and e_i and f_i are the error terms. The authors' results for a sample of OECD countries show that there is an inverse relationship between the median age of the population and the maturity structure of the country's sovereign debt.

[3] If the risk aversion coefficient is equal to 1, we would not see these effects between generations of investors. When the risk aversion coefficient is greater than 1, demand favors assets that increase in price when interest rates decline, which holds for sovereign bonds.

[4] The slope of the interest rate curve is the spread between the interest rates of 30-year bonds and 10-year bonds.

2.2. Preferred habitat theory

The preferred habitat theory (Culbertson, 1957, Modigliani and Sutch, 1967) helps explain the term structure of interest rates. It establishes that investors try to reduce their exposure to risk considering their preferred habitat. This habitat is an area of the yield curve in which the life of assets matches the life of liabilities. Thus, economic agents are able to choose the maturities of their investments to suit their preferred habitat. Investors abandon their habitat only if they are compensated with a premium. That is, they only change their preferred investment horizon if the return is higher in another habitat.

The preferred habitat theory is directly linked to this study on sovereign debt maturity. Our proposed model states that the age of investors influences the average maturity of sovereign debt. Thus, younger investors locate their preferred habitat in an area of the yield curve where the investment horizon is long. In contrast, older investors' preferred habitat is in investments with shorter maturities because their age makes them reduce their investment horizon.

2.3. Behavioral finance

Behavioral finance has its origins in the so-called Prospect Theory, which was developed by Kahneman and Tversky (1979) as a counterpoint to the expected utility theory. It suggests that individuals are not entirely rational and are risk averse, so biases in behavior are motivated by individuals' personal characteristics and psychological nature, which influence their investment decisions.

This study is related to the theory of behavioral finance regarding gender and the educational level of investors and their relationship to the maturity structure of sovereign debt. Several studies link gender and investment decisions. Barber and Odean (2001) analyze the behavior of men and women regarding investment decisions and conclude that men have an excess of confidence (overconfidence), as other authors had already established (Lewellen et al., 1977 and Lunderberg et al., 1994, among others). This overconfidence indicates that men have a higher risk tolerance and therefore assume more risk in their investment decisions.

Moreover, according to the behavioral finance theory, individuals are sometimes reluctant to invest, which may be related to their educational level. This factor is related to two elements (Elan, 2010): a lack of financial knowledge and a lack of confidence. A lack of financial knowledge refers to the assumption that individuals who have less knowledge about the functioning of financial economics are less likely to invest because they are more risk averse (Van Rooji et al., 2010). A lack of confidence refers to the assumption that investors do not invest because of a fear of being cheated and losing their investment (Luigi et al., 2008). This confidence is determined by sociocultural factors. We believe that investors with more education are less risk averse because of their financial knowledge and, consequently, their greater reliance on markets.

2.4. Liquidity preference theory

This theory, developed by Hicks (1939), argues that in an environment of uncertainty and risk aversion, economic agents demand more liquid bonds because they incorporate less uncertainty. Investors request a liquidity premium for longer-term investments, which is directly related to maturity.

This paper analyzes the influence of the current financial crisis on the maturity structure of sovereign debt. The crisis has increased uncertainty, especially in the

sovereign debt market. According to the liquidity preference theory, this uncertainty implies an increase in demand for safer and more liquid bonds and therefore shorter maturities. We also examine the influence of the introduction the euro as the single European currency. This factor may reduce uncertainty and therefore the long-term liquidity premium, which can cause an increase in the average maturity of sovereign debt.

3. LITERATURE REVIEW

This section provides a brief summary of the literature on the study of the maturity structure of sovereign debt. In this regard, recent developments related to the current financial crisis have generated grave concern about the impact of sovereign debt on countries' finances. However, many studies have focused on analyzing the volume of debt, interest rates and sovereign risk premia but not on the maturity structure, which may significantly affect an economy's liquidity (Goudswaard, 1990). This study analyses this key aspect of a country's finances.

The sovereign debt maturity is the average period until the date when the debt of a state must be paid (Kanzczuk and Alfaro, 2006). States decide to issue debt with different maturities because it may be beneficial to smooth the cost of debt (Niepelt, 2008).

There are two lines of research on the maturity structure of sovereign debt. The first studies its determinants. There are numerous studies in the field of corporate finance (Myers, 1977; Barclay and Clifford, 1995; Guedes and Opler, 1996 and Faulkender, 2005). However, in the area of public finance, the number of studies is much smaller. Goudswaard (1990) analyzes the determinants of the maturity structure of sovereign debt in the Netherlands between 1960 and 1985. His results indicate that real interest rates and changes in capital market conditions and investment preferences, as approximated through the average maturity of corporate debt, influence the average maturity of sovereign debt.

Missale and Blanchard (1994) analyze the relationship between the maturity structure and the debt/GDP ratio in Belgium, Ireland and Italy between 1960 and 1990, and the authors find an inverse relationship between the two variables. De Haan et al. (1995) perform this analysis for eight OECD countries and confirm the existence of an indirect relationship. However, their results are not the same for all countries because the USA and Canada show a direct relationship between the average maturity of sovereign debt and the debt/GDP ratio. Bodnaruk (1999) presents similar conclusions in his analysis of the structure of Ukrainian debt maturities between 1996 and 1998, where the debt/GDP ratio has a positive and significant effect on the average maturity.

The second line of research analyzes the optimal structure of sovereign debt maturities and attempts to determine the ideal combination of a country's short- and long-term issues. Ramanarayanan and Arellano (2008) apply a dynamic model that takes into account the possibility of default to analyze the optimal maturity structure in emerging market countries. The authors present evidence that the composition of the maturity structure of sovereign debt is related to interest rate differentials. Thus, if the spreads on short-term sovereign debt are reduced, the spreads of long-term instruments are higher, and therefore the average maturity of issued debt increases.

Also in this line of research, Lustig (2006) and Perez (2013) argue that long-term debt can protect countries from possible shocks because it reduces the need to

refinance debt with shorter maturity debt. Jeanne (2009) shows that reduced average maturity structures can create tensions that encourage governments to pursue policies that have creditor-friendly mechanisms to offset the potential risk of default. In addition, Tirole (2003) indicates that a short-term debt structure generates greater discipline by countries' fiscal authorities. Broner et al. (2012) conclude that in times of crisis, the horizon of debt issues shortens because the risk of long-term bonds increases at a higher rate than the risk of bonds with shorter maturities. In a context of risk-averse investors, short-term debt is a better option because the uncertainty is lower.

4. HYPOTHESES FORMULATION

In this section, we propose the hypotheses to be tested, argued and justified according to the theoretical background and the cited literature. As stated previously, the aim of this paper is to analyze the effects of certain demographic factors on the maturity structure of sovereign debt.

4.1. Does the age of the population affect the average maturity of sovereign debt?

The combination of generations of investors with short- and long-term investment horizons can influence the average maturity of sovereign debt (Guibaud et al., 2013). On one hand, if agents are more risk averse than what the logarithmic utility function implies, when the size of the younger generation increases, long-term bonds are more expensive and their supply by the government increases, which represents an increase in the average maturity of sovereign debt. On the other hand, a larger generation of older investors with a short-term investment horizon causes a decrease in the average maturity of sovereign debt.

