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Sovereign Risk Premium and Macroeconomy: Causal Relationship

Maria Botey-Fullat, Cristina Marín-Palacios, Jesús Garcia Garcia-Doncel

ABSTRACT

In recent years, because of the 2008 financial crisis and the evolution of the sovereign debt markets, there has been a significant increase in interest in understanding the factors that determine the risk premium, becoming a key indicator of the financial stability of countries, and a measure of the risk assumed by investors who buy in a country's bonds or shares and for those responsible for the monetary policy. The aim of this study is to identify the possible causal relationships between the risk premium and various macroeconomic variables, as well as external factors that could influence its evolution. To do this, sources of economic-financial information based on monthly data covering the period from 2004 to 2022 are used. The methodology used focuses on the estimation of VAR (Autoregressive Vectors) models, which allows examining the dynamic interaction and causality between multiple variables. These models are suitable for studying the interdependence and mutual influence between the variables considered. The results obtained show that, although the risk premium has an autoregressive trend, there are other macroeconomic variables, such as the monetary aggregate M1, the bank default rate and the unemployment rate, which play a significant role in its behavior. Likewise, it is observed that external factors, such as the exchange rate or volatility index, also exert a significant influence on the risk premium.

KEY WORDS: risk premium, sovereign bond, fiscal policy, monetary policy, public indebtedness, VAR-model.

JEL Classification: E43, E44, E62, G12

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1. Introduction

In recent years and since the 2008 financial crisis, the sovereign risk premium has become popular in society due to its impact on the economy and financial markets. Also, numerous researchers have addressed its study and contributed to make it a continuously topical issue (Corradin et al., 2021; Dahlquist & Hasseltoft, 2013; Favero & Missale, 2012; Krishnamurthy et al., 2018; Liu & Huang, 2022; Manganelli & Wolswijk, 2009).

From a conceptual point of view, the risk premium is a term that estimates the risk of investing in a financial asset, so the higher the premium, the higher the risk involved in that investment. This concept reflects the additional cost that an issuer of a financial asset has with respect to another considered as a reference, a differential that is due to the higher profitability required when one wishes to invest in risky assets (Tkalec et al., 2014).

Likewise, for investments in sovereign public debt, the risk premium measures the confidence/

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distrust that investors have in the economy of a given country, being considered an indicator of its solvency and financial stability (Afonso et al., 2015). Specifically, Spain's risk premium is determined as the difference between the yield of the Spanish ten-year sovereign bond and the yield of the German bond for the same maturity, considered as a reference for its security and guarantee.

However, there is no doubt that since the beginning of this century Spain's sovereign risk premium has been significantly influenced by the creation of the Economic and Monetary Union (EMU), one of the most important events in European economic history at the end of the last century and the result of agreements on economic and fiscal policies that sought economic cohesion and solidarity among EU countries (Lane, 2012).

The repercussions of some of the decisions adopted at its creation on the risk premium make it convenient to mention some of the agreements that were established in the development of the Eurozone. Thus, the process of creation took place in three phases (Delors Report, June 1988) and possibly one of the most relevant events of the first phase was the adoption of the Treaty on European Union, which established the convergence criteria related to price stability, exchange rates, interest rates and government finances (Maastricht, February 1992).

The second phase was characterized by actions that advanced in this integration, agreements were reached such as the creation of the European Monetary Institute (EMI) in 1994, precursor of the European Central Bank (ECB) or the establishment of the

Stability and Growth Pact (June 1997, reformed in 2005 and 2011) where the States undertook to comply with deficit and debt conditions (deficit/GDP ratio below 3% and debt/GDP ratio below 60%) aimed at guaranteeing budgetary discipline to maintain sound finances. However, the end of this phase was marked by some important decisions such as the creation of the ECB or the eleven States, including Spain, which initially fulfilled the conditions for participating in the third phase of EMU, jointly constituting the Eurosystem.

The third phase involved the launching of EMU in January 1999, with significant agreements such as the adoption of the single currency, the irrevocable fixing of the exchange rates of the currencies of the eleven member countries and the beginning of the implementation of the single monetary policy under the responsibility of the ECB.

In short, the creation of the Eurozone has brought advantages for the Member States by acting as a safeguard against turbulence or risks at certain times, has made it possible to define a common monetary policy and has increased interdependence between European economies (European Commission, 2010)

In this context, Spain's entry into the euro led to a progressive decrease in the risk premium and to its being placed on a par with German debt, considered a benchmark for its safety, so that the protection offered by Germany in particular and the Eurosystem in general to the weakest countries was a guarantee for the markets, until the 2008 crisis and the subsequent outbreak of the European debt crisis in 2010.

The aim of this paper is to identify the variables that can influence Spain's risk premium. The determination of the risk premium as the spread between the yield of the Spanish sovereign bond and the German bond for the same maturity is a procedure that does not respond to the causes that can affect its value and, therefore, it has aroused interest if the risk premium can be estimated empirically.

And, despite the existence of works that address this study, there is no clear evidence on the causes that affect the level of the risk premium (Alqaralleh, 2024; Bouker & Mansouri, 2022; Cakici, 2024; Codogno et al., 2003; Favero et al., 2005; Haugh et al., 2009). Moreover, there are few studies applied to Spain and, as García & Werner (2016) point out, the variables that can influence the risk premium may vary depending on numerous factors, including the country.

Therefore, this research differs from previous works because it is applied to Spain, the fourth European economy, with few studies and which has experienced very acute crises

in its economic and financial environment in recent years, and because of the macroeconomic context considered, in the sense of the variables used and the time frequency of the information.

Consequently, the contribution of this research focuses on identifying whether there are macroeconomic variables causing variations in the sovereign risk premium. The aim of this study is to analyze the possi-

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ble impact, interrelationships and transmission mechanisms of the variables studied, which are important to experimentally determine whether the fluctuations in the risk premium are attributable to changes in the Spanish macroeconomic environment. Identifying the macroeconomic variables that affect the risk premium is important for numerous reasons. On the one hand, the sovereign risk premium is an indicator that informs us about the probability that a country will meet its financial obligations affecting economic stability and solvency, this information models the perception that investors have of the country affecting their decisions of where to place their capital. On the other hand, if changes in macroeconomic variables were to affect the risk premium in a delayed manner, this would allow us to anticipate risk premium values and would offer a great advantage to investors. This information would also be valuable for governments since they could avoid further indebtedness through changes in their macroeconomic policy.

In addition, this research incorporates information on situations that are very different from those that define the economic and political environment of other previous studies. It analyzes a period with recent events that add more uncertainty in an economic outlook characterized by a perceptible economic slowdown in Spain.

Some events have had a strong impact on the Spanish economy in the period studied. Thus, in 2019, the health crisis caused by the COVID-19 pandemic was very pronounced in Spain due to the strict long-term confinement, affecting sectors that were highly exposed to restrictions, such as tourism, hospitality and commerce, and small businesses more severely (Álvarez Rodríguez et al., 2022). The following year, in 2020, the geopolitical and economic ramifications of Brexit produced bad economic effects in Spain, activity in exporting or importing companies was reduced and the labour market declined (Nazarczuk et al., 2020). After several years of increasing public debt, in 2021 and 2022, the European Central Bank's (ECB) monetary policy adjustments, such as the net cessation of purchases (Government Procurement Programme [PSPP]) and the Pandemic Emergency Purchase Programme (PEPP) forced Spain to reduce spending and adopt tighter fiscal measures, causing a cooling of the economy; in 2022. In addition, economic tensions and disruptions caused by the war in Ukraine in 2022 had a substantial impact by increasing food, transport, and energy prices, causing high inflation (Cámara & Jiménez, 2023).

Due to all these high-profile events, Spain presents a unique context for this analysis due to its specific economic and political landscape, which distinguishes it from other countries. The Spanish economy has experienced a significant slowdown and structural challenges in recent years, such as high levels of unemployment and significant public debt. These factors contribute to the distinctive nature of Spain's sovereign risk premium and underscore the importance of understanding the macroeconomic variables at play. Likewise, the current economic situation is marked by the rise in interest rates, the rise in inflation and the establishment of the ECB's new purchase programme, the TPI (Transmission Protection Instrument, July 2022), a mechanism that allows the purchase of debt from countries such as Spain, where it considers that the rise in their risk premiums puts the transmission of monetary policy at risk. This instrument offers Spain the possibility of stabilizing its risk premium and reducing financing costs provided that structural reforms are complied with in its fiscal and spending policies.

Therefore, to develop this work, the following structure is considered: after the introduction, the material and methods section deals with the theoretical framework, the variables and the methodology used, followed by the results and discussion, and finally the conclusions.

2. Theoretical Framework

The main theories, concepts and existing literature that support the approach of the study and the hypotheses that are raised are presented below.

2.1. Historical Background

Among the functions of a state are to acquire goods, provide public services and achieve an adequate state of well-being for its population. These functions lead it to intervene in the economy to reduce economic and social inequality and generate public spending that can be financed with public revenues, obtained mainly from taxes. However, as these revenues are often insufficient

to meet all the State's expenditures, it frequently resorts to other forms of financing (indebtedness through the issuance of public debt or, if possible, money creation).

Therefore, government deficit and indebtedness are somewhat interacting macroeconomic variables that characterize the overall economic-financial environment. The investor detects greater financial risk in his investments, due to the uncertainty or possibility that the real return on the investment is different from the expected return. Their worsening often leads to a loss of investor confidence in a country's economic policy and frequently has a negative impact on the markets and can affect the sovereign risk premium.

As a result, financial markets can penalize governments for their lack of fiscal discipline and/or their indebtedness through the risk premium, which pushes sovereign bond yields higher. And a rise in the public deficit can condition economic growth, either by having to increase the tax burden or by having to increase its indebtedness.

