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**PREDICTION OF FINANCIAL CRISES IN  
SOUTHERN EUROPE AND IRELAND**

**Tese no âmbito do Doutoramento em Economia, orientada pelo Professor Doutor António Manuel Portugal Duarte e pelo Professor Doutor Pedro Miguel Avelino Bação e apresentada à Faculdade de Economia da Universidade de Coimbra.**

Dezembro de 2021





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DE  
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Universidade de Coimbra para obtenção do grau de Doutor

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e

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## Resumo

Com esta dissertação pretendemos analisar, no rescaldo da crise financeira internacional de 2008-2009, os fatores fundamentais que nos países do Sul da Europa e na Irlanda contribuíram para potenciar os efeitos desta crise financeira e da subsequente crise da dívida soberana da Zona Euro. Estudámos a evolução destas economias nos últimos séculos, com enfoque nos períodos de crise financeira, discutindo o contexto da arquitetura da União Económica e Monetária e as diferentes circunstâncias e as distintas políticas económicas implementadas em cada país.

Para investigar os principais determinantes das crises financeiras, e em particular dos eventos de crises bancárias, aplicámos abordagens econométricas distintas.

No capítulo 2, que dedicámos ao estudo das crises bancárias na Irlanda e Espanha, utilizámos um modelo logit binominal, e em anexo, mostrámos a tentativa de utilização de um modelo KLR.

No capítulo 3, estudamos os eventos de crises financeiras, onde incluímos crises da dívida soberana, crises cambiais, crises de inflação e crises bancárias, na Grécia e em Portugal. Neste trabalho voltou a ser aplicado o modelo logit binomial, e adicionalmente utilizamos dois modelos logit multinominais.

No capítulo 4, aplicámos uma nova técnica de machine learning chamada Support Vector Machine, com diferentes tipos de funções Kernel.

Em ambos os trabalhos usamos um conjunto de dados robustos para 69 países, entre 1960 e 2016, e um conjunto alargado de variáveis macroeconómicas relevantes: taxa de crescimento do Produto Interno Bruto (PIB); termos da troca; taxa de depreciação da taxa de câmbio; taxa de juro real; taxa de inflação; défice; crédito ao sector privado, e PIB per capita. Para estudar outros tipos de crises financeiras, que não só as crises bancárias, foram utilizadas também como variáveis explicativas a dívida pública e saldo da balança de transações correntes.

Além da componente retrospectiva da análise, em relação aos fatores que contribuíram para as crises financeiras passadas, discutimos o estado atual destas quatro economias, com atenção especial para os principais impactos da pandemia de Covid-19.

Principalmente, tentámos ajudar a responder a algumas questões: Quais são os melhores modelos para a previsão de crises financeiras? Quais são as variáveis macroeconómicas mais relevantes na previsão do despoletar de crises financeiras? É uma nova crise financeira (grave) mais provável ou menos provável de acontecer em breve do que há dez anos, quando

a crise financeira internacional abriu caminho para a crise da dívida soberana? Dada a arquitetura da Zona Euro, quais são as opções de política económica disponíveis para as autoridades nacionais que buscam reduzir a probabilidade ou o impacto de uma nova crise? Quais foram os impactos principais da pandemia Covid-19 sobre o risco de uma nova crise financeira? Existem diferenças substanciais entre Irlanda, Espanha, Grécia e Portugal?

**Classificação JEL:** E44, F37, G01

**Palavras-chave:** crises financeiras, modelos logit, *Support Vector Machine*, Países do Sul da Europa, Irlanda.

## **Abstract**

In this dissertation, we provide an analysis of the fundamental factors that, in the countries of Southern Europe and Ireland, contributed to potentiate the effects of the aftermath of the 2008-2009 international financial crisis, and subsequently led to the sovereign debt crisis in the Eurozone. We examine the evolution of these economies in recent centuries, focusing on periods of financial crisis. We discuss the consequences of the context provided by the architecture of the Economic and Monetary Union, as well as the different circumstances and different economic policies implemented in each country.

To investigate the main determinants of financial crises, and in particular the events of financial crisis, we applied several quantitative approaches.

In chapter 2, which we dedicated to the study of banking crises in Ireland and Spain, we used a binomial logit model. In the appendix to that chapter, we show the result of applying a KLR model to that issue.

In chapter 3, we study the events of financial crisis in a broad sense - where we include sovereign debt crises, currency crises, inflation crises, and banking crises - in Greece and Portugal. In this chapter, again we employed the binomial logit model, and additionally, we used two multinomial logit models.

In chapter 4, we applied a machine learning technique called Support Vector Machine, with different types of kernel functions.

In all chapters, we used a large data set, covering 69 countries between 1960 and 2016, and containing a broad set of relevant macroeconomic variables: Gross Domestic Product (GDP) growth rate; terms of trade; exchange rate depreciation rate; real interest rate; inflation rate; deficit; credit to the private sector, and GDP per capita. In chapters 2 and 3, we also used as explanatory variables the public debt and the current account balance, both in percentage of GDP.

In addition to the retrospective component of the analysis, concerning the factors that contributed to past financial crises, we discuss the current state of these four economies, with special attention to the impacts of the Covid-19 pandemic.

Mainly, we tried to help to answer some questions: What are the best models for forecasting financial crises? What are the most relevant macroeconomic variables in predicting the onset of financial crises? Is a new (severe) financial crisis more likely or less likely to happen soon than ten years ago, when the international financial crisis paved the way for the sovereign debt crisis? Given the architecture of the Eurozone, what are the economic policy options

available to national authorities seeking to reduce the likelihood or impact of a new crisis?

What were the main impacts of the Covid-19 pandemic on the risk of a new financial crisis?

Are there substantial differences between Ireland, Spain, Greece, and Portugal?

**JEL Classification:** E44, F37, G01

**Keywords:** financial crises, early warning logit models, Support Vector Machine, Southern Europe, Ireland.

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## Introduction

In September 1945, when World War II ended, the European continent, which for centuries had a hegemonic role in the world at various levels (economic, scientific, technological...) was completely devastated. The war, which resulted in the death of approximately 60 million people, mainly on the European continent, was also responsible for the unlimited destruction of the productive capacity in Europe. The European countries could not do more than watch the emergence of a new world order, a bipolar world where the two great actors are the United States of America (USA) and the Soviet Union. Americans and Soviets began to compete for the expansion of their zones of influence, which would evolve in 1947 to the antagonism known as the Cold War.

Despite this context of tremendous uncertainty, the second half of the twentieth century was, at the European level, a period of peace and unprecedented economic growth. This period is inseparable from the creation of the European Economic Community (CEE) in 1957, which would evolve to the European Union in 1993. So, in the early 1990s, when the Soviet Union dissolved, and the USA was confirmed as the world's, at the time, only superpower, the countries of western Europe had already recovered an important role in the world economy, being duly integrated into the existing capitalist system.

