UNIVERSITY OF MACEDONIA
SCHOOL OF ECONOMIC & PERIPHERAL STUDIES
DEPARTMENT OF ECONOMIC STUDIES
MSC IN APPLIED ECONOMICS

Master Thesis

The determinants of Sovereign Risk: an empirical analysis for the OECD countries

Sampsonidou Sofia

Supervisor: *Professor George Bampinas*

Thessaloniki 2023

MASTER THESIS

The determinants of Sovereign Risk: an empirical analysis for the OECD countries

Sampsonidou Sofia

mae22006

Supervisor: Professor George Bampinas

Abstract

This thesis focuses on the determinants of sovereign risk. Initially, the measurements of sovereign risk and the factors that affect it are explained. Furthermore, a panel regression analysis using a dataset of 24 OECD countries during a period from 2000 to 2020 is performed. The results showed that the unemployment rate has a positive and statistically significant effect on sovereign risk. In the second part of the empirical analysis, the sample is divided into categories. The first category divides the countries into the EMU and the non-EMU members. The results showed that the unemployment rate was statistically significant only in the first group. The second category divides the data into three time periods: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020). In the first period, the foreign exchange reserves were found to have a statistical and economic effect on sovereign risk, while in the second period, the VIX Index and in the third period the unemployment rate have a statistically significant effect on sovereign risk.

Key Words: sovereign risk, panel regression analysis, government bond yield spreads, credit default swaps (CDS), credit ratings, foreign exchange reserves, unemployment rate, VIX Index

Περίληψη

Η παρούσα διπλωματική εργασία στοχεύει στην ανάλυση των παραγόντων που επηρεάζουν τον κίνδυνο κρατικής αφερεγγυότητας (sovereign risk). Αρχικά, αναλύονται οι μεταβλητές που μπορούν να μετρήσουν τον συγκεκριμένο κίνδυνο καθώς και μεταβλητές που μπορούν να τον επηρεάσουν. Επιπλέον, χρησιμοποιώντας δεδομένα για 24 χώρες – μέλη του ΟΟΣΑ για την περίοδο 2000 – 2020, διενεργείται μία ανάλυση παλινδρόμησης για δεδομένα panel (panel regression analysis). Τα αποτελέσματα έδειξαν ότι το ποσοστό ανεργίας έχει θετική και στατιστικά σημαντική επίδραση στον κίνδυνο. Στην συνέχεια, τα δεδομένα χωρίζονται σε δύο κατηγορίες. Η πρώτη, χωρίζει τις χώρες σε κράτη μέλη της Οικονομικής και Νομισματικής Ένωσης (ΟΝΕ) και σε κράτη μη – μέλη της ΟΝΕ. Τα αποτελέσματα έδειξαν και πάλι ότι το ποσοστό ανεργίας επηρεάζει θετικά και στατιστικά σημαντικά τον κίνδυνο αλλά μόνο στην πρώτη ομάδα χωρών. Η δεύτερη κατηγορία χωρίζει το δείγμα σε τρία χρονικά διαστήματα: πριν την κρίση (2000-2006), κατά την διάρκεια της κρίσης (2007-2009) και μετά την κρίση (2010-2020). Τα αποτελέσματα έδειξαν ότι πριν την κρίση υπάρχει στατιστικά σημαντική σχέση μεταξύ του κινδύνου και των συναλλαγματικών διαθεσίμων. Κατά την διάρκεια της κρίσης φαίνεται να υπάρχει θετική σχέση μεταξύ του δείκτη VIX και του κινδύνου, ενώ μετά την κρίση, το ποσοστό ανεργίας επηρεάζει θετικά τον κίνδυνο.

Λέξεις Κλειδιά: κίνδυνος κρατικής αφερεγγυότητας, ανάλυση παλινδρόμησης δεδομένων panel, αποδόσεις κυβερνητικών ομολόγων, αξιολόγηση πιστοληπτικής ικανότητας, ποσοστό ανεργίας, δείκτης VIX, συναλλαγματικά διαθέσιμα

Contents

List of Tables

List of Figures

1. Introduction

The recent financial crisis, which began with the collapse of real estate prices around the world in 2007 and was followed by the bankruptcy of the Lehman Brothers, has increased the interest of academics in studying the term sovereign risk. Sovereign risk denotes the risk of a country failing to pay its debt obligations. The causes that drive to this payment failure vary from country to country. Plausible explanations may include a banking crisis, a country’s political instability, or factors like the level of debt, etc. (Sturzenegger & Zettelmeyer, 2007). For instance, Greece in 2012 and Lebanon in 2020 are countries that were not able to pay their debt because the level of debt was unsustainable while Ukraine in 2018, Argentina in 2014 and 2019, and Ecuador in 2008 and 2012 due to political instability. Moreover, a nation's capability to pay its debt is seriously affected by persistent economic stagnation, which also makes its economy more susceptible to shocks like a pandemic or recession (Sturzenegger & Zettelmeyer, 2007). Russia and Ukraine in 1998, Argentina in 2001, and Venezuela in 2017 are examples of countries that failed to meet their debt obligations due to economic stagnation.

The European debt crisis, or in other words, the Eurozone crisis took place from 2009 until the late 2010s led many countries like Italy, Portugal, Spain, Ireland, and Greece, to inability to meet their debt obligations without the assistance of third parties such as IMF, European Central Bank or other countries. The same happened in previous crises like the Asian crisis in the late 1990s, the Latin American debt crisis in the early 1980s, and others.

Given the magnitude of the sovereign debt markets, which are enormous and quickly growing, having a clear understanding of sovereign risk is absolutely essential. The first that dealt with the factors that affect sovereign risk was Edward (1984), who studied the determinants of interest rate spreads. Thereafter, more papers studied the variables that can measure sovereign risk and their determinants. Variables that are used as a measurement of sovereign risk are Credit Default Swaps (CDS), Government Bond Yield Spreads, interest rate spreads, and Credit Ratings (Hilscher & Nosbusch , 2010). On the other side, the factors that affect sovereign risk can be categorized into local and global factors. Local factors are indicators like the debt-to-GDP ratio, the foreign exchange reserves, the exchange rate, and others, while global factors are variables like the VIX Index, liquidity, and others (Dieckmann & Plank, 2012).

This study aims to examine the determinants of sovereign risk by using as a dependent variable the spread between the 10-year government bond yield of a country and Germany's 10-year government bond yield. A dataset of 24 countries members of the OECD of 5 different continents from 2000 to 2020 is used to describe the effect of the independent variables on the spread. The Organisation for Economic Co-operation and Development (OECD) is a forum where 38 countries collaborate in order to handle the economic, social, and governance difficulties of globalization as well as to take advantage of its potential (OECD, 2008).[1]

A panel data regression analysis was performed in order to analyze the determinants of sovereign risk. Initially, a pooled OLS model and then a fixed effects model with country effects were performed. Thenceforward, a redundant fixed effects test was performed in order to justify which one of the previous models is more appropriate to use. In the end, a random effects model and a Hausman test were performed in order to show if it's better to use the fixed effects or the random effects model. In the second part of the panel data regression analysis, the sample was divided into two country groups: the EMU member countries and the non-EMU member countries. The Economic and Monetary Union (EMU) was established in 1992 and consists of the coordination of economic and fiscal policies, a shared monetary policy, and the use of the euro as a single currency and represents a significant development in the integration of EU economies (European Commission, 2007). The third part of this section categorizes the sample into three time periods: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020).

The results of the analysis showed that there is a positive and statistically significant relationship between the unemployment rate and spreads, and therefore, the sovereign risk in the full sample dataset. The coefficient of the unemployment rate was found to be approximately 0.22 for every regression that was performed. In the second part, the results showed that there is a statistically significant effect of the unemployment rate on spread only in the EMU member countries, while only in the non-EMU members group the coefficient of the VIX Index is statistically significant but it is negative and different than was expected. In the third part, the results showed that in the pre-crisis period, only the foreign exchange reserves (minus gold) have a statistically significant effect on sovereign risk. However, its coefficient is very close to zero. In the during-crisis sample,

[1] South Africa is the only country that is included in the dataset and it's not an OECD member. However, since 2007 South Africa is one of the five Key Partners of the OECD along with China, India, Brazil, and Indonesia.

only the coefficient of the VIX Index is found to have a statistically and economically significant effect on spreads and it equals approximately 0.03. Finally, in the post-crisis period, the unemployment rate has a statistically and economically significant effect on the sovereign risk and its coefficient equals approximately 0.27.

The structure of this paper is organized as followed. First, the literature review is discussed in section 2, and in section 3 the sovereign risk and the variables that measure and affect sovereign risk are analyzed. Section 4 analyzes the methodology that is used in the econometric analysis and section 5 describes the data structure. Finally, section 6.1 explains the results of the previous analysis by using the full data sample. Section 6.2 presents the results of the EMU member countries and the non-EMU member countries. Section 6.3 reports the results of the three time-period categories: pre-crisis (2000 – 2006), during-crisis (2007 – 2009), and post-crisis (2010 – 2020). Section 7 contains the conclusion.

2. Literature Review

A large number of literature attempts to explain the determinants of the pricing of sovereign risk. A great number of studies focus on government bond yields or interest rate differentials as a measure of sovereign risk, while others examine credit ratings and Credit Default Swaps.

Codogno et al. (2003) try to examine the determinants of the 10-year government bond yields in the Eurozone. By analyzing a dataset of 11 European countries during the period of 1990-2002, they found that the changes in the Eurozone sovereign bond yield differentials can be explained by changes in international risk factors such as corporate bond spreads relative to US Treasury yields or US swap.[2,3] Another finding is that liquidity has explanatory power for some countries. Aßmann and Hogrefe (2012), by using the spreads of 10-year government bonds for 10 countries, found that the debt/ GDP ratio was the only important factor in the period 2003-2007. Bernoth et al. (2012) examine the effects of the monetary union on risk premiums. More specifically, they use data from 1993 to 2009 for 15 EMU countries and conclude that both before and after the implementation of EMU, yield spreads considerably change in response to measures of governmental debt. The public debt, foreign reserves, the current account balance, and inflation were among the local macroeconomic factors that Edwards (1984) identified to be significant predictors in an early analysis of the factors influencing government bond spreads.

Although many papers study government bond spreads, some literature examines the relationship between fiscal variables and interest rates. Haugh et al. (2009) find that bond yield spreads in the euro area are significantly influenced by differences in fiscal policies, particularly those that have an impact on future deficits and the debt service ratio. According to Canzoneri et al. (2002), anticipated deficits have an impact on the difference between US long-term and short-term interest rates. Ardagna et al. (2007) discover that primary deficits have a sizable positive impact on long-term interest rates and that only countries with debt-to-GDP ratios above average experience an

[2] Treasury yield is the effective yearly interest rate, stated as a percentage, that the U.S. government pays on a certain debt obligation. In other words, it describes the annual return that investors might anticipate from owning a U.S. government security with a specific maturity.

[3] The US Treasury Swaps work similarly to other interest rate swaps, but these are linked to US Treasuries more than any other index. A Treasury contract would be an agreement between two independent parties to swap one payment stream for another over a predetermined amount of time.

increase in interest rates. Faini et al. (2004) show that government debt has a positive effect on ex-post real interest rates.

Cantor and Pecker (1996) presented one of the earliest empirical studies on the factors influencing sovereign credit ratings, focusing on an analysis of the rating criteria and their effect on sovereign borrowing costs. They discovered that factors such as per capita income, GDP growth, inflation, external debt, the degree of economic development, and the history of defaults may all be used to describe ratings. Afonso et al. (2007) analyze the factors influencing sovereign debt credit ratings for the years 1995 to 2005. They discover that the GDP per capita, GDP growth, government debt, government effectiveness indicators, external debt, external reserves, and default history all have an impact on the sovereign credit ratings.

Aizenman et al. (2013) found that there is a positive relationship between sovereign risk and some macroeconomic factors, such as inflation, state fragility, external debt, and commodity terms of trade volatility. Moreover, they found that there is a negative relationship between trade openness, the fiscal balance to GDP ratio, and the sovereign CDS spreads. They use data for 20 emerging market economies during a period of 7 years separated into periods (pre-crisis 2004-2007, crisis 2008-2009, post-crisis 2010-2011) and they conclude that before the crisis external factors like trade openness were more important but during the crisis, the governments were more focused on the use of the fiscal and monetary policy. This means that factors like inflation or the public debt to GDP ratio were statistically more important in explaining the sovereign risk. Longstaff et al. (2011) found that global factors can explain better sovereign risk than local economic factors. More precisely, they used a dataset of 26 developed and less developed countries and they showed that indices like investment flows and risk premiums have better explanatory power and although local factors affect the sovereign risk, global factors are strongly related to the sovereign CDS spreads therefore to the sovereign risk. Delatte et al. (2014) by using a dataset of five peripheral European countries during the period 2006-2012 found that sovereign CDS spreads are subject to significant nonlinear dynamics. Badaoui et al. (2013) used data for CDS and bond markets and showed that there is a stronger relationship between CDS spreads and liquidity than sovereign bond spreads.

Beirne & Fratzscher (2013) examine the determinants of sovereign risk by using both the government bond yields and the CDS spreads as well as the credit ratings. More precisely, by using a dataset of 31 during the period 1999-2001 they find that a great amount of the sovereign risk is associated with the countries' local factors, like public debt, growth rate, current account, fiscal balance, and others. They, also, discover that cross-country contagion has an impact on the pricing of sovereign risk, meaning that the spread of a bad sovereign shock from nations like Greece increased the cost of sovereign risk in other, related nations.

Rodriguez et al. (2018) investigate the relationship between CDS spreads and Credit Ratings. They use a dataset of 54 countries during the period 2005-2016 and they discover that average credit ratings are much lower in countries with higher CDS spreads during the previous three years. They also find that there is a negative relationship between CDS spreads and average ratings during the sample period. Lastly, they show the use of CDS in forecasting rating changes since they are a significant factor in determining government debt ratings.

Alesina et al. (1992), in their paper, analyzed a sample of 12 OECD countries during the period 1974-1989 and found that the increase in the government's debt return relative to the private return can explain the existence of high stocks or rapid fluctuations of the country's debt. Bi et al. (2012), in their paper, use data for Greece and Italy during the post-EMU period and they find that Italy's probability for default is higher than the Greek government's. However, the Italian government's willingness to service its debt is higher by 12%.

Other studies use the EMBI[4] spread as a measure of sovereign risk. For example, Hilscher & Nosbusch (2010) focused on the effect of the volatility of terms of trade on yield spreads. In particular, by using a dataset of 31 emerging countries from 1970 to 2007, they found that not only the relationship between these two is statistically and economically significant, but also that other macroeconomic factors such as the VIX Index or country-specific variables have substantial explanatory power. Borri & Verdelhal (2011) divide nations according to two risk factors—their correlation with U.S. economic conditions and their default probabilities—create portfolios of sovereign bond indices and discover the covariances between returns and one risk factor equate to average EMBI excess returns.

[4] The Emerging Markets Bond Index (EMBI) is a benchmark index that measures the total return of global sovereign and corporate bonds issued by emerging markets that meet specified liquidity and structural requirements. Hilscher & Nosbusch (2010) and Borri & Verdelhal (2011) use data from J.P. Morgan's Emerging Market Bond Index (EMBI).

3. Measurements and Determinants of Sovereign Risk

3.1. Measuring Sovereign Risk

The term Sovereign Risk is used to describe the risk of a government failing to repay its loan obligations to its creditors (Heffernan, 1986). To finance their economic needs and other commitments, such as budget expenses, pension passives, or social security schemes, governments issue debt due to bonds or loans. However, in the event of an unforeseen event that is not included in the government's budget, the state will not be able to meet its loan obligations. This could lead to a deficit for the country and adversely affect its creditworthiness.

Credit Ratings

Although there is no certain formula that measures sovereign risk, it can be measured by rating agencies, such as Moody's, Standard & Poor's, Fitch, etc. (IMF, 2010). These agencies assess a credit rating for each country based on its ability or willingness to service its debt on time by evaluating factors like the country's solvency and liquidity, political stability, or any other factor that indicates financial or social unrest. A rating conveys how likely it is that the rated party will experience default within a specified time frame. A time span of one year or less is typically regarded as short-term, and anything longer than that is seen as long-term. Institutional investors generally preferred long-term ratings in the past. However, short-term ratings are frequently applied too. Table 1 shows the long-term ratings and the definitions of the ratings for the three main Credit Rating Agencies, Moody's, S&P, and Fitch. The highest rating is AAA for S&P and Fitch and Aaa for Moody's, while the lowest rating is D for S&P and Fitch and C for Moody's. The highest rating translates into a lower probability of default. Austria, Canada, Switzerland, Australia, and the USA are some of the countries with the highest ratings, while countries like Zambia, Venezuela, Suriname, and Sri Lanka are some with the lowest ranking (IMF, 2010).

Some other aspects that help the Rating Agencies to determine the debt repayment ability are the economic policy variables like GDP, the level of debt, the inflation and the unemployment rate, variables that affect the current account balance of payments, and others (Lonning, 2000). A higher rating indicates a higher ability to repay the debt or otherwise a smaller probability of failing to pay. This translates into a lower sovereign risk. Arezki et al. (2011), in their study, focus on the effects of news about sovereign ratings on European financial markets during the period 2007-

2010 and they show that downgrades in sovereign ratings have statistically and economically substantial spillover effects on various financial markets and national economies.