These arguments link directly to the preferred habitat theory (Culbertson, 1957 and Modigliani and Sutch, 1967), which holds that investors choose the investment terms that best suit their preferences. Thus, older investors rely on shorter maturities, while younger investors choose longer maturities.

The proposed model considers two generations of individuals: the younger generation (age 25 to 49), which has a long-term investment horizon, and the older generation (age 50 to 74), which has a short-term investment horizon[5]. The preferred habitat theory holds that these generations select their investment horizons that best suit their preferences.

As stated above, demography may affect the maturity structure of sovereign debt. Currently, there is a general trend in developed countries toward an aging population and a falling birthrate, which generates a reversal of population pyramids. This phenomenon is indicative of the generation with a long-term investment horizon losing ground, while the older generation acquires more weight. According to this reasoning, the average maturity of sovereign debt should tend to decrease in the future as a greater proportion of the population sees a reduced time horizon for their investments.

[5] The young generation invests in two-period bonds (long term), while the older generation invests in single-period or short-term bonds (Guibaud et al., 2013).

Following the above arguments, we propose the following hypothesis:

Hypothesis 1: The average maturity of sovereign debt demonstrates an inverse relationship to the age of the population.

This hypothesis states that the greater the age of the population, the greater the proportion of individuals with a reduced investment horizon, which leads to a decrease in long-term bonds over short-term bonds. States will adapt their bond supply to the characteristics of their clientele, which implies a reduction in the average maturity of sovereign debt.

Nevertheless, this relationship can also be influenced by the income levels of the two generations of investors. Thus, if the income of the younger generation increases, they will have more financial resources for their investments, and their time horizon will be long term. Therefore, a higher level of income for the young generation implies a greater demand for long-term bonds and an increase in the average maturity of sovereign debt. However, if the income of the older generation increases, they will increase the demand for short-term bonds, reducing the average maturity of sovereign debt.

Guibaud et al. (2013) recommend taking into account the income per capita of different generations of individuals. This paper incorporates proxies that analyze how the economic resources of these generations affect the average maturity of sovereign debt. Given these arguments, we hypothesize:

Hypothesis 2: Income per capita of the young generation is directly related to the average maturity of sovereign debt. In the case of the older generation, this relationship is the opposite.

According to this hypothesis, an increase in the income of the younger generation indicates that they have greater resources for investment. Because these individuals have a long-term investment horizon, the demand for long-term sovereign debt increases and therefore so does its average maturity.

4.2. The influence of gender on the maturity structure of sovereign debt

Many studies note the existence of differences in investment decisions between men and women because risk perceptions are different by gender.

Behavioral finance suggests that investors are not rational and do not maximize their expected utility function. In addition, individuals are risk averse and place greater emphasis on probable losses than potential gains (Kahneman and Tversky, 1979). Risk aversion is closely linked to investors' risk tolerance, i.e., risk-averse individuals are less tolerant of the financial risks of an investment (Mulino and Chai, 2008). In this regard, numerous studies show that women have lower risk tolerance than men (Jianakoplos and Bernasek, 1998; Dwyer et al., 2002; Graham et al., 2002; Harris and Jenkins, 2006; Feng and Seasholes, 2008; Barnea et al., 2010 and Sachse et al., 2012). This behavior may be related to the phenomenon of overconfidence, whereby individuals show overconfidence in their knowledge and evaluation of investments in financial decision-making. Many researchers have studied this phenomenon (Chuang and Lee, 2006 and Ko and Huang, 2007, among others). Overconfidence has also been analyzed according to the gender of individuals, and the main conclusion is that women exhibit less confidence than men (Estes and Hosseini, 1988; Masters, 1989; Powell and Ansic, 1997 and Barber and Odean, 2001). In particular, Estes and Hosseini (1988) conclude that gender is an important factor for confidence in financial decision-making.

According to this argument, the proportion of women in the population may influence the maturity structure of sovereign debt. Women, who are more risk averse, seek safer investments. As risk increases in the same sense as the term to maturity of an investment, women demand shorter-term investments where uncertainty and risk are lower. Thus, according to the above arguments, we propose the following hypothesis:

Hypothesis 3: The structure of the population according to gender affects the maturity structure of sovereign debt.

The structure of the population according to gender can affect the average maturity structure of sovereign debt. A higher proportion of women indicates a greater number of risk-averse individuals and therefore investors with short-term investment horizons. In contrast, a society with a higher proportion of men should show a greater number of less risk-averse economic agents and therefore investors with longer investment horizons.

4.3. Effects of educational level on the average maturity of sovereign debt

The analysis of educational level as a determinant of investment decisions has been studied extensively, especially since the rise of behavioral finance (Bernheim et al., 2001, Mandell and Klein, 2009 and Cole et al., 2012, among others). Hilgert et al. (2003), for example, build an index of financial practices and conclude that financial literacy contributes positively to better results in the index.

This paper attempts to relate educational level to the term of investments to determine whether educational level can influence the structure of sovereign debt maturity. As proposed in behavioral finance theory, individuals are risk averse. In this sense, individuals with a high educational level demonstrate greater financial knowledge and have lower risk aversion (Paun et al., 2008) because they believe that their financial training allows them to avoid or reduce that risk (overconfidence). Similarly, investors with high educational levels are more willing to invest because they understand the performance of the financial markets (Van Rooji et al., 2010). According to these arguments, we suggest the following hypothesis:

Hypothesis 4: The higher the educational level, the greater the financial literacy and therefore the lower the risk aversion. A higher educational level increases the demand for long-term bonds and increases the average maturity of sovereign debt.

A large number of highly educated individuals, especially in the fields of economics and finance, indicate a greater number of agents with lower risk aversion and greater overconfidence. These investors seek bonds with higher returns, leading them to assume more risk. This creates a greater demand for long-term bonds and consequently an increase in the average maturity of sovereign debt.

4.4. Maturity structure of sovereign debt during the crisis

According to Broner et al. (2013), investors demand a higher premium on long-term bonds, which encourages economies, especially emerging markets, to issue short-term debt. Short-term debt is particularly issued in periods of crisis. In these cases, the cost of long-term debt increases in a greater proportion than the short-term debt, reducing the average maturity of sovereign debt. Following the preference liquidity theory (Hicks, 1939) in a context where investors are risk averse, investors demand more short-term bonds in periods of crisis to reduce risk and uncertainty by seeking low-risk assets that are more liquid than long-term bonds. Thus, according to these arguments, we suggest the following hypothesis:

Hypothesis 5: In periods of crisis, the average maturity of sovereign debt is reduced.

Investor preferences change toward seeking liquidity and safer investments during periods of financial turmoil. Therefore, demand for short-term bonds increases during these periods, which forces states to adapt their maturity structure to the new preferences of investors.

To complete the analysis, we also analyze the relationship between the maturity structure of sovereign debt and the introduction of the euro because all the analyzed countries belong to the euro zone. In this sense, the existence of a single currency results in a reduction of uncertainty and volatility (Bean, 1992). Therefore, the existence of a single currency must increase the average maturity of sovereign debt because a monetary union leads to greater investor confidence and reduces uncertainty. In this sense, we propose the following hypothesis:

Hypothesis 6: The introduction the euro as the single European currency increases the average maturity of sovereign debt.

The climate of certainty and confidence that results from the introduction of the euro encourages investors to increase their investment horizons.