The prosperity of the so-called developed countries made the Great Depression associated with the 1929 Wall Street crash an event too far away. And despite the occurrence of financial crises in other corners of the world, namely in the second half of the twentieth century, a conviction became dominant, both in America and in Europe, that financial crises were events that happen in other countries and at other times, a behaviour to which the economists Reinhart and Rogoff (2009) called the “this time is different” syndrome.

As a result, economic agents began to increasingly ignore the possibility that unbridled financial expansion could give rise to a new financial crisis of major proportions. And policymakers also started to believe that the so-called developed economies do not need to apply the same tools used by developing economies in times of greater tightening, such as debt restructuring, capital controls, and significant financial repression, as discussed by Claessens et al. (2014).

However, the “this time is different” syndrome sufferers were wrong once again. In late July 2007, the sharp drop in the Dow-Jones index in the USA, motivated by the possible collapse of the mortgage market, signalled the start of what became known as the subprime crisis or the Great Recession, and dragged several American financial institutions into a

situation of insolvency. The bankruptcy of centenary investment bank Lehman Brothers in September 2008 marked the beginning of the worst phase of the crisis, turning the Great Recession into the biggest financial crisis since the Great Depression. In a world more interconnected and globalized than ever, the crisis quickly reached Europe, and led to a dramatic increase in public debt, contributing to the Eurozone sovereign debt crisis that affected some countries in the Eurozone, especially Greece, Portugal, Spain, and the Republic of Ireland.

The Irish banking crisis was the result of the sharp drop in house prices and the increase in credit default situations that created financing difficulties for banks in Ireland. In September 2008, the Irish government decided to bail out its financial system by issuing a blanket guarantee in favour of six Irish financial institutions – see the discussion in O'Sullivan and Kennedy (2009). This was followed by a bailout to banks, which was the main reason why the Irish government requested assistance from the European Union and the International Monetary Fund (IMF) in November 2010, with a total amount of €85 billion.

Greece was the Eurozone country most affected by the crisis. In November 2009, the unsustainability of the Greek debt became clear. Not only did the structural weaknesses of the economy contribute greatly to this, but also the revelations that the values of deficits and public debt had been tampered with for many years (Kouretas and Vlamis, 2010). In May 2010 and February 2012, Greece received two separate bailouts, from the IMF and the European Union, to avoid bankruptcy. At the same time, in return for the bailouts, the country was forced to implement a rigorous austerity program. A third bailout was approved in August 2015. The new bailout passed despite the results of a referendum, where most Greek voters rejected the terms of the bailout. In the end, the three financial assistance programs to Greece totalled a disbursement of more than € 326 billion. Additionally, it should be noted that the Greek crisis not only had a strong contagion effect throughout the Eurozone but also showed the flaws and limitations of the European project, putting the Eurozone itself at risk.

Portugal was one of the most affected countries by the contagion effect of the Greek crisis. Given the costs incurred in providing financial assistance to the financial sector and the rapid growth of public indebtedness, investors began to pay attention to the risk associated with the Portuguese debt. The stability and growth programs implemented by the Portuguese Government, the first one from March 2010, did not change this scenario. The financial assistance was provided by the Troika, composed of the European Commission,

the European Central Bank, and the International Monetary Fund, and was an indispensable emergency solution to the financing problem. The Financial Assistance Program was signed in May 2011 and included a total funding amount for the period of €78 billion (Alexandre et al., 2016).

The Spanish financial crisis was strongly associated with some macroeconomic and financial imbalances accumulated since participation in the Economic and Monetary Union. The imbalances were associated with a housing boom, excess debt, and loss of competitiveness (Ortega and Peñalosa, 2012). In 2012, Spain was unable to rescue its financial sector and requested a rescue package provided by the European Stability Mechanism, a new financial assistance instrument for Eurozone member states created one year before, from which Spain used €41.3 billion.

Although the topic of forecasting financial crises is a topic that has been widely studied in the economic literature, there is still argument about the causes of financial crises and when and how to intervene, not least because, as concluded by Claessens et al. (2014), there still seems to be no single set of indicators that can explain the various types of crises or that can do so consistently over time. The research presented in this dissertation provides a contribution to this debate.

Apart from the Introduction and the Conclusion, this dissertation is organized in three chapters, corresponding to three different approaches to the topic of prediction of financial crises.

In chapter 2, titled “Ireland and Spain: Will there be another banking crisis soon?”, we begin by presenting and discussing the most relevant moments of the economic history of these countries in the twentieth century, starting in two crucial moments: the Irish independence in 1922 and the end of the Spanish Civil War in 1939. We give special attention to the banking crises faced by these countries during the period where the focus of our analysis is, namely the Great Recession and its aftermath. In that chapter, we construct a new banking crisis warning system, using a binomial logit model and a data set for 69 countries, between 1960 and 2016. The data set contains a diversified set of countries from the five continents, some which are more and some which are less likely to be faced with events of financial crises.

The explanatory variables used are the GDP growth, the terms of trade, the rate of depreciation of the exchange rate, the real interest rate, the inflation rate, the deficit, domestic credit to the private sector, and the GDP per capita. The availability of data restricted the

choice of countries, the period, and the selection of macroeconomic indicators included in the empirical analysis.

The dependent variable is a dummy that indicates the occurrence of a banking crisis, where the number “1” represents the occurrence of a banking crisis in a certain country in a specific year, and “0” means there was no crisis in that country in that year. We want to highlight that we also used a signal approach model, more specifically a KLR model; however, the results were not satisfactory.

Our results suggest, in the first place, that the most relevant macroeconomic variables used in our stochastic model are the GDP growth rate, terms of trade, public government deficit, domestic credit to the private sector, and GDP per capita. Secondly, the results also indicate that our model would have been useful in the prediction of the banking crises with which Ireland and Spain were confronted in the second half of the twentieth century and the beginning of the twenty-first century. Finally, regarding the probability of having a new banking crisis, our results demonstrate that Spain is more exposed to the negative impacts of the Covid-19 pandemic than Ireland.

Chapter 3, with the title “Did they ask for it? Determinants of the Greek and Portuguese financial crises”, presents a new financial crisis warning index for Portugal and Greece. We start the chapter with an analysis of the evolution of both economies in the last decades, with a focus on the periods of where financial crises occurred. To investigate the key determinants of those financial crises, we use logit models with leading macroeconomic indicators. In addition to the data used in the previous chapter, we also included in the models the government debt and the current account balance.

In the binomial logit model, the dependent variable is the dummy that indicates the occurrence of any of four types of financial crises: sovereign debt crises; inflation crises; currency crises, or banking crises. The value “1” represents a crisis in a certain country in a certain year, and “0” means there was no crisis in that country in that year. In the first multinomial logit model, the number “2” means that a financial crisis started in a certain country in a certain year (thus, “2” marks the first year of the financial crisis), “1” means that the financial crisis is continuing in a certain country in a certain year (thus, “1” marks the subsequent years of financial crisis), and “0” means there was no crisis in that country in that year. In the second multinomial logit model, the number “2” represents the occurrence of more than one type of financial crisis in a certain country in a certain year, “1” means that one type of financial crisis occurred in a certain country in a certain year, and “0” means that there was no crisis in that country in that year. Obviously, these models are estimated on

panel data. The models provide information not only about the determinants of past financial crises, but also about the current state of both economies, namely about whether the probability of a financial crisis has decreased since the end of the Financial Assistance Programs.