Table 1: *Long-term Credit Rating*

Moody's	S&P	Fitch	Definition
Aaa	AAA	AAA	Highest quality obligations with minimal risk
Aa1	AA+	AA+	High-quality obligations with very low credit risk
Aa2	AA	AA	
Aa3	AA-	AA-	
A1	A+	A+	Upper-medium-grade obligations with low credit risk (Strong payment capacity)
A2	A	A	
A3	A-	A-	
Baa1	BBB+	BBB+	Medium-grade with moderate credit risk (Adequate payment capacity)
Baa2	BBB	BBB	
Baa3	BBB-	BBB-	
Ba1	BB+	BB+	Speculative elements with substantial credit risk (Likely to fulfill obligations, ongoing uncertainty)
Ba2	BB	BB	
Ba3	BB-	BB-	
B1	B+	B+	High-risk obligations with high credit risk
B2	B	B	
B3	B-	B-	
Caa1	CCC+	CCC+	Poor standing obligations with very high credit risk (Vulnerable to default)
Caa2	CCC	CCC	
Caa3	CCC-	CCC-	
Ca	C	C	High speculative and near-to-default obligations with some prospect of recovery
C	D	D	Lowest-rated class obligations in default with little prospect of recovery

Source: IMF, Moody's, Standard & Poor's, Fitch

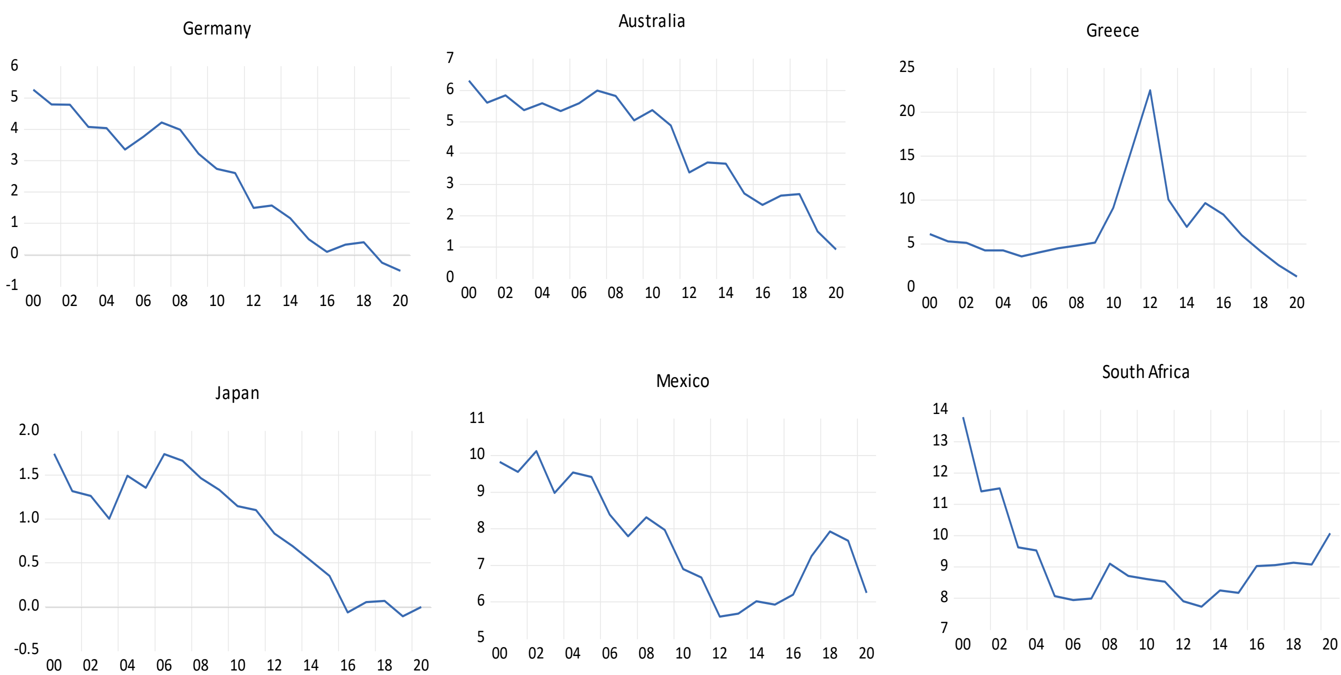
Government Bond Yield Spreads

There are, also, other indicators for measuring sovereign risk. The risk premium represents the difference between the interest rate of the sovereign bond and the interest rate of a risk-free bond of comparable maturity. It can also be measured by the yield differential between a country's government bond and a benchmark country's bond. A benchmark country bond could be a US Treasury bond or Germany's interest rate (Aizenman et al., 2013). It is also known as the spread.

The wider the spread, the higher the risk. Many papers are dealing with the 5-year or 10-year government bond yields and other with interest rates. Countries like Nigeria, Brazil, and Turkey had the highest 10-year government bond yield in 2022, while others like Japan, Germany, and Switzerland had the lowest. On the other side, Argentina, Venezuela, and Zimbabwe have the highest interest rates, while Japan, Sweden, Switzerland, and Spain have the lowest.

Figure 1 shows the 10-year Government Bond yields of Germany and other countries of 5 different continents, Australia, Greece, Japan, Mexico, and South Africa from 2000 to 2020. Greece recorded the highest price in 2012 at 22.5 basis points, while Germany in 2020 recorded the lowest price at – 0.5 basis points.

Figure 1: *10y Government Bond Yields (Germany, Australia, Greece, Japan, Mexico & South Africa)*

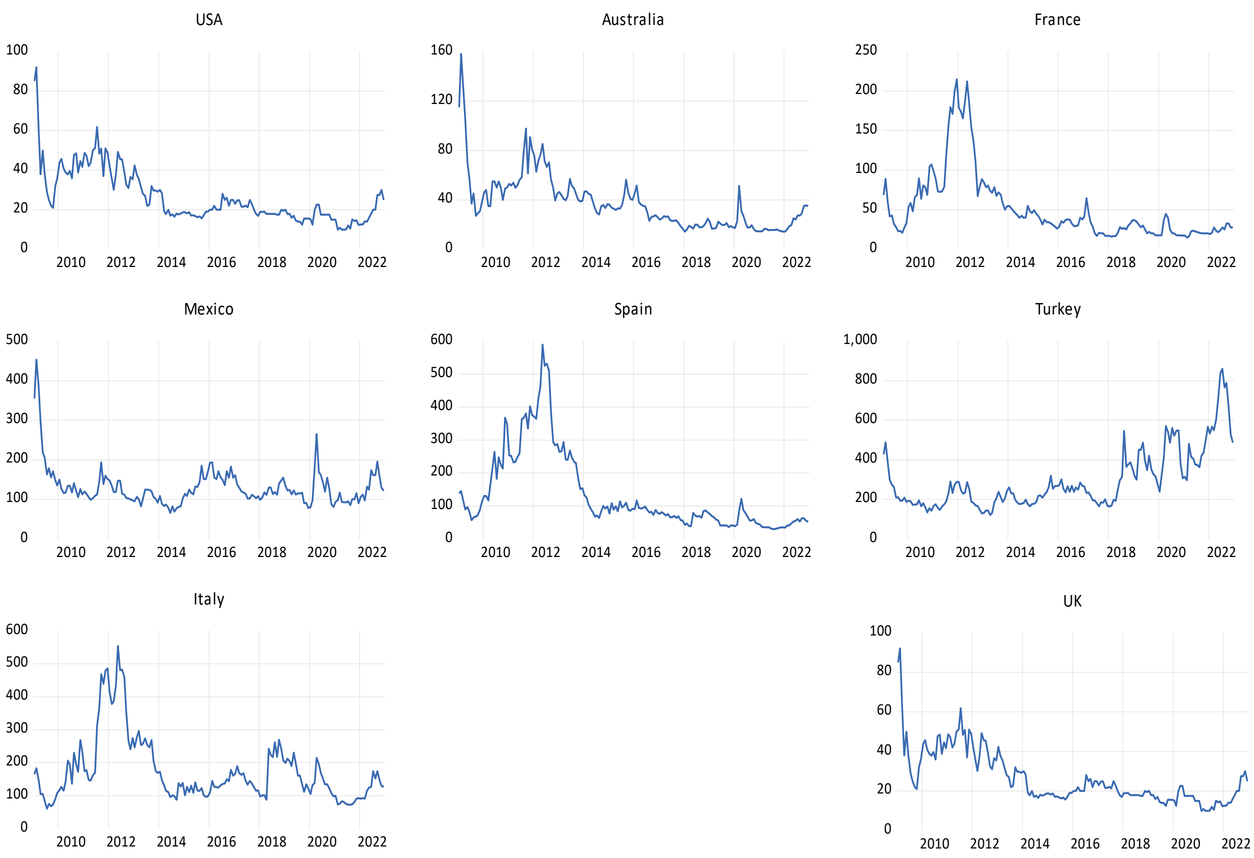


Source: World Bank Data – World Development Indicators

Credit Default Swaps

Another way to measure sovereign risk is through Credit Default Swaps or CDS. A CDS can be described as an agreement between two parties, a borrower and a lender, or otherwise, a CDS buyer and a CDS seller, where the buyer agrees to proceed to a series of payments to the CDS seller. In return, the buyer receives compensation in case of a credit event occurrence. In general, it is a contract to hedge the risk of the creditworthiness of corporate and sovereign bonds. When an event of default occurs, the CDS seller has to pay the entire amount that has been agreed including the interest. The way the CDS affect the sovereign risk is similar to the risk premium. When the Credit Default Swaps are higher, the risk increases. Figure 2 shows monthly data of CDS from January 2009 to December 2022 for 8 countries, the USA, Australia, France, Mexico, Spain, Turkey, Italy, and the United Kingdom. Turkey recorded the highest price among these countries at 860 basis points in July 2022, while the USA recorded the lowest in August 2021 at 10 basis points.

Figure 2: *Credit Default Swaps (USA, Australia, France, Mexico, Spain, Turkey, Italy & UK)*



Source: investing.com

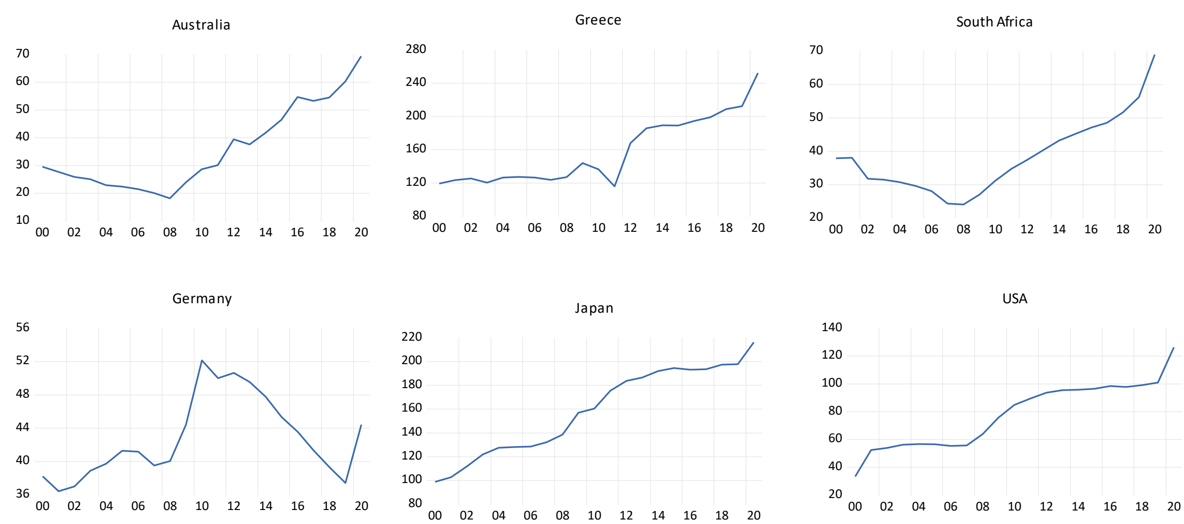
3.2. Determinants of Sovereign Risk

There are different determinants that can affect the level of the yield spreads or the CDS spreads or the Credit Ratings and therefore the sovereign risk. It could be local or country-specific variables such as debt-to-GDP ratio, foreign exchange reserves, terms of trade, unemployment level, government effectiveness, etc., or global factors such as the VIX Index[5], MSCI World Financials Index return, liquidity, and many more (Dieckmann & Plank, 2012).

Debt-to-GDP ratio

The debt-to-GDP ratio compares a government's public debt to its Gross Domestic Product (GDP). It accurately predicts a nation's capacity to repay its debts by contrasting what it owes with what it produces. The debt-to-GDP ratio could alternatively be used to calculate the amount of time required by a government to repay its debt if GDP is used for repayment. A higher debt-to-GDP ratio is translated into a higher sovereign risk. (Caner et al., 2010). In other words, there is a smaller probability of a country servicing its debt obligations when the debt-to-GDP ratio is higher. Data from the IMF[6] showed that the country with the highest general government debt-to-GDP ratio in 2021 was Japan with a percentage of 262.5%. Venezuela follows with a percentage of 240.5%. Figure 3 shows the debt-to-GDP ratio of six countries (Australia, Greece, South Africa, Germany, Japan, and the USA) from 2000 to 2020.

Figure 3: *Debt-to-GDP ratio (Australia, Greece, South Africa, Germany, Japan & USA)*



Source: World Bank Data – World Development Indicators

[5] The Volatility Index of the S&P 500

[6] International Monetary Fund. "General Government Debt: Percent of GDP," Sort by Value.

Foreign Exchange Reserves

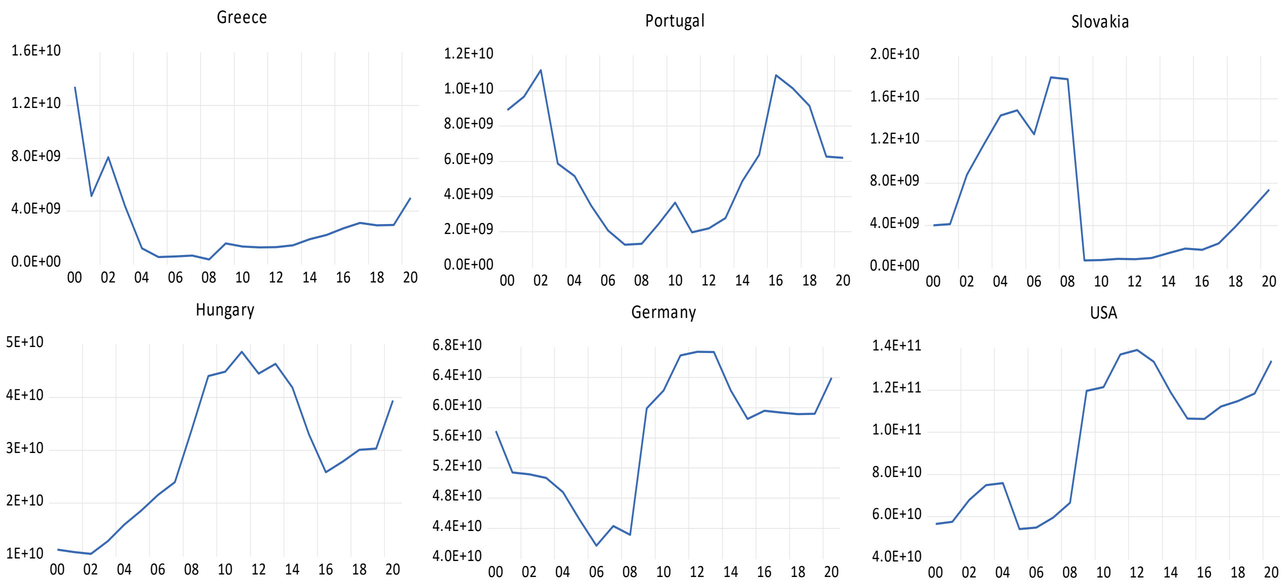
The term foreign exchange reserves is used to describe the assets, like bank notes, foreign currencies, bonds, treasury bills, and others, that are held in reserve by a central bank or other monetary authorities in foreign currencies. They aim to preserve the government's market confidence, balance its budget, or control the value of its currency abroad. One or more reserve currencies, primarily the US dollar and to a lesser extent the euro, British pound, the Chinese yuan, or the Japanese yen are used to hold reserves. There is a negative relationship between sovereign risk and foreign exchange reserves. That means that there is a higher probability for a country to not service its debt obligations when the foreign exchange reserves are lower (Afonso et al., 2007).

Some countries hold a part of their reserves in gold, such as Russia. However, in case of an economic negative shock, the value of gold will not be sufficient to meet the needs of the country, since gold is a commodity. That's why most of the studies, like Dieckmann & Plank (2012), Longstaff (2011), Hilscher & Nosbusch (2010), Afonso et al. (2007), and Edwards (1984), use data for foreign exchange reserves without including gold.

China is the holder with the most foreign exchange reserves, most of them in U.S. dollars, making by that way the execution of the country's international trade easier[7]. Figure 4 presents the foreign exchange reserves (minus gold) for 6 countries (Greece, Portugal, Slovakia, Germany, Hungary, and the USA) during the period 2000-2020. For the first three countries, the foreign exchange reserves decreased during the 2007-2009 crisis while for the other three countries, they increased.

[7] Federal Reserve Bank of St. Louis. "Total Reserves Excluding Gold for China".

Figure 4: *Foreign Exchange Reserves (minus gold) (Greece, Portugal, Slovakia, Germany, Hungary & USA)*



Source: World Bank Data – World Development Indicators

Terms of Trade

Terms of trade can be described as the percentage of the ratio between the government's exports to its imports. In other words, it shows the number of exports required to buy one unit of import (Hilscher & Nosbusch, 2010). Higher terms of trade indicate a positive economic sign, which means a rise in exports, while imports are declining or staying stable. The changes in a country's terms of trade have an impact on its capability to service its external debt obligations. Some indicators that can affect the level of terms of trade are inflation, scarcity[8], or even the quality and size of the goods and services that are traded. There is a negative relationship between sovereign risk and the terms of trade. When there is a rise in the percentage of terms of trade, there is a lower probability for a country to default (Hilscher & Nosbusch, 2010).