For its part, the Keynesian school (1936) was one of the most significant schools of economic thought, advocating state intervention through fiscal and monetary policies to correct market imbalances and to promote full employment, price stability and economic growth. The Keynesian school defended the increase in public spending to stimulate aggregate demand and debt was fundamental to finance this public spending without the need to increase fiscal pressure, thus breaking with the traditional aversion to public debt.

The classical school (late eighteenth century to the early twentieth century), represented by economists such as Smith, Ricardo, Malthus or Stuart Mill were not in favor of public debt, although they were not totally opposed to it, since they considered some positive effects, such as being a form of investment of savings, allowing an increase in wealth, increasing effective demand or transferring the burden of extraordinary expenses to future generations when they are favored by them (Lluch, 1972).

The Chicago School (mid-20th century), known as the new classicism and represented mainly by Milton Friedman, was characterized by rejecting the ideas of Keynesianism and defending the free market, the rationality of public spending and monetarism, believing that a constant and moderate expansionary money supply would regulate the economy.

Covering the public deficit, with taxes or debt, has been the subject of interest over time, schools of economic thought and great economists such as Smith, Keynes or Friedman have approached their study with different conclusions.

2.2. Conceptual Background

Globalization has led to a worldwide economic and financial interrelation between countries, causing a contagion effect with positive or negative repercussions (Ballester et al., 2019; Beirne & Fratzscher, 2013; Fry-McKibbin et al., 2014). This process has made it possible for investors to have information to select those investments that best suit their decisions based on certain objectives to be achieved.

In this context, financial markets play a fundamental role in the functioning of the economy and, in general, in the financial system. Moreover, if the markets are efficient, they offer all the information available and investors can choose the most appropriate options according to certain criteria, such as the return and risk they wish to assume, which are relevant characteristics of any financial asset and of public debt. All this means that there can be an interaction between financial markets and some variables external to the market that can influence the price of the asset (Flannery & Protopapadakis, 2002).

The macroeconomic literature deals with the study of monetary policy and among its effects, analyzes those related to asset prices. Public debt as a financial asset also interacts in the field of financial economics with valuation models, which attempt to estimate the price of an asset based on the updating of expected future yields, with an appropriate discount rate according to the risk of the asset.

Economic theory also considers that the investor should be compensated for the risks associated with his investment and, the reward is produced by the risk premium, whereby riskier investments

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are expected to have a relatively higher return than safer investments (Damodaran, 1999). Moreover, economic theory considers that as the value of the risk premium increases, the cost of financing for different economic agents is higher. Consequently, this transfer effect has an important impact on the price and return of financial assets, but also on the economy in general, as it can condition consumption, saving and investment decisions and affect growth, which will have an impact on the risk premium.

There are authors who state the influence of political, social, economic and even international factors on the risk premium (Alessandrini et al., 2012; Álvarez et al., 2020; Favero & Missale, 2012; Gerlach et al., 2010; Maltritz, 2012; Remolona et al., 2007). In addition, there are public agencies, such as the IMF (2017) and the European Commission (2018), which estimate that the risk premium increases by 3 to 4 basis points for each percentage increase in the debt-to-GDP ratio above 60%.

The cost of sovereign public debt has been addressed in the literature, with research usually relating its variation to both internal country and external factors (Manganelli & Wolswijk, 2009; Dahlquist & Hasseltoft, 2013, Álvarez et al., 2020 or Bretscher et al. 2023). However, there is no consensus in research on which internal and/or external variables are significant in explaining the cost of sovereign debt and the level of the risk premium.

On the one hand, Álvarez (2020) and Bretscher (2023) argue that the market does not always take the same risk factors as determinants in its assessment of the risk premium of sovereign debt and that it does not behave rationally, in periods of growth it underestimates risk while in periods of uncertainty it overreacts. This way of acting means that the macroeconomic variables that determine economic growth and the risk of an investment do not always have the same weight on investors or on the risk premium, obtaining contradictory results. On the other hand, Dahlquist & Hasseltoft (2013) argue that risk premiums depend on both country-specific and global factors, and that global factors appear to offset movements in expected returns and expected short-term interest rates, so that current returns are little affected.

Nevertheless, there are works that state that macroeconomic variables usually partially justify the variation of the risk premium (Ludvigson & Ng, 2009; García & Werner, 2016). Some of these macroeconomic variables used are the level of debt, fiscal imbalance and economic growth (GDP), used to measure debt or fiscal deficit relatively. Thus, there are authors who recognize the importance of economic growth and, in addition, consider that the risk increases with the increase in public debt (Alcidi & Gros, 2018; Ardagna et al., 2007; Aßmann & Boysen-Hogrefee, 2012; Bernoth et al., 2006; Blanchard, 2019; Cecchetti et al., 2011; Laubach, 2009; Reinhart & Rogoff, 2010; Reinhart et al., 2012). There is also research linking the cost of sovereign government debt to interest rates (Cakici, 2024; Codogno et al., 2003; Fuest & Gros, 2019; Haugh et al., 2009; Laubach, 2003; Manganelli & Wolswijk, 2009). And the fact is that the evolution of interest rates set by the ECB reflects the state of the Eurozone economy, which is usually relevant for international investors when making investment decisions.

Two exogenous variables have been included positive and temporary shock to the risk premium with public debt and public spending. The model also relates it to a fall in production, labor supply, and loans.

Considering the literature, we can assume that there may be a relationship between macroeconomic variables and the risk premium, however, to adequately describe the possible hypotheses, we must express which macroeconomic variables are going to be considered for each of the aspects: credit risk, monetary policy, economic growth, socioeconomic factors, risk aversion, external economic indicators, ... Therefore, it is described below which variables have been decided to include in the study, what literature justifies it and what hypotheses are raised.

2.3. Variable Selection And Hypotheses

The variables selected for analysis (Table 1) cover a wide range of factors, such as credit risk, monetary policy, economic growth, socio-economic indicators and risk aversion. Each of these variables

has been carefully chosen to ensure representation of the macroeconomic environment. The credit risk variables reflect the probability of default by borrowers (DEFAULT, DEBT), providing information on financial stability and creditworthiness within the economy. Monetary policy variables, which include interest rates (CPI) and money supply (M1), are key to understanding the regulatory framework and central bank interventions that influence economic activity.

Economic growth variables (IPI, ESI) provide a measure of overall economic performance and the country's capacity for expansion and development. Socio-economic factors, such as the unemployment variable (UNEM), provide broader social context and its interaction with economic performance. Together, these variables provide a robust and nuanced description of a country's macroeconomic outlook.

Finally, risk aversion takes into account the situation of international risk or contagion. The VIX index is one of the variables used for its estimation, it measures the future or expected volatility of the S&P 500 index options and is known as the fear index, the higher it is the higher the pessimism or fear, while if it tends to 0 it reflects a feeling of confidence (Arghyrou & Kontonikas, 2011; Borgy et al., 2011; Gerlach et al., 2010; Güneş et al., 2024; Kilponen et al., 2012; Remolona et al., 2007).

Also, it is employed the European volatility index V2TX that measures the implied volatility of the EURO STOXX 50 index options market, it is an index like the VIX but as a reference it considers the European market (Alqaralleh, 2024; Kilponen et al., 2015; López & Esparcia, 2021).

Therefore, the following hypotheses are established:

1. Reduction in the risk premium (RISK_P) because of the increase in the variables corresponding to the monetary aggregate M1 (M1), the industrial production index (IPI), the economic sentiment index (ESI) and the exogenous variable CHANGE.

This premise is supported by works such as those of Arghyrou and Kontonikas (2012), García and Werner (2016) or Álvarez et al. (2020), which state that economic activity reduces the risk premium. Likewise, in relation to the monetary aggregate authors such as Baldacci et al. (2011), Kinateder and Wagner (2017), Mpapalika and Malikane (2019), Tzeng (2023) or Alqaralleh (2024) indicate that monetary expansion influences the decrease in the spread in sovereign bond yields and in the risk premium. As for the exogenous variable CHANGE, the existing literature relates it to an improvement in the economy and therefore to a reduction in the risk premium.

In turn, the consumer price index, which estimates the country's inflation, the monetary aggregate M1, which determines the total amount of money in the economy, and the interest rate have an impact on monetary policy (Castelnuovo & Pellegrino, 2018; Gnewuch, 2022). The industrial production index, a variable considered a proxy for GDP, measures production, eliminating the influence of prices. In addition, the current and capital account trade balance represents the exchange of capital between a country and the rest of the world, estimating the competitiveness of the economy (Cakici, 2024; Gómez-Puig et al., 2014; Martínez et al., 2013) and the economic sentiment index gathers the opinion of businessmen and consumers through a set of confidence indexes for various sectors (Industry, Services, Consumption, Construction and Retail Trade) are considered factors interrelated to the growth of the economy (Álvarez et al. 2020; Garcia & Werner, 2016).

2. Increase in the risk premium (RISK_P) due to the growth of debt/GDP (DEBT), trade deficit (C_DEF), unemployment (UNEM), non-performing loans (DEFAULT), interest rate (INTEREST), inflation (CPI), unemployment rate (UNEM) and European V2TX volatility index (V2TX).

This hypothesis is supported by research that points out that the increase in the risk premium is a consequence of the deterioration of the macroeconomy (Alessandrini et al., 2012; Barrios et al., 2009; Beirne & Fratzsces, 2013; Erer & Erer, 2020; García & Werner, 2016; García-Vaquero & Casado, 2011; Kilponen et al., 2015; Maltritz, 2012; Tkalec et al., 2014). On the exogenous variable V2TX, the growth of fear of investment leads to an increase in the risk premium.

Thus, the public deficit and public debt come to estimate credit risk and are variables that affect the fiscal situation and the economy's ability to meet its obligations. In relation to the unemployment variable (UNEM), it measures unemployment in relation to the active population and non-performing loans, which quantifies the level of non-compliance with payment obligations, are factors with a strong economic-social impact and can affect the risk premium.