Our outcomes suggest that GDP growth, real interest rate, inflation rate, the first difference of the variable credit, GDP per capita, government debt, and current account balance are relevant variables for predicting the onset of a financial crisis. Our results also indicate that in 2020 Greece and principally Portugal were less at risk of a financial crisis, compared with a few years ago. However, the Covid-19 pandemic was a game-changer, and its total effects on the economies of these countries are far from being known.

In chapter 4, titled “Support Vector Machines and the prediction of crises in Ireland, Spain, Greece, and Portugal”, uses that specific machine learning technique, with different types of kernel functions - linear, quadratic polynomial, cubic polynomial, radial basis (RBF), and sigmoid - to predict financial crises in these four Eurozone countries. In addition, we compare the results obtained using this methodology with the results obtained in the previous chapters, where we used logit models for the prediction of crises in the same countries. Because of that we also use the same data set with panel data for 69 countries, the same long period from the 1960s to 2016, and the same macroeconomic variables used in the previous chapters. According to our results, the SVM model with the RBF kernel has the best performance regarding the prediction of crisis, even when compared with the binomial logit model. Furthermore, we analyse what the results of the models say not only about the financial crises of the new century, but also about the impacts of the Covid-19 pandemic. Namely, we use the models to investigate which of the four countries have been more vulnerable to crises since 2001, how that the Covid-19 pandemic impacted that vulnerability, and predict the evolution of the risk of a crisis until 2026.

Finally, the Conclusion provides a synthesis of the main conclusions of our research and gives some clues about possible future research.





## Chapter 2 - Ireland and Spain: Will there be another banking crisis soon?

### 2.1. Introduction

After decades of sustained economic growth, including the period known as the Great Moderation, the world was not prepared for the post-September 15, 2008. On this date, the giant global financial service firm Lehman Brother, with more than 150 years of history and 26 thousand employees worldwide, at the time the fourth largest investment bank in the United States of America (USA), declared bankruptcy, largely because of the exposure to the subprime mortgage financial products.

However, the world had started on this path a few decades before. The doctrine of tax reduction and the progressive relaxation of the regulatory interference in the economy adopted by the presidency of Ronald Reagan in the USA (between 1981 and 1989), and by the Prime Minister of United Kingdom (UK) Margaret Thatcher (from 1979 to 1990), strongly shaped the behaviour of the financial markets. The last years of the twentieth century and the beginning of the twenty-first followed this deregulation trend. A good example of that was the abolition of the Glass-Steagall act in 1999 in the USA, a rule created in 1933 after the Great Depression, with the main goal of separating commercial and investment banks, which did not allow investment banks to take deposits and deal with the public.

In addition, benefiting from innovation and technological developments, it was also a period of explosive growth of the banking sector. Financial products reached a new level of complexity, with new products like hedge funds or special purpose investment vehicles, and investors were encouraged to take additional risks.

The huge scale of asset securitization and collateralization of debt obligations, and the failure to assess the risk in derivatives correctly<sup>1</sup>, allowed a massive increase in the flow of credit into financial and housing markets. Part of this credit boom flowed to the subprime borrowers. These would purchase houses that they could afford only if the property itself appreciates over time. On the other hand, the increase in demand fuelled by the credit boom created a substantial housing bubble in the USA, which made purchasing a house look like a good investment even for subprime borrowers.

However, when the subprime mortgage market collapsed in the middle of 2007 it was not clear for most economists that a global financial crisis was coming. Even after the

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<sup>1</sup> Many of these type of investment products was classified with triple A by the Credit Rating Agencies, the highest investment grade.

Lehman Brothers bankruptcy, there was a dominant belief that the set of monetary and fiscal policies available to the USA authorities could contain the impacts of the failure of this investment bank and prevent the contagion to the real economy, a belief that fits into what was described by Reinhart and Rogoff (2009) as the “this time is different” view.

The knowledge about the effects and impacts of the Great Depression allowed the policymakers, governments and central banks, to reduce the magnitude of the impacts of the crisis, according to Eichengreen (2014). The taxes were cut. The interest rates were reduced. An unprecedented amount of money was printed. The credit was extended to values never seen before. Public spending was increased. Capital and liquidity were provided to the distressed capital institutions. And in the end, there were no substantial runs on banks, unlike what commonly happened during the Great Depression.

However, as discussed also in Eichengreen (2014), the so-called “Lehman Brothers moment” was the trigger to the greatest financial crisis since the Great Depression of 1929-1933, a period that became known as the Great Recession of 2008 and 2009. The recession still led to very high level of unemployment – above 10% in the USA, although not as high as in the Great Depression, when reached almost 25% – and to very substantial levels of public debt, around 100% of GDP.

In a world strongly connected and more globalized than ever, where capital could be moved almost freely between the more developed countries, the financial crisis – which had its epicentre in the USA – rapidly turned global and was particularly severe in the European Union (EU), mainly in southern European countries – Greece, Portugal, and Spain – but also in Ireland, showing how vulnerable the global finance system was.

Despite many studies that were issued on the topic of financial crisis prediction<sup>2</sup>, there are still questions about the causes of crises and about when and how to intervene. As Claessens et al. (2014) conclude, it appears that there is no single set of indicators that can explain the various types of crises or can do so consistently over time.

This chapter analyses and discusses the issue of banking crises, namely the main macroeconomic variables that can enhance these events. The focus is on the specificities of Ireland and Spain, two Eurozone countries particularly affected by the Great Recession.

Our main goal is to create a valid and simple warning index of the banking crises that is not only quantifiable but also sufficiently generic to be used efficiently around the globe,

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<sup>2</sup> As the works of Demirguc-Kunt and Detragiache (1998), Kaminsky et. al (1998) or, more recently, Kiley (2021).

alerting the authorities to the impacts that some variations in specific important macroeconomic variables can have on the likelihood of a financial crisis.

For that purpose, we have used a broad and diverse database, with annual data for a large number of countries (69), including countries of each continent and with different experiences regarding the frequency and severity of financial crises. The data set also covers a long period of time, limited by the availability of data, from 1960 until 2016. And in line with the more relevant economic literature about this topic, we decided to use the logit model, where the dependent variable is a dummy variable that identifies periods of occurrence of a banking crisis. We consider eight explanatory variables: GDP growth; terms of trade; rate of exchange rate depreciation; real interest rate; inflation; fiscal government surplus; domestic credit, and GDP per capita.