However, most of the papers that study the determinants of sovereign risk use as a variable the volatility of terms of trade (Aizenman et al., 2013, Hilscher & Nosbusch, 2010, Dieckmann & Plank, 2012). The volatility of terms of trade is calculated by the median standard deviation of the percent change in terms of trade. Although there is a negative relationship between terms of trade and sovereign risk, the volatility of terms of trade is positively related to sovereign risk. This means

[8] Scarcity reflects the discrepancy between finite resources and conceivably endless wants.

that an increase in the volatility of terms of trade indicates a higher probability for the country to fail to meet its debt obligations (Hilscher & Nosbusch, 2010).

Figure 5 shows the terms of trade volatility for six countries (Germany, Greece, Iceland, Ireland, Japan, and the USA) from 2000 to 2020. From these countries, Iceland recorded the highest terms of trade volatility in 2010 at 716 basis points, while the USA recorded the lowest in 2010 at approximately 0.0 basis points.

Figure 5: *Terms of Trade Volatility (Germany, Greece, Iceland, Ireland, Japan & USA)*

Source: World Bank Data – World Development Indicators

Unemployment Rate

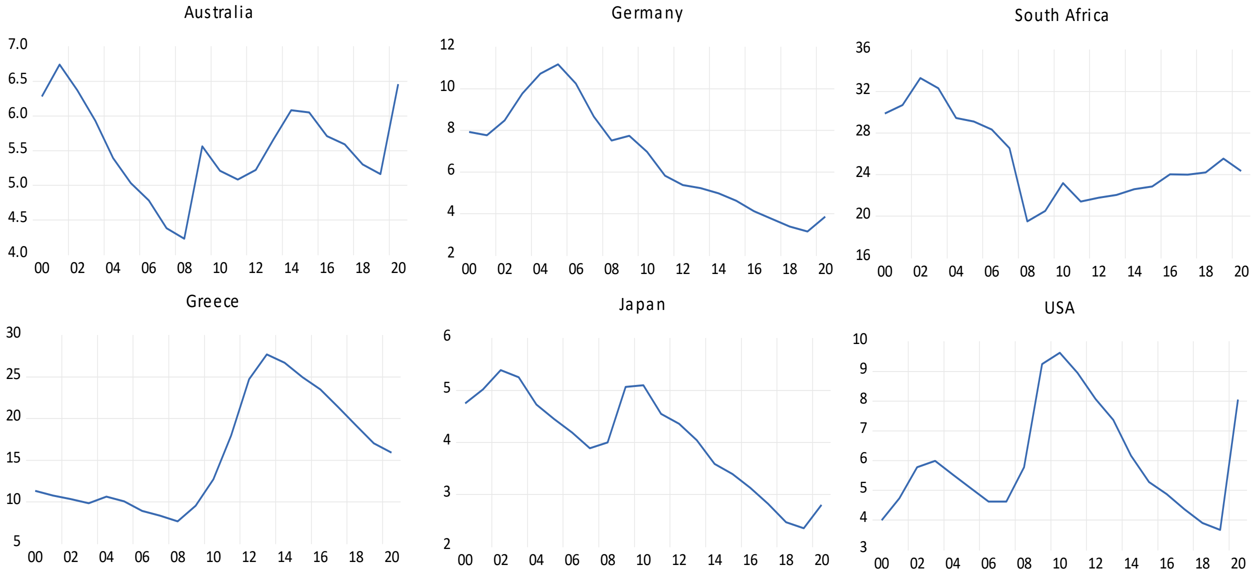
The unemployment rate describes the percentage of the population that belongs to the labor force but is not currently employed. It's calculated by the percentage ratio of unemployed individuals relative to the total labor force. Each country's statistical institute conducts labor force surveys in which they determine the unemployment rate. The unemployment rate increases in periods of recession and decreases in periods of expansion (Mankiw, 2020).

Unemployment can be divided into different categories. Firstly, there is voluntary and involuntary unemployment. While the first describes a condition where the individual leaves his job willingly in search of another one, in the second one the individual was fired. Both of these two categories can be classified into for others, frictional, cyclical, structural, and institutional (Mankiw, 2020). Frictional unemployment describes the persons that left willingly their job and look for a new one or the students that have just graduated and are trying to enter the workforce. This type of unemployment is usually short–lived. Cyclical unemployment describes the changes in the number of unemployed workers during economic upturns and downturns. Structural unemployment is caused by a technical shift in the economy's structure, where labor markets are located. The workers who are displaced from jobs that are no longer necessary as a result of technological advancement may become unemployed. Lastly, institutional unemployment can be caused by long-term or permanent institutional elements or economic incentives, such as high minimum wage floors, extensive social welfare programs employment discrimination, etc. (Mankiw, 2020).

Unemployment is positively associated with sovereign risk (Afonso et al., 2007). When the unemployment rate increases, the labor markets are less flexible and more vulnerable to economic changes. In addition, as mentioned above, the unemployment rate increases in periods of recession. This means that the government is more likely to fail to service its loan obligations.

Figure 6 presents the unemployment rate of 6 countries (Australia, Germany, South Africa, Greece, Japan, and the USA) from 2000-2020.

Figure 6: *Unemployment Rate (Australia, Germany, South Africa, Greece, Japan & USA)*



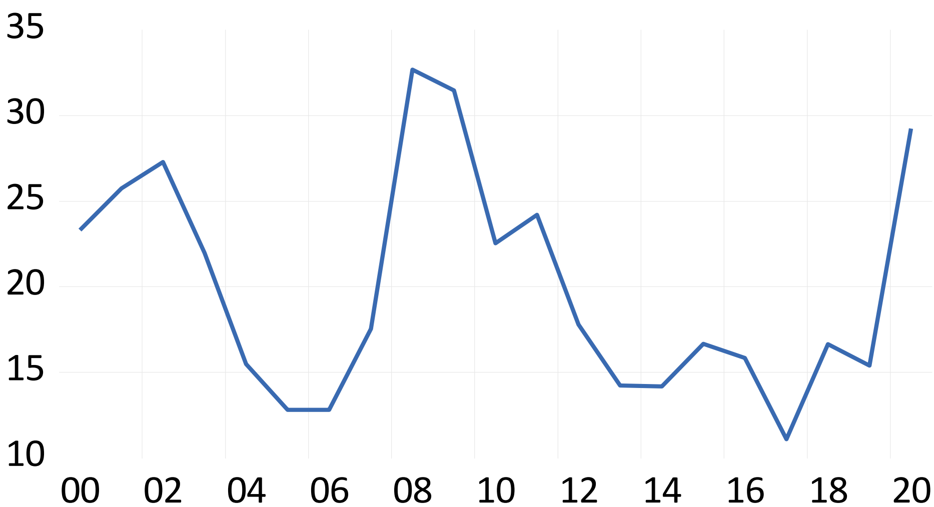
Source: World Bank Data – World Development Indicators

VIX Index

The Cboe Volatility Index (VIX) was created by the Cboe Options Exchange (Cboe) and reflects the market's expectations for the relative strength of upcoming price swings of the S&P 500 Index. It produces a 30-day forecast of volatility because it is drawn from the pricing of SPX index options with close-in expiration dates. It offers a measurable estimate of market risk and investor sentiments. In general, the VIX Index increase when the stocks fall, and vice versa (Whaley, 2009). The equivalent European index is the VSTOXX Index (or V2TX). Figure 7 presents the VIX Index from 2000 to 2020.

Many studies that are focusing on the global factors of sovereign risk found a positive relationship between the VIX Index and sovereign risk (Delatte et al., 2014 & Hilscher & Nosbusch, 2010 & Beirne & Fratzscher, 2013).

Figure 7: *VIX Index*



Source: Cboe Options Exchange (Cboe)

Liquidity

The term liquidity describes the effectiveness or simplicity with which a security or asset can be transformed into immediate cash without impacting its market price. Cash itself is the most liquid asset. In other words, it is the degree to which an asset may be swiftly purchased or sold on the market at a price representing its underlying value. Real estate, fine art, and collectibles are examples of tangible goods that are all rather illiquid. Other financial assets fall at various points throughout the liquidity spectrum, from stocks to partnership units (Badaoui et al., 2013).

The studies use different variables to measure liquidity. For example, papers, like Delatte et al. (2014) and Badaoui et al. (2013), use the bid-ask spread as a proxy for liquidity.[9] Hilscher & Nosbusch (2010) use the TED spread as a proxy.[10] Most of the studies are trying to find the relationship between CDS spreads and liquidity. However, some of them showed a positive relationship (Badaoui et al., 2013), and others didn't find a clear relation (Longstaff et al., 2015).

Others

In the previous analysis, it was presented some of the factors that affect sovereign risk. These factors are uniformly included in each study that examines the determinants of sovereign risk, or, otherwise, the determinants of one of the variables that can measure sovereign risk. However, there are other indicators that seem to affect sovereign risk either positively or negatively. More precisely, variables like GDP per capita, Real GDP growth, fiscal balance, government effectiveness, unit labor force, exchange rate, and stock market volatility index have a negative relationship with sovereign risk as the probability of a country failing to meet its loan obligations rises while these indicators decrease, and the opposite (Afonso et al., 2007 & Dieckmann & Plank, 2012 & Delatte et al., 2014).

On the other hand, variables such as external debt, MSCI World Financial Index[11], industrial production, default history, and times of default relate positively to sovereign risk because when they increase the probability of a country failing to service its debt increases (Afonso et al., 2007 & Longstaff et al., 2011 & Aizenman et al., 2016).

Although there are variables that relate positively or negatively to the sovereign risk, there are others that the correlation between them is uncertain. For example, inflation and current account balance (Afonso et al., 2007).

[9] The difference between the ask price and the bid price for a marketable item is known as the bid-ask spread. The difference between the highest price a buyer is ready to pay for an item and the lowest price a seller is willing to take is known as the bid-ask spread.

[10] The TED spread is used to describe the difference between the three-month U.S. Treasury bills rate and the three-month London Interbank Offer Rate (LIBOR).

[11] The MSCI Indexes serve as a measure of the state of the local stock market. It tracks the performance of the stocks included in the index, just like other indices do such as the Dow Jones Averages or the S&P 500.

4. Methodology

Panel data are a type of datasets that include various cross-section observations across different time periods (Wooldridge J. , 2001). More precisely, panel datasets contain observations about different individuals, countries, firms, etc. that are collected on a regular frequency. This term is also known as longitudinal data (Matyas & Sevestre, 1996). Panel data analysis can lead to many positive outcomes. Firstly, panel data are able to model both the characteristics of the whole cross-sectional groups and every group separately. Furthermore, compared to cross-sectional or time series data, panel data are more efficient, more flexible, and more informational and are able to detect statistical effects that the other data cannot (Mills & Patterson, 2007). Lastly, when groups are combined into time series, estimate biases may occur. Panel data help reduce these biases (Wooldridge J. , 2016).

This study aims to examine the determinants of sovereign risk through a panel data regression analysis. Data from 24 countries that cover a period of 21 years are used in this analysis. Firstly, unit root tests are performed in every variable, both in levels and 1st differences. The second part contains the panel data regression analysis. Initially, a pooled OLS and a fixed effects model with country effects are performed. A redundant fixed effects test examines which one of the previous models is more appropriate to use. In the end, a random effects model and a Hausman test are performed in order to examine if it's better to use the fixed effects model or the random effects model. All of these tests are analyzed in this section.

4.1. Unit Root Tests

Five unit root tests are performed for the panel variables (Levin, Lin & Chu t* (2002), Im, Pesaran & Shin (2003), ADF - Fisher Chi-square (Maddala & Wu, 1999), PP - Fisher Chi-square (Choi, 2001), and Hadri (1999)) and one unit root test is performed for the time series variables (Augmented Dickey-Fuller (Said & Dickey, 1984)). All variables are tested both in levels and in 1st differences.

Augmented Dickey-Fuller (ADF) Unit Root Test

A unit root test examines if a time-series variable has a unit root or it's stationary. More analytically, it tests if any root of the polynomial $f(x) = 1 - a_1x - a_2x^2 - \cdots - a_nx^n = 0$ equals to 1 (Dickey & Fuller, 1979). The augmented Dickey – Fuller unit root test (Said & Dickey,

1984) is an augmented version of the Dickey – Fuller autoregressive unit root test which is used in more complicated and larger time series. The equation that is tested is the following:

$$\Delta y_t = a_0 + \beta y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \cdots + \gamma_{p-1} \Delta y_{t-p+1} + \varepsilon_t$$

where p is the lag order of the autoregressive model, a_0 is the constant number, β is the coefficient of the lagged y_{t-1} and ε_t is the error. The ADF unit root test examines the null hypothesis $H_0{:}\,\beta = 0$ that there is a unit root in the time series sample. The alternative hypothesis $H_1{:}\,\beta < 0$ indicates stationarity (Wooldridge, 2016). The ADF t – statistic is negative and is compared to the relevant critical value of the Dickey – Fuller test. At some level of confidence, the smaller the t – statistic, the greater the rejection of the null hypothesis. In other words, when $p - value < 0.05$, the null hypothesis is rejected in the 5% significance level and the time series variable is stationary. When $p - value > 0.05$, the null hypothesis cannot be rejected and the time series variable contains a unit root.

Levin, Lin & Chu t (LLC) Unit Root Test*

This test was proposed by Levin, Lin & Chu (2002) and is a pooled t – test that allows heterogeneity of cross–sectional units (Mills & Patterson, 2007). The equation that is tested in this model is the following:

$$\Delta y_{it} = a_{i,0} + \beta y_{i,t-1} + \sum_{j=1}^{n} \gamma_j \Delta y_{i,t-j} + \delta_i t + \theta_t + \varepsilon_{it}$$

where j is the number of time series and i is the number of the cross-sectional data that are included in the panel data. This test allows two-way fixed effects, one from the coefficient $a_{i,0}$ and one from the coefficient θ_t. The null hypothesis is $H_0{:}\,\beta = 0$ for all i, indicating that the panels contain a unit root. The alternative hypothesis is $H_1{:}\,\beta < 0$ for all i, indicating that the panels are stationary. When the t – statistic is smaller than the critical value of the significance level then the null hypothesis is rejected. In other words, when $p - value < 0.05$, the null hypothesis is rejected in the 5% significance level. When $p - value > 0.05$, the null hypothesis cannot be rejected and the series contains a unit root (Levin, Lin & Chu, 2002).

Im, Pesaran & Shin (IPS) Unit Root Test

Im et al. (2003) extended the LLC test allowing the existence of heterogeneity for the $y_{i,t-1}$ coefficient (Mills & Patterson, 2007). This test allows β_i to have different values across groups. The model that is tested is the following

$$\Delta y_{it} = a_{i,0} + \beta_i y_{i,t-1} + \sum_{j=1}^{n} \gamma_{ij} \Delta y_{i,t-j} + \delta_i t + \theta_t + \varepsilon_{it}$$

The null hypothesis is $H_0\colon \beta_i = 0$ for all i, indicating a unit root and the alternative hypothesis is $H_1\colon at\ least\ one\ of\ \beta_i < 0$ for all i, indicating a that the series is stationary. Im et al. (2003) created the $\bar{t}$ statistic (or $t - bar$), which is calculated as the average of the ADF t – statistics of the null hypothesis $H_0\colon \beta_i = 0$ for all i (t_{pi}). So, the $\bar{t}$ is calculated as $\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{pi}$. They created the IPS statistic for the panel date unit root test that is calculated as

$$t_{IPS} = \frac{\sqrt{N}(\bar{t} - 1/N \sum_{i=1}^{N} E[t_{iT}|p_i = 0])}{\sqrt{Var[t_{iT}|p_i = 0]}}$$

where t_{IPS} converges to the normal standard distribution, $T \rightarrow \infty$ and $N \rightarrow \infty$ successively.[12] When $p - value > 0.05$, the null hypothesis cannot be rejected at the significance level of 5% and the series contains a unit root. Otherwise, when $p - value < 0.05$, the null hypothesis is rejected in the 5% significance level. In other words, the statistic value is greater than the critical value, the null hypothesis is rejected and the series is stationary (Im et al., 2003).

ADF - Fisher Chi-square Unit Root Test

In order to improve the disadvantages of the two previous panel unit root tests, Maddala & Wu (1999) in their paper created a model in which there are N unit root tests and they test the following statistic: $\Pi = -2\sum_{i=1}^{N} \ln p_i$, where p_i are the p-values of DF and ADF unit root tests and $-2In\pi_i$ follows a χ^2 distribution with 2 degrees of freedom. Π statistic follows a χ^2 distribution with $2N$ degrees of freedom, since $T_i \rightarrow \infty$ for finite N (Maddala & Wu, 1999). The null hypothesis tests for unit root and the alternative hypothesis tests for stationary series. When the statistic value is greater than the critical value, the null hypothesis is rejected and the series is stationary. In other,

[12] $E[t_{iT}|p_i = 0]$ and $Var[t_{iT}|p_i = 0]$ values are mentioned in Im, Pesaran & Shin (2003).

words, when $p - value < 0.05$, the null hypothesis is rejected in the 5% significance level. When $p - value > 0.05$, the null hypothesis cannot be rejected and the series contain a unit root (Mills & Patterson, 2007).