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3. Material and Methods

3.1. Variables and Information Sources

The selected explanatory variables attempt to characterize both the country's macroeconomic environment and the international situation, considering as a reference other precedent works (Bakker et al., 2019; Christoffel et al., 2011; Corsetti et al., 2012; Hansen, 2019; Hordahl et al., 2008).

In short, the endogenous variables used are the risk premium (RISK_P); the debt/GDP ratio (DEBT); inflation (CPI); the monetary aggregate M1 (M1); the interest rate (INTEREST); the economic sentiment index (ESI); the industrial production index (IPI); unemployment (UNEM); non-performing loans, determined by the ratio of non- performing loans to total loans (DEFAULT); the current and capital account trade balance (goods and services), defined by the trade coverage ratio, using the ratio of import expenditures to export revenues (C_DEF) and the public deficit, estimated by the fiscal coverage ratio, using the ratio of fiscal expenditures to fiscal revenues (DEF_P).

Two exogenous variables have been included that correspond to the European volatility index VSTOXX (V2TX) and the euro-dollar exchange rate (CHANGE), two external variables that aim to capture global financial instability and the perception of risk in the foreign exchange markets. The influence of these variables, a priori, is independent of the group of endogenous variables that interact with each other. In addition, as they are considered exogenous, their changes have an impact on the same period as the dependent variable. As for research dealing with the volatility of financial markets, they usually use, among the variables, the VIX market volatility index (Alqaralleh, 2024; Aydın & Özel, 2024; Behera et al., 2023; Güneş et al., 2024). However, studies that consider the European volatility index V2TX are scarce in the literature, although this variable is strongly correlated with the VIX (Antal & Kaszab, 2022; Muñoz & Gálvez, 2023).

In relation to the euro-dollar exchange rate (CHANGE), there are studies that also address its impact under various approaches (Basu et al., 2024; de Beer et al., 2022; El Ouazzani et al., 2023; Ekĭ ncĭ et al., 2024).

The information on all the variables studied is monthly character, extends from January 2004 to December 2022 (total, 228 periods) and has been obtained from public organizations (Bank of Spain (2022) (variables: C_DEF, DEFAULT, DEF_P); National Institute of Statistics (2022) (variables: IPI, CPI); Eurostat (2022) (variable: ESI); European Central Bank (2022) (variables: M1, INTEREST); and from financial websites (Investing (2022) (variables: RISK_P, CHANGE, V2TX); Expansion (2022) (variable: DEBT, UNEM)).

In summary, the variables studied are listed in Table 1.

3.2. Methodology

To achieve the objectives of this research, an analysis of the dynamic interrelation between several variables will be carried out.

The main methods for modeling the dynamic interrelationship between various variables are the Vector Autoregressive Model (VAR) and the Vector Error Correction Model (VECM). There is some other method such as the Autoregressive Distributed Lag Model (ADL), however, this type of analysis is more restrictive, it requires defining what the dependent variable is, it is a regression that involves lagging independent variables, this model is less suitable for our study.

The methodology that applies VAR models is suitable for analyzing the interrelationship between several variables over time. It not only studies how each variable depends on itself in the past, but also how it depends on the past values of the other variables, as you don't need to impose direct causal relationships, but VAR captures how these variables evolve together. These models allow modeling dynamic and simultaneous relationships between variables, it is important when studying variables that can influence each other, such is the case of the macroeconomic variables discussed in this study (Dellaportas et al, 2023).

Another possible method is the Vector Error Correction Model (VECM). If the series are not stationary, but there is a linear combination of them that is, the variables are cointegrated. In this case, one could use VECM error correction models that combine cointegration with a VAR-like approach. In this study, the cointegration of the variables is analyzed and the appropriate method is decided.

The methodology applied corresponds to multivariate models (VAR/VECM), which consider that all variables are endogenous and there is an interrelation between

them. These techniques have been used by numerous authors in different settings and, in particular, it has been applied in the context of this work (Ang et al., 2006; Beechey et al., 2009; Botey-Fullat et al., 2023; Christiano et al., 2005; Forni & Gambetti, 2016; Gürkaynak & Wright, 2012; Jardet et al., 2013; Kopp & Williams, 2018; Rudebusch & Wu, 2008; Shaikh, 2020; Smets & Wouters, 2007; Wu, 2003).

Consequently, a VAR (p) model (Y_t) is defined by a set of variables consisting of lagged variables (Y_{t-i}) weighted by the coefficient matrix Ai (i=1,2,..., p), where p is the number of lags. Also, by exogenous variables (X_t) affected by the coefficient matrix B and by the disturbances or error term (e_t), considered independent and identically distributed (i.i.d, N(0,Ω)).

$$Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + BX_t + e_t$$

However, this VAR model can be reformulated by defining a VECM model, with the following variables in levels and differences:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{p-1} \pi_i \Delta Y_{t-i} + BX_t + e_t$$

The variables in this model are:

ΔYt = is the difference operator (Y_t - Y_{t-1}).

π = matrix with rank r, contains the cointegration relationships between the k variables,

with $\pi = -(I - \sum_{i=1}^{p} A_i)$.

Table 1

Variables Studied, Source and Type of Variable in Extended VAR model

Name	Description	Source	Type of variable in extended VAR model	Effect on RISK_P according to the hypotheses
RISK_P	Spanish Risk Premium	Investing (2022)	Endogenous and Main variable	
CHANGE	Euro-dollar exchange rate	Investing (2022)	International Exogenous variable	-
V2TX	European V2TX volatility index	Investing (2022)	International Exogenous variable	+
IPI	Industrial production index	National Institute of Statistics (2022)	Spanish Endogenous variable	-
ESI	Economic sentiment index	Eurostat (2022)	Spanish Endogenous variable	-
M1	Monetary aggregate	European Central Bank (2022)	Spanish Endogenous variable	+
DEBT	Growth of debt/GDP	Expansion (2022)	Spanish Endogenous variable	+
C_DEF	Trade deficit	Bank of Spain (2022)	Spanish Endogenous variable	+
UNEM	Unemployment rate	Expansion (2022)	Spanish Endogenous variable	+
DEFAULT	Non-performing loans to total loans rate	Bank of Spain (2022)	Spanish Endogenous variable	+
INTEREST	Inflation	European Central Bank (2022)	Spanish Endogenous variable	+
IPC	Interest rate	National Institute of Statistics (2022)	Spanish Endogenous variable	+
DEF_P	Fiscal expenditures to fiscal revenues rate	Bank of Spain (2022)	Spanish Endogenous variable	+

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πi = matrix of coefficients of the differences ΔY_{t-i}, where $\pi_i = (-\sum_{j=i+1}^{p} A_j)$.

X_t= exogenous variable

The existence of cointegration relationships means that the matrix has a rank "r" less than the number of variables "k" ($r < k$). π has a rank "r" smaller than the number of variables "k" ($r < k$), and the matrix can be decomposed into the product of two matrices (πinto the product of two matrices ($\pi=\alpha\beta'$); α, of dimensions (k x r), corresponds to the coefficients that represent the speed of adjustment, while β', of dimensions (r x k), collects the coefficients that correspond to the cointegration relationships and define the equilibrium relationships, i.e. each of them defines a linear combination of variables that is stationary.

Therefore, the choice between these alternative models (VAR or VECM model) depends on the characteristics of the variables, which requires analyzing their stationarity and cointegration to decide which procedure to apply.

4. Results

The results are presented in three sections. The first (section 4.1) describes the time series of the selected variables, commenting on the context, the main variations and their possible causes. The following section (4.2) checks the necessary conditions for the application of the VAR and VECM models, concluding that they are met for the VAR model and not for VECM.

In the third section (4.3) he describes the results obtained by applying the VAR methodology for the dynamic analysis of the relationships between the selected variables, highlighting the relationships with the RISK_P variable.

4.1. Variable Analysis

The Spanish economy has experienced remarkable economic growth from the beginning of this century until 2007, with growth rates that have exceeded those of the Eurozone, which has led to a rapid convergence of the Spanish economy (GDP_sp) with respect to other Eurozone countries (GDP_ue). However, with the onset of the crisis there was a period of deceleration, both at European and Spanish level, which finally led to the contraction of GDP in 2008, with negative rates that were temporarily maintained until 2010 in the EU and until 2013 in Spain.

Concern that some European countries in the Eurozone might incur a sovereign debt crisis began to spread among investors at the end of 2007 and impacted the European economy in 2008. The causes of this situation were the strong growth of the real estate sector, which led to the so-called real estate bubble, the increase in private and public debt, the contagion effect of possible bankruptcies of some financial institutions and the downgrading of sovereign debt.

In short, the sovereign debt crisis, the banking system and, in general, the economic system, led to a loss of investor confidence in the economic-financial situation of some countries and the perception of a contagion in the Eurozone that would cause an economic recession. Concerns about a collapse of the global economy intensified, so the Eurozone approved a rescue fund to ensure financial stability in the face of possible bailouts (European Financial Stability Facility (EFSF), May 2010). This measure was implemented together with others intended to give signals of confidence to the markets, such as the establishment of deposit insurance, banking supervision or those carried out by the European Central Bank to lower interest rates and facilitate liquidity among European banks.

However, these decisions did not produce the desired effect, and the insolvency risk situation increased in the Eurozone with the crises in some countries at the end of 2011. Consequently, credit rating agencies downgraded the sovereign debt rating of several countries (junk bond in Greece, Ireland and Portugal and a somewhat better rating in Spain (Baa3), justifying this decision to the contraction in credit, the rise in the risk premium, the crisis of confidence in the markets and the global risk of economic recession in the Eurozone (Kilponen et al., 2015).