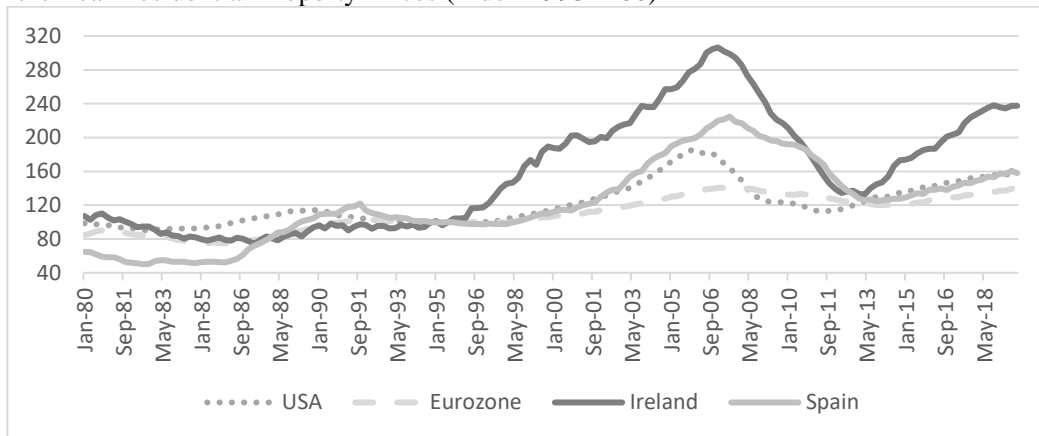
The main contributions that we expect to result from this study are not only a better understanding of specificities of the economic history of Ireland and Spain, and particularly of the periods of banking crisis experienced by these countries in the last decades, but also the creation of a warning index of a banking crisis that could be easily implemented. Finally, although it is a relatively recent subject, we will use the model to understand the possible impacts of the Covid-19 pandemic on the risk of Ireland and Spain being confronted with a new banking crisis.

The paper is structured in six sections and one appendix. Section 2.2 discusses some initial pieces of evidence regarding why Ireland and Spain were the first countries to be affected by the Great Depression when the problems in America have arrived in Europe. Section 2.3 makes a contextualization of the political and economic history of both countries, starting in two important moments of the history of each country: the Irish Independence in 1922, and the end of the Spanish Civil War in 1939. It gives special attention to the banking crises that these two countries faced in this period. Namely, it discusses the motives that contributed to the size of the impact of the Great Recession of 2008 and 2009 in those countries. Section 2.4 summarizes what we consider to be the most important precedent research that has used logit models for the prediction of financial crises. Section 2.5 describes the data and macroeconomic variables used in the empirical analyses and presents the results. Finally, section 2.6 shows the main conclusions of the chapter, raises some points concerning the economic performance and possibility of occurrence of banking crises in the Eurozone in the next years and gives some clues regarding possible future complementary studies. In appendix A, we discuss the signals approach techniques, more specifically the KLR models, and the results of the application of this approach to our data set.

## 2.2. Banking crisis and links between the USA, Ireland, and Spain

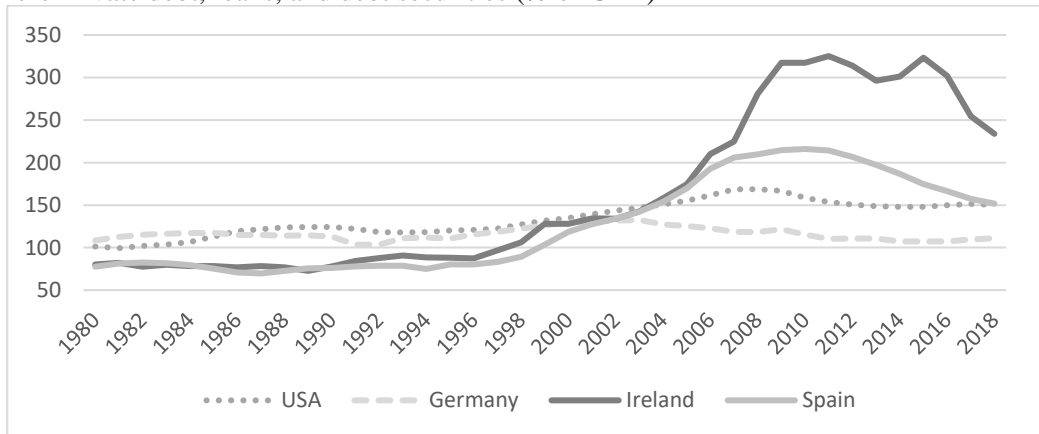
The USA experienced a strong housing boom at the end of the twentieth century and the beginning of the twenty-first century. However, the variation of the residential property prices was even more problematic in Ireland and Spain, as shown in Figure 2.1. Between the beginning of 1995 and the end of 2006, the valuation of the real residential property prices was more than 80% in the USA, approximately twice the average of the Eurozone, against 115% in Spain, and more than 200% in Ireland.

**Figure 2.1:** Real Residential Property Prices (Index 1995=100)



Source: Federal Reserve Bank of St. Louis.

**Figure 2.2:** Private debt, loans, and debt securities (% of GDP)



Source: World Economic Outlook.

One of the variables that have actively contributed to this real estate performance was the behaviour of private debt. The private debt in the USA between 1995 and 2007 has increased from 40% to 170% of the GDP. The credit boom was even higher in Ireland and Spain. The introduction of the European single currency in 1999 allowed a higher degree of

economic and financial interaction among the European Union (EU) members and reduced the interest rates. As a result, a huge amount of capital has arrived at the countries of the periphery of Europe, which accelerated, even more, the property boom. The increase of private debt, for the same period, was more than 150% in both countries, representing 225% of the Irish GDP, and 206% of the Spanish GDP. As a comparison term, in Germany, the private debt remained stable throughout this period, as can be seen in Figure 2.2.

Although the legal definitions of banking can vary across countries, authors like Lindgren et al. (1996), note that the essential characteristics are the same all around the world: banks issue liquid, nominally valued liabilities, many of which are payable on demand at par, and they mainly acquire assets that are illiquid, relatively difficult to value, and of longer maturity than their liabilities. The same authors define a sound banking system as one in which most banks, mainly those accounting for a substantial amount of assets and liabilities, are not only solvent but also are likely to remain so. In addition, the authors conclude that a weak banking system can damage the performance of the economy, and because of that, the promotion of a sound banking system should be a policy objective in the design of macroeconomic policies.

The construction of a banking crisis data set, and the definition of what should be the requirements to characterize an event as a banking crisis, is also challenging.

One of the first papers to construct a comprehensive data set of episodes of bank insolvency was Caprio and Klingebiel (1996). Their work relied upon the assessment of a variety of finance professionals in pulling together characterizations of factors that have caused the crises, and they have used only published sources or interviews with experts familiar with individual episodes. As an output, they constructed a sample of almost seven dozen countries, for which information was available since 1970.

A comprehensive data set, regarding the financial crisis, was also constructed by Reinhart and Rogoff (2009). The authors studied the evolution of sovereign debt, deflation, currency, and banking crises, for 66 countries, in the last eight centuries, with a great level of detail since 1800. In that work, the definition of banking crisis includes bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions, like the crises in Venezuela in 1993 and in Argentina in 2001. The definition also includes the situations when there are no runs, but closure, merging, takeover, or large-scale government assistance of at least an important financial institution, or group of institutions, with risk of contagion, an example of which is what happened in Thailand between 1996 and 1997.