PP - Fisher Chi-square Unit Root Test

Choi (2001) proposed a panel data unit root test in which there is either a finite or an infinite number of groups in the data and various non-stochastic and stochastic component types are expected to exist in each group. Choi (2001), in this test, used a method to combine the p-values from the unit root tests that were applied in every group of the panel data. Choi (2001) uses the $\Pi - statistic$ as in Maddala & Wu (1999) test but combines that with two other test statistics: $\mathrm{Z} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i)$ which is known as the inverse normal test, where $\Phi^{-1}(p_i)$ refers to the standard normal cumulative distribution (Choi, 2001) and $L = \sum_{i=1}^{N} \ln(\frac{p_i}{1-p_i})$, which is known as the logit test (Choi, 2001). The null hypothesis tests for unit root and the alternative hypothesis tests for stationarity. The null hypothesis in rejected at the significance level a when $\Pi > c_{pa}, Z > c_{za}\ and\ L > c_{la}$, where c_{pa} refers to the upper tail of the χ^2-distribution with $2N$ degrees of freedom, c_{za} is the lower tail of the N distribution and c_{la} refers to the lower tail of the t-distribution with $5N + 4$ degrees of freedom (Choi, 2001). In other words, when $p - value < 0.05$, the null hypothesis is rejected at the significance level of 5% and the panel data series is stationary.

Hadri Stationarity Test

Hadri (2000) proposes a stationarity test in which the null hypothesis tests for stationarity and the alternative tests for a unit root in the panel data. This test is based on the Lagrange Multiplier (LM) test. The model that is tested is the following: $y_{it} = r_{i0} + \beta_i t + \sum_{i=1}^{t} u_{it} + \varepsilon_{it}$, where r_{i0} are referred as the fixed unknowns and play the role of heterogeneous intercepts. Furthermore, $\mathrm{E}(\varepsilon_{it}) = 0$, $\mathrm{E}({\varepsilon_{it}}^2) = \sigma_\varepsilon^2 > 0$, $\mathrm{E}(u_{it}) = 0$, $\mathrm{E}(\sigma_u^2) = \sigma_u^2 \geq 0$ and $\lambda = \frac{\sigma_u^2}{\sigma_\varepsilon^2}$. The Hadri (2000) null hypothesis is $H_0: \lambda = 0$ and the alternative is $H_1: \lambda > 0$. The LM statistic equals

$$LM = \frac{\frac{1}{N} \sum_i^N \frac{1}{T^2} \sum_{t=1}^{T} S_{it}^2}{\widehat{\sigma_\varepsilon^2}}$$

where S_{it} is the partial sum of the residuals and $\widehat{\sigma_\varepsilon^2}$ is an estimator of σ_ε^2 for the null hypothesis (Hadri, 2000). Null hypothesis is rejected when the LM – statistic is greater than the critical value at a certain significance level. In other words, when $p - value < 0.05$ the null hypothesis is rejected at the significance level of 5% and the panel data contain a unit root.

4.2. Panel Data Regression Analysis

Consider that a linear panel data regression model is the following

$$y_{i,t} = a + \sum_{j=2}^{k} \beta_j X_{j,i,t} + \sum_{w=1}^{m} \gamma_w Z_{w,i} + \delta t + \varepsilon_{i,t}$$

where y is the dependent variable, X and Z are the independent variables, i is the number of the cross – sectional observations[13] and t is the time period. Furthermore, a is the constant coefficient and β and γ are the coefficients of the independent variables. j is referred to the observed explanatory variables and w is referred to the unobserved explanatory variables. δ is the time trend coefficient (Maddala, 2001). Since the term $\sum_{w=1}^{m} \gamma_w Z_{w,i}$ describes the unobserved effects, the previous equation can be written as

$$y_{i,t} = a + \sum_{j=2}^{k} \beta_j X_{j,i,t} + c_i + \delta t + \varepsilon_{i,t}$$

where $c_i = \sum_{w=1}^{m} \gamma_w Z_{w,i}$. Eliminating c_i from the equation can lead to a bias problem (Maddala, 2001). There are many panel data regression models and they are depending on how the heterogeneity is modeled. In this section, three of these models will be discussed: Pooled OLS model, Fixed Effects Model, and Random Effects Model.

Pooled OLS Model

This regression model is a standard Ordinary Least Squares (OLS) model, in which there are no cross-sectional or time effects (Mills & Patterson, 2007). More precisely, $\sum_{w=1}^{m} \gamma_w Z_{w,i}$ is a constant number, it doesn't correlate with X and there is a linear correlation between dependent and the independent variables (Wooldridge J. , 2001). The estimated equation that results from the

[13] It may denote countries, individuals, firms, etc.

regression model is $y_i = \hat{a} + \hat{\beta} X_i + e_i$, where $\hat{a}$ and $\hat{\beta}$ are the estimated coefficients. e_i is independently and identically distributed and follows the normal distribution with zero mean and variance σ_e^2 ($e_i \sim N(0, \sigma_e^2)$). There are $k + 1$ number of coefficients. The null hypothesis that examines if the coefficients are statistically significant is $H_0: \hat{a} = 0$ and $H_0: \hat{\beta} = 0$. The alternative hypothesis is $H_1: \hat{a} \neq 0$ and $H_1: \hat{\beta} \neq 0$. If the t – statistic of the coefficient is greater than the critical value at a certain significance level, the null hypothesis is rejected and the coefficient is statistically significant. In other words, when the p – value is smaller than 0.05, then the null hypothesis is rejected and the coefficient is statistically significant at the significance level of 5%.

Fixed Effects Model

The fixed effects regression model is used on panel data analysis in order to eliminate any individual (or cross-sectional) characteristics that do not change over time. In other words, this model allows the regression model's intercept to take different values freely among the cross-sectional data (Maddala, 2001). More precisely, the unobservable variables c_i are constants and are correlated with the included variables. The equation that will be tested is the following $y_{i,t} = a_i + \beta_i X_{i,t} + \varepsilon_{i,t}$. The estimated equation that results from the OLS regression model is $y_{i,t} = \widehat{a_i} + \widehat{\beta_i} X_{i,t} + e_{i,t}$, where $\widehat{a_i}$ and $\widehat{\beta_i}$ are the estimated coefficients. $e_{i,t}$ is independently and identically distributed and follows the normal distribution with zero mean and variance σ_e^2 ($e_{i,t} \sim N(0, \sigma_e^2)$). There are $k + N$ number of parameters and N cross-sectional effects (Maddala, 2001). The null hypothesis that examines if the coefficients are statistically significant is $\mathrm{H}_0: \widehat{\alpha_i} = 0$ and $\mathrm{H}_0: \widehat{\beta_i} = 0$. The alternative hypothesis is $\mathrm{H}_1: \widehat{\alpha_i} \neq 0$ and $\mathrm{H}_1: \widehat{\beta_i} \neq 0$. If the t – statistic of the coefficient is greater than the critical value at a certain significance level, the null hypothesis is rejected and the coefficient is statistically significant. In other words, when the p – value is smaller than 0.05, then the null hypothesis is rejected and the coefficient is statistically significant at the significance level of 5%. This model is better to use when the analysis is focused on a specific set of cross-sectional dimensions, for example countries, firms, households, etc.

Random Effects Model

The random effects model describes that the relationship between the explanatory factors and the response variable is constant across all observations. However, these fixed effects may be different from one observation to the other (Mills & Patterson, 2007). The equation that will be used in the random effects regression model may be $y_{i,t} = a_0 + a_i Z_i + \beta_i X_{i,t} + \varepsilon_{i,t}$, where a_0 is the constant coefficient. In this case, the estimated equation that results from the regression model will be $y_{i,t} = \widehat{a_0} + \widehat{a_\iota} Z_i + \widehat{\beta_\iota} X_{i,t} + e_{i,t}$, where, $\widehat{a_0}$, $\widehat{a_\iota}$ and $\widehat{\beta_\iota}$ are the estimated coefficients. $e_{i,t}$ is independently and identically distributed and follows the normal distribution with zero mean and variance σ_e^2 ($e_{i,t} \sim N(0, \sigma_e^2)$). The null hypothesis that examines if the coefficients are statistically significant is $\mathrm{H_0}: \widehat{\alpha_0} = 0$, $\mathrm{H_0}: \widehat{\alpha_1} = 0$ and $\mathrm{H_0}: \widehat{\beta_1} = 0$. The alternative hypothesis is $\mathrm{H_1}: \widehat{\alpha_1} \neq 0$, $\mathrm{H_1}: \widehat{\alpha_1} \neq 0$ and $\mathrm{H_1}: \widehat{\beta_1} \neq 0$. If the t – statistic of the coefficient is greater than the critical value at a certain significance level, the null hypothesis is rejected and the coefficient is statistically significant. In other words, when the p–value is smaller than 0.05, then the null hypothesis is rejected and the coefficient is statistically significant at the significance level of 5%.

Hausman Test

This test was proposed by Hausman (1978) and is also known as the Hausman Specification Test. It is used in panel data analysis in order to examine which one of the fixed effects or the random effects model is more appropriate to be used in the analysis. The test is applied to the random effects model and tests if the individual characteristics are correlated with the regressors (Mills & Patterson, 2007). The null hypothesis denotes that there is no correlation (or that the random effects model is more appropriate to use) and the alternative hypothesis denotes that the individual characteristics are correlated with the regressors (or that the fixed effects model is better to use). The null hypothesis is rejected at the significance level of 5% when the $p - value$ is smaller than 0.05. Rejecting H_0 means that the initial hypothesis of random effects is wrong (Wooldridge, 2016).

Redundant Fixed Effects Test

This test is a Likelihood Ratio F-test that examines whether is more appropriate to use the pooled OLS or the fixed effects models.[14] The null hypothesis denotes that the most efficient model to use is the pooled OLS and the alternative denotes that the most efficient model to use is the fixed effects model. The H_0 hypothesis is rejected when $F_{stat} > F_{critical}$ at a certain significance level. Otherwise, if $p - value < 0.05$, the H_0 is rejected at the significance level of 5% and the most appropriate model to use is the fixed effects.

[14] This test is mostly associated with the EViews software.

5. Data

A sample of annual data of 24 countries that are members of the OECD during a period of 21 years, from 2000 to 2020, is contained in this study.[15] The list of the countries is shown in table 2. There is at least one country from each continent. 17 countries are from Europe (11 of them are members of the eurozone), 2 are from Oceania, 3 are from America, 1 from Africa, and 1 from Asia. All countries are selected based on the data availability.

Table 2: *List of countries*

Country	Country Code	Continent	EU Member	Currency
Australia	AUS	Oceania	☐	Australian dollar (AUD)
Austria	AUT	Europe	☑	Euro (EUR)
Belgium	BEL	Europe	☑	Euro (EUR)
Canada	CAN	America	☐	Canadian dollar (CAD)
Finland	FIN	Europe	☑	Euro (EUR)
France	FRA	Europe	☑	Euro (EUR)
Germany	GER	Europe	☑	Euro (EUR)
Greece	GRE	Europe	☑	Euro (EUR)
Hungary	HUN	Europe	☑	Hungarian forint (HIF)
Iceland	ISL	Europe	☐	Icelandic króna (ISK)
Ireland	IRL	Europe	☑	Euro (EUR)
Italy	ITA	Europe	☑	Euro (EUR)
Japan	JPN	Asia	☐	Japanese yen (JPY)
Mexico	MEX	America	☐	Mexican peso (MXN)
New Zealand	NZL	Oceania	☐	New Zealand dollar (NZD)
Poland	POL	Europe	☑	Polish zloty (PLN)
Portugal	POR	Europe	☑	Euro (EUR)
Slovakia	SVK	Europe	☑	Euro (EUR)
South Africa	ZAF	Africa	☐	South African rand (ZAR)
Spain	ESP	Europe	☑	Euro (EUR)
Sweden	SWE	Europe	☑	Swedish krona (SEK)
Switzerland	CHE	Europe	☐	Swiss franc (CHF)
United Kingdom	GBR	Europe	☐	British pound (GBP)
United States of America	USA	America	☐	US dollar (USD)

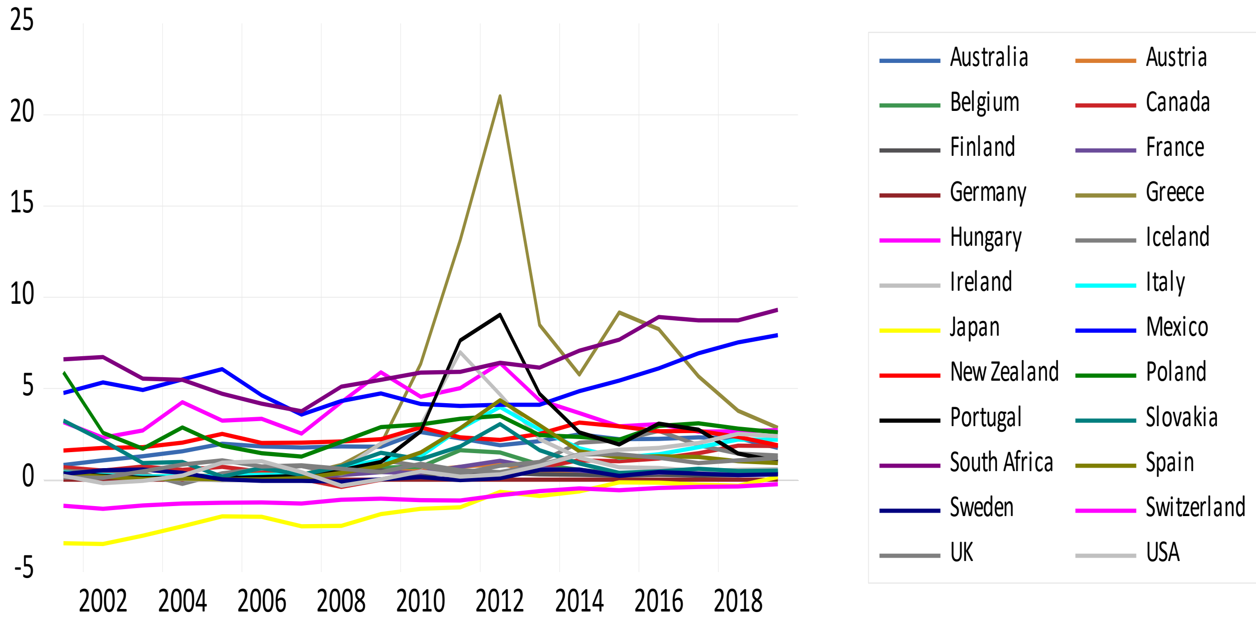
The variable that is used as a measurement of sovereign risk is the 10-year government bond spread which is calculated as the difference between a country's 10-year government bond and Germany's 10-year government bond of the same year. Figure 3 shows the spreads of all countries from 2000

[15] South Africa is the only country that is included in the dataset and it's not an OECD member. However, since 2007 South Africa is one of the five Key Partners of the OECD along with China, India, Brazil, and Indonesia.

to 2020. Greece recorded the highest and the third highest spread in 2012 at 21.0 percentage points and in 2015 at 9.2 percentage points, while South Africa recorded the second-highest spread from the countries of the sample at 9.3 percentage points in 2019. Japan recorded the lowest spread at -3.5 percentage points in 2001. Moreover, this analysis uses 5 independent variables, the debt-to-GDP ratio, the foreign exchange reserves (minus gold), the terms of trade volatility, the unemployment rate, and the VIX Index. Debt-to-GDP ratio describes the central government debt as a percent of the GDP (every county's GDP is measured in US dollars), reserves are defined in US dollars while the unemployment rate is measured as a percentage of the total labor force. Terms of trade volatility is calculated as the median standard deviation of the percent change of terms of trade and the VIX Index shows the market's expectations for the relative strength of upcoming price swings of the S&P 500 Index. Table 3 shows a list of the indicators that are used in this analysis, their description, and the source from where the data were downloaded. The majority of the data were collected from World Bank – World Development Indicators, while data for government bond yields were collected from the Federal Reserve Bank of St. Louis database (FRED), and VIX Index data were collected from CBOE.[16] The analysis and the regressions were performed with the use of EViews 12.

[16] Debt-to-GDP ratio data for Finland, Germany, Italy, Mexico, Poland, Portugal, and South Africa were collected from FRED, while the rest of them were collected from the World Bank Database. Spreads were calculated with the use of Excel, while Volatility of Terms of Trade is calculated with the use of EViews.

Figure 8: *10y Government Bond Yield Spreads 2000-2020*



Note: This figure shows the spreads of all countries from 2000 to 2020. Greece recorded the highest and the third highest spread in 2012 at 21.0 basis points and in 2015 at 9.2 basis points, while South Africa recorded the second highest spread from the countries of the sample at 9.3 basis points in 2019. Japan recorded the lowest spread at -3.5 basis points in 2001. **Source:** World Bank, FRED

Table 3*: List of Variables*

Name	Symbol	Description	Source
10 - Year Government Bond Yield spreads	spread	Difference between a country's 10-year Government Bond and Germany's 10-year Government Bond	FRED, World Bank, own calculations
Debt-to-GDP ratio	gov_debt	Central government debt, total (% of GDP)	FRED, World Bank
Foreign Exchange Reserves	reserves	Total reserves minus gold (current US$)	World Bank
Unemployment Rate	un	Unemployment, total (% of the total labor force) (national estimate)	World Bank
Terms of Trade Volatility	tot_vol	The median standard deviation of terms of trade	World Bank, own estimations
VIX Index	vix_index	The Volatility Index of the S&P 500	CBOE

As explained above, the debt-to-GDP ratio is expected to have a positive relationship with sovereign risk and therefore with the government bond yield spread. Foreign exchange reserves are expected to have a negative relationship, while the volatility of terms of trade, unemployment, and the VIX Index are expected to have a positive impact on spreads.

Table 4 reports the descriptive statistics for the dependent variable in levels and first differences. Table 5 and Table 6 demonstrate the descriptive variables for the independent variables in levels and first differences too.