The downturn of the Spanish economy was intense and prolonged, but from 2014 onwards it returned to economic growth with positive rates higher than those of the Eurozone, a situation that continued until 2019, despite the slowdown in the growth of the Spanish economy from 2015 onwards. The Spanish economy continued with moderate growth with levels close to 2.0 %, values higher than those of the Eurozone until the onset of the 2019 health crisis. But the health crisis of 2019

meant practically the paralysis of the economy causing a strong contraction of the Spanish GDP, with negative rates that reached levels below -10%, while in the Eurozone the fall was lower and stood at values close to -6%. This contraction of the economy was soon overcome in both Spain and the Eurozone, and they returned to positive rates in 2021, with somewhat higher levels in the case of Spain (Figure 1).

On the other hand, the level of the Spanish public deficit until 2007 was low and even surpluses reached 2%, but with the onset of the 2008 crisis, the economy and the financial environment began to deteriorate, and the public deficit fell sharply, reaching levels close to -10%, a situation that lasted until 2012. Since then, the reduction of the public deficit has been constant until reaching values close to 3% in 2018, but the health crisis has caused the deficit to reach levels close to those of 2009 again in 2020.

The health crisis has had a strong impact on the economy and has forced the European Union to adopt measures, such as the activation of the General Escape Clause in March 2020, which temporarily suspended the application of the EU Stability and Growth Pact, allowing Member States to take emergency measures to reduce the economic and social impact of the pandemic, a clause that is expected to be in force until 2023.

These measures appear to have had a favorable effect on the economy, as Spain returns to the economic growth phase as of 2021 and with the increase in tax revenues has reduced the public deficit (DEF_P) in 2022, reaching levels just below 5% (4.8%).

On the other hand, public debt (DEBT) has experienced strong growth in relation to the levels existing prior to the 2008 crisis (below 50% of GDP). Since then, debt growth has been almost continuous, although with periods of certain stability where the debt level has remained close to 100% (2013-2019). However, since the health crisis there has been an upturn in debt, reaching values close to 120% in 2020, a level that has been reduced and is close to 113% at the end of 2022.

The trade balance is in deficit, with the value of imports exceeding that of exports. Until 2007, the deficit was between -6% and -9% of GDP, but with the onset of the 2008 crisis, the deficit was reduced to reach levels close to -4% in 2009. This decline in the deficit was maintained until 2013 and, subsequently, it has evolved with some stability between -1% and -3%, but the health crisis has impacted the growth of the trade deficit to slightly above 5% in 2022 (Figure 2).

Simultaneously, the reduction of the unemployment rate (UNEM) was significant until mid-2007 in Spain, going from levels of 12% to rates of 8%. However, the slowdown of the economy, mainly due to the construction sector, had a negative impact on the

Figure 1
Economic Growth, Spain, EU

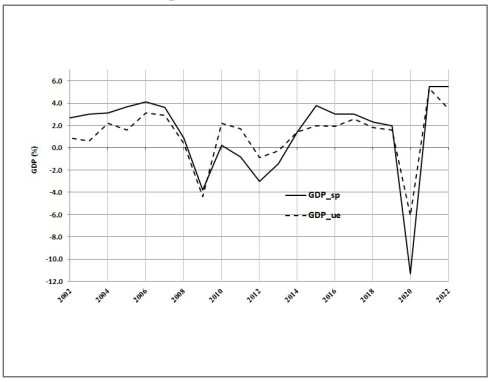
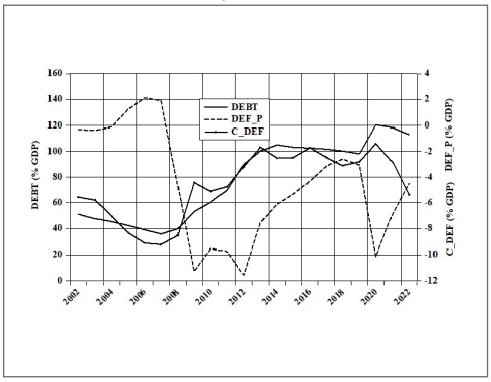


Figure 2
Debt, Public and Trade Deficit (% GDP))



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labor market and, this caused a strong growth in the unemployment rate reaching levels of 26% in 2013. But, with the beginning of the growth phase of the Spanish economy in 2014, a stage of steady reduction in the unemployment rate began, reaching levels close to 14% in 2019. The health crisis truncated this trend and originated a new upturn (16%), but it was temporary and the reduction in unemployment has continued to the present, standing at levels of 13% (Figure 3).

On the other hand, non-performing loans (DEFAULT) remained stable until the 2008 crisis, from this moment on it starts to grow up to maximum values close to 14% in 2014, from then on its decrease has been constant until reaching levels below 4% at present. In general, its behavior is somewhat similar to that experienced by the unemployment rate, although with some difference, such as the evolution in the stage prior to the 2008 crisis of both variables, the period in which their maximums are reached or the increase in the unemployment rate as a consequence of the health crisis which in non-performing loans has had practically no impact (Figure 3).

The industrial production index D(LIPI) and the economic sentiment index D(LESI) are two indicators that consider economic activity under different approaches. Thus, different stages can be distinguished in their behaviors, until the 2008 crisis the industrial production index increases, on the other hand the economic sentiment index maintains a stable trend, to give way to another period until 2012, where both indexes present a similar behavior. Subsequently, until the health crisis of 2019, the evolution has been somewhat different, the industrial production index increases continuously, while the economic sentiment index does so until 2014 to continue with some stability. The health crisis of 2019 negatively affected both indexes, but the economic sentiment index had a slower recovery, even with falls in 2022, not so the industrial production index that has remained more stable (Figure 4).

The interest rate has been marked until the 2008 crisis, first with periods of decreases and certain stability and then with increases up to maximum levels of around 6%. However, from 2008 onwards there is a significant decrease in interest rates, giving way in 2016 to a period of stability until mid-2022 where the trend changes, there is an increase in the rates of rates because of the increases in the price of money by the ECB (Figure 5).

On the other hand, the evolution of the monetary aggregate M1 has had constant fluctuations in its evolution, with minimum levels in 2008 and 2011 and a maximum level close to 12%. However, the health crisis led the ECB to carry out a strong monetary expansion in 2020, reaching levels of 16% and, since then, monetary contraction has been constant until reaching values below 1%, like those of 2008 (Figure 5).

As for inflation, it has followed an increasing trend with certain seasonality and, despite there being periods in which it has been controlled (periods from 2012 to 2021), the sharp increase in inflation since mid-2021 should be highlighted (Figure 5).

Figure 3
Unemployment, Non-performing Loans, Rates

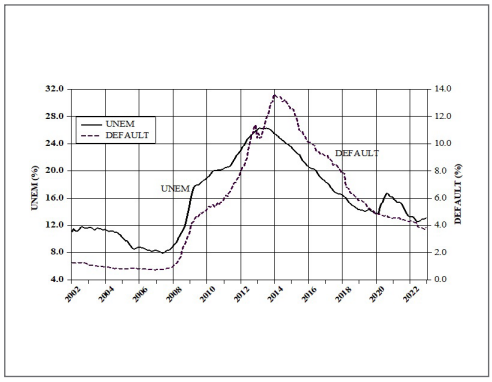


Figure 4
Industrial Price, Economic Sentiment, Index

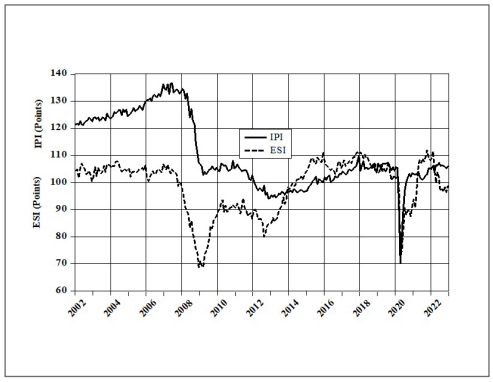
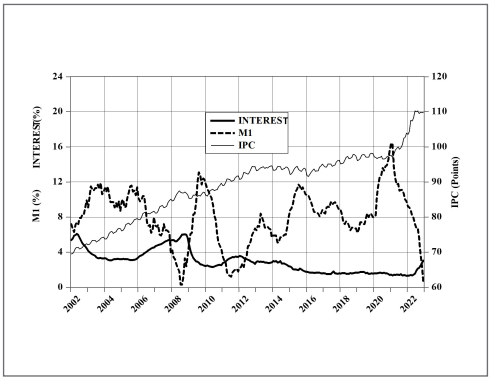


Figure 5

Description, Variables (Interest, Monetary Aggregate M1, Consumer Price Index)



The risk premium on Spanish sovereign debt has shown different trends over time. Since the creation of the EMU and until 2008, Spain and Germany maintained small differences in their sovereign debt yields (Codogno et al., 2003 or Geyer et al., 2004). However, the divergence between Spanish and German sovereign debt began to manifest itself at the beginning of 2009, when their yields started to increase (Figure 6).

Spain, with a low level of public debt compared to the levels of other countries, presented a reduced possibility of a bailout in 2008. However, Spain's situation deteriorated and although it adopted austerity measures to reduce its public deficit, in an attempt to give signs of confidence to the financial markets, they were not enough, and the weakness of economic growth and international pressure led to the adoption of more intense austerity measures in early 2011.

These measures continued with the change of government, but the nationalization of Savings and Financial Bank (BFA) in May 2012 intensified international concern, about the solvency of European banks and about sovereign debt, which affected the markets and the risk premium that soared to 511 basis points (Figure 7).

At the same time, Spain proposed to the European Commission to modify the rules of the European rescue fund to clean up the banks without going through the State and without resorting to debt, possibly to avoid an increase in the Spanish risk premium and an inevitable rescue of its finances. This proposal was positively received by the markets and the risk premium fell below 500 points.