Table 1. Expected signs of the relationship between the variables in the study and the average maturity of sovereign debt.

Variable	Characteristics	Average maturity
Age	Young	+
	Older	-
Income per capita by generation	Income (25-49)	+
	Income (50-74)	-
Gender	Men	+
	Women	-
Educational level	Tertiary education	+
Crisis	Yes	-
	No	+
Euro	Yes	+
	No	-

This table shows the expected signs of the variables related to the socio-demographic characteristics of investors and the average maturity of sovereign debt. It also includes the expected signs for the variables relating to the crisis and the introduction of the euro. A positive sign indicates an increase in the average maturity for this variable, and a negative sign reflects a reduction in the average maturity.
Source: own elaboration

The expected signs of the relationship between the variables in this study and the average maturity of sovereign debt are shown in Table 1. Regarding age, a higher proportion of an older population creates a greater number of short-term investors, which can contribute to a decrease in the average maturity of sovereign debt. The income per capita of the older generation is inversely related to the average maturity because older investors prefer short-term investments. The relationship for the income per capita of the young generation is the opposite. In regard to gender, a higher proportion of women leads to a reduction of the average maturity of sovereign debt because, according to behavioral finance, women are more risk averse and prefer

shorter-term investments. Similarly, the literature states that higher education tends to reduce risk aversion, increasing longer-term investments and therefore increasing the average maturity of sovereign debt. In addition, periods of crisis increase uncertainty and consequently reduce the average maturity of sovereign debt. In the case of the introduction of the single European currency, the expected sign is positive because a monetary union can reduce uncertainty and increase confidence, which encourages longer-term investments.

5. DATA AND METHODOLOGY

This section describes the data and methodology used in the study to analyze the effects of specific socio-demographic factors on the maturity structure of sovereign debt. We selected eleven countries from the Economic and Monetary Union (Germany, Austria, Belgium, Spain, Finland, France, Greece, Holland, Ireland, Italy and Portugal)[6], and the time horizon extends from 1980-2010, inclusive, with annual periodicity. The selection of the data is due to reasons of data availability.

5.1. Data

The following are the variables included in the study, along with a brief description and the data source. A brief summary of the variables is also presented in Table 2.

- Dependent variable: average maturity of sovereign debt. This variable is calculated as the weighted average maturity of marketable sovereign debt. These statistics include the average maturity of all debt instruments of the central government, excluding regional and local debt, as well as Social Security funds. The data are obtained from the OECD Central Government Debt Statistical Yearbook.
- The explanatory variables are:
  - Control variables: we take into account the following macroeconomic variables traditionally considered in the literature.
    - Inflation: shows a negative relationship with maturity because it increases long-term uncertainty, which results in a greater preference for shorter maturities (Goudswaard, 1990 and Dagher, 2010). The data are obtained from the OECD Statistics Database.
    - 10-year bonds' interest rate: these interest rates are the most representative of a country's issues. Interest rates, both nominal and real, maintain an inverse relationship with debt maturity when the state seeks to reduce the cost of issuance. Therefore, if the long-term interest rate increases, short-term issues increase and the average maturity decreases (Goudswaard, 1990). The field of corporate finance also demonstrates an inverse relationship between the interest rates and debt maturity (Baker, 2003). The data are obtained from the Eurostat Statistics Database.
    - GDP: is a proxy for the business cycle. It is expected that in phases of expansion, sovereign debt maturity increases, and in periods of recession, the average maturity is reduced, so the expected relationship is direct (Goudswaard, 1990). The data are obtained from the OECD Statistics Database.

[6] We selected euro area countries because they have a greater number of observations on the average maturity of sovereign debt and because they issue the most sovereign debt in the domestic currency (euros), which avoids the effects of other factors such as exchange rate risk.

  - Debt/GDP ratio: is the most common variable used to measure exposure to sovereign debt. The results are not unanimous regarding the expected sign of this variable in relation to sovereign maturity (De Haan et al., 1995; Missale and Blanchard, 1994; and Bodnaruk, 1999). The data are obtained from the Eurostat Statistics Database.
- The median age of the population of each country, the entire sample, the European Union (27 countries) and the Economic and Monetary Union (17 countries). An increase in the median age of the population should decrease the average maturity of the country's sovereign debt because the investors' investment horizon is reduced. Under the proposed model, an increase in the population's median age increases the demand for bonds with shorter maturities, and the supply of government bonds adjusts to the preferences of its clientele. The data are obtained from the Eurostat Statistics Database.
- Income per capita for different generations of individuals: this variable is included to take into account the suggestion of Guibaud et al. (2013) to consider income per capita by generation. We present two generations of individuals, a younger generation that ranges between 25 and 49 years old, and an older generation that ranges between 50 and 74 years old. The young generation has a longer-term investment horizon, while the older generation has a shorter-term investment horizon. We calculate the income per capita of each generation as the product of the activity rate[7] in this age range multiplied by the GDP per capita in each country. Higher income for the younger generation (between 25 and 49 years old) implies an increase in the average maturity of sovereign debt because the younger generation would then have more financial resources to invest, and their preferred investment horizon is long term. Therefore, the income per capita of the young generation should be positively related to the average maturity of sovereign debt. In contrast, the income per capita of the older generation (between 50 and 74 years old) must maintain an inverse relationship with the average maturity. This variable is developed based on data from the Eurostat Statistics Database.
- The gender of individuals: we consider the female population[8] between 25 and 74 years old. The greater the number of women investing, the greater the demand for short-term bonds because women are more risk averse and therefore seek safer and shorter-term investments. The data are obtained from the Eurostat Statistics Database.
- Educational level: we use the total number of tertiary education[9] graduates in the fields of social sciences, business and law[10], as well as the total number of graduates in all fields. The data are obtained from the Institute for Statistics of UNESCO.
- Two dummy variables: one dummy variable includes the effect of the current financial crisis[11] and takes the value 0 before 2008 and 1 otherwise. In periods of

[7] We employ the activity rate to weight the GDP per capita by generations because labor income is considered the main economic resource from which investments are subsequently made.
[8] We take as a starting point 25 years of age because we believe that individuals join the labor market by that age and have income to invest in the financial markets.
[9] Tertiary education includes all public and private institutions (universities, research institutes, laboratories, etc.) in which individuals study after high school.
[10] This definition matches that reflected in the Institute for Statistics of UNESCO.
[11] We select 2008 instead 2007 because the maturity structure began to be affected by the crisis in 2008 despite the crisis beginning in the second half of 2007.

crisis, the average maturity of sovereign debt tends to decrease as uncertainty increases, which increases short-term issues. The other dummy variable is used to analyze the effect of the introduction of the euro as the single European currency on the average maturity of sovereign debt. This variable takes the value 0 prior to 2002 and 1 otherwise. In this case, the effect is the opposite of the effect of the crisis because the EMU reduces uncertainty.

Table 2. Variables included in the analysis.