Table 7 shows the correlation matrix. A correlation matrix is a way of comparing the correlation coefficients for various indicators. The correlation between all potential pairs of values in a table is shown in the matrix. In other words, it shows to which degree two variables are connected. The first cell contains the correlation coefficient. The numbers in the parentheses denote the t-statistic and the third cell is the $p - value$. When the $p - value$ is smaller than 0.05 then the coefficient is statistically significant and there is a correlation between the two variables. As is shown in Table 7, there is a negative and statistically significant correlation between spreads and reserves (the coefficient is -0.229557) and a positive and statistically significant correlation between spreads and the unemployment rate (0.538761). Furthermore, there is a positive correlation between the Debt-to-GDP ratio and foreign exchange reserves (0.326961) and Debt-to-GDP ratio and volatility of terms of trade (0.132057). Lastly, foreign exchange reserves and the unemployment rate are negatively correlated (-0.217903).

Tables 8 and 9 show the results of the unit root tests in levels and 1st differences. As explained above, in this paper, five panel unit root tests and one time-series test are performed. The panel unit root tests are Levin, Lin & Chu t* (2002), Im, Pesaran & Shin W-stat (2003), ADF - Fisher Chi-square (Maddala & Wu, 1999), PP - Fisher Chi-square (Choi, 2001), and Hadri (1999). In the first four, the null hypothesis assumes that the panel data have a unit root and the alternative assumes that there is not a unit root[17]. The Hadri Z-stat test has a null hypothesis that there is not a unit root and that the panel data are stationary, while the alternative assumes non-stationarity. The unit root test that is performed for the VIX Index variable is the Augmented Dickey-Fuller test (ADF) because this variable is in time series form. The null hypothesis says that there is a unit

[17] In the first test assumes a common unit root process, while Im, Pesaran & Shin W-stat (2003), ADF - Fisher Chi-square (Maddala & Wu, 1999), PP - Fisher Chi-square (Choi, 2001) assume an individual unit root process.

root in the time series sample and the alternative tests for stationarity. In every test, if the $p-value$ is smaller than 0.05, the null hypothesis is rejected.

Table 8 shows the results of these tests on the levels of the variables. The first number of each cell is the $p-value$ and the red numbers are the statistical value of each cell. In the Hadri Z-stat test the null hypothesis is rejected for every variable since the $p-value < 0.05$ in every case. That means that the alternative hypothesis is accepted which means that the panel data are stationary. On the other side, in Levin, Lin & Chu t* test, Im, Pesaran & Shin W-stat test, and ADF - Fisher Chi-square test, the null hypothesis is rejected for the 10-year government bond spreads, the volatility of terms of trade, and the unemployment rate, and for the rest variables the null hypothesis cannot be rejected. In PP - Fisher Chi-square test the null hypothesis is rejected only for the volatility of terms of trade.

Table 9 presents the results of the unit root tests on the 1st differences of the variables. The first number of each cell is the $p-value$ and the red numbers are the statistic value of each cell. In the Hadri Z-stat test the null hypothesis is rejected for the Debt-to-GDP ratio, foreign exchange reserves, and volatility of terms of trade since $p-value < 0.05$ and that means the panel data are stationary. On the other side, in Levin, Lin & Chu t* test, the null hypothesis is rejected for every variable except the Debt-to-GDP ratio. In Im, Pesaran & Shin W-stat test, ADF - Fisher Chi-square test, and PP - Fisher Chi-square test the null hypothesis is rejected for every variable.

For the VIX Index, the ADF test (Said & Dickey, 1984) has been performed in levels and 1st differences. In levels, the null hypothesis cannot be rejected, since the $p-value < 0.05$. This means that there is a unit root. In 1st differences, the null hypothesis is rejected, because the $p-value < 0.05$. This means that the data are stationary.

Table 4: *Descriptive Statistics - Dependent Variable*

	Levels (spread)	**1st Differences (dspread)**
Mean	1,483686	0,0104
Median	0,670451	0,006401
Maximum	21,00237	7,862388
Minimum	-4,095667	-12,51961
Std. Dev.	2,378981	1,078886
Skewness	2,334379	-2,180001
Kurtosis	13,87291	53,05649
Jarque-Bera	2940,369	50493,25
Probability	0	0
Sum	747,7776	4,991911
Sum Sq. Dev.	2846,754	557,5541
Observations	504	480

Notes: This table reports the descriptive statistics for the annual 10-year Government Bond Yield spreads in levels and first differences for 24 countries, measured in basis points. The time series covers the period from 2000 to 2020. The data source is the FRED database.

Table 5*: Descriptive Statistics - Independent Variables (Levels)*

	Levels				
	gov_debt	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	73,13807	8,99E+10	16,95856	8,471806	19,95143
Median	58,49205	3,22E+10	8,101261	6,88	17,54
Maximum	252,2862	1,34E+12	715,5708	33,29	32,69
Minimum	16,30735	3,38E+08	0,022728	2,25	11,09
Std. Dev.	43,45292	2,2E+11	41,24321	5,620201	6,353103
Skewness	1,086342	4,1524	11,40271	1,970519	0,555159
Kurtosis	3,897343	19,96256	174,1805	6,872555	2,083108
Jarque-Bera	116,0414	7490,659	626280,1	641,0979	43,54341
Probability	0	0	0	0	0
Sum	36861,59	4,53E+13	8547,116	4269,79	10055,52
Sum Sq. Dev.	949742,8	2,44E+25	855604,2	15888,09	20302,04
Observations	504	504	504	504	504

Notes: This table reports the descriptive statistics for the independent variables in levels. The variable gov_debt refers to Debt-to-GDP ratio, reserves denote the foreign exchange reserves (minus gold), tot_vol is the volatility of terms of trade, ur is the unemployment rate and vix_index refers to the volatility index of the S&P500. All data are annual and the sources are the World Bank – World Development Indicators, FRED, and CBOE. The times series covers the period from 2000 to 2020.

Table 6: *Descriptive Statistics - Independent Variables (1st Differences)*

	1st Differences				
	dgov_debt	***dreserves***	***dtot_vol***	***dur***	***dvix_index***
Mean	2,132701	5750000000	-0,008285	-0,042917	0,2965
Median	0,588945	1070000000	0,17005	-0,15	-0,445
Maximum	51,81561	2,16E+11	487,0128	6,76	15,15
Minimum	-32,65012	-31000000000	-700,1759	-7,030001	-8,93
Std. Dev.	7,475086	23900000000	44,24282	1,263888	6,037318
Skewness	2,02558	6,03425	-5,19232	0,845399	0,964797
Kurtosis	13,33269	45,60415	165,0892	9,909712	3,667933
Jarque-Bera	2463,529	39215,24	527614,9	1012,058	83,38932
Probability	0	0	0	0	0
Sum	1023,696	2,76E+12	-3,976694	-20,6	142,32
Sum Sq. Dev.	26765,04	2,74E+23	937607,7	765,1613	17459,17
Observations	480	480	480	480	480

Notes: This table reports the descriptive statistics for the independent variables in 1st differences. The variable dgov_debt refers to Debt-to-GDP ratio, dreserves denote the foreign exchange reserves (minus gold), dtot_vol is the volatility of terms of trade, dur is the unemployment rate and dvix_index refers to the volatility index of the S&P500. All data are annual and the sources are the World Bank – World Development Indicators, FRED, and CBOE. The times series covers the period from 2000 to 2020.

Table 7: *Correlation Matrix*

Variables	Variables: ***spread***	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
spread	1 ----- -----					
gov_debt	-0,01801 (-0,403587) 0,6867	1 ----- -----				
reserves	-0,22956 (-5,284432) 0	0,326961 (7,751733) 0	1 ----- -----			
tot_vol	-0,00678 (-0,151822) 0,8794	0,132057 (2,984922) 0,003	0,021578 (0,483586) 0,6289	1 ----- -----		
ur	0,538761 (14,32847) 0	0,078131 (1,75592) 0,0797	-0,2179 (-5,00241) 0	-0,048508 (-1,088114) 0,2771	1 ----- -----	
vix_index	-0,06373 (-1,430831) 0,1531	-0,06407 (-1,438492) 0,1509	-0,04436 (-0,994915) 0,3203	0,033774 (0,757154) 0,4493	-0,021981 (-0,492604) 0,6225	1 ----- -----

Notes: This table presents the correlation matrix. The first cell contains the correlation coefficient. The numbers in the parentheses denote the t – statistic and those in the third cell are the p-values. When the p-value is smaller than 0.05 then the coefficient is statistically significant and there is a correlation between the two variables. There is a negative and statistically significant correlation between spreads and reserves and a positive and statistically significant correlation between spreads and the unemployment rate. Furthermore, there is a positive correlation between the Debt-to-GDP ratio and foreign exchange reserves and Debt-to-GDP ratio and volatility of terms of trade. Lastly, foreign exchange reserves and the unemployment rate are negatively correlated.

Table 8: *Unit Root Tests (Levels)*

	Levels					
	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Levin, Lin & Chu t*	0,0244	0,9981	0,2817	0,0000	0,0001	—
	-1,97091	2,89962	-0,57786	-4,31745	-3,88935	—
Im, Pesaran & Shin W-stat	0,0171	1,0000	0,9581	0,0000	0,0001	—
	-2,11784	4,75814	1,72894	-8,10537	-3,64316	—
ADF - Fisher Chi-square	0,0089	0,9923	0,8595	0,0000	0,0020	—
	71,7502	27,5306	37,6164	247,901	81,1391	—
PP - Fisher Chi-square	0,5856	0,9995	0,1504	0,0000	0,7750	—
	43,3099	22,2070	58,1139	927,822	40,3679	—
Hadri Z-stat	0,0000	0,0000	0,0000	0,0000	0,0000	—
	4,63617	11,5474	13,9560	4,88198	6,84151	—
Augmented Dickey-Fuller test	—	—	—	—	—	0,2596
	—	—	—	—	—	-2,06446

Notes: This table shows the results of these tests on the levels of the variables. The first number of each cell is the p-value and the red numbers are the statistic value of each cell. In the Hadri Z-stat test the null hypothesis is rejected in every variable since the p-value < 0.05 in every case. On the other side, in Levin, Lin & Chu t* test, Im, Pesaran & Shin W-stat test, and ADF - Fisher Chi-square test, the null hypothesis is rejected for the 10-year government bond spreads, the volatility of terms of trade, and the unemployment rate, and for the rest variables the null hypothesis cannot be rejected. In PP - Fisher Chi-square test the null hypothesis is rejected only for the volatility of terms of trade. In the ADF test, the null hypothesis cannot be rejected, since the p-value < 0.05.

Table 9: *Unit Root Tests (1st differences)*

	1st Differences					
	dspread	***dgov_debt***	***dreserves***	***dtot_vol***	***dur***	***dvix_index***
Levin, Lin & Chu t*	0,0000	0,9729	0,0108	0,0000	0,0000	—
	-11,178	1,92568	-2,29684	-16,4842	-4,29546	—
Im, Pesaran & Shin W-stat	0,0000	0,0001	0,0000	0,0000	0,0000	—
	-9,44106	-3,61982	-5,80777	-14,1440	-5,94404	—
ADF - Fisher Chi-square	0,0000	0,0007	0,0000	0,0000	0,0000	—
	176,828	85,5407	119,468	349,697	118,346	—
PP - Fisher Chi-square	0,0000	0,0000	0,0000	0,0000	0,0000	—
	200,904	119,019	259,031	877,037	129,325	—
Hadri Z-stat	0,2508	0,0043	0,0000	0,0000	0,6562	—
	0,67192	2,62674	9,57755	10,0552	-0,40217	—
Augmented Dickey-Fuller test	—	—	—	—	—	0,0398
	—	—	—	—	—	-3,14804

Notes: Table 9 presents the results of the unit root tests on the 1st differences of the variables. The first number of each cell is the p-value and the red numbers are the statistic value of each cell. In the Hadri Z-stat test the null hypothesis is rejected for the Debt-to-GDP ratio, foreign exchange reserves, and volatility of terms of trade since the p-value < 0.05 and that means the panel data are stationary. In Levin, Lin & Chu t* test, the null hypothesis is rejected for every variable except the Debt-to-GDP ratio. In Im, Pesaran & Shin W-stat test, ADF - Fisher Chi-square test, and PP - Fisher Chi-square test the null hypothesis is rejected for every variable. For the ADF test, the null hypothesis is rejected, since the p-value < 0.05.

6. Results

This section presents the results of the panel data regression analysis. A sample of 24 countries over a period of 21 years is used for this analysis. In the beginning, the results of regressions using the full sample of data are listed.

6.1. Full Sample Analysis

Table 10 shows the results of the pooled OLS model. As it's showed in the table, the unemployment rate and foreign exchange reserves are statistically significant, because the $p - valu$ is smaller than 0.05. The coefficient for the unemployment rate is positive and 0.2188 and the coefficient of the foreign exchange reserves is very small, but negative, as expected. This means that if the unemployment rate increases by 1%, the government bond yield spread, and therefore the sovereign risk, will increase by 0.21 percentage points.

Table 11 presents the results from the fixed effects model with country effects (or cross-sectional). The $p - value$ is smaller than 0.05 for the Debt-to-GDP ratio, foreign exchange reserves, and the unemployment rate which means that the coefficients of these variables are statistically significant. As it was expected, the coefficients of the Debt-to-GDP ratio and the unemployment rate are positive, 0.01 and 0.21 respectively. Although the coefficient of the foreign exchange reserves is very small and near zero, it is positive. Table 12 shows the results of the Redundant Fixed Effects Tests. This test is provided by EViews and tests whether is better to use the Pooled OLS Model or the Fixed Effects Model. When the $p - value$ is smaller than 0.05, then the best model to use is the Fixed Effects Model. In this study, $p - value = 0 < 0.05$, and that means that the null hypothesis is rejected and the best model to use is the fixed effects model.

Table 13 reports the results of the Random Effects Model. The $p - values$ of the coefficients of the unemployment rate, the Debt-to-GDP ratio, and the foreign exchange reserves are smaller than the level of significance of 5%. That means that these coefficients are statistically significant. The coefficients of the Debt-to-GDP ratio and unemployment rate are positive as it was expected. A change by 1% in the unemployment rate increases the spread by approximately 0.22 percentage points. Furthermore, an increase of 1% in the Debt-to-GDP ratio increases the spread by approximately 0.01%. However, the coefficient of the foreign exchange reserves is positive but very close to zero. Table 14 shows the results from the Hausman Test. This test compares the fixed effects and the random effects model and selects which model is better to use. When the $p - value$ is smaller than the 5% level, then the most appropriate model to use is the fixed effects model. The results of this analysis showed that $p - value = 1.000$, which is greater than 0.05, and that means that the null hypothesis cannot be rejected and the most appropriate model to use is the Random Effects Model.[18]

In conclusion, all three regressions showed that the coefficient of the unemployment rate is statistically and economically significant and equals approximately 0.21. Fixed effects and random effects models showed that the Debt-to-GDP ratio coefficient is statistically and economically significant and equals approximately 0.01. The coefficient of the foreign exchange reserves is almost 0 in every regression. Between the pooled OLS model and the fixed effects model, the most appropriate to use is the fixed effects model, and between the fixed effects model and the random effects model, the most appropriate to use is the random effects model.

Table 10: *Pooled OLS Model (full sample)*

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	0,278407	0,361374	0,770414	0,4414
gov_debt	-0,001624	0,002214	-0,73342	0,4636
reserves	-1,19E-12	4,41E-13	-2,70185	0,0071
tot_vol	0,001536	0,002176	0,70576	0,4807
ur	0,218834	0,016425	13,32362	0
vix_index	-0,022493	0,014007	-1,60584	0,1089
Root MSE	1,976933	R-squared		0,308066
Mean dependent var	1,483686	Adjusted R-squared		0,301119
S.D. dependent var	2,378981	S.E. of regression		1,988806
Akaike info criterion	4,22478	Sum squared resid		1969,765
Schwarz criterion	4,275048	Log-likelihood		-1058,64
Hannan-Quinn criter.	4,244498	F-statistic		44,34443
Durbin-Watson stat	0,289934	Prob(F-statistic)		0

Notes: This table shows the results of the pooled OLS model. As it's showed in the table, the unemployment rate and foreign exchange reserves are statistically significant because the p-value is smaller than 0.05. The coefficient for the unemployment rate is positive and 0.2188 and the coefficient of the foreign exchange reserves is very small, but negative, as expected. This means that if the unemployment rate increases by 1%, the government bond yield spread, and therefore the sovereign risk, will increase by 0.21 percentage points. The sample consists of annual data from 24 countries over the time of 21 years (2000-2020).

[18] A $p - value = 1$ indicates that there is no evidence that the random effects model estimates are invalid. The fixed effects estimates are valid under both the null and the alternative.

Table 11: *Fixed Effects Model (full sample)*

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-1,079986	0,314506	-3,43391	0,0006
gov_debt	0,011185	0,003066	3,647554	0,0003
reserves	2,18E-12	6,63E-13	3,293677	0,0011
tot_vol	-0,002282	0,001778	-1,28338	0,2
ur	0,213251	0,021322	10,00145	0
vix_index	-0,010956	0,009143	-1,19837	0,2314
		Effects Specification		
Cross-section fixed (dummy variables)				
Root MSE	1,248271	R-squared		0,724134
Mean dependent var	1,483686	Adjusted R-squared		0,707872
S.D. dependent var	2,378981	S.E. of regression		1,285811
Akaike info criterion	3,396475	Sum squared resid		785,3228
Schwarz criterion	3,639441	Log-likelihood		-826,912
Hannan-Quinn criter.	3,491782	F-statistic		44,53035
Durbin-Watson stat	0,735694	Prob(F-statistic)		0

Notes: This table presents the results from the fixed effects model with country effects (or cross-sectional). The p-value is smaller than 0.05 for the Debt-to-GDP ratio, foreign exchange reserves, and the unemployment rate which means that the coefficients of these variables are statistically significant. As it was expected, the coefficients of the Debt-to-GDP ratio and the unemployment rate are positive, 0.01 and 0.21 respectively. Although the coefficient of the foreign exchange reserves is very small and near zero, it is positive. The sample consists of annual data from 24 countries over the time of 21 years (2000-2020).