In spite of this, the economic situation was critical, and the credit rating agencies downgraded Spain's rating, which made the possibility of a bailout of

Figure 6

Yield Sovereign Bond (Spain)

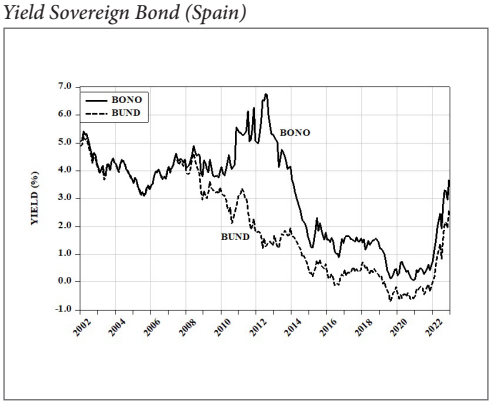
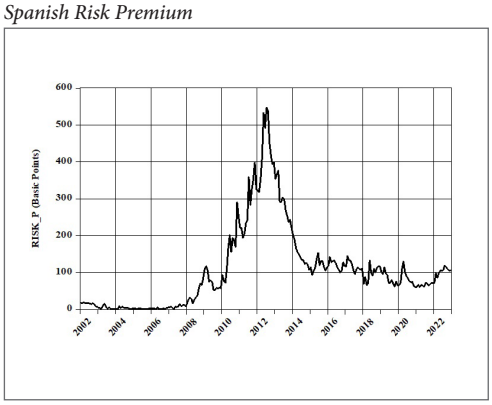


Figure 7

Spanish Risk Premium



Spain more evident. Finally, it asked the Eurozone for a bailout to clean up the Spanish financial system, aimed at supporting banks with problems and the State being the guarantor of the money granted, conditioned to the adoption of austerity measures (June 9, 2012).

However, the poor economic outlook continued in mid-2012 and considering that the bailout would increase Spain's indebtedness, the rating agencies downgraded Spain's sovereign debt rating (Moody's: A3 to Baa3). This situation affected the risk premium, which reached 552 points and soon after to soar to 589 points, with an almost unsustainable yield on debt exceeding 7% in secondary markets.

In this critical context, several events took place with positive consequences: on the one hand, reports from the Ministry of Economy and the Bank of Spain on the recapitalization needs of Spanish banks appeared, which were lower than expected, causing a significant drop in the risk premium to 477 points (mid-June 2012) and, on the other hand, Spain finally obtained the acceptance of its proposal on the use of the rescue fund to clean up the banks without going through the State (end of June 2012). The response of the markets was positive and the risk premium fell to 474 points, a fall also favored by the statements of the President of the ECB expressing his support for preserving the euro.

Economic growth recovered from 2014 onwards, which led to an improvement in Spain's debt rating (Moody's: Baa2), contributing to the decline in the risk premium below 100 basis points in 2015, with a further improvement in the debt rating in 2018 (Moody's: Baa1). This level of the risk premium, close to 100 basis points, has remained stable to date, despite moments of increased volatility (Figure 7).

In addition, the European Central Bank decided to initiate a phase of purchasing government debt securities to stabilize European economies in 2014. The ECB's objective was to provide security and financial support to countries in issuing debt and reducing its cost. Among the ECB's asset purchase programs, the Public Sector Purchase Program (PSPP) and the Pandemic Emergency Purchase Program (PEPP) stand out for their relevance. The PSPP quantitative easing program was established in March 2015 to guarantee the purchase of public debt, with Spain being one of the countries that have benefited from these purchases. However, this program has been questioned by the German Constitutional Court in May 2020 for not being in line with the ECB's price stability objective.

Also, another program with a strong impact has been the PEPP program established in March 2020, allowing the ECB to purchase different types of assets in the financial markets to counter the risks of the pandemic (COVID-19) with the aim of controlling the monetary policy transmission mechanism. However, given the inflationary risks at the beginning of 2023, the ECB has decided to reduce its holdings of Eurosystem securities under the asset purchase program (APP) for both the PSPP and the PEPP, although it will reinvest the securities purchased as they mature (Benigno et al., 2023).

4.2. VAR or VECM Model Estimation

The endogenous variables show significant relative variation reflecting their non- stationarity, so they have been log-transformed to reduce their dispersion (represented by the initial "L").

The choice of a VAR / VECM model leads to the analysis of the stationarity and cointegration of the variables. The study of stationarity is carried out by means of the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests with constant term, testing the existence of unit roots for each series, both in level and in first differences. In general, for the "series in level" the null hypothesis is not rejected, which shows the existence of unit roots and their lack of stationarity, on the contrary, for the "series in first differences" the null hypothesis is rejected, consequently the series are integrable of order 1, I (1) (Table 2).

As for cointegration, the Engle and Granger individual cointegration test is applied under the null hypothesis of no cointegration and to select the number of lags the Schwarz information criterion is applied with a constant term in the equation specification. In general, the null hypothesis of lack of cointegration between the different series is not rejected, except for some variables (industrial production index (LIPI), public deficit (LDEF_P) and trade deficit (LC_DEF)). This lack of cointegration in most of the variables leads us to discard their cointegration (Table 3).

Consequently, the lack of cointegration between

Table 2

Unit Root Tests, in Levels and Differences (Δ), (t-statistic and p-value in parentheses)

Variables	Series	Dickey-Fuller Augmented	Philips-Perron	Variables	Series	Dickey-Fuller Augmented	Philips-Perron
	Level	-1.59	-1.77		Level	-1.13	-1.09
LRISK_P		(0.48)	(0.39)	LIPC		(0.70)	(0.71)
	Δ	-24.16	-27.79		Δ	-3.55	-12.39
		(0.00)	(0.00)			(0.00)	(0.00)
	Level	-0.52	-0.12		Level	-2.44	-1.78
LDEBT		(0.88)	(0.94)	LINT-		(0.13)	(0.39)
	Δ	-4.08	-16.83	EREST	Δ	-4.65	-11.67
		(0.00)	(0.00)			(0.00)	(0.00)
	Level	-2.72	-3.08		Level	-1.56	-1.16
LM1		(0.07)	(0.03)	LUNEM		(0.50)	(0.69)
	Δ	-12.23	-12.31		Δ	-4.23	-5.71
		(0.00)	(0.00)			(0.00)	(0.00)
	Level	-1.75	-1.66			-1.83	-1.13
LIPI		(0.40)	(0.44)	LDE-		(0.36)	(0.70)
	Δ	-12.76	-14.37	FAULT		-3.10	-10.56
		(0.00)	(0.00)			(0.02)	(0.00)
	Level	-2.36	-2.39		Level	-2.09	-15.89
LESI		(0.15)	(0.14)	LDEF_P		(0.24)	(0.00)
	Δ	-12.79	-15.20		Δ	-8.95	-97.10
		(0.00)	(0.00)			(0.02)	(0.00)
	Level	-1.22	-3.13		Level	-2.09	-15.89
LC_DEF		(0.66)	(0.03)	LDEF_P		(0.24)	(0.00)
	Δ	-3.61	-19.55		Δ	-8.95	-97.10
		(0.00)	(0.00)			(0.02)	(0.00)

Table 3

Single Equation Cointegration Test (Null Hypothesis: Series are not Cointegrated)

Dependent	Prob.*	Dependent	Prob.*
LRISK_P	0.133	LDEF_P	0.975
LDEBT	0.144	LDEFAULT	0.922
LINTEREST	0.978	LUNEM	0.974
LM1	0.600	LESI	0.121
LIPC	0.597	LC_DEF	0.795
LIPI	0.000		

Note: *MacKinnon (1996) p-values.

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the variables makes it necessary to discard a VECM model and approach the study through a multivariate VAR model.

4.3. VAR Model Results

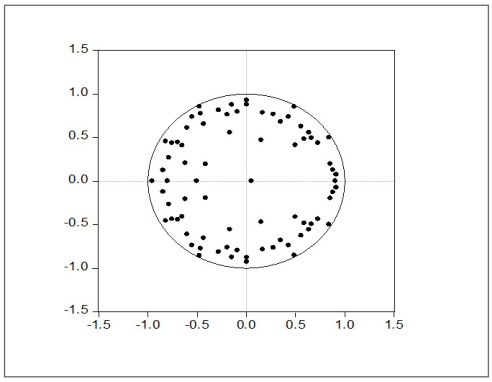
To estimate the VAR model, it is necessary to convert the series into stationary, with a logarithmic transformation and with a regular differencing (represented with initial "D"). Also, is necessary to define the optimal number of lags to be used, because if it is excessive, it can reduce the degrees of freedom unnecessarily or, on the contrary, if it is reduced it can cause a lack of specification, which would affect the autocorrelation of the residuals. Therefore, various information criteria are applied to select the length of the lags (Sequential (LR), Final Prediction Error (FPE), Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ) tests). These criteria lead to different number of delays, Schwarz (SC) and Hannan-Quinn (HQ)) set a reduced number of delays (1 and 3 respectively), the Akaike criterion (AIC), the Sequential test (LR) and the final prediction error test (FPE) set 7 delays. In addition, to select the optimal number of lags, another condition is established, the absence of autocorrelation in the residuals among these possibilities, which finally leads to choose a model with 7 VAR lags (7) (Table 4).