More recently, Laeven and Valencia (2018) drew on 151 systemic banking crisis episodes around the globe during 1970-2017. The authors used as a definition for banking crisis an event that simultaneously meets two criteria: 1) substantial signs of financial distress in the banking system, like important bank runs, losses in the banking system, and/or bank liquidations; 2) significant policy intervention measures regarding the banking sector in response to considerable losses in the banking system, more specifically, the cases when at least three of six criteria are met: deposit freezes and/or bank holidays; significant bank nationalizations; significant bank restructuring fiscal costs (at least 3% of GDP); extensive liquidity support (at least 5% of deposits and liabilities to non-residents); significant guarantees put in place, and significant asset purchases (at least 5% of GDP). In addition, when the losses in the banking sector and/or liquidations are severe, the authors treat the first criterion as a sufficient condition to date a systemic banking crisis. More precisely, this can happen in three cases: i) if a banking system of any country exhibits significant losses resulting in a share of nonperforming loans above 20% of total loans; ii) if a banking system shows important losses resulting from bank closures of at least 20% of banking system assets, and iii) if the fiscal restructuring costs of the banking sector are sufficiently high, exceeding 5% of GDP.

To study whether financial crises have become more frequent and severe, Bordo et al. (2001) developed and analysed a database spanning 120 years of financial history. The authors found that since the abandonment of the Bretton Woods fixed exchange rate system in 1973, crises have become more frequent, but have not grown more severe. The main explanation for the growing frequency of crises is the increase of capital mobility. This stresses not only the need to strengthen financial institutions regulation and supervision, but also that the authorities should be more careful with the provision of liquidity, ensuring that it cannot be used to support insolvent institutions and delay the recognition of financial distress. Finally, the authors also found that banking crises are costlier in the presence of pegged exchange rate regimes.

From their study of systemic banking crises in a sample of 66 countries, since the beginning of the nineteenth century, Reinhart and Rogoff (2013) concluded that not only these episodes are normally preceded by asset price bubbles, large capital inflows, and credit booms, in both rich and poor countries, but also that these situations usually create a huge increase, around 86%, in debt in the medium term. Therefore, it is not surprising that Ireland and Spain have been some of the countries most affected by the financial crisis that started in the USA, and that both have faced severe banking crises.

### **2.3. Irish and Spanish modern economic history: a survey**

In 1922, following more than one century in which the island of Ireland was part of the UK, a period of great poverty and famines responsible for more than one million deaths and an even higher number of immigrants, and after two years and half of the war of independence, 26 of 32 counties of the island declared independence and the Irish Free State was created with the signature of the Anglo-Irish Treaty. As discussed in Fitzgerald and Kenny (2020), as a part of the Anglo-Irish Treaty of 1921, the Irish Free State accepted an undefined share of the UK public debt and the redrawing of the Irish boundary by an independent Boundary Commission. The terms of the Treaty were the immediate cause of the subsequent Irish civil war, which lasted until the middle of 1923 and aggravated the public debt. As an example, between 1922 and 1927, the expenditures of the Irish Free State were on average 16% higher than the revenues (excluding borrowings), according to Duncan (1928). However, considering only the period of the civil war, this difference was more than double, 34%.

The Anglo-Irish agreement of 1925 removed a dormant UK claim on the Irish Free State of 155,75 million pounds, which corresponded to almost 80% of the Irish Gross National Product (GNP) at the time. As a result of this agreement, and of prudent fiscal management in the early years of the state, the level of public debt remained quite low at the time, being around 40% of GNP in 1938, according to Fitzgerald and Kenny (2018).

With the adoption of the new constitution in 1937, the new country changed its name to Ireland and implemented a republican regime. In contrast with the more agricultural and catholic counties that formed the Republic of Ireland, the 6 counties of Northern Ireland that remained part of the UK were more developed, industrialized, and populated by a majority of Protestants.

The Great Depression that started in 1929 in the USA had a recessive impact worldwide and Ireland was not an exception. Following the trend of other countries, the elections of 1932 brought a substantial change in terms of economic policy. The more liberal and free-trade-supporter government led by Cosgrave from Fine Gail was substituted by the government of the Fianna Fáil headed by Valera, which advocated economic nationalism and protectionist measures.

Although Ireland did not participate in the Second World War (WW2), the scenario of stagnation and emigration in Ireland persisted, and the period was marked by

nationalizations, implementation of import substitution policies, and the Anglo-Irish Trade War, from 1932 to 1938. Neary and Ó Gráda (1991) estimate that the average tariff level rose from 9% in 1931 to 45% in 1936. However, the authors also conclude that, given that the country was so poor at the beginning of the 1930s, in absolute terms there actually was a small improvement in the well-being of Irish people during this decade. In relative terms, Broadberry and Klein (2012) show that, between 1929 and 1950, the GDP in Ireland increased by 23%, while on average in Europe, experiencing a post WW2 boom, the GDP variation was almost 38.9%.

According to Ó Gráda (2008), in the late 1950s, something changed in the economy, and Ireland entered a period of economic growth, albeit modest, that would last for several years. The new Fianna Fáil government, this time led by Lemass Valera, changed the strategy to what was known by the “Whitaker economic model”, from the name of the secretary of the Department of Finance. Despite the delay, the agrarian society was starting to industrialize. There was an investment in education. The protectionist measures were reversed, promoting free trade and closer integration with the international economy. High technology and foreign direct investment were encouraged. In contrast, this was a period of economic decline and political instability in Northern Ireland, marked by the outbreak of violence in the late 1960s, a political, nationalistic, ethnic, sectarian, and religious conflict, known as The Troubles or Northern Ireland conflict. Despite some improvements, Daly (2016) points out that the gap between Ireland’s growth rate and living standards and those of Western Europe expanded between 1958 and 1973.

In turn, in Spain, the Civil War, which took place from 1936 to 1939, was responsible for the death of more than 200 thousand people and the destruction of 30% of the industrial production. According to Frank (1987), the Spanish Civil War was the conflict that preceded the horrors of WW2, and where both ideological and political tensions can be found. The victory of the Falangists led by General Franco marked the end of the Second Spanish Republic (that had been proclaimed in 1931) and the implementation of a dictatorial regime. Franco ruled Spain until his death at the end of 1975, when he was substituted by his appointed successor, Juan Carlos de Borbón, to establish a new monarchy.

During the 1940s and the first years of the 1950s, Franco implemented a regime based on isolation, autarchy, control, and public intervention in the economy. It was a period of poor economic performance that is known as the first Franco period. According to López (2002), this was a phase of catastrophic evolution of the Spanish economy, and the national income recovered to the level before the civil war only in the middle of the 1950s.