Variable	Description	Source
Maturity	Average maturity of sovereign debt	OECD Statistics
Median age (logs)	Median age of the population for each country in the sample	Eurostat
Median age of the sample (logs)	Mean of the median age of all the countries in the sample	Own elaboration
Median age of the European Union (logs)	Median age of the 27 countries in the European Union	Eurostat
Median age of the Economic and Monetary Union (logs)	Median age of the 17 countries in the Economic and Monetary Union	Eurostat
Income per capita (25-49) (logs)	Estimation for the income per capita for the young generation (25-49)	Own elaboration
Income per capita (50-74) (logs)	Estimation for the income per capita for the older generation (50-74)	Own elaboration
Population of women between 25 and 74 years old (logs)	Number of women between ages 25 and 74	Eurostat
Educational level	Number of tertiary education graduates in the social sciences, business and law and total number of graduates in all fields	Unesco
Crisis	Dummy variable that reflects the effect of the current financial crisis and takes the value 1 since 2008 and 0 otherwise	Own elaboration
Euro	Dummy variable that reflects the effect of the introduction of the euro as the single European currency and takes the value 1 since 2002 and 0 otherwise	Own elaboration
Debt/GDP	Public debt to GDP ratio	Eurostat
Inflation	Changes in the inflation rate	OECD Statistics
10-year bond interest rate	10-year sovereign bond interest rate	Eurostat
GDP (logs)	Gross Domestic Product	OECD Statistics

This table shows the variables included in the study as well as a brief description and the data source.
Source: own elaboration.

5.2. Methodology

We use panel data to analyze the effects of specific socio-demographic factors on the maturity structure of sovereign debt. The data cover a set of 11 countries and 31 periods that constitute an unbalanced panel of 341 observations. This technique is the most appropriate for a sample of cross-sectional and time-series data and allows us to account for unobserved heterogeneity across countries. The model is analyzed with the following equation:

$$\text{Maturity}_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 Age_{it} + \beta_3 GDPpg_{it} + \beta_4 Gender_{it} + \beta_5 EL_{it} + \beta_6 Dummy_{it} + \delta_{it} + \varepsilon_{it} \quad (3)$$

where subscript *i* indicates the country, and subscript *t* indicates the time period. $Maturity_{it}$ is the dependent variable, the average maturity of sovereign debt; X_{it} is a vector incorporating the control variables, which include the debt/GDP ratio, inflation, GDP and the 10-year bond interest rate; the variable Age[12] is the median age of the population; *GDPpg* is the GDP per capita by generation; *Gender* is a variable for the number of women between 25 and 74 years old; *EL* represents the educational level; and *Dummy* is a dummy variable that takes into account the effect of the current financial crisis and the introduction of the euro. Finally, δ_{it} represents country effects, and ε_{it} is the error term.

We use fixed or random effects according to the results provided by the Hausman test (1978). This test contrasts the relationship between estimates from the two methods. In the case that the null hypothesis is rejected, i.e., there is no correlation between the explanatory variables and the error, the use of fixed effects provides consistent results for the estimators of the regression with panel data; however, the acceptance of the null hypothesis indicates that the most appropriate method is the application of random effects.

Table 3. Descriptive statistics of the variables.

Variable	Mean	Median	Maximum	Minimum	Standard deviation	N
Maturity	5,40	5,72	9,60	0,13	1,74	244
Debt/GDP	0,608	0,534	1,478	0,101	0,288	305
GDP	499.536,5	208.473,6	2.495.000	6.779,26	593.343	341
Inflation	0,048	0,029	0,284	-0,045	0,052	341
10-year bond interest rate	0,074	0,061	0,241	0,027	0,039	297
Age	36,5	36,8	44,2	26,5	3,428	330
Income per capita 25-49	20.107,69	19,908	33.989	9.576	5.565,27	223
Income per capita 50-74	8.903,32	7.868,40	20.090	4.012	3.496,81	223
Women 25-74	7.399.926	3.316.296	27.373.322	471.256	7.888.209	330
Graduates in social sciences, business and law	61.390,57	28.674	280.032	6.892	67.448,35	110

This table shows the descriptive statistics of the variables included in the analysis.
Source: own elaboration.

[12] The demographic variables are assumed to be exogenous (Guibaud et al., 2013), so there is no endogeneity bias in the estimates. The same assumption can be made for income per capita by generation, gender and educational level.

The main descriptive statistics of the variables included in the analysis are shown in Table 3 and Table 4. The value of the dependent variable, that is, the average maturity of sovereign debt, indicates an average of 5.40 years for the total sample. Holland and Spain have the highest and lowest average maturity of sovereign debt, at 7.43 and 3.92 years, respectively. Germany and Ireland have the oldest and youngest populations, respectively (40 years old compared with 30 years old). Ireland has the highest income per capita by generation while Greece and Portugal have the lowest. The proportion of women aged between 25 and 74 years old was similar in all countries analysed, approximately 50.4%. Furthermore, France and Germany have the highest and lowest number of graduates in the social sciences, economics and law, respectively (1.11% compared with 0.28%).

Table 4. Descriptive statistics by country

País	N	Maturity (mean)	Age (mean)	Income cápita 25-49 (mean)	Income per cápita 50-74 (mean)	Proportion of women 25-74 (mean)	Proportion of graduates in social sciences, business and law (mean)
Germany	21	5.52	39.41	22.448	10.632	49.9	0.28
Austria	30	6.28	37.22	25.219	10.178	50.6	0.38
Belgium	21	5.41	37.50	19.641	6.643	50.0	0.69
Spain	31	3.92	37.30	14.930	6.396	50.4	0.52
Finland	21	4.44	37.70	24.438	12.935	50.0	0.53
France	21	6.32	37.41	20.922	8.614	51.2	1.11
Greece	8	7.41	37.30	12.902	5.584	50.8	0.42
Holland	31	7.43	35.93	23.208	10.572	49.5	0.63
Ireland	13	5.25	30.43	26.980	14.826	49.9	0.40
Italy	31	3.95	38.53	17.672	6.884	50.8	0.46
Portugal	16	4.69	35.57	12.376	6.760	51.8	0.58
Total	244	5.41	36.55	20.107	8.903	50.4	0.55

This table shows the descriptive statistics of the variables included in the analysis by country. The variables are the mean values of age, income per capita by generation, proportion of women between 25 and 74 years old over the total women between this age range, and proportion of graduates in social sciences, business and law over the total population between 25 and 49 years old. The number of observations (column 1) refers to the average maturity of sovereign debt.
Source: own elaboration.

6. RESULTS AND DISCUSSION

Next, we present the results of different analyses regarding the effect of socio-demographic factors on the maturity structure of sovereign debt.

6.1. Average maturity of sovereign debt and age

The results of the panel data regression of age on the average maturity of sovereign debt are shown in Table 5. The first column shows the variables included in the analysis. The next columns show the results of the estimates obtained by the panel data methodology.

Table 5. Panel data regression on age (dependent variable: logarithm of the average maturity of sovereign debt).