Table 4
VAR Lag Order Selection (lag order selected by the criterion, 5% level)*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3945.55	NA	2.54e-29	-34,52	-34,12	-34,42
1	4310.31	684.33	2.95e-30	-36,73	-34.45*	-35,84
2	4560.69	445.36	9.46e-31	-37,82	-33,76	-36,24
3	4782.41	372.81	3.96e-31	-38,69	-32,82	-36.39*
4	4914.18	208.73	3.74e-31	-38,86	-31,08	-35,75
5	5049.24	200.78	3.51e-31	-39,02	-29,38	-35,14
6	5213.56	228.30	2.62e-31	-39,42	-27,93	-34,78
7	5352.52	179.54*	2.55e-31*	-39,58*	-26,26	-34,20
8	5475.60	147.04	2.99e-31	-39.57	-24,44	-33,48

Note: LR: Sequential modified; FPE: Final prediction error; AIC: Akaike; SC: Schwarz; HQ: Hannan-Quinn
Source: Own elaboration

Figure 8
Inverse Roots of AR Characteristic Polynomial



Next, having defined the VAR model (7), it is essential to study its stationarity according to the value of the roots of the characteristic polynomial. Thus, when they are less than one, being located within the unit circle, it verifies the stability condition of the model (Figure 8).

On the other hand, it is important to test the assumption of a temporal relationship between the variables in a VAR model and to study their causality to define the meaning and transmission of information. To this end, the Granger test is used to determine whether, based on the data (not on the theory), there is a variable whose changes precede those of another variable (Table 5).

In general, the causality analysis reflects some relationships between the different macroeconomic variables, although there are variables whose behavior is scarce or somewhat more restricted.

In relation to the independent variables, the risk premium has practically no effect on the remaining dependent variables. Likewise, there are variables that only affect some specific dependent variables (interest on inflation and economic sentiment index on public debt). The rest of the independent variables interact with a greater number of dependent variables, such as public debt anticipates some variables (economic sentiment index and trade deficit), as does the monetary aggregate, which is a precursor of certain variables (risk premium, interest and economic sentiment index), and the industrial production index, which precedes other variables (public debt, public deficit and economic sentiment index), likewise the public deficit on several variables (public debt, inflation, trade deficit) or the non-performing loans rate on specific variables (risk premium, economic sentiment index, unemployment rate and trade deficit) or the unemployment rate on certain variables (industrial production index, economic sentiment index and non-performing loans rate) or the trade deficit on

Table 5

VAR Granger Causality/Block Exogeneity Wald Tests (p_values)

	Dependent variable										
Independent variable (Excluded)	D(LRISK_P)	D(LDEBT)	D(LINTEREST)	D(LM1)	D(LIPC)	D(LIPI)	D(LDEF_P)	D(LESI)	D(LDEFAULT)	D(LUNEM)	D(LC_DEF)
	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.	Prob.
D(LRISK_P)		0.200	0.648	0.519	0.966	0.626	0.098	0.202	0.641	0.467	0.478
D(LDEBT)	0.160		0.484	0.658	0.825	0.598	0.242	0.055	0.199	0.770	0.001
D(LINTEREST)	0.998	0.913		0.892	0.029	0.674	0.152	0.170	0.313	0.408	0.085
D(LM1)	0.009	0.289	0.012		0.464	0.608	0.149	0.040	0.861	0.733	0.738
D(LIPC)	0.814	0.579	0.001	0.422		0.430	0.000	0.556	0.296	0.625	0.542
D(LIPI)	0.799	0.023	0.655	0.493	0.210		0.001	0.000	0.243	0.239	0.072
D(LDEF_P)	0.121	0.002	0.336	0.817	0.000	0.579		0.393	0.709	0.686	0.000
D(LESI)	0.703	0.013	0.880	0.758	0.349	0.063	0.499		0.201	0.375	0.074
D(LDEFAULT)	0.014	0.232	0.065	0.264	0.183	0.587	0.544	0.011		0.008	0.029
D(LUNEM)	0.114	0.098	0.404	0.082	0.949	0.006	0.151	0.003	0.036		0.108
D(LC_DEF)	0.105	0.003	0.592	0.295	0.056	0.506	0.000	0.457	0.272	0.895	

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certain variables (public debt and public deficit).

As for the dependent variables, there are some that do not respond to any variable, such as the monetary aggregate M1 or do so in isolation to some individual variable (industrial production index, non-performing loans and unemployment rate). The rest of the variables show a somewhat broader relationship depending on the variables that interact as antecedents (risk premium, public debt, interest rate, inflation, public deficit, economic sentiment index, trade deficit).

Relative to exogenous variables, the European volatility index VSTOXX (V2TX) is used, which has the advantage of being better adapted to European volatility and its impact is evident in some variables, specifically it positively influences the risk premium and the monetary aggregate M1, a conclusion like that reached by Álvarez et al., (2020) considering the VIX index.

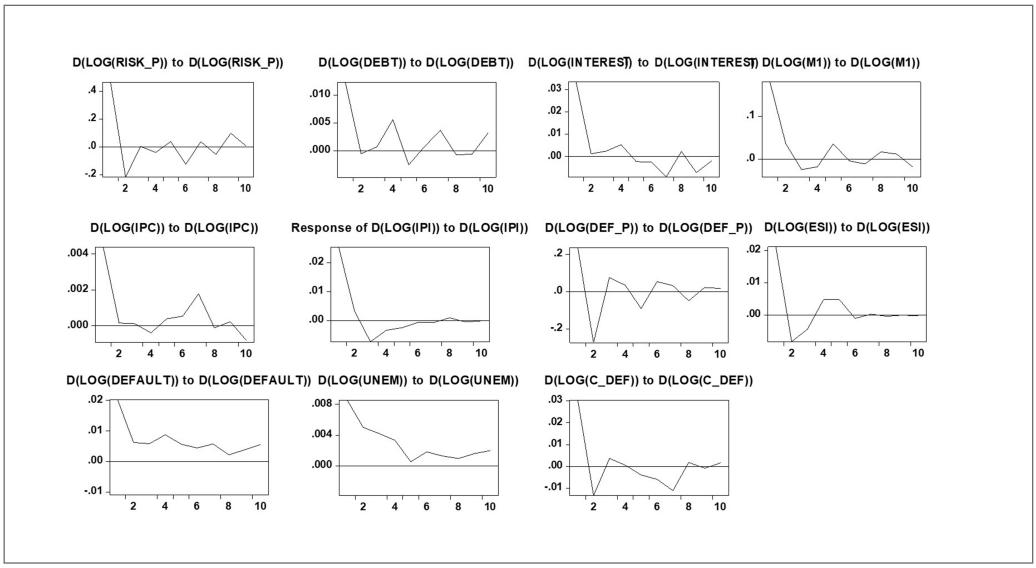
About CHANGE variable, it is used with a macroeconomic and financial approach in the sense of analyzing its influence on some macroeconomic variables and on the risk premium. Specifically, the euro-dollar exchange rate influences some variables, in particular it is positively related to the interest rate and the public deficit and negatively to the monetary aggregate M1, this behavior is in line with the literature, since when investor confidence is reduced and risk increases, it usually causes weakness in the euro. Regarding the interest rate on the euro-dollar exchange rate, its effect is interpreted in the sense that by increasing the interest, the euro becomes more attractive to investors, who will demand more euros, causing the currency to appreciate.

On the other hand, since the estimated VAR model is stationary, it can be reformulated in the form of moving averages to obtain the impulse-response function of each variable. This Impulse-Response Function quantifies the temporal effect that an impulse or disturbance produces on one of the endogenous variables. In addition, as it is assumed that there is an interrelation between the variables, an impact on a variable not only has repercussions on that same variable but is also transmitted dynamically to the rest of the endogenous variables through their temporal structure (Hamilton, 1994).

Thus, considering the different impulse-response functions, it is observed that all the variables respond to changes in their own innovations, generally decreasing and attenuating over time (Figure 9).

Figure 9

Impulse-response Function of the Variables to Changes in Own Innovations



In addition, a priori, this impact spreads to other macroeconomic variables whose intensity of effect is conditioned by the impact and the response variable. In the case of the risk premium D(LRISK_P), the other macroeconomic variables do not have a significant impact, although they cause slight variations with changes of sign in the risk premium. Furthermore, it is found that the impact of the interest rate and inflation is practically nil compared to the greater influence of the non-performing loans (D(LDEFAULT) and unemployment rate D(LUNEM)) (Figure 10).

Alternatively, it is also interesting to consider whether the risk premium has an impact on macroeconomic variables. In general, the impact on the macroeconomic is reduced, although in this context the public deficit, the economic sentiment index and the unemployment rate show a somewhat greater interaction. In the case of the public deficit and the economic sentiment index without a clear trend, causing alternate movements with increases and decreases in their levels, however its impact on the unemployment rate raises the level of unemployment (Figure 11).

As for public debt D(LDEBT), its evolution over time is marked by its own impact and tends to cause changes with alternating signs. However, the impact of the rest of the variables is small and leads to responses with different signs. Nevertheless, the macroeconomic variables cause an impact in which a certain general trend prevails, positive in the case of the monetary aggregate D(LM1), the unemployment rate D(LUNEM), non-performing loans (D(LDEFAULT)) and the trade deficit D(LC_DEF) and negative for the public deficit D(LDEF_P) and the industrial production index D(LIPI).

Consequently, the growth of debt is favored by an expansive monetary policy, by an increase in unemployment and non-performing loans and by an growth in the trade deficit, while a rise in economic activity (industrial production index) and in the public deficit lead to a contraction of debt.