The implementation of Plan de Estabilización of 1959, associated with the substantial financial aid received from the USA during the period of Cold War and the favourable international environment, changed this scenario and that period became known as the second Franco period. The Plan marks the abandonment of the infeasible nationalist path of Spanish capitalism. As detailed in Biescas and Lara (1980), financial investment was encouraged, and direct foreign investment and new technology flowed in; a (modest) reindustrialization process was started, and the tourism sector grew robustly. On average, the real GDP grew at a rate of 7% per year in the 1960s.

However, the oil crisis that started in 1973 had a strong impact in Spain, a country very dependent on energy imports. It increased the inflation rate to two digits, more specifically to 11.4%. The negative environment that resulted from the rise of the oil prices also reduced Spanish exports, the foreign investment inflows, and the number of tourists. In addition, as the government did not make the necessary economic adjustment, a series of imbalances aggravated even more the negative effects of the crisis. As an example, the current account balance between 1973 and 1976 was always negative, exceeding 3% of the GDP. Cortiña (1990) argues that this crisis showed the structural problems of the Spanish economy were a consequence of a quantitative growth model, but without any quality, due to the interventionism and intense protectionism of the non-competitive corporate capitalism regime, that caused major production distortions and rigid markets, and making Spain at that time still a very poor country in comparison with the European counterparts.

The Spanish democracy began in the context of a deep crisis, with high inflation rates (which reached the peak of 24.5% in 1977), productive stagnation, and a large external deficit, as discussed by Duque (1987). The transition to democracy, with the implementation of the parliamentary system under the monarch Juan Carlos I, started in 1975. The regime evolved to a full democracy in a process marked by the draft of the political reform law presented by the interim centrist government of Adolfo Suarez, the 1977 general elections won by Suarez's Union of Democratic Centre (UCD), the Moncloa Pacts (a political agreement regarding the economic and political reforms, signed by the main political parties), and the 1978 referendum that approved the Constitution.

It is in this recessive context created by the oil crisis and aggravated by the political transition process, that in 1977 begins the most representative banking crisis of the twentieth century in Spain. Betrán and Pons (2017) studied the mechanisms of transmission of this crisis and concluded that an industrial crisis was responsible for the increased number of failures of firms, leading to a stock exchange downturn. Some Spanish banks were caught

with large industrial portfolios and saw their balance sheets deteriorate sharply, resulting in a banking crisis. Baeza and López (2013) point out as the main causes of this crisis the lack of efficiency and adequacy of many banks, given the context of transformation of the banking system, with liberalization and increase in competition, and the need to incorporate technological development. In addition, some banks officials had insufficient experience and professionalism, and allowed a great concentration of the risks to occur. The legal framework also contributed, with weak and underdeveloped regulation, and with lack of reliable accounting and auditing systems. According to Cuervo (1988), the banking crisis, which lasted until 1985, affected 56 of the 110 banks operating in Spain at the end of 1977, representing 27% of the economic dimension of this sector. It was the most brutal crisis in Spanish financial history, and it is considered by Reinhart and Rogoff (2009) as one of the five biggest crises in terms of severity.

After the second oil shock, in 1979, the vulnerabilities and problems of the Spanish economy were aggravated, not only by the restrictive monetary policies implemented all over Europe, but also by new events of internal political instability. First, the resignation of Adolfo Suárez in 1981, due to an internal political crisis in UCD, the discussions of the autonomy status of Catalonia and Basque Country, and terrorist attacks in the latter region. Second, the assault on the parliament and failed coupe tentative of Coronel Tejero during the vote for the investiture of the new UCD government lead by Calvo Sotelo. And finally, the new electoral process at the end of 1982<sup>3</sup>.

The election resulted in a new prime minister: Felipe González, from the Spanish Socialist Workers' Party (PSOE). The new government implemented the Medium-Term Economic Program 1983-1986. According to Quintana (1999), it included both sanitation measures and economic-institutional reforms, and it was designed to meet many objectives: reduction of inflation; liberalization of the economy to implement a market economy; adaptation and reconversion of the industrial structure and energy adjustment; public sector reform; creation of incentives to increase private capital investment (like labour market flexibility), and tackle the banking crisis. Quintana (1999) also argues that it was the implementation of those measures that created the conditions for the integration of Spain into the CEE. According to Segura (1990), despite some excessive gradualism and incomplete institutional reforms, the Program was a remarkable success of economic management.

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<sup>3</sup> For more details, we recommend Andreu (2004).

The end of the banking crisis in 1985 was a result of a very important legislative initiative, from we highlight the royal decree 3048/1977 that made deposit guarantee funds mandatory in banking institutions, and the law 13/1985 that defined the solvency coefficients, the mandatory values of own resources and the definition of obligations regarding financial information reporting by financial intermediaries to regulators<sup>4</sup>.

In 1986, after seven years of negotiations, Spain officially joined the CEE. As discussed by Manuel and Royo (2004) the accession to CEE was in the first place a political decision aimed at ending the isolation of Spain in the European context and consolidating the move towards democratic institutions. From their analysis of the following fifteen years, Manuel and Royo (2004) conclude that the benefits for the Spanish Economy offset the disadvantages, such as loss of sovereignty, costs in terms of economic adjustments, and the negative impact on uncompetitive manufacturing and agricultural sectors. The list of economic benefits is more extensive and includes liberalization and modernization of the economy; dramatic trade expansion allowed by the European Common Market; great flow of foreign direct investment; increase in efficiency, productivity, and competitiveness; cohesion policy and structural funds that allowed the improvement of physical infrastructures; lower interest rates; inflation kept under control, and better economic performance.

In the Irish case, after two attempts to become part of the CEE without success, the accession treaty was signed in 1972, and the country joined Belgium, France, Italy, Germany, Luxembourg, and the Netherlands in CEE at the beginning of 1973, accompanied by the UK and Denmark. In the same year, an election resulted in a new government, a coalition between Fine Gael and the Labour party. Fitzgerald (2002) presents a discussion of the benefits for Ireland of CEE membership. Concerning the economic benefits, the author starts by highlighting the importance, for a country that was very dependent on exports to the UK, of the access of Irish farmers to the continental market. Second, the author highlights the impact of the financial transfers within the framework of the common agricultural policy and structural funds, given that Ireland at the time was one of the poorest countries in the union. Third, the access to continental member states' market for goods manufactured in Ireland, in association with an available and productive English-speaking workforce and a wide range of financial incentives for investors, allowed Ireland to attract large amounts of external investment, including USA multinational high-tech companies, especially in the

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<sup>4</sup> Additional details can be found in Molina and Martín-Aceña (2011).

1990s. Regarding political and psychological benefits, the author focuses the analysis on the fact that as Ireland and UK joined the union together, this allowed a closer and ultimately warmer relationship between them to develop, mitigating the British superiority complex, whilst also boosting Irish self-confidence in its relations with the UK. Finally, the author points out the gender equality benefits, with equal opportunities given to women, and environmental benefits resulting from new legislation drafted in accordance with European standards.