Variables	Model 1	Model 2	Model 3	Model 4
Debt/GDP	0.208	0.173	0.250*	0.234*
	(1.30)	(1.38)	(1.82)	(1.73)
GDP (logs)	0.029	0.026	0.686***	0.663***
	(0.51)	(0.41)	(4.36)	(4.25)
Inflation	-11.440***	-12.508***	-4.982***	-4.896***
	(-9.69)	(-9.98)	(-5.17)	(-5.16)
10-year bond interest rate	-8.577***	-9.595***	-2.360***	-2.279***
	(-5.82)	(-6.09)	(2.64)	(-2.61)
Median age (logs)	-0.821			
	(-1.18)			
Median age of the sample (logs)		-0.855*		
		(-1.86)		
Median age of the EU (logs)			-1.995**	
			(-2.15)	
Median age of the EMU (logs)				-1.711**
				(-2.02)
Constant	4.717**	5.163***	0.125	-0.596
	(2.11)	(2.98)	(0.07)	(-0.37)
Hausman test	0.7669	0.1171	0.0001	0.0001
F-statistic	46.76	49.08	34.01	33.95
R^2	0.50	0.52	0.73	0.73
N	232	232	203	203

This table shows the estimates of the panel data regression of the dependent variable, the logarithm of the average maturity of sovereign debt, on age. The control variables considered are the debt/GDP ratio, the logarithm of GDP, inflation and the 10-year bond interest rate[13]. The age-related variables are the annual median age in each country, the annual median age of the entire sample, the annual median age of the EU (27 countries) and the annual median age of the euro area (17 countries), all expressed in logarithms. We use fixed or random effects according to the results of the Hausman test, which are also displayed in the table. T-statistics are shown in brackets.
*Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.
Source: own elaboration.

We first include the control variables that may act as determinants of the maturity structure of sovereign debt, and then we incorporate the demographic variable for age. We present four models (columns 2-5) because we have four variables for the age of the population (the annual median age in each country, the annual median age of the entire sample, the annual median age of the EU (27 countries) and the annual median age of the euro area (17 countries). We use fixed or random effects estimates according to the results of the Hausman test[14].

The control variables show the expected signs. The coefficients of inflation and the 10-year bond interest rate are especially significant. As expected, inflation is inversely related to the average maturity of sovereign debt because it increases

[13] We use nominal interest rates in the estimates. The results using real interest rates do not vary substantially from those reflected in Table 4. These results are available upon request from the authors.
[14] Following Guibaud et al. (2013), we also conduct OLS regressions, and the results do not vary substantially. These results are available upon request from the authors.

uncertainty and encourages investment in instruments with shorter maturities (Goudswaard, 1990 and Dagher, 2010). This significance is maintained in all the analyzed models. The 10-year bond interest rate also shows a significant, indirect relationship in the four models. GDP shows the expected direct relationship with the dependent variable, as expected. However, GDP is only significant in Models 3 and 4. The debt/GDP ratio shows the same behavior. In this case, the sign of the relationship is contradictory to the literature (De Haan et al., 1995; Missale and Blanchard, 1994; and Bodnaruk, 1999). In this study, debt/GDP ratio shows a positive relationship with the average maturity of sovereign debt.

The results in Table 5 indicate the existence of an inverse relationship between the average maturity of sovereign debt and the age of the population. This relationship is maintained regardless of the age variable used. The results are significant and show the expected sign in all the analyzed models with the exception of Model 1, where the sign is correct, but it is not statistically significant.

These results confirm those obtained by Guibaud et al. (2013) and by extension, the preferred habitat theory of Modigliani and Sutch (1967). Investors choose their investment horizon according to their preferences, and age is a key variable in selecting that term. Young investors, with a long investment horizon, prefer long-term investments, while the older generation prefers a shorter investment period. This result contradicts Hypothesis 1 (H_1), which proposes an inverse relationship between the average maturity of sovereign debt and the age of the population.

6.2. Average maturity of sovereign debt and income per capita by generation

The results for the panel regressions of the average maturity of sovereign debt on income per capita by generation are shown in Table 6. The dependent variable is the average maturity of sovereign debt, and the variables included in the analysis are shown in column 1.

Table 6. Regression with panel data on income per capita by generation (dependent variable: logarithm of the average maturity of sovereign debt).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Debt/GDP	0.400***	0.306***	0.240***	0.491***	0.467***	0.419***
	(3.22)	(3.35)	(2.70)	(3.99)	(4.32)	(4.09)
GDP (logs)	0.069	0.728***	0.540***	0.400***	0.882***	0.705***
	(1.28)	(5.99)	(4.09)	(2.72)	(6.50)	(5.02)
Inflation	-2.189**	-1.410*	-1.906**	-2.087**	-1.293	-1.845**
	(-1.99)	(-1.72)	(-2.33)	(-2.33)	(-1.60)	(-2.32)
10-year bond interest rate	-4.929***	-2.932***	-1.804**	-3.918***	-3.639***	-2.654***
	(-5.13)	(-3.82)	(-2.28)	(-4.40)	(-4.43)	(-3.23)
Income per capita (25-49) (logs)	0.223		1.138***	0.066		1.197***
	(-1.56)		(3.82)	(0.26)		(4.06)
Income per capita (50-74) (logs)		-0.565***	-0.964***		-0.577***	-0.993***
		(-4.71)	(-6.29)		(-4.87)	(-6.74)
Age (logs)				-0.915*	-0.847**	-1.052***
				(-1.86)	(-2.02)	(2.64)
Constant	-1.351	-2.628***	-7.859***	-0.785	-1.415	-8.315***
	(-1.04)	(-2.91)	(-4.98)	(-0.59)	(-1.32)	(-2.87)
Hausman test	0.6139	0.0031	0.0308	0.0272	0.0001	0.0009
F-statistic	36.25	41.58	42.52	33.68	41.75	44.10
R^2	0.49	0.77	0.79	0.75	0.79	0.80
N	194	194	194	194	194	194

This table shows the estimates of the panel data regression of the dependent variable, logarithm of the average maturity of sovereign debt, on income per capita by generation. The control variables considered are debt/GDP ratio, the logarithm of GDP, inflation and the average rate on 10-year bonds. The age variable refers to the median age of the sample expressed in logarithms[15]. The variables relating to income by generation are income per capita for the generation aged between 25 and 49 years and for the generation aged between 50 and 74 years. We use fixed or random effects according to the results of the Hausman test, which are also displayed in the table. T-statistics are shown in brackets.

*Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.

Source: own elaboration.

We include the control variables and proceed to gradually incorporate the variables related to income per capita by generation (one group 25-49 years old and one group 50-74 years old). The variables are first added individually and then in aggregate form. Subsequently, we include these variables along with age, both individually and in aggregate. This method produces 6 models, and the results are shown in columns 2-7. We use fixed or random effects based on the results of the Hausman test. The control variables show the expected signs and are significant in almost all the analyzed models.

As seen in Table 6, only the variable for income of the 50-74 year age group is significant (Model 2) when considered individually. Its sign is as expected, demonstrating an inverse relationship with respect to the dependent variable. This result indicates that income per capita of the older generation has an indirect relationship with

[15] We use the median age of the sample because it provides more robust estimations.

the average maturity of sovereign debt, as the investment horizon for these individuals is short-term. When we include income per capita for the two generations, the results are significant for both generations with the expected signs. The income per capita of the younger population maintains a positive relationship with the average maturity of sovereign debt, i.e., a higher level of income in that group increases the average maturity because the younger generation's investment horizon is longer, while for the older generation, the relationship is the opposite.

When age is included along with the variables related to income per capita by generation, the results do not vary substantially. Age maintains its inverse relationship with the dependent variable in all the models in the same way as income per capita of the older generation. For the younger generation, income per capita is only significant when all the variables are included together (Model 6). Thus, we confirm Hypothesis 2 (H_2) and establish the existence of a relationship between income per capita by generation and the average maturity of sovereign debt, although this relationship is more robust with for the older generation.