Table 12: *Redundant Fixed Effects Test (full sample)*

Effects Test	***Statistic***	***d.f.***	***Prob.***
Cross-section F	31,148085	(23, 475)	0
Cross-section Chi-square	463,46558	23	0

Notes: This test compares the Pooled OLS model and the fixed effects model and tests if it's which one better to use. When the p-value is smaller than 0.05, then the fixed effects model is better. In this case, p-value = 0 and that means that the most appropriate model to use is the fixed effects model.

Table 13: *Random Effects Model (full sample)*

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-0,925548	0,447009	-2,07054	0,0389
gov_debt	0,009464	0,002905	3,25747	0,0012
reserves	1,64E-12	6,21E-13	2,643789	0,0085
tot_vol	-0,002097	0,001762	-1,19014	0,2346
ur	0,218809	0,020316	10,77018	0
vix_index	-0,012474	0,009131	-1,366	0,1726
	Effects Specification			
			S.D.	Rho
Cross-section random			1,5894	0,6044
Idiosyncratic random			1,285811	0,3956
	Weighted Statistics			
Root MSE	1,2877	R-squared		0,268877
Mean dependent var	0,257936	Adjusted R-squared		0,261536
S.D. dependent var	1,507477	S.E. of regression		1,295434
Sum squared resid	835,7185	F-statistic		36,62876
Durbin-Watson stat	0,688266	Prob(F-statistic)		0
	Unweighted Statistics			
R-squared	0,164075	Mean dependent var		1,483686
Sum squared resid	2379,674	Durbin-Watson stat		0,241713

Notes: This table reports the results of the Random Effects Model. The p-values of the coefficients of the unemployment rate, the Debt-to-GDP ratio, and the foreign exchange reserves are smaller than the level of significance of 5%. That means that these coefficients are statistically significant. The coefficients of the Debt-to-GDP ratio and unemployment rate are positive as it was expected. A change by 1% in the unemployment rate increases the spread by approximately 0.22 percentage points. Furthermore, an increase of 1% in the Debt-to-GDP ratio increases the spread by approximately 0.01%. However, the coefficient of the foreign exchange reserves is positive but very close to zero. The sample consists of annual data from 24 countries over the time of 21 years (2000-2020).

Table 14: *Hausman Test (full sample)*

Test Summary		**Chi-Sq. Statistic**	**Chi-Sq. d.f.**	**Prob.**
Cross-section random		0	5	1
* Cross-section test variance is invalid. Hausman statistic set to zero.				
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var (Diff.)**	**Prob.**
gov_debt	0,00948	0,008093	0,000002	0,2956
reserves	0	0	0	0,0086
tot	0,009518	0,006685	0,000009	0,3514
ur	0,208209	0,216393	0,000054	0,2635
vix_index	-0,011512	-0,013191	0	0,0004

Notes: This table shows the results from the Hausman Test. This test compares the fixed effects and the random effects model and selects which model is better to use. When the p-value is smaller than the 5% level, then the most appropriate model to use is the fixed effects model. The results of this analysis showed that p-value=1.000, which is greater than 0.05, and that means that the null hypothesis cannot be rejected and the most appropriate model to use is the Random Effects Model.

6.2. EMU & non-EMU Members

In this section, the sample is separated into two parts. One consists of countries that are members of the Economic and Monetary Union and the other one consists of countries that are not members of the EMU. The same econometric tests are performed, as those in the previous section for both EMU and non-EMU members. Table 15 reports the descriptive statistics of the levels of the dependent and the independent variables.

Table 15: *Descriptive Statistics (EMU & non-EMU members)*

			EMU Members			
	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	1,101424	82,94835	2,08E+10	11,35258	9,768485	19,95143
Median	0,372749	76,70692	1,10E+10	7,787902	8,48	17,54
Maximum	21,00237	252,2862	7,61E+10	73,90132	27,69	32,69
Minimum	-4,095667	26,99303	3,44E+08	0,128976	3,14	11,09
Std. Dev.	2,259776	39,76239	2,06E+10	12,85141	4,867543	6,360579
Skewness	4,62602	1,014573	0,960574	2,444439	1,496396	0,555159
Kurtosis	33,14573	4,444243	2,508744	10,06456	5,252028	2,083108
Jarque-Bera	9570,767	59,70651	37,84686	710,4136	135,0237	19,9574
Probability	0	0	0	0	0	0,000046
Sum	254,4289	19161,07	4,80E+12	2622,445	2256,52	4608,78
Sum Sq. Dev.	1174,515	363641	9,74E+22	37986,53	5449,385	9305,103
Observations	231	231	231	231	231	231
			non-EMU Members			
	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	1,807138	64,83707	1,48E+11	21,70209	7,374615	19,95143
Median	1,401857	48,89941	4,77E+10	8,418746	5,43	17,54
Maximum	10,58602	216,2789	1,34E+12	715,5708	33,29	32,69
Minimum	-3,520413	16,30735	3,38E+08	0,022728	2,25	11,09
Std. Dev.	2,432865	44,76485	2,86E+11	54,3753	5,978411	6,358453
Skewness	0,851884	1,353293	2,89766	8,934699	2,531021	0,555159
Kurtosis	3,950319	4,146336	10,35356	103,6028	8,89603	2,083108
Jarque-Bera	43,29249	98,27651	997,1392	118757,8	686,9072	23,58601
Probability	0	0	0	0	0	0,000008
Sum	493,3488	17700,52	4,05E+13	5924,671	2013,27	5446,74
Sum Sq. Dev.	1609,923	545058,5	2,23E+25	804215,2	9721,66	10996,94
Observations	273	273	273	273	273	273

Notes: This table presents the descriptive statistics of the endogenous and exogenous variables of the EMU members and non-EMU members groups. The first group consists of 11 countries and the second group consists of 13 countries. Each sample covers a period of 21 years (2000-2020).

Initially, a pooled OLS model regression is performed. Table 16 shows the results of this model. The first panel shows the results for the EMU member countries and the second panel shows the results for the non-EMU member countries. The coefficients of foreign exchange reserves, and the unemployment rate are statistically significant, in both cases, since the $p - value < 0.05$. The effect of all three variables on the spread is what was expected (positive for the unemployment rate, and negative for the foreign exchange reserves). A 1% change in the unemployment rate, will increase the spreads by 0.23 percentage points, in the sample of the EMU members, and by 0.21 percentage points in the sample of the non-EMU members. The effect of the foreign exchange reserves on the spreads is almost zero for both samples. Although the coefficient of the debt-to-GDP ratio is statistically significant in both samples, it's positive in the first one and negative in the second. The VIX Index is statistically significant in the second sample. However, the effect on the spreads is negative and it's different from what was expected.

Table 17 presents the results of the regression of the fixed effects model with country effects. The first panel contains the results for the group of EMU member countries and the second panel shows the results for the group of EMU member countries. For the EMU members group the coefficient of the unemployment rate is the only one that is statistically significant because the $p - value < 0.05$. The coefficient equals approximately 0.33. That means that if the unemployment rate increases by one percent, the spread, and therefore the sovereign risk will rise by 0.33 percentage points. In the second group of countries, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the VIX Index are statistically significant. However, only the coefficient of the debt-to-GDP ratio seems to have the effect on the spread that was expected. For instance, a 1% change in the debt-to-GDP ratio will increase the spread by approximately 0.01. The coefficient of the foreign exchange reserves is close to zero, but positive, and the coefficient of the VIX Index is negative. Table 18 shows the results of the Redundant Fixed Effects Tests for both groups of countries. The null hypothesis is rejected in both groups since the $p - value < 0.05$. That means that between the pooled OLS model and the fixed effects model, the most appropriate to use is the fixed effects model.

Table 19 reports the results of the random effects model for the two groups. In the first group, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the unemployment rate appear to be statistically significant, since the $p - value$ is smaller than the significance level of

5%. Furthermore, these coefficients have the effect on the spreads that was expected. This means that a 1% change in the debt-to-GDP ratio will increase the sovereign risk by approximately 0.01 percentage points. Furthermore, if the unemployment rate increases by 1%, then the spreads will increase by approximately 0.28 percentage points. The coefficient of the foreign exchange reserves is negative but close to zero. In the second group, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the VIX Index seem to be statistically significant, because the $p - value < 0.05$. However, only the coefficient of the debt-to-GDP ratio has the effect that was expected. The coefficient of the foreign exchange reserves is close to zero but positive, and the coefficient of the VIX Index is negative. Table 20 shows the results of the Hausman Test. In the group of EMU-member countries, the $p - value$ is smaller than the 5% significance level, which means that the null hypothesis is rejected and the most appropriate model to use is the fixed effects model. For the non-EMU members, the Hausman test showed a $p - value$ equals to 1. In this case, the most appropriate model to use is the random effects model.

In conclusion, in this section, the sample was categorized into two groups: the EMU member countries and the non-EMU member countries. The analysis showed that for the EMU members group, the most appropriate model to use is the fixed effects model with country effects. The coefficient of the unemployment rate is statistically significant, positive, and equal to approximately 0.34. For the non-EMU members' group, the analysis showed that between pooled OLS model and the fixed effects model, the most appropriate to use is the fixed effects model and between this model and the random effects model the most appropriate is the random effects model. In both models, the coefficients that are statistically significant are those of the foreign exchange reserves and the VIX Index. In both cases, the coefficient of the foreign exchange reserves is positive but very close to zero, and the coefficient of the VIX Index is negative and different from what was expected. The unemployment rate has no effect on the spread in this group of countries, in contrast to the other group.

Table 16: *Pooled OLS (EMU & non-EMU members)*

EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-2,195181	0,493015	-4,45257	0
gov_debt	0,015406	0,003057	5,038994	0
reserves	-2,01E-11	5,49E-12	-3,66452	0,0003
tot_vol	-0,006732	0,009161	-0,73487	0,4632
ur	0,239825	0,024577	9,758158	0
vix_index	0,008557	0,017147	0,499018	0,6183

Root MSE	1,617487	R-squared	0,485441
Mean dependent var	1,101424	Adjusted R-squared	0,474006
S.D. dependent var	2,259776	S.E. of regression	1,638912
Akaike info criterion	3,851573	Sum squared resid	604,3572
Schwarz criterion	3,940986	Log-likelihood	-438,857
Hannan-Quinn criter.	3,887636	F-statistic	42,45351
Durbin-Watson stat	0,761426	Prob(F-statistic)	0

non-EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	2,164533	0,507798	4,262588	0
gov_debt	-0,008633	0,003279	-2,63279	0,0091
reserves	-1,56E-12	5,08E-13	-3,06409	0,0025
tot_vol	-0,000387	0,00224	-0,17274	0,863
ur	0,215448	0,02119	10,16725	0
vix_index	-0,057274	0,020967	-2,73165	0,0069

Root MSE	1,893745	R-squared	0,468047
Mean dependent var	1,68652	Adjusted R-squared	0,455009
S.D. dependent var	2,602683	S.E. of regression	1,921392
Akaike info criterion	4,172132	Sum squared resid	753,1165
Schwarz criterion	4,267764	Log-likelihood	-432,074
Hannan-Quinn criter.	4,210793	F-statistic	35,89847
Durbin-Watson stat	0,100954	Prob(F-statistic)	0

Notes: This table presents the results of the pooled OLS model. The first panel shows the results for the EMU member countries and the second panel shows the results for the non-EMU member countries. The coefficients of foreign exchange reserves, and the unemployment rate are statistically significant, in both cases, since the p-value < 0.05. The effect of all three variables on the spread is what was expected (positive for the unemployment rate, and negative for the foreign exchange reserves). The effect of the foreign exchange reserves on the spreads is almost zero for both samples. Although the coefficient of the debt-to-GDP ratio is statistically significant in both samples, it's positive in the first one and negative in the second. The VIX Index is statistically significant in the second sample. However, the effect on the spreads is negative and it's different from what was expected. The group of EMU members consists of 11 countries and the group of the EMU member countries consists of 13 countries. The sample covers a period of 21 years (2000-2020).

Table 17: *Fixed Effects Model (EMU & non-EMU members)*

EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-2,300495	0,573502	-4,01131	0,0001
gov_debt	0,00582	0,00645	0,90234	0,3679
reserves	-1,40E-11	1,37E-11	-1,01984	0,309
tot_vol	-0,027114	0,014018	-1,93423	0,0544
ur	0,337945	0,035206	9,599038	0
vix_index	0,010867	0,016225	0,669769	0,5037
	Effects Specification			
Cross-section fixed (dummy variables)				
Root MSE	1,476446	R-squared		0,571265
Mean dependent var	1,101424	Adjusted R-squared		0,541354
S.D. dependent var	2,259776	S.E. of regression		1,530398
Akaike info criterion	3,755681	Sum squared resid		503,5552
Schwarz criterion	3,994117	Log-likelihood		-417,781
Hannan-Quinn criter.	3,85185	F-statistic		19,09837
Durbin-Watson stat	0,899188	Prob(F-statistic)		0

non-EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	0,844285	0,282741	2,986078	0,0031
gov_debt	0,015073	0,002794	5,394108	0
reserves	1,78E-12	4,42E-13	4,021389	0,0001
tot_vol	-0,001075	0,001157	-0,92909	0,3537
ur	0,01441	0,022632	0,636702	0,5249
vix_index	-0,018107	0,008008	-2,26112	0,0246
	Effects Specification			
Cross-section fixed (dummy variables)				
Root MSE	0,797956	R-squared		0,892027
Mean dependent var	1,807138	Adjusted R-squared		0,884829
S.D. dependent var	2,432865	S.E. of regression		0,825639
Akaike info criterion	2,518342	Sum squared resid		173,8285
Schwarz criterion	2,75633	Log-likelihood		-325,754
Hannan-Quinn criter.	2,613875	F-statistic		123,9234
Durbin-Watson stat	0,520285	Prob(F-statistic)		0

Notes: The first panel contains the results for the group of the EMU member countries and the second panel shows the results for the group of the non-EMU member countries. For the EMU members group the coefficient of the unemployment rate is the only one that is statistically significant because the p-value<0.05. The coefficient equals approximately 0.23. That means that if the unemployment rate increases by one percent, the spread, and therefore the sovereign risk will rise by 0.23 percentage points. In the second group of countries, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the VIX Index are statistically significant. Only the coefficient of the debt-to-GDP ratio seems to have the effect on the spread that was expected. The group of EMU members consists of 11 countries and the group of non-EMU member countries consists of 13 countries. The sample covers a period of 21 years (2000-2020).

Table 18: *Redundant Fixed Effects Tests (EMU & non-EMU members)*

EMU Members

Effects Test	Statistic	d.f.	Prob.
Cross-section F	4,303884	(10, 215)	0
Cross-section Chi-square	42,151053	10	0

non-EMU Members

Effects Test	Statistic	d.f.	Prob.
Cross-section F	95,420674	(12, 255)	0
Cross-section Chi-square	464,918541	12	0

Notes: This table shows the results of the Redundant Fixed Effects Tests for both groups of countries. The null hypothesis is rejected in both groups since the p-value < 0.05. That means that between the pooled OLS model and the fixed effects model, the most appropriate to use is the fixed effects model.

Table 19: *Random Effects Model (EMU & non-EMU Members)*

EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-2,278075	0,526745	-4,32482	0
gov_debt	0,012946	0,003919	3,303678	0,0011
reserves	-2,16E-11	7,26E-12	-2,97283	0,0033
tot_vol	-0,017852	0,010747	-1,66102	0,0981
ur	0,281444	0,027885	10,09308	0
vix_index	0,010393	0,016084	0,646148	0,5188
		Effects Specification		
			S.D.	Rho
Cross-section random			0,423726	0,0712
Idiosyncratic random			1,530398	0,9288
		Weighted Statistics		
Root MSE	1,546359	R-squared		0,436197
Mean dependent var	0,681786	Adjusted R-squared		0,423669
S.D. dependent var	2,063901	S.E. of regression		1,566841
Sum squared resid	552,3732	F-statistic		34,81518
Durbin-Watson stat	0,827249	Prob(F-statistic)		0
		Unweighted Statistics		
R-squared	0,47587	Mean dependent var		1,101424
Sum squared resid	615,5988	Durbin-Watson stat		0,742286

non-EMU Members

Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	0,874232	0,581179	1,504239	0,1337
gov_debt	0,013647	0,002747	4,967969	0
reserves	1,57E-12	4,35E-13	3,617652	0,0004
tot_vol	-0,001111	0,001154	-0,96241	0,3367
ur	0,031155	0,021978	1,417518	0,1575
vix_index	-0,019595	0,008001	-2,44904	0,015
	Effects Specification			
			S.D.	Rho
Cross-section random			1,83718	0,832
Idiosyncratic random			0,825639	0,168
	Weighted Statistics			
Root MSE	0,842092	R-squared		0,207796
Mean dependent var	0,176377	Adjusted R-squared		0,19296
S.D. dependent var	0,947846	S.E. of regression		0,851501
Sum squared resid	193,5895	F-statistic		14,00684
Durbin-Watson stat	0,470071	Prob(F-statistic)		0
	Unweighted Statistics			
R-squared	-0,339316	Mean dependent var		1,807138
Sum squared resid	2156,195	Durbin-Watson stat		0,042204

Notes: This table reports the results of the random effects model for the two groups. In the first group, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the unemployment rate appear to be statistically significant, since the p-value is smaller than the significance level of 5%. Furthermore, these coefficients have the effect on the spreads that was expected. In the second group, the coefficients of the debt-to-GDP ratio, foreign exchange reserves, and the VIX Index seem to be statistically significant, because the p-value < 0.05. However, only the coefficient of the debt-to-GDP ratio has the effect that was expected. The group of EMU members consists of 11 countries and the group of non-EMU member countries consists of 13 countries. The sample covers a period of 21 years (2000-2020).