Also, the interest rate D(LINTEREST) responds to its own impact, together with the positive effect of

Figure 10

Impact of Macroeconomic Variables on the Risk Premium

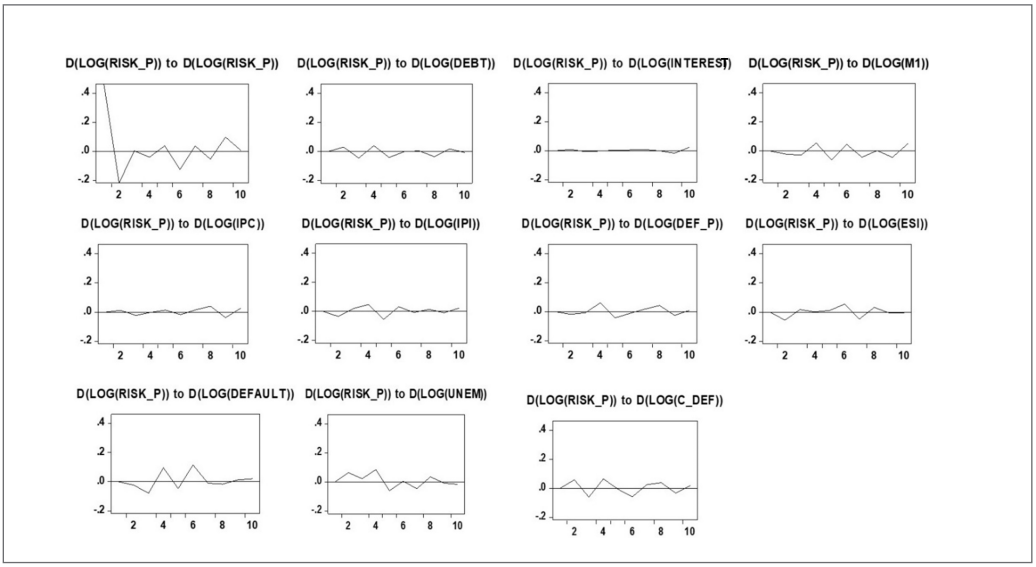


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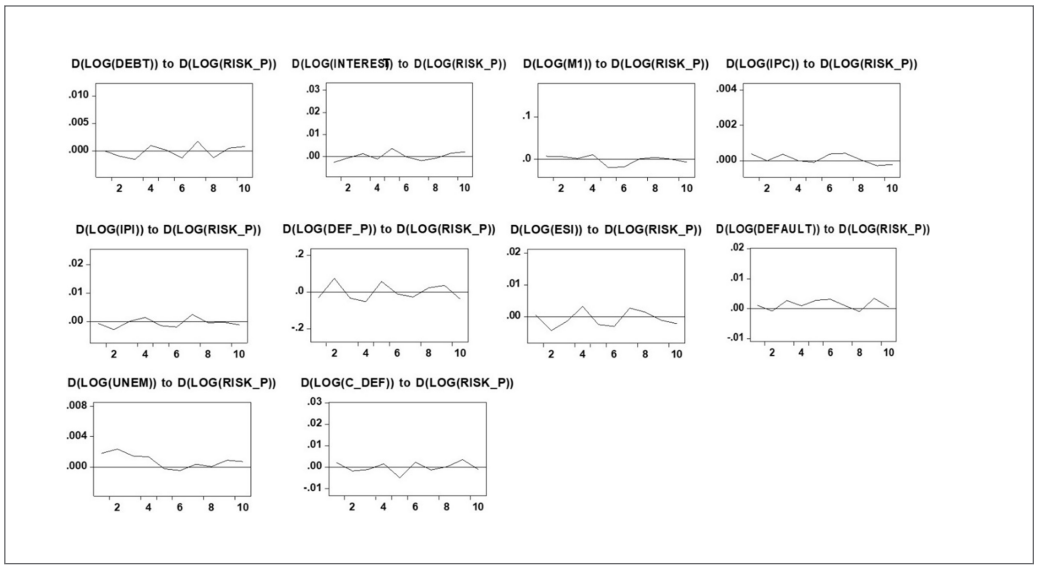
Figure 11

Impact of the Risk Premium on Macroeconomic Variables



inflation D(LIPC) and the negative impact of the monetary aggregate D(LM1), while the remaining variables are of little relevance to the interest rate.

In essence, an expansionary monetary policy reduces the interest rate, while an increase in inflation influences the growth of the interest rate.

Likewise, the response of the monetary aggregate M1 D(LM1) to its own impact is significant and of the remaining macroeconomic variables only the negative influence of some should be highlighted (inflation D(LIPC), public debt D(LDEBT), industrial production index D(LIPI) and unemployment rate D(LUNEM)).

In conclusion, the evolution of monetary policy (monetary aggregate M1) is conditioned by its own behavior. However, other macroeconomic variables also influence monetary policy decisions, such as an increase in inflation, debt, the unemployment rate or the industrial production index, which tend to lead to a restrictive monetary policy.

On the other hand, inflation D(LIPC) has an influence on itself and, in general, its response is positive with periods of decline, while the impact of macroeconomic variables is insignificant, despite the positive effect of non-performing loans (D(LDEFAULT)), the public deficit D(LDEF_P) and the trade deficit D(LC_DEF) and the negative impact of the interest rate D(LINTEREST).

Then again, the economic sentiment index D(LESI) reacts significantly to shocks from the industrial production index D(LIPI) and the remaining macroeconomic variables have a reduced influence, although there are some with a somewhat larger impact, such as the interest rate D(LINTEREST), the unemployment rate D(LUNEM) and the monetary aggregate M1 D(LM1) with a negative effect, while public debt D(LDEBT) has a positive influence.

In short, the industrial production index and the economic sentiment index have a mutual relationship. However, the response is different depending on the impact: an increase in the industrial production index causes an increase in the economic sentiment index, while an increase in the economic sentiment index causes a decrease in the industrial production index. Also, the influence of certain variables has a favorable effect on these indices, such as an expansive monetary policy, an increase in debt or a reduction in interest rates, while an increase in the unemployment rate or the non-performing loans causes these indicators to fall.

As for the public deficit, D(LDEF_P), reacts to its own impact with variations in the sign of its response. However, the influence of the other macroeconomic variables is reduced but causes variations with changes of sign in the public deficit. For some variables the positive effect prevails over the negative one (risk premium D(LRISK_P), public debt D(LDEBT), interest rate D(LINTEREST), inflation D(LIPC)) while the negative impact predominates for the industrial production index D(LIPI).

In general, the evolution of the public deficit itself causes alternative movements up and down in its level. Changes in the remaining macroeconomic variables do not have a significant effect, although there are variables that cause a somewhat greater reaction on the public deficit (risk premium, public debt, interest rate, industrial production index inflation).

The response of non-performing loans D(LDEFAULT) to the impact of the variable itself is decreasing and permanent. The remaining macroeconomic variables have a positive effect (interest rate D(LINTEREST), public deficit D(LDEF_P), unemployment rate D(LUNEM), inflation D(LIPC)) but others also have a negative impact (monetary aggregate M1 D(LM1), public debt D(LDEBT))

Therefore, non-performing loans is a variable influenced by its own evolution. However, some variables tend to increase their level (the interest rate, the public deficit, the unemployment rate or inflation), while other variables influence its decline (monetary aggregate M1 or public debt).

The unemployment rate D(LUNEM) responds to its own impact in a decreasing and permanent way. Among the macroeconomic variables, the negative impact of one group of variables (inflation D(LIPC), industrial production index D(LIPI), monetary aggregate M1 D(LM1)) must be distinguished from the positive effect of another group (risk premium D(LRISK_P), interest rate D(LINTEREST), non-performing loans rate (D(LDEFAULT)).

In summary, the level of the unemployment rate has an impact on its future evolution, although the influence of other variables also affects this rate, causing reductions in the case of an increase in inflation and industrial activity or with an expansive monetary policy; on the other hand, the rise in interest rates and non-performing loans or even the risk premium tends to raise the unemployment rate.

The trade deficit D(LC_DEF) reacts to shocks of the same variable in a decreasing way and with a negative trend until it disappears. The rest of the macroeconomic variables present an opposite effect, some have a negative impact (interest rate D(LINTEREST), non-performing loans rate D(LDEFAULT), unemployment rate D(LUNEM)), while others have a positive influence (industrial production index D(LIPI)) and the public deficit D(LDEF_P) causes changes of sign.

Consequently, the trade deficit decreases with a lag in the face of increases in the interest rate, unemployment or the public deficit, while an increase in the industrial production index tends to increase the trade deficit.

Schematically, the most important results can be seen in Figure 12.

5. Discussion

The experimental estimation of the risk premium has been addressed in the literature, however, the results are not conclusive, and the analysis procedure used, the variables considered, the time horizon, the granularity of the information and even the geographical environment or the country of the research may have an impact (Afonso et al., 2012; Bernoth & Erdogan, 2012; García & Werner, 2016; Georgoutsos & Migiakis, 2013; Haugh et al., 2009; Kilponen et al., 2015).

In this sense, the international results on the risk premium are contrasting; some authors, such as Beirne and Fratzscher, 2013 or Aizenman et al, 2013 state that in the period prior to the 2008 crisis the risk premium was estimated to be undervalued, during the period of the 2008 crisis was considered overvalued and, subsequently with the intervention of the ECB with the purchase of debt its free fluctuation was limited (Kilponen et al., 2015). Also, other researchers such as Geyer et al. (2004) find no interrelation between macroeconomic variables and the risk premium, while others consider that the risk premium is influenced by the evolution of the macroeconomy (Beirne & Fratzscher, 2013; Bernoth & Erdogan, 2012; Bernoth & Herwartz, 2021; Bretscher, 2023; Cakici, 2024; Reinhart & Rogoff, 2010; Tkalec et al., 2014).