6.3. Gender and average maturity of sovereign debt

The results of the panel regressions of the average maturity of sovereign debt on gender are shown in Table 7. As in the previous cases, the dependent variable is the average maturity of sovereign debt, expressed in logarithms, and the variables included in the regressions are shown in column 1.

Table 7. Regression with panel data on gender (dependent variable: logarithm of the average maturity of sovereign debt).

Variables	Model 1	Model 2	Model 3	Model 4
Debt/GDP	0.094	0.138	0.187	0.281***
	(0.61)	(0.94)	(1.40)	(2.46)
GDP (logs)	-0.122	-0.004	0.019	0.552***
	(-0.97)	(-0.09)	(0.46)	(3.58)
Inflation	-3.559***	-3.405***	-2.963**	-1.341
	(-2.94)	(-2.85)	(-2.47)	(-1.46)
10-year bond interest rate	-7.966***	-7.206***	-9.290***	-1.949**
	(-6.15)	(-6.63)	(-5.95)	(-2.37)
Women 25-74 (logs)	0.126			
	(0.99)			
Proportion of women 25-74		-1.181	-0.005	-18.923***
		(-0.25)	(-0.01)	(-4.42)
Age (logs)			-0.870*	-0.818*
			(-1.78)	(-1.69)
Income per capita (25-49) (logs)				1.037***
				(3.15)
Income per capita (50-74) (logs)				-0.858***
				(-5.16)
Constant	1.784**	2.747	5.160**	4.651
	(2.15)	(1.19)	(2.09)	(1.49)
Hausman test	0.4452	0.5133	0.2275	0.0436
F-statistic	47.08	46.96	40.86	39.36
R^2	0.51	0.50	0.52	0.80
N	232	232	232	194

This table shows the estimates of the regression of the dependent variable, logarithm of the average maturity of sovereign debt, on gender. The control variables considered are debt/GDP ratio, the logarithm of GDP, inflation and the average rate on 10-year bonds. The variables relating to gender are the population of women aged between 25 and 74 expressed in logarithms and the percentage of women in the total population in that age group. The variable age is the median age of the sample expressed in logarithms. We also include the income per capita by generation in logarithms. We use fixed or random effects according to the results of the Hausman test, which are also displayed in the table. T-statistics are shown in brackets.
*Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.
Source: own elaboration.

The results for gender are shown in Models 1 and 2 in Table 7. We use the logarithm of the number of women between 25 and 74 years old and the proportion of women in that age range over the total population as gender variables. The results indicate that gender is not significant as a determinant of the maturity structure of sovereign debt (Model 1). The signs are not as expected, but this result is not conclusive because the sign is not accompanied by the appropriate level of significance. When we use the proportion of women over the total population (Model 2), we also obtain results that are not significant.

The inclusion of age (Model 3) also yields not significant results on gender, while age maintains its significance and the expected relationship with the dependent variable. In Model 4, we include the variables related to income per capita by

generation. In this case, when all the variables are included together, we obtain significant results for gender, which indicates an inverse relationship between the proportion of women and the average maturity of sovereign debt, as proposed by our hypothesis. It is also noteworthy that age and income per capita by generation maintain the expected signs and significance.

Although Model 4 shows a significant coefficient for gender, the results are not consistent and robust enough to confirm whether the higher risk aversion of women (Harris and Jenkins, 2006 and Barnea et al., 2010, among others) influences the average maturity of sovereign debt. We also cannot determine whether there are differences according to gender because the results for men are also not significant[16]. Therefore, based on the results and the estimates obtained from Table 7, we do not confirm Hypothesis 3 (H_3), which indicates that gender could affect the average maturity of sovereign debt.

Although most studies on gender and risk aversion show less excess confidence (overconfidence) in women and a higher risk aversion (Estes and Hosseini, 1988 and Barber and Odean, 2001, among others), some studies find that there are no perceived differences between men and women (Hardies et al., 2012), which may justify the lack of significance in our results.

6.4. Average maturity of sovereign debt and educational level

The results of the panel data regressions that relate educational level and the average maturity of sovereign debt are shown in Table 8.

[16] The results of the panel data regressions of the average maturity of sovereign debt on the proportion of men are available upon request from the authors.

Table 8. Regression with panel data on educational level (dependent variable: logarithm of the average maturity of sovereign debt).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Debt/GDP	0.164	0.299*	0.680***	0.471**	0.500**
	(0.94)	(2.27)	(3.86)	(2.31)	(2.50)
GDP (logs)	0.239***	0.075	0.968***	1.202***	1.089***
	(4.74)	(0.39)	(5.44)	(4.94)	(4.69)
Inflation	-0.606	-0.757	-0.122	0.425	0.592
	(-0.24)	(-0.85)	(-0.15)	(0.53)	(0.78)
10-year bond interest rate	-0.960	-3.773***	-3.114**	-2.551	-3.588**
	(-0.29)	(-3.21)	(-2.00)	(-2.49)	(-2.41)
Graduates in social sciences, business and law (logs)	-0.008		0.122*	0.191**	
	(-0.14)		(1.81)	(2.49)	
Graduates in all fields (logs)		0.046			0.110
		(0.51)			(1.10)
Age (logs)			-5.023***	-3.237**	-2.144*
			(-4.39)	(-2.41)	(-1.68)
Income per capita (25-49) (logs)				-0.066	0.182
				(-0.13)	(0.39)
Income per capita (50-74) (logs)				-0.669**	-0.766**
				(-2.20)	(-2.60)
Proportion of women 25-74				-2.424	4.842
				(-0.24)	(0.53)
Constant	-1.865**	0.241	6.507	4.170	-3.056
	(-2.16)	(0.48)	(3.31)	(0.55)	(-0.46)
Hausman test	0.0209	0.1645	0.0000	0.0000	0.0000
F-statistic	16.14	4.63	25.78	23.94	22.22
R^2	0.72	0.18	0.81	0.83	0.82
N	110	110	110	110	110

This table shows the estimates of the panel data regressions of the dependent variable, logarithm of the average maturity of sovereign debt, on educational level. The control variables considered are debt/GDP ratio, the logarithm of GDP, inflation and the average rate on 10-year bonds. The variables relating to educational level are the total number of graduates in tertiary education and the number of graduates in the fields of social sciences, business and law, expressed in logarithms. We also include the median age of the sample expressed in logarithms, the income per capita by generation in logarithms and the percentage of women between 25 and 74 years old. We use fixed or random effects according to the results of the Hausman test, which are also displayed in the table. T-statistics are shown in brackets.

*Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.

Source: own elaboration.

Table 8 shows that the inclusion of educational level along with the control variables yields non-significant results for both the number of graduates in the fields of social sciences, business and law (Model 1) and for the total number of graduates (Model 2). We also include age with the number of graduates in social sciences, business and law (Model 3). Age maintains an inverse and significant relationship with the dependent variable. In this case, the number of graduates in the social sciences, business and law present significant values with the expected sign, indicating an increase in the average maturity of sovereign debt. The results are similar when we include the rest of the variables (Model 4). Age and income per capita of the older

generation still maintain the significance of the previous analyses, and the number of graduates in the fields of social sciences, business and law show a direct relationship with the dependent variable. In contrast, when we use the total number of graduates in all fields, the results are not significant. This result implies that specific education in fields related to economics and finance has a greater influence on investment decisions and on the average maturity of sovereign debt.