Table 20: *Hausman Test (EMU & non-EMU Members)*

	EMU Members			
Test Summary		***Chi-Sq. Statistic***	***Chi-Sq. d.f.***	***Prob.***
Cross-section random		14,843556	5	0,0111
Cross-section random effects test comparisons:				
Variable	***Fixed***	***Random***	***Var (Diff.)***	***Prob.***
gov_debt	0,00582	0,012946	0,000026	0,1642
reserves	0	0	0	0,5162
tot_vol	-0,027114	-0,017852	0,000081	0,3034
ur	0,337945	0,281444	0,000462	0,0086
vix_index	0,010867	0,010393	0,000005	0,824

	non-EMU Members			
Test Summary		***Chi-Sq. Statistic***	***Chi-Sq. d.f.***	***Prob.***
Cross-section random		0	5	1
* Cross-section test variance is invalid. Hausman statistic set to zero.				
Cross-section random effects test comparisons:				
Variable	***Fixed***	***Random***	***Var (Diff.)***	***Prob.***
gov_debt	0,015073	0,013647	0	0,0054
reserves	0	0	0	0,0108
tot_vol	-0,001075	-0,001111	0	0,6682
ur	0,01441	0,031155	0,000029	0,0019
vix_index	-0,018107	-0,019595	0	0

Notes: This table shows the results of the Hausman Test. In the group of EMU-member countries, the p-value is smaller than the 5% significance level, which means that the null hypothesis is rejected and the most appropriate model to use is the fixed effects model. For the non-EMU members, the Hausman test showed a p-value equal to 1. In this case, the most appropriate model to use is the random effects model.

6.3. Pre, during & post-crisis

In this section, the sample is divided into 3 time periods. The first period consists of 7 years, from 2000 to 2006, and is the pre-crisis period. The second one covers a time period of 3 years, from 2007 to 2009. These years the period of extreme stress in global financial markets and banking systems between mid-2007 and early 2009. The last period is defined as the post-crisis period and covers a time period of 11 years, from 2010 to 2020. The steps of the analysis are the same as in the previous sections. Table 21 presents the descriptive statistics of the variables of these three groups in levels.

Table 21: *Descriptive Statistics (pre, during & post- crisis)*

pre-crisis (200-2006)

	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	0,901359	57,98872	4,93E+10	17,45786	8,35494	19,92
Median	0,282375	53,71289	1,97E+10	9,021003	6,465	21,98
Maximum	8,522708	128,603	8,80E+11	324,4342	33,29	27,29
Minimum	-3,520413	18,40035	3,38E+08	0,022728	2,26	12,81
Std. Dev.	1,932141	29,568	1,31E+11	35,21756	6,070918	5,685496
Skewness	1,237656	0,845632	5,145219	6,149599	2,260497	-0,125381
Kurtosis	5,394961	2,813242	29,65913	46,22696	8,336922	1,349971
Jarque-Bera	83,04107	20,26678	5716,215	14138,88	342,4548	19,49834
Probability	0	0,00004	0	0	0	0,000058
Sum	151,4283	9742,105	8,27E+12	2932,921	1403,63	3346,56
Sum Sq. Dev.	623,439	146002,6	2,84E+24	207126,2	6154,959	5398,253
Observations	168	168	168	168	168	168

during-crisis (2007-2009)

	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	0,948485	62,33826	7,27E+10	18,89223	7,57875	27,23667
Median	0,474424	47,64409	3,01E+10	8,72113	7,17	31,48
Maximum	5,901116	156,9884	1,02E+12	228,558	26,54	32,69
Minimum	-2,551455	16,30735	3,44E+08	0,701474	2,25	17,54
Std. Dev.	1,669219	37,23855	1,96E+11	35,48989	4,042277	6,922592
Skewness	0,990421	0,812228	4,448108	4,468557	2,389739	-0,690712
Kurtosis	4,341929	2,681318	21,26795	24,3207	10,37759	1,5
Jarque-Bera	17,17351	8,221254	1238,582	1603,333	231,8168	12,47499
Probability	0,000187	0,016397	0	0	0	0,001955
Sum	68,29094	4488,354	5,24E+12	1360,241	545,67	1961,04
Sum Sq. Dev.	197,8268	98456,38	2,72E+24	89426,79	1160,14	3402,482
Observations	72	72	72	72	72	72

post-crisis (2010-2020)						
	spread	***gov_debt***	***reserves***	***tot_vol***	***ur***	***vix_index***
Mean	2,000221	85,72398	1,21E+11	16,11346	8,789735	17,98455
Median	1,216242	82,39197	4,64E+10	7,420333	6,99	16,64
Maximum	21,00237	252,2862	1,34E+12	715,5708	27,69	29,25
Minimum	-4,095667	18,67812	7,19E+08	0,032471	2,35	11,09
Std. Dev.	2,67182	48,41639	2,64E+11	46,08438	5,680527	5,031629
Skewness	2,494188	0,835336	3,499677	13,38008	1,613836	0,930935
Kurtosis	13,62558	3,111858	14,3907	202,6244	4,902046	2,968863
Jarque-Bera	1515,656	30,84025	1966,13	446226	154,3922	38,14283
Probability	0	0	0	0	0	0
Sum	528,0584	22631,13	3,18E+13	4253,954	2320,49	4747,92
Sum Sq. Dev.	1877,457	616510,7	1,83E+25	558551,5	8486,586	6658,447
Observations	264	264	264	264	264	264

Notes: This table presents the descriptive statistics (in levels) of the variables of the three groups. The first period consists of 7 years, from 2000 to 2006, and is the pre-crisis period. The second one covers a time period of 3 years, from 2007 to 2009. These years the period of extreme stress in global financial markets and banking systems between mid-2007 and early 2009. The last period is defined as the post-crisis period and covers a time period of 11 years, from 2010 to 2020. Each sample consists of 24 countries.

Table 22 presents the results of the pooled OLS regression. The first part shows the results of the pre-crisis period. The coefficients of the debt-to-GDP ratio, foreign exchange reserves, and unemployment rate are statistically significant because the $p-value$ is smaller than 5%. The coefficient of the unemployment rate equals approximately 0.14 which indicates that a 1% change in the unemployment rate will increase the spread and therefore the sovereign risk by 0.14 percentage points. The coefficient of the foreign exchange reserves is positive but is close to zero. The coefficient of the debt-to-GDP ratio is negative and not what was expected based on the theory. In the second part, the results of the during-crisis period are presented. In the second part, the coefficients of the foreign exchange reserves, and the unemployment rate are statistically significant at the 5% significance level since the $p-value < 0.05$. Both coefficients affect the spreads in the way it was expected. A 1% change in the unemployment rate will increase the spread and therefore the sovereign risk by 0.14 percentage points. However, the coefficient of the foreign exchange reserves is still close to zero and that means that the effect on the sovereign risk is negligible. The third part shows the results of the post-crisis period. Only the coefficient of the unemployment rate is statistically significant and it equals 0.26. That means that the effect of the unemployment rate on the sovereign risk is higher than in the post and during-crisis periods.

Table 23 reports the results of the fixed effects model with country effects. The first part shows the results of the pre-crisis period. The only coefficient that is statistically significant is the coefficient of the foreign exchange reserves which is negative but very close to zero. The second part shows the results of the regression of the during-crisis period. The coefficient of the VIX Index is statistically significant and equals approximately 0.02. This means that a 1 % change in the VIX Index, will increase the spread by 0.02 percentage points. The third part shows the results of the post-crisis period. The coefficients of the debt-to-GDP ratio, and the unemployment rate are statistically significant since the p-value is smaller than 0.05. However, only the coefficient of the unemployment rate has the effect on spreads that was expected. This means that a 1% change in the unemployment rate will increase the spread by approximately 0.27 percentage points. Table 24 presents the results of the redundant fixed effects tests for the three periods. The null hypothesis is rejected in every period because the $p - value < 0.05$. This means that the more appropriate model to use is the fixed effects model.

Table 25 shows the results of the random effects model. The first part presents the results of the pre-crisis period. The coefficients of the foreign exchange reserves and the unemployment rate are statistically significant, but only the coefficient of the unemployment rate has the expected effect on spreads and it's approximately 0.11. This means that if the unemployment rate increases by 1% the spreads will increase by 0.11 percentage points. The coefficient of the foreign exchange reserves is close to zero. The second part shows the results of the during-crisis period. The coefficients of the unemployment rate and the VIX Index are statistically significant since the $p - value < 0.05$ and affect the spread the way it was expected. The unemployment rate coefficient equals approximately 0.08, while the VIX Index coefficient equals approximately 0.03. The third part shows the results of the post-crisis period. The coefficients of the debt-to-GDP ratio and the unemployment rate are statistically and economically significant. However, the coefficient of the unemployment rate is negative and different from what was expected. The coefficient of the unemployment rate is 0.27. Table 26 presents the results of the Hausman test. The null hypothesis is rejected in the first and the second part. That means that in the pre-and during-crisis period group the most appropriate model to use is the fixed effects model. In the third part, the null hypothesis cannot be rejected since the $p - value$ is greater than 5%. This means that the most appropriate model to use in this case is the random effects model.

In conclusion, in this section, the sample was separated into three time-period groups: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020). For the first group, the analysis showed that the most appropriate model to use is the fixed effects model with country effects. This regression showed that only the coefficient of the foreign exchange reserves is statistically significant but very close to zero. For the second group, the analysis showed that between pooled OLS and the fixed effects model, the most appropriate to use is the fixed effects model, and between this model and the random effects model is the random effects model. In both cases, the coefficient of the VIX Index is statistically and economically significant. Furthermore, in the random effects model, the coefficient of the unemployment rate is statistically significant and equal to approximately 0.08. For the third group, the analysis showed that between pooled OLS and the fixed effects model, the most appropriate to use is the fixed effects model, and between this model and the random effects model is the random effects model. In both models, the coefficients of the unemployment rate and the debt-to-GDP ratio are statistically significant. However, the coefficient of the debt-to-GDP ratio is negative and different from what was expected. The coefficient of the unemployment rate equals approximately 0.27 in both cases.

Table 22: *Pooled OLS model (pre, during & post-crisis)*

	pre-crisis (2000-2006)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	0,893362	0,513206	1,740746	0,0836
gov_debt	-0,02002	0,004224	-4,73938	0
reserves	-2,55E-12	9,62E-13	-2,64526	0,009
tot_vol	0,001925	0,003293	0,584702	0,5596
ur	0,147647	0,019308	7,646811	0
vix_index	0,00136	0,020226	0,067255	0,9465
Root MSE	1,454914	R-squared		0,429586
Mean dependent var	0,901359	Adjusted R-squared		0,411981
S.D. dependent var	1,932141	S.E. of regression		1,481612
Akaike info criterion	3,659199	Sum squared resid		355,6182
Schwarz criterion	3,77077	Log-likelihood		-301,373
Hannan-Quinn criter.	3,70448	F-statistic		24,40086
Durbin-Watson stat	0,145339	Prob(F-statistic)		0

	during-crisis (2007-2009)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
c	-0,477011	0,774481	-0,61591	0,5401
gov_debt	-0,00911	0,005222	-1,74439	0,0857
reserves	-2,05E-12	9,61E-13	-2,13045	0,0369
tot_vol	0,006173	0,004947	1,247864	0,2165
ur	0,149004	0,04278	3,483052	0,0009
vix_index	0,03291	0,024564	1,339747	0,1849
Root MSE	1,355034	R-squared		0,331737
Mean dependent var	0,948485	Adjusted R-squared		0,281111
S.D. dependent var	1,669219	S.E. of regression		1,415286
Akaike info criterion	3,612196	Sum squared resid		132,2004
Schwarz criterion	3,801918	Log-likelihood		-124,039
Hannan-Quinn criter.	3,687725	F-statistic		6,552703
Durbin-Watson stat	0,179451	Prob(F-statistic)		0,000053

	post-crisis (2010-2020)			
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
c	0,232757	0,579022	0,401983	0,688
gov_debt	-0,003158	0,003024	-1,04429	0,2973
reserves	-6,98E-13	5,63E-13	-1,24017	0,216
tot_vol	0,000874	0,002958	0,295569	0,7678
ur	0,268144	0,025606	10,47171	0
vix_index	-0,013831	0,026755	-0,51696	0,6056
Root MSE	2,154946	R-squared		0,34701
Mean dependent var	2,000221	Adjusted R-squared		0,334355
S.D. dependent var	2,67182	S.E. of regression		2,179859
Akaike info criterion	4,418863	Sum squared resid		1225,961
Schwarz criterion	4,500134	Log-likelihood		-577,29
Hannan-Quinn criter.	4,45152	F-statistic		27,42112
Durbin-Watson stat	0,393829	Prob(F-statistic)		0

Notes: This table presents the results of the pooled OLS regression. The first part shows the results of the pre-crisis period. The coefficients of the debt-to-GDP ratio, foreign exchange reserves, and unemployment rate are statistically significant. In the second part, the coefficients of the foreign exchange reserves, and the unemployment rate are statistically significant at the 5% significance level. The third part shows the results of the post-crisis period. Only the coefficient of the unemployment rate is statistically significant and it equals 0.26. The dataset consists of 24 countries and covers a period of 21 years (2000-2020). The sample is divided into three-time period groups: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020).

Table 23: *Fixed Effects model (pre, during & post-crisis)*

	pre-crisis (2000-2006)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-0,169776	0,565901	-0,30001	0,7646
gov_debt	0,00277	0,009586	0,288967	0,773
reserves	2,87E-12	1,22E-12	2,342842	0,0206
tot_vol	0,001209	0,00251	0,481669	0,6308
ur	0,059413	0,046813	1,269173	0,2065
vix_index	0,012639	0,008382	1,507849	0,1339
	Effects Specification			
Cross-section fixed (dummy variables)				
Root MSE	0,543285	R-squared		0,920463
Mean dependent var	0,901359	Adjusted R-squared		0,904441
S.D. dependent var	1,932141	S.E. of regression		0,597276
Akaike info criterion	1,962874	Sum squared resid		49,58671
Schwarz criterion	2,50213	Log-likelihood		-135,881
Hannan-Quinn criter.	2,18173	F-statistic		57,4502
Durbin-Watson stat	0,910368	Prob(F-statistic)		0

	during-crisis (2007-2009)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-0,723594	0,526976	-1,37311	0,1768
gov_debt	0,010932	0,010926	1,000588	0,3226
reserves	1,37E-12	5,90E-12	0,231972	0,8177
tot_vol	0,007571	0,00504	1,502412	0,1403
ur	0,013229	0,052654	0,251255	0,8028
vix_index	0,023782	0,010793	2,203412	0,033
	Effects Specification			
Cross-section fixed (dummy variables)				
Root MSE	0,389944	R-squared		0,944658
Mean dependent var	0,948485	Adjusted R-squared		0,908622
S.D. dependent var	1,669219	S.E. of regression		0,504585
Akaike info criterion	1,759927	Sum squared resid		10,94804
Schwarz criterion	2,676918	Log-likelihood		-34,3574
Hannan-Quinn criter.	2,124984	F-statistic		26,21405
Durbin-Watson stat	1,849769	Prob(F-statistic)		0

	post-crisis (2010-2020)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	1,685489	0,70383	2,39474	0,0174
gov_debt	-0,026284	0,006327	-4,15446	0
reserves	3,05E-12	1,77E-12	1,729853	0,085
tot_vol	-0,00141	0,002125	-0,6633	0,5078
ur	0,271474	0,039521	6,869102	0
vix_index	-0,009095	0,016924	-0,53741	0,5915
	Effects Specification			
Cross-section fixed (dummy variables)				
Root MSE	1,298524	R-squared		0,762899
Mean dependent var	2,000221	Adjusted R-squared		0,734648
S.D. dependent var	2,67182	S.E. of regression		1,376316
Akaike info criterion	3,580031	Sum squared resid		445,1475
Schwarz criterion	3,972843	Log-likelihood		-443,564
Hannan-Quinn criter.	3,737875	F-statistic		27,00492
Durbin-Watson stat	1,093281	Prob(F-statistic)		0

Notes: This table reports the results of the fixed effects model with country effects. The first part shows the results of the pre-crisis period. The only coefficient that is statistically significant is the coefficient of the foreign exchange reserves which is negative but very close to zero. The second part shows the results of the regression of the during-crisis period. The coefficient of the VIX Index is statistically significant and equals approximately 0.02. The third part shows the results of the post-crisis period. The coefficients of the debt-to-GDP ratio, and the unemployment rate are statistically significant since the p-value is smaller than 0.05. However, only the coefficient of the unemployment rate has the effect on spreads that was expected. The dataset consists of 24 countries and covers a period of 21 years (2000-2020). The sample is divided into three-time period groups: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020).

Table 24: *Redundant Fixed Effects Test (pre, during & post-crisis)*

Effects Test	Statistic	d.f.	Prob.
pre-crisis (2000-2006)			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	37,298195	(23,139)	0
Cross-section Chi-square	330,982659	23	0
during-crisis (2007-2009)			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	20,705907	(23,43)	0
Cross-section Chi-square	179,363384	23	0
post-crisis (2010-2020)			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	17,921868	(23,235)	0
Cross-section Chi-square	267,451654	23	0

Notes: This table presents the results of the redundant fixed effects tests for the three periods. The null hypothesis is rejected in every period because the p-value< 0.05. This means that the more appropriate model to use is the fixed effects model.