The high expectations of Ireland would not be fulfilled in the 1970s and 1980s. To the difficulties created by the Northern Ireland conflict, high inflation and recessive international conjuncture that resulted from the oil crises of the 1970s, one should add erratic policies characterized by poor management of the economy and new high taxes, sometimes above 50%, and political instability resulting in five elections between the middle of 1977 and the end of 1982. As an example of the economic situation during that period, note that Callan and Nolan (1994) report that the degree of inequality in the distribution of the gross income among Irish householders widened between 1973 and 1987, a year in each almost one-fifth of the population was unemployed.

Despite the many changes that have taken place in Ireland since joining the CEE in 1972, in the early 1990s, Ireland continued to be one of the least developed countries in Western Europe. However, the increase in the structural and cohesion funds distributed to the poorest countries in the CEE had an important impact on the increase in public investment and on domestic infrastructure. Ireland entered the so-called “Celtic Tiger phase”, which changed the scenario dramatically<sup>5</sup>. It was a rare example of a Western country matching the high-level growth rates of East Asian nations, namely of the Four Asian Tigers<sup>6</sup>.

At a European level, we must stress the importance of the signature of the Single European Act in 1986, which established the stages, the timetable, and the measures necessary for the completion of the internal market in 1992. In addition, the signature of the European Union treaty in Maastricht, when CEE changed its name to European Union, must also be considered a crucial moment, because it defined the criteria<sup>7</sup> that the countries should

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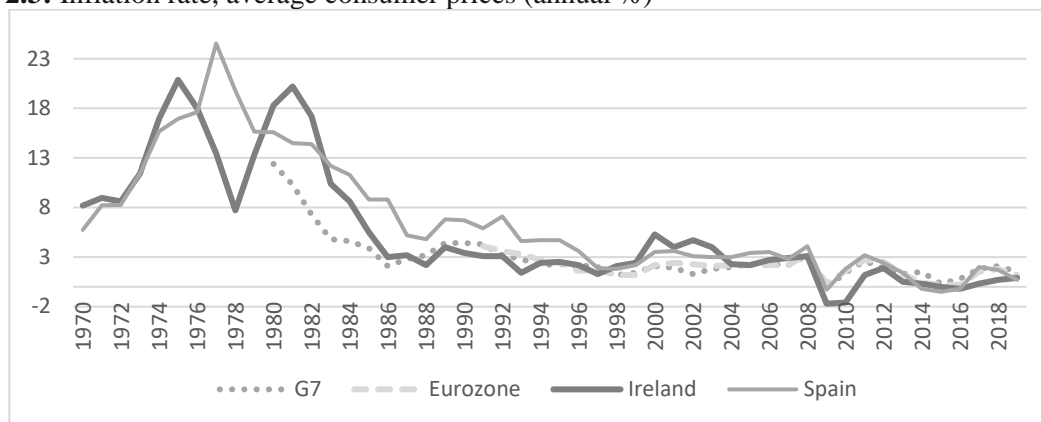
<sup>5</sup> For more details regarding Ireland’s CEE / EU experience, we recommend Laffan and O’Mahony (2008).

<sup>6</sup> Hong Kong, Singapore, South Korea, and Taiwan.

<sup>7</sup> Criteria to be accepted as member of the EMU: the inflation rate should be below 1.5 percentage points plus the average of the three lowest inflation rates of the European Union; the ratio of the annual government deficit to GDP should be lower than 3%; the ratio of gross government debt to GDP should be less than 60%; applicant countries should have joined the exchange-rate mechanism of the European Monetary System for two consecutive years and must not have devalued its currency during the period, and the nominal long-term interest

meet to be accepted as a part of the Economic and Monetary Union (EMU), and thus to be able to join the future Euro Area, with its single/common currency.

**Figure 2.3:** Inflation rate, average consumer prices (annual %)



Source: World Economic Outlook

The impact of the economic policies implemented in this period on the inflation rate, in both countries, was notorious and can be seen in Figure 2.3. Following the trend in the G7 (the seven more developed countries<sup>8</sup>), the inflation rate was consistently reduced, in less than 10 years at the end of the 1970s, from more than 20% to values close to 3% in Ireland and 5% in Spain.

The main political shift in Ireland started in the middle of the 1990s with the coalition government of Fianna Fáil and Progressive Democrats, led by Prime Minister Haughey. The main policies were continued by the subsequent governments of Fianna Fáil and Fine Gael, in minority or coalition. Foreign direct investment was encouraged even more, with generous incentives given by the Industrial Development Authority. Productivity was actively promoted. The public spending was reduced. The taxes were cut. The most visible measure was the drastic reduction of taxation, with the main goal of attracting multinationals from high-tech and financial services industries, mainly from the USA. A 10% corporate low-tax rate started to be applied to profits from the manufacturing industry, internationally traded services, and to all activities located in the International Financial Services Centre in Dublin. Since the end of the 1990s, Ireland's standard corporate tax rate became 12,5% for all activities, in contrast with the more than 30% paid by some companies in the period before. It is also important to highlight, at the political level, the importance of the signature of the

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rate should be lower than 2 percentage points plus the average of the interest rates in the three member states with the lowest inflation rates.

<sup>8</sup> Canada, France, Germany, Italy, Japan, United Kingdom and USA.

Good Friday Agreement or Belfast Agreement in 1998, which ended most of the violence of the political conflict in Northern Ireland, the Troubles.

According to O'Rourke (2016), the Irish independence would not have worked as well for Ireland as it did without the EU, and the single market program was crucial for the development of the country.

Table 2.1 presents five views regarding the main internal factors that contributed to the high economic performance of Ireland during the Celtic Tiger period.

**Table 2.1:** Different views on what led to the Celtic Tiger period

<p>To the impact of the large injection of European structural funds, Kennedy (1998) adds the importance, in the late 1980s, of moderate wage arrangements negotiated through the National Partnership, the successful anti-inflationary policies, the control of public finances, and the sustained improvement in educational participation and quality, that have created the conditions for a huge inflow of high-tech multinationals.</p>
<p>In a similar way, for O'Donnell (1998), the cohesive trade union movement and the achievement of consensus across the social partners and the political parties on the strategy to be implemented and on public finances were essential to reach a high degree of wage coordination. The author also argues that the association of a young, well-educated, English-speaking workforce and the improvement of infrastructure in this period attracted a huge inflow of leading USA enterprises. Finally, the author highlights the importance of a new set of Irish enterprises and the deregulation of the service sectors.</p>
<p>The prolonged and reliable policy of targeting foreign investment, the consistency in industrial policy over long periods, the development of a political consensus in the 1980s on tackling Ireland's critical fiscal problems, the major increase in demand for skilled labour in the 1990s, when there was a rapid growth in the private services sector in areas which also require skilled employees, and the free movement in goods and foreign direct investment were critical to the economic performance of Ireland according to Fitzgerald (1999).</p>
<p>There were many important factors, according to Burnham (2003), that made Ireland well prepared to take advantage of the direct and indirect impacts of a favourable external context, resulting from the telecommunications revolution: demographic patterns; the legacy of English law and language; openness of the economy to foreign trade and investment; the single European market; prior decisions focusing on education and telecommunications investment, and the improvement of government tax and spending policies that encouraged investment and work.</p>
<p>Finally, Grubel (2003) emphasizes the contribution to a favourable climate for foreign direct investment of several policies put in place towards the end of the 1980s: the successful fiscal adjustment that reversed the upward trend in the tax burden, especially a low corporate tax; the</p>

competitive level of the exchange rate; wage moderation; Ireland's commitment to the European project; Ireland's location; use of the English language; familiar business culture, general openness to American influences.