In contrast to these results, this research shows

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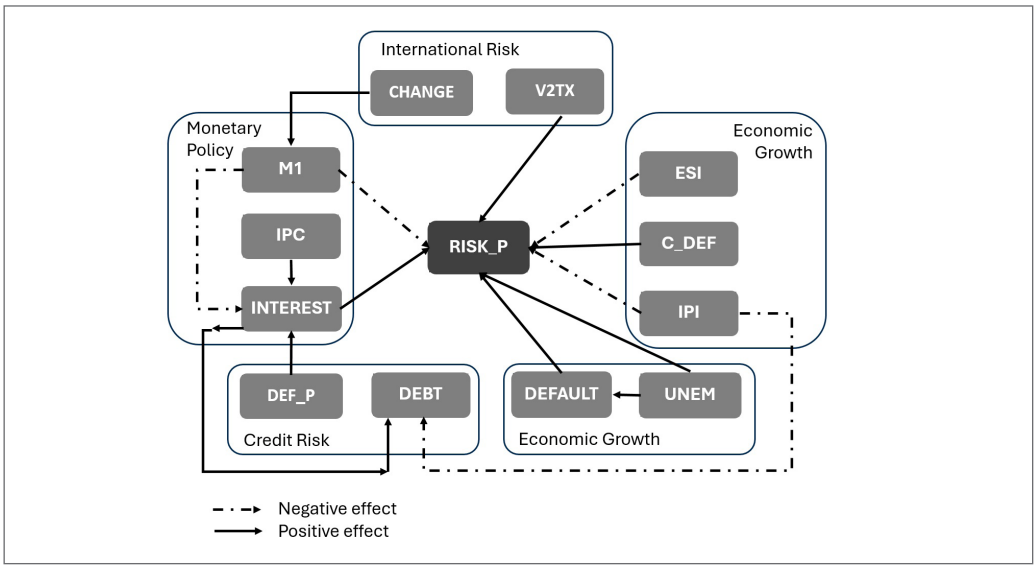
Figure 12
Outline of Key Results



that, in general, the risk premium is significantly conditioned by the variable itself, possibly due to its control by the ECB since the debt crisis in the EU in 2010.

On the other hand, public debt does not have a significant effect on the risk premium, a result that coincides with authors such as Bernoth abd Erdogan (2012), Martinez et al. (2013) or Lagoa et al. (2022) who find that public debt is not significant. However, this result differs from that obtained by other authors such as De Grauwe and Ji (2012), Bernoth et al. (2012), Bi (2012), Tkalec et al. (2014), Kilponen et al. (2015) or Mpapalika and Malikane (2019) who observe a positive relationship with fiscal variables (public debt and public deficit).

As for the public deficit, it increases the risk premium, although its impact is delayed and not very relevant. This behavior coincides with authors such as Sgherri and Zoli (2009), Barrios et al. (2009), Baldacci and Kumar (2010), Bernoth and Erdogan (2012), Aizenman et al. (2013) or Costantini et al. (2014) who indicate the influence of the public deficit on the risk premium, although there is no general consensus on its significance (Aβmann & Boysen-Hogrefe 2012; Stamatopoulos et al., 2017; Lagoa et al., 2022).

Consequently, growth of debt/GDP (DEBT) and trade deficit (C_DEF), do not have a significant effect on the risk premium in the study period, which means that the second hypothesis is not fully fulfilled, however, the variables unemployment (UNEM), non-performing loans (DEFAULT), interest rate (INTEREST), inflation (CPI) and European volatility index V2TX (V2TX) do have a positive influence on the risk premium.

The causes may be due to the ECB's control of the risk premium through asset purchases and the establishment of the escape clause after the outbreak of the pandemic, which made it possible to temporarily suspend fiscal rules to provide governments with budgetary flexibility.

In relation to the interest rate, the risk premium does not respond to variations in its level, although the interest rate is positively correlated with public indebtedness, a result that coincides with the opinion of other authors such as Conway & Orr (2002), Laubach, (2003), Codogno et al., (2003), Bernoth et al., (2006), Manganelli & Wolswijk (2009) or Haugh et al., 2009.

The impact of the M1 aggregate on the risk pre-

mium is small, however, initially, an increase in the monetary aggregate causes a decrease in the risk premium but, subsequently, there are positive and negative fluctuations on the level of the risk premium. There is no consensus in the literature on the impact of monetary policy on sovereign bond markets and on the risk premium. In fact, while some papers find a significant effect (Altavilla et al., 2021; De Santis, 2020; Kilponen et al., 2015; Krishnamurthy & Vissing-Jorgensen, 2011), other research points out that its impact is low (Aastveit et al., 2017; Arnold & Vrugt, 2010; Castelnuovo & Pellegrino, 2018; Gnewuch, 2022).

As for inflation, the risk premium is not affected by its behavior, a result that coincides with that obtained by Mendonça and Nunes (2011), Maltritz (2012), Stamatopoulos et al. (2017) or Álvarez et al. (2020), but opposite to that of other authors such as Claessens et al, (2009), Barrios et al., (2009), Reinhart and Rogoff (2010), Baldacci et al. (2011), Alessandrini et al., 2012 or Tkalec et al. (2014) who state that inflation influences the increase of the risk premium.

As for the European volatility index, V2TX has a positive influence on the risk premium and on the M1 monetary aggregate, a conclusion close to the one reached by Álvarez et al., (2020) considering the VIX index, while the euro-dollar exchange rate is positively related to the interest rate and the public deficit and negatively to the M1 monetary aggregate.

In short, the endogenous variable, the monetary aggregate M1, verifies the initial hypothesis (its increase causes a reduction in the risk premium (RISK_P). Regarding the growth of the variables the industrial production index (IPI), the economic sentiment index (ESI) and the exogenous variable CHANGE, it is found that they have a negative effect on the risk premium, as indicated in the first hypotheses

The industrial production index and the economic sentiment index are two variables with somewhat similar behavior on the risk premium, although they have little impact on the risk premium. However, their growth causes a reduction in the risk premium, but its effect is lagged. This behavior is consistent with the research of Baek et al. (2005), Siklos (2011), Arghyrou and Kontonikas, 2012, Garcia and Werner (2016) or Álvarez et al. (2020) that manifest the existence of a negative relationship with the risk premium.

The impact of the trade balance on the risk premium is not clear, although its impact is small. This behavior differs from that obtained in other papers where this variable is related to GDP and they state that the deficit in the trade balance increases the risk premium (Barrios et al., 2009; Gómez-Puig et al., 2014; Martinez et al., 2013; Özatay et al., 2009; Rault & Afonso, 2011).

Regarding the euro-dollar exchange rate, its effect is interpreted in the sense that by increasing the interest rate, the euro becomes more attractive to investors, who will demand more euros, causing the currency to appreciate

In summary, the industrial production index, the economic sentiment index and the trade balance, variables that are related to the growth of the economy, have a weak relationship with the risk premium. However, the growth of the industrial production index or the sentiment index reduces the risk premium, as hypothesized in the initial hypothesis.

As for the unemployment rate and non-performing loans, their growth increases the risk premium, with the difference that non-performing loans affects in a lagged manner. This result for the unemployment rate is similar to that obtained in other works such as Barrios et al., 2009; Alessandrini et al., 2012; Maltritz, 2012 or Kilponen et al., (2015). However, for non-performing loans, no references are found on its impact on the risk premium, although it is a factor that contributes to increase the deterioration of the economy and, in this sense, Beirne and Fratzscher (2013) point out that the deterioration of the macroeconomy is one of the causes of the increase in sovereign risk.

In conclusion, the socio-economic variables constituted by the unemployment rate and the non-performing loans rate seem to have an impact on the risk premium. An increase in the unemployment rate or in the non-performing loans rate increases the risk premium, confirming the initial hypothesis.

As for the remaining macroeconomic variables, the interaction is reflected between some variables,

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so the industrial production index reduces public debt, but public debt also has a positive lagged influence on the industrial production index. Likewise, monetary expansion, estimated with the aggregate M1, decreases the interest rate and inflation increases interest rate.

6. Conclusions

This paper investigates the explanatory and predictive power of macroeconomic factors on the risk premium in Spain. Understanding the determinants of the risk premium is becoming increasingly important for both investors and policy makers. Moreover, in recent years, this interest has increased in the wake of the 2008 crisis and the evolution of sovereign debt markets is becoming increasingly relevant for monetary policy. Therefore, the study of their link with the general macroeconomic situation has become an issue of some importance also from the point of view of future policies to be developed.

This research contributes to extend the study on the role of macroeconomic variables in explaining the risk premium using an empirical approach based on VAR models with an analysis of the time structure of macroeconomic factors and the risk premium.

The results obtained show that macroeconomic factors such as the monetary aggregate M1, the non-performing loans or unemployment rate play a role in forecasting the risk premium, while the other variables have little influence over the study period.

Consequently, macroeconomic factors are scarcely relevant for predicting the behavior of the risk premium, despite the existence of some variable that exerts some influence and, therefore, leads to differentiate between the risk premium observed in the sovereign debt market and the risk premium estimated through macroeconomic fundamentals. Nor does the risk premium significantly affect macroeconomic variables; it is the macroeconomic variables themselves that are related to each other.

In general, some of the results obtained coincide with those reported in the literature, such as the industrial production index, the economic sentiment index, the unemployment rate or the non-performing loans rate, while there is no consensus as to the size of their impact on the risk premium.

7. Limitations and Future Research Directions

The results obtained may be of interest to researchers, since from this study they can design other analyses that include the variables that have turned out to be significant and other variables that have not been treated, perhaps with social or political characteristics. For political leaders, who, in view of the unemployment rate or non-performing loans, can make decisions in advance on social or fiscal policies that reduce the expected growth of the risk premium.

Finally, it can also be of interest to investors, because knowledge of these relationships with macroeconomic indicators can provide advance information on risk premium movements, facilitating their investment decisions.

Macroeconomic variables, particularly the risk premium, play an essential role in shaping policies that promote stability and economic growth, improving Spain's position in the global financial landscape.

It is important to note that the degree of differentiation between countries is significant, each with a different political, social, economic, financial, and fiscal structure, which means that any change in European monetary policy by the ECB can be transmitted heterogeneously between the countries of the Eurozone and, therefore, the reaction of the financial markets to certain monetary policy decisions is asymmetrical. This different behavior of countries in the face of debt policies limits the possible extrapolation of the results to other countries. In addition, although the selection of the variables to be included in the study has been justified, the macroeconomic orientation of the study may be limiting, because it has led us to the non-inclusion of social or political variables that could also affect the risk premium.

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