Table 25: *Random Effects model (pre, during & post-crisis)*

	pre-crisis (2000-2006)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	0,187683	0,558156	0,336255	0,7371
gov_debt	-0,010687	0,00714	-1,49668	0,1364
reserves	2,32E-12	1,10E-12	2,111019	0,0363
tot_vol	0,001684	0,002421	0,69574	0,4876
ur	0,118128	0,033786	3,496326	0,0006
vix_index	0,010184	0,00833	1,222629	0,2232
	Effects Specification			
			S.D.	Rho
Cross-section random			1,454918	0,8558
Idiosyncratic random			0,597276	0,1442
	Weighted Statistics			
Root MSE	0,602363	R-squared		0,089161
Mean dependent var	0,138204	Adjusted R-squared		0,061049
S.D. dependent var	0,633044	S.E. of regression		0,613417
Sum squared resid	60,95735	F-statistic		3,171602
Durbin-Watson stat	0,776292	Prob(F-statistic)		0,009278
	Unweighted Statistics			
R-squared	0,245411	Mean dependent var		0,901359
Sum squared resid	470,4401	Durbin-Watson stat		0,100588

	during-crisis (2007-2009)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	-0,279186	0,482641	-0,57846	0,5649
gov_debt	-0,003836	0,006701	-0,5724	0,569
reserves	-2,50E-12	1,58E-12	-1,5842	0,1179
tot_vol	0,006106	0,004384	1,392884	0,1683
ur	0,085946	0,037796	2,273947	0,0262
vix_index	0,032368	0,009493	3,409547	0,0011
	Effects Specification			
			S.D.	Rho
Cross-section random			1,417629	0,8876
Idiosyncratic random			0,504585	0,1124
	Weighted Statistics			
Root MSE	0,48294	R-squared		0,281876
Mean dependent var	0,190924	Adjusted R-squared		0,227473
S.D. dependent var	0,573892	S.E. of regression		0,504414
Sum squared resid	16,79262	F-statistic		5,181236
Durbin-Watson stat	1,34418	Prob(F-statistic)		0,000453
	Unweighted Statistics			
R-squared	0,294893	Mean dependent var		0,948485
Sum squared resid	139,4891	Durbin-Watson stat		0,161821

	post-crisis (2010-2020)			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
c	1,148259	0,697966	1,645152	0,1012
gov_debt	-0,017783	0,005123	-3,47097	0,0006
reserves	1,16E-12	1,16E-12	1,003908	0,3164
tot_vol	-0,001537	0,002106	-0,72973	0,4662
ur	0,278266	0,035253	7,893415	0
vix_index	-0,010289	0,016914	-0,6083	0,5435
	Effects Specification			
			S.D.	Rho
Cross-section random			1,816853	0,6354
Idiosyncratic random			1,376316	0,3646
	Weighted Statistics			
Root MSE	1,37116	R-squared		0,212584
Mean dependent var	0,445387	Adjusted R-squared		0,197324
S.D. dependent var	1,54814	S.E. of regression		1,387012
Sum squared resid	496,3409	F-statistic		13,93082
Durbin-Watson stat	0,973119	Prob(F-statistic)		0
	Unweighted Statistics			
R-squared	0,267637	Mean dependent var		2,000221
Sum squared resid	1374,98	Durbin-Watson stat		0,351277

Notes: This table shows the results of the random effects model. The first part presents the results of the pre-crisis period. The coefficients of the foreign exchange reserves and the unemployment rate are statistically significant, but only the coefficient of the unemployment rate has the expected effect on spreads. The second part shows the results of the during-crisis period. The coefficients of the unemployment rate and the VIX Index are statistically significant. The third part shows the results of the post-crisis period. The coefficients of the debt-to-GDP ratio and the unemployment rate are statistically and economically significant. However, the coefficient of the debt-to-GDP ratio is negative and different from what was expected.

Table 26: *Hausman Test (pre, during & post-crisis)*

		pre-crisis (2000-2006)		
Test Summary		***Chi-Sq. Statistic***	***Chi-Sq. d.f.***	***Prob.***
Cross-section random		12,873826	5	0,0246
Cross-section random effects test comparisons:				
Variable	***Fixed***	***Random***	***Var (Diff.)***	***Prob.***
gov_debt	0,00277	-0,010687	0,000041	0,0354
reserves	0	0	0	0,3095
tot_vol	0,001209	0,001684	0	0,4743
ur	0,059413	0,118128	0,00105	0,07
vix_index	0,012639	0,010184	0,000001	0,0085
		during-crisis (2007-2009)		
Test Summary		***Chi-Sq. Statistic***	***Chi-Sq. d.f.***	***Prob.***
Cross-section random		3,955418	5	0,5559
Cross-section random effects test comparisons:				
Variable	***Fixed***	***Random***	***Var(Diff.)***	***Prob.***
gov_debt	0,010932	-0,003836	0,000074	0,087
reserves	0	0	0	0,4966
tot_vol	0,007571	0,006106	0,000006	0,5556
ur	0,013229	0,085946	0,001344	0,0473
vix_index	0,023782	0,032368	0,000026	0,0945
		post-crisis (2010-2020)		
Test Summary		***Chi-Sq. Statistic***	***Chi-Sq. d.f.***	***Prob.***
Cross-section random		0	5	1
* Cross-section test variance is invalid. Hausman statistic set to zero.				
Cross-section random effects test comparisons:				
Variable	***Fixed***	***Random***	***Var (Diff.)***	***Prob.***
gov_debt	-0,026284	-0,017783	0,000014	0,022
reserves	0	0	0	0,1557
tot_vol	-0,00141	-0,001537	0	0,662
ur	0,271474	0,278266	0,000319	0,7038
vix_index	-0,009095	-0,010289	0	0,0423

Notes: This table presents the results of the Hausman test. The null hypothesis is rejected in the first and the second part. That means that in the pre-and during-crisis period group the most appropriate model to use is the fixed effects model. In the third part, the null hypothesis cannot be rejected since the p-value is greater than 5%. This means that the most appropriate model to use in this case is the random effects model. The dataset consists of 24 countries and covers a period of 21 years (2000-2020). The sample is divided into three-time period groups: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020).

7. Conclusion

This master thesis aims to analyze the determinants of sovereign risk. The term of sovereign risk describes the risk of a country failing to repay its loan obligations to its creditors. The recent financial crisis increased the interest of academics in studying sovereign risk. The first part presents a literature review of previous studies that tried to explain sovereign risk and its determinants. The next part described the variables that can measure the sovereign risk. These variables are the government bond yield spreads, the credit default swaps, and the credit ratings. The factors that can affect the sovereign risk can be local variables like the debt-to-GDP ratio, the unemployment rate, the foreign exchange reserves, and others, and global variables like the VIX Index, liquidity, and others.

In the next part of this study, a panel regression analysis is performed in order to analyze the determinants of sovereign risk. Data from 24 countries that are members of the OECD from 2000 to 2020 were used. The variable that is used as a dependent variable is the 10-year government bond spread which is calculated as the difference between a country's 10-year government bond minus Germany's 10-year government bond of the same year. Moreover, 5 indicators were used as independent variables: the debt-to-GDP ratio, the foreign exchange reserves (minus gold), the terms of trade volatility, the unemployment rate, and the VIX Index. Firstly, the descriptive statistics of each variable, and then the unit root test results in levels and first differences were presented.

The results of the panel regression analysis are showed in the last section. Initially, a pooled OLS model and then a fixed effects model with country effects was performed. Thenceforward, a redundant fixed effects test was performed in order to justify which one of the previous models is more appropriate to use. At the end, a random effects model and a Hausman test were performed in order to show if it's better to use the fixed effects or the random effects model. In the second part of the panel date regression analysis, the sample was divided into two country groups: the EMU member countries and the non-EMU member countries. The Economic and Monetary Union (EMU) was established in 1992 and consists of the coordination of economic and fiscal policies, a shared monetary policy, and the use of the euro as a single currency and represents a significant development in the integration of EU economies (European Commission, 2007). The third part of this section categorize the sample into three time periods: pre-crisis (2000-2006), during-crisis (2007-2009), and post-crisis (2010-2020).

The results of the analysis showed that there is a positive and statistically significant relationship between the unemployment rate and spreads, and therefore, the sovereign risk in the full sample dataset. The coefficient of the unemployment rate was found to be approximately 0.22 for every regression that was performed. In the second part, the results showed that there is a statistically significant effect of the unemployment rate on spread only in the EMU member countries, while only in the non-EMU members group the coefficient of the VIX Index is statistically significant but it is negative and different than was expected. In the third part, the results showed that in the pre-crisis period, only the foreign exchange reserves have a statistically significant effect on sovereign risk. However, its coefficient is very close to zero. In the during-crisis sample, only the coefficient of the VIX Index is found to have a statistically and economically significant effect on the spread and it equals approximately 0.03. Finally, in the post-crisis period, the unemployment rate has a statistically and economically significant effect on the sovereign risk and its coefficient equals approximately 0.27.

In conclusion, this study tried to examine the determinants of sovereign risk by using a dataset of 24 countries over a period of 21 years and this sample was divided into several categories. In most cases, the unemployment rate was statistically and economically significant and its coefficient was approximately 0.2 to 0.3. This means that the unemployment rate is a significant indicator of sovereign risk. Furthermore, there were cases that the foreign exchange reserves didn't have the effect on sovereign risk that was expected. However, its coefficient was very close to zero. The results could be different if the dependent variable or some of the independent variables are different than what was used in this thesis. Furthermore, the results might differ if the number of the countries or the time period is larger or smaller. Lastly, future studies on sovereign risk could study if the recent crisis of the COVID-19 pandemic changed the way that some factors affect the sovereign risk.

References

Afonso, A. et al. (2007). What "hides" behind sovereign debt ratings? *European Central Bank: Working Paper Series, 711*.

Aizenman, J., et al. (2013). Fundamentals and Sovereign Risk of Emerging Markets. *Pacific Economic Review, 21*(2), pp. 151-177.

Alesina, A., et al. (1992, October). Default Risk on Government Debt in OECD Countries. *Economic Policy*, pp. 421-463.

Amstad, M., et al. (2020). Does sovereign risk in local and foreign currency differ? *Journal of International Money and Finance, 101*(C). doi:j.jimonfin.2019.102099

Ardagna, S., et al. (2007). Fiscal Discipline and the Cost of Public Debt Service: Some Estimates for OECD Countries. *The B.E. Journal of Macroeconomics, 7*(1). doi:10.2202/1935-1690.1417

Arezki, R., et al. (2011). Sovereign Rating News and Financial Markets Spillovers: Evidence from the European Debt Crisis. *CESifo Working*(3411).

Aßmann, C., & Boysen-Hogrefe, J. (2012). Determinants of government bond spreads in the Euro Area: in good times as in bad. *Empirica, 39*(3).

Badaoui, S., et al. (2013). Do sovereign credit default swaps represent a clean measure of sovereign default risk? A factor model approach. *Journal of Banking & Finance*(37), pp. 2392–2407.

Beirne, J., & Fratzscher, M. (2013). The pricing of sovereign risk and contagion during the European sovereign debt crisis. *Journal of International Money and Finance, 34*, pp. 60-82. doi:10.1016/j.jimonfin.2012.11.004

Bernoth, K., et al. (2012). Sovereign risk premiums in the European government bond market. *Journal of International Money and Finance*(31), pp. 975-995. doi:10.1016/j.jimonfin.2011.12.006

Bi, H., & Traum, N. (2012). Estimating Sovereign Default Risk. *The American Economic Review, 3,* pp. 161-166.

Borri, N., & Verdelhan, A. (2011). Sovereign Risk Premia. *AFA 2010 Atlanta Meetings Paper*.

Breitung, J. (2001). The local power of some unit root tests for panel data. *Advances in Econometrics, 15*, pp. 161-177. doi:10.1016/S0731-9053(00)15006-6

Caner, M., et al. (2010). Finding the Tipping Point—When Sovereign Debt Turns Bad. *Policy Research Working Paper*(5391). doi:10.1596/1813-9450-5391

Cantor, R., & Packer, F. (1996). Determinants and Impact of Sovereign Credit Ratings. *Economic Policy Review, 2*(2), pp. 37-54.

Canzoneri, M., et al. (2002). Should the European Central Bank and the Federal Reserve Be Concerned about Fiscal Policy? *Presented at the Federal Reserve Bank of Kansas City's Symposium 'Rethinking Stabilization Policy'.*

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money and Finance*, pp. 249-272. doi:https://doi.org/10.1016/S0261-5606(00)00048-6

Codogno, L., et al. (2003). Yield spreads on EMU government bonds. *Economic Policy, 18*(37), pp. 503-532.

Delatte, A.-L., et al. (2014). Nonlinearities in sovereign risk pricing: the role of CDS index contracts. *NBER Working Paper*.

Dickey, D., & Fuller, W. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association, 74*(366), pp. 427-431. doi:https://doi.org/10.2307/2286348

Dickey, D., & Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica, 49*(4), pp. 1057-1072. doi:https://doi.org/10.2307/1912517

Dieckmann, S., & Plank, T. (2012). Default Risk of Advanced Economies: An Empirical Analysis of Credit Default Swaps during the Financial Crisis. *Review of Finance*(4), pp. 903-934.

Edwards, S. (1984). LDC Foreign Borrowing and Default Risk: An Empirical Investigation, 1976-80. *The American Economic Review, 74*(4), pp. 726-734.

European Commission - General Secretariat of the Council of the European Union. (2007). *Economic and monetary union – Legal and political texts.* Luxembourg: Office for Official Publications of the European Communities: European Communities.

Faini, R., et al. (2004). Fiscal Policy and Interest Rates in Europe. *Economic Policy, 21*(47).

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal*(3). doi:https://doi.org/10.1111/1368-423X.00043

Haugh, D., et al. (2009). What Drives Sovereign Risk Premiums? An analysis of recent evidence from the euro area. *OECD Economics Department Working Papers, 718*. doi:10.1787/222675756166

Hausman, J. (1978). Specification Tests in Econometrics. *Econometrica, 46*(6), pp. 1251-1271. doi:https://doi.org/10.2307/1913827

Heffernan, S. A. (1986). *Sovereign Risk Analysis (RLE Banking & Finance)* (1 ed.). London: Routledge. doi:10.4324/9780203109175

Hilscher, J., & Nosbusch , Y. (2010, April). Determinants of Sovereign Risk: Macroeconomic Fundamentals and the Pricing of Sovereign Debt. *Review of Finance, 14*(2), pp. 235–262.

Im, K., et al. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics, 155*(1), pp. 53-74. doi:https://doi.org/10.1016/S0304-4076(03)00092-7

IMF. (2010). *The uses and abuses of Sovereign Credit Ratings.*

Levin, A., et al. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *The Journal of Econometrics, 108*(1), pp. 1-24. doi:https://doi.org/10.1016/S0304-4076(01)00098-7

Longstaff, F. A., et al. (2011). How Sovereign Is Sovereign Credit Risk? *American Economic Journal: Macroeconomics, 3*(2), pp. 75-103. doi:10.1257/mac.3.2.75

Longstaff, F., et al. (2005). Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market. *The Journal of Finance, 60*(5), pp. 2213-2253.

Lonning, I. M. (2000). Default Premia on European Government Debt. *Review of World Economics, 136*, pp. 259-283.

Maddala, G. (2001). *Introduction to Econometrics* (Vol. 3rd). West Sussex, England: WIley.

Maddala, G., & Wu, S. (1999). A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin Of Economics and Statistics, 61*, pp. 631-652. doi:https://doi.org/10.1111/1468-0084.0610s1631

Maltritz, D. (2012). Determinants of sovereign yield spreads in the Eurozone: A Bayesian approach. *Journal of International Money and Finance, 31*(3), pp. 657-672.

Mankiw, G. (2020). *Principles of Macroeconomics* (9th ed.). Cengage Learning, Inc.

Matyas, L., & Sevestre, P. (1996). *The Econometrics of Panel Data - A Handbook of the Theory with Applications.* Dordrecht, The Netherlands: Kluwer Academic Publishers.

Mills, T., & Patterson, K. (2007). *Palgrave Handbook of Econometrics* (Vol. 1). New York: Palgrave Macmillan.

Mpapalika, J., & Malikane, C. (2019). Determinants of Sovereign Risk Premium in African Countries. *Journal of Risk and Financial Management, 12,* pp. 1-29.

OECD, Organisation for Economic Co-operation and Development. (2008). *The OECD.*

Ordoñez-Callamand, D., et al. (2017). Sovereign Default Risk in OECD Countries: Do Global Factors Matter? *Borradores de Economia*(996).

Pesaran, M. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics, 22*, pp. 265-312. doi: https://doi.org/10.1002/jae.951

Rodríguez, I., et al. (2018). Measuring Sovereign Risk: Are CDS Spreads Better than Sovereign Credit Ratings? *Financial Management*, pp. 229 – 256.

Said, S., & Dickey, D. (1984). Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order. *Biometrika, 71*(3), pp. 599-607. doi:https://doi.org/10.2307/2336570

Sturzenegger, F., & Zettelmeyer, J. (2007). *Debt Defaults and Lessons from a Decade of Crises.* The MIT Press.

Whaley, R. (2009). Understanding the VIX. *The Journal of Portfolio Management Spring*, *35*(3), pp. 98-105. doi:10.3905/JPM.2009.35.3.098

Wooldridge, J. (2001). *Econometric Analysis of Cross Section and Panel Data.* Cambridge, Massachusetts: The MIT Press.

Wooldridge, J. (2016). *Introductory Econometrics: A Modern Approach.* Adrian MI: South-Western Cengage Learning.