In Spain, the governments of PSOE / González and Popular Party (PP) of Aznar (prime minister from 1996 to 2004) adopted policies to comply with the criteria to be part of the EMU, and Spain was at the forefront when the single currency was launched in 1999. For Frieden (1998), although the economic benefits of establishing a monetary union do not overtake the costs, the anti-inflationary credibility, the broader links to European political integration, and the support from powerful business interests, made the Euro attractive and feasible. As observed by de Motes (2015), after all, Europe has been the horizon of progress for the Spanish economy.

And so, when the Euro was launched in 1999, Ireland and Spain were both in the front platoon. On the website of the European Union<sup>9</sup> it is argued that the single currency has many theoretical advantages: the ease with which prices can be compared between countries, which boosts competition between businesses, thereby benefiting consumers: price stability; the Euro makes it easier, cheaper and safer for businesses to buy and sell within the Euro area and to trade with the rest of the world; improved economic stability and growth; better integrated and therefore more efficient financial markets, and greater influence in the global economy, and a tangible sign of a European identity. However, there are also disadvantages. Not wanting to be exhaustive, we highlight, as an example, the fact that Stiglitz (2016) argues that the European single currency has failed to achieve the goals of prosperity and political integration, mainly because the creation of a single currency was flawed at birth. The author claims that the establishment of the Euro was done without a set of institutions that enabled a region with Europe's diversity to effectively function and that the rules and regulations of the Eurozone were not designed to promote growth, employment, and stability.

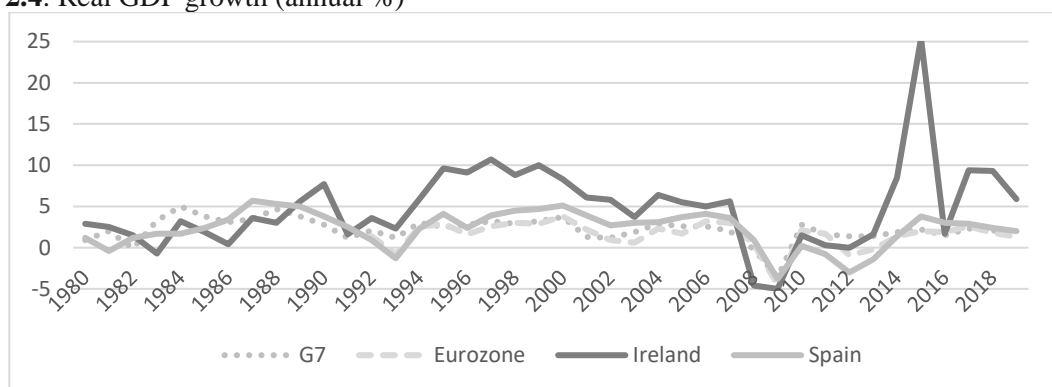
Both Ireland and Spain had a good performance in terms of GDP in the 1990s. The real GDP growth in Ireland, between the 1990s and 2007, was always higher, sometimes more than double, than the average of the European Union partners and also than the average of the G7, as can be seen in Figure 2.4. Between 1995 and 2000, the Irish real GDP grew at an average rate of 9.4%, and at 5.4% between 2001 and 2007. It should also be mentioned

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<sup>9</sup> [https://europa.eu/european-union/about-eu/euro/benefits\\_en](https://europa.eu/european-union/about-eu/euro/benefits_en)

that, between 2001 and 2003, the Irish economy felt the negative impacts of problems associated with the stock market bubble caused by excessive speculation in technology companies, such as the large reduction in investment in the worldwide information technology industry, and the breach of trust resulting from the terrorist attacks on 11 September 2001 in the USA.

**Figure 2.4:** Real GDP growth (annual %)



Source: World Economic Outlook.

The Spanish GDP growth rates were not as high as in Ireland. However, Spain had a better performance than the average real gross domestic product of the more developed countries in the periods between 1986 and 1992 and from 1994 to 2007, being one of the most dynamic in Europe. Between 1987 and 1989 and in 2000 the Spanish GDP even increased at a rate above 5%. The year 1993 was a period of recession. It was the end of the economic cycle characterized by a large influx of cohesion funds used in huge public investments, from which the most emblematic were the railway network, the Barcelona Olympic Games, and the Expo 92 in Seville. The crisis brought high unemployment and the situation was aggravated by drought and low agricultural production. At an international level, the Gulf War also impacted the economic performance, through increased oil prices. As a result, the Spanish Government decided to devaluate its currency, the peseta, by 20% in total<sup>10</sup>.

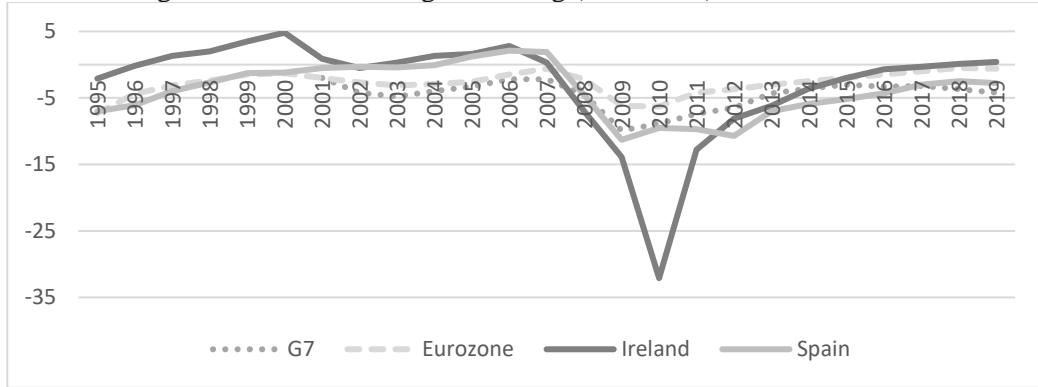
The good performance of the Irish and Spanish public finances can be seen in Figure 2.5. On one hand, in contrast with the average G7, the Irish government always achieved public budget surpluses between 1995 and 2017. The only exception was 2002, when Ireland had a deficit of 0,5% of GDP, which is, however, a small value when compared with the average deficit of 4.2% of the G7. On the other hand, in the last decades of the twentieth

<sup>10</sup> This period is discussed in Duque (2002).



century, the government in Spain always reported high public deficits. This situation improved in the first years of the new century; in 2006 and 2007, under the government of the new PSOE leader Zapatero (prime minister between 2004 and the end of 2011), Spain had a surplus for the first time in its democracy.