The results are not robust enough to roundly confirm Hypothesis 4 (H_4). Although Models 3 and 4 show a positive and significant relationship with the dependent variable, the inclusion of educational level on its own does not produce significant results. The lack of data for this variable may be the cause of this absence of robustness in the results[17].

6.5. Crisis, Euro and the average maturity of sovereign debt

The results regarding the relationship between the current financial crisis, the introduction of the euro as the single European currency and the average maturity of sovereign debt are shown in Table 9. As noted, the existence of a crisis period reduces the average maturity of sovereign debt because investors seek safer and shorter-term investments with the increase of uncertainty (Broner et al., 2013). Similarly, the introduction of the euro reduces uncertainty and increases confidence, which we expect to increase the average maturity.

[17] The data relating to educational level provided by UNESCO are only available from 1998. A larger sample for this variable may provide more robust results.

Table 9. Regression with panel data on the financial crisis and the introduction of the euro (dependent variable: logarithm of the average maturity of sovereign debt).

Variables	Model 1	Model 2	Model 3	Model 4
Debt/GDP	0.135	0.137	0.219	0.510**
	(0.88)	(0.92)	(1.53)	(2.38)
GDP (logs)	-0.008	-0.001	0.192*	1.173***
	(-0.16)	(-0.02)	(1.82)	(4.78)
Inflation	-3.354***	-3.019**	-2.734***	0.425
	(-2.78)	(-2.39)	(-3.14)	(0.53)
10-year bond interest rate	-7.252***	-7.813***	-5.419***	-2.312
	(-6.63)	(-6.15)	(-4.89)	(-1.43)
Crisis (*dummy*)	0.002		-0.006	-0.027
	(0.03)		(-0.18)	(-0.91)
Euro (*dummy*)		-0.046		
		(-0.84)		
Graduates in social sciences, business and law (logs)				0.190**
				(2.44)
Age (logs)			-0.668	-2.927**
			(-1.55)	(-2.44)
Income per capita (25-49) (logs)				-0.173
				(-0.34)
Income per capita (50-74) (logs)				-0.577*
				(-1.87)
Proportion of women 25-74				-3.201
				(-0.31)
Constant	2.198***	2.125***	1.903	3.989
	(-3.15)	(3.11)	(1.61)	(0.52)
Hausman test	0.7705	0.8059	0.0000	0.0000
F-statistic	46.65	47.01	26.23	20.99
R^2	0.50	0.50	0.66	0.82
N	232	232	232	110

This table shows estimates of the panel data regressions of the dependent variable, logarithm of the average maturity of sovereign debt, on the current financial crisis and the EMU. The control variables considered are debt/GDP ratio, the logarithm of GDP, inflation and the average rate on 10-year bonds. *Crisis* is a dummy variable that represents the effect of the current financial crisis and takes the value 1 since 2008 and 0 otherwise. *Euro* is a dummy variable that reflects the introduction of the single European currency and takes the value 1 since 2002 and 0 otherwise. The variables relating to educational level are the overall number of graduates and the number of graduates in the fields of social sciences, business and law, expressed in logarithms. We also include the median age of the sample expressed in logarithms, income per capita by generation in logarithms and the percentage of women in the population between 25 and 74 years old. We use fixed or random effects according to the results of the Hausman test, which are also displayed in the table. T-statistics are shown in brackets.
*Significance at the 10% level ** Significance at the 5% level *** Significance at the 1% level.
Source: own elaboration.

The results for the crisis as a determinant of the average maturity of sovereign debt are shown in Table 9 (Model 1). The results do not support the existence of an inverse relationship between the crisis and the maturity structure because there is no statistical significance. We also obtain no evidence for a relationship between the introduction of the euro and the maturity structure (Model 2). These results may be due to the lack of observations included in the dummy variables because the data are of annual frequency. These results contradict Hypothesis 5 (H_5), which states that in periods of crisis, the average maturity of sovereign debt is reduced, and Hypothesis 6 (H_6), which proposes that the introduction of the single European currency causes an increase in the average maturity of sovereign debt.

The inclusion of the crisis[18] along with age (Model 3) also yields non-significant results, and age loses its statistical significance despite maintaining the proper sign. Finally, we include all the variables together in the last column. The inverse relationship between age and the dependent variable remains robust, as is the case for income per capita of the older generation and the number of graduates in the fields of social sciences, business and law. In contrast, the proportion of women and the financial crisis yield no statistically significant results in the estimates.

7. CONCLUSIONS

In this paper, we propose a model to analyze the effects of specific socio-demographic factors (age, income per capita by generation, gender and educational level) on the maturity structure of sovereign debt in Europe between 1980 and 2010. We also take into account the main determinants of the maturity structure of sovereign debt according to the literature and the possible impacts of the financial crisis and the introduction of the single European currency. We consider that younger generations with a long-term investment horizon coexist with older generations with a short-term investment horizon.

We obtain evidence of the existence of a highly significant, inverse relationship between the age of the population and the average maturity of sovereign debt. These results hold whether we consider the age of the sample, the age of the European Union or the age of the euro zone. These results are in line with those obtained by Guibaud et al. (2013) for a set of OECD countries. The conclusion we can draw is that an increase in the age of the population implies a reduction in the average maturity of the debt. Because the trend in developed countries is toward an aging population, this result indicates that the maturity structures of these countries tend to be reduced by this demographic factor.

Regarding income per capita by generation (younger generation between 25 and 49 years old and older generation between 50 and 74 years old), we also obtain relevant results. Individually, the inclusion of both generations only yields significant results for the older generation, indicating an inverse relationship. This result implies that a higher level of income for this generation causes a reduction in the average maturity of sovereign debt. When the two generations are included simultaneously, they both yield significant results with the expected sign. Therefore, an increase in the income of the younger generation increases the average maturity of sovereign debt, and an increase in the income for the older generation reduces it.

[18] We analyze Models 3 and 4 replacing the *Crisis* variable for the *Euro* variable, and the results remain not statistically significant. The results of these estimates are available upon request from the authors.

Level of education has a direct relationship with the maturity structure of sovereign debt, although the results are not statistically robust enough to draw conclusions because their individual inclusion is not significant. However, the analysis of the effects of gender, the current financial crisis and the introduction of the euro yields no conclusive results on the average maturity of sovereign debt.

REFERENCES

Alfaro, L., & Kanczuk, F. (2006). Deuda soberana: Indexación y vencimiento. *Inter-American Development Bank, Research Department, Working Paper,* (4460)

Arellano, C., & Ramanarayanan, A. (2012). Default and the maturity structure in sovereign bonds. *Journal of Political Economy, 120*(2), 187-232.

Baker, M., Greenwood, R., & Wurgler, J. (2003). The maturity of debt issues and predictable variation in bond returns. *Journal of Financial Economics, 70*, 261-291.

Barber, B. M., & Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment *The Quarterly Journal of Economics, 116*(1), 261-292.

Barclay, M. J., & Clifford, W. S. (1995). The maturity structure of corporate debt. *The Journal of Finance, 50*(2), 609-631.

Barnea, A., Cronqvist, H., & Siegel, S. (2010). Nature or nurture: What determines investor behavior? *Journal of Financial Economics, 98*(3), 583-604.

Bean, C. R. (1992). Economic and monetary union in europe. *Journal of Economic Perspectives, 6*(4), 31-52.

Bernheim, B. D., Garrett, D. M., & Maki, D. M. (2001). Education and saving: The long-term effects of high school financial curriculum mandates. *Journal of Public Economics, 80*(3), 435-465.

Bodnaruk, A. (1999). Determinants of sovereign debt term for transition countries. *EERC MA Program in Economics, Working Paper.*

Broner, F. A., Lorenzoni, G., & Schmukler, S. L. (2013). Why do emerging economies borrow short term? *Journal of the European Economic Association, 11*, 67-100.

Cole, S. A., Paulson, A. L., & Shastry, G. K. (2012). *Harvard Business School Finance Working Paper,* (09-071).

Cole, H. L., & Kehoe, T. J. (2000). Self-fulfilling debt crises. *The Review of Economic Studies, 67*(1), 91-116.

Culbertson, J. M. (1957). The term structure of interest rates. *The Quarterly Journal of Economics, 71*(4), 485-517.

Chuang, W., & Lee, B. (2006). An empirical evaluation of the overconfidence hypothesis. *Journal of Banking & Finance, 30*(9), 2489-2515.

Dagher, J. (2010). Inflation and the maturity structure of nominal debt. *SSRN Working Paper Series.*

De Haan, J., Sikken, B. J., & Hilder, A. (1995). On the relationship between the debt ratio and debt maturity. *Applied Economics Letters, 2*(12), 484-486.

Dwyer, P. D., Gilkeson, J. H., & List, J. A. (2002). Gender differences in revealed risk taking: Evidence from mutual fund investors. *Economics Letters, 76*(2), 151-158.

Elan, S. (2010). Behavioral patterns and pitfalls of U.S. investors. *Federal Research Division, Library of Congress.*

Estes, R., & Hosseini, J. (1988). The gender gap on wall street: An empirical analysis of confidence in investment decision making. *Journal of Psychology, 122*(6), 577-590.

Faff, R., Mulino, D., & Chai, D. (2008). On the linkage between financial risk tolerance and risk aversion. *Journal of Financial Research, 31*(1), 1-23.

Faulkender, M. (2005). Hedging or market timing? selecting the interest rate exposure of corporate debt. *The Journal of Finance, 60*(2), 931-962.

Feng, L., & Seasholes, M. S. (2008). Individual investors and gender similarities in an emerging stock market. *Pacific-Basin Finance Journal, 16*(1–2), 44-60.

Goudswaard, K. P. (1990). Determinants of public debt maturities. *De Economist, 138*(1), 33-46.

Graham, F., Stendardi, E. J., Myers, J. K., & Graham, M. J. (2002). Gender differences in investment strategies: An information processing perspective. *International Journal of Bank Marketing, 20*(1), 17-26.

Guedes, J., & Opler, T. (1996). The determinants of the maturity of corporate debt issues. *The Journal of Finance, 51*(5), 1809-1833.

Guibaud, S., Nosbusch, Y., & Vayanos, D. (2013). Bond market clienteles, the yield curve and the optimal maturity structure of government debt. *Review of Financial Studies, 26*, 1914-1961.

Guiso, L., Sapienza, P., & Zingales, L. (2008). Trusting the stock market. *The Journal of Finance, 63*(6), 2557-2600.

Hardies, K., Breesch, D., & Branson, J. (2012). Male and female auditor's overconfidence. *Managerial Auditing Journal, 27*(1), 105-118.

Hardies, K., Breesch, D., & Branson, J. (2013). Gender differences in overconfidence and risk taking: Do self-selection and socialization matter? *Economics Letters, 118*(3), 442-444.

Harris, C. R., & Jenkins, M. (2006). Gender differences in risk assessment: Why do women take fewer risks than men? . *Judgment and Decision Making, 1*(1), 48-63.

Hausman, J. A. (1978). Specification test in econometrics. *Econometrica, 46*(6), 1251-1271.

Hicks, J. R. (1939). *Value and capital*. Oxford: Clarendon.

Hilgert, M. A., & Hogarth, J. M. B., S.G. (2003). Household financial management: The connection between knowledge and behavior. *Federal Reserve Bulletin,* (Jul), 309-322.

Jeanne, O. (2009). Debt maturity and the international financial architecture. *American Economic Review, 99*(5), 2135-2148.

Jianakoplos, N. A., & Bernasek, A. (1998). Are women more risk averse? *Economic Inquiry, 36*(4), 620-630.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica (Pre-1986), 47*(2), 263-291.

Ko, J., & Huang, Z. (2012). Time-inconsistent risk preferences in a laboratory experiment. *Review of Quantitative Finance and Accounting, 39*(4), 471-484.

Lewellen, W. G., Lease, R. C., & Schlarbaum, G. G. (1977). Patterns of investment strategy and behavior among individual investors. *Journal of Business, 50*(3), 296-333.

Lundeberg, M. A., Paul, W. F., & Punccohar, J. (1994). "Highly Confident but wrong: Gender differences and similarities in Confidence judgments". *Journal of Educational Psychology, 86*(1), 114-121.

Lustig, H., Sleet, C., & Yeltekin, S. (2005). Fiscal hedging and the yield curve. *National Bureau of Economic Research Working Paper Series,* (11687)

Mandell, L., & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning, 20*(1), 15-24.

Masters, R. (1989). Study examines investors' risk-taking propensities. *Journal of Financial Planning, 2*(3), 151-155.

Missale, A., & Blanchard, O. J. (1994). The debt burden and debt maturity. *The American Economic Review, 84*(1), 309-319.

Modigliani, F., & Sutch, R. (1967). Debt management and the term structure of interest rates: An empirical analysis of recent experience. *Journal of Political Economy, 75*, 569-589.

Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*(2), 147-175.

Niepelt, D. (2008). Debt maturity without commitment. *Swiss National Bank, Study Center Gerzensee, Working Paper.*

Paun, C., Musetescu, R., Brasoveanu, I., & Draghici, A. (2008). Empirical evidence on risk aversion for individual capital markets investors. *Review of Economic and Business Studies, 1*, 91-101.

Perez, D. (2013). Sovereign debt maturity structure under asymmetric information. *Stanford Institute for Economic Policy Research Discussion Paper,* (12-020).

Powell, M., & Ansic, D. (1997). Gender differences in risk behaviour in financial decision-making: An experimental analysis. *Journal of Economic Psychology, 18*(6), 605-628.

Rodrik, D., & Velasco, A. (1999). Short-term capital flows. *National Bureau of Economic Research Working Paper Series,* (7634).

Sachse, K., Jungermann, H., & Belting, J. M. (2012). Investment risk – the perspective of individual investors. *Journal of Economic Psychology, 33*(3), 437-447.

Schubert, R., Brown, M., Gysler, M., & Brachinger, H. W. (1999). Financial decision-making: Are women really more risk-averse? *The American Economic Review, 89*(2), 381-385.

Tirole, J. (2003). Ineffcient foreign borrowing: A dual- and common-agency perspective. *American Economic Review, 93*(5), 1678-1702.

Van Rooij, M., Lusardi, A., & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics, 101*(2), 449-472.

Vayanos, D., & Vila, J. L. (2009). A preferred-habitat model of the term structure of interest rates. *National Bureau of Economic Research Working Paper Series,* (15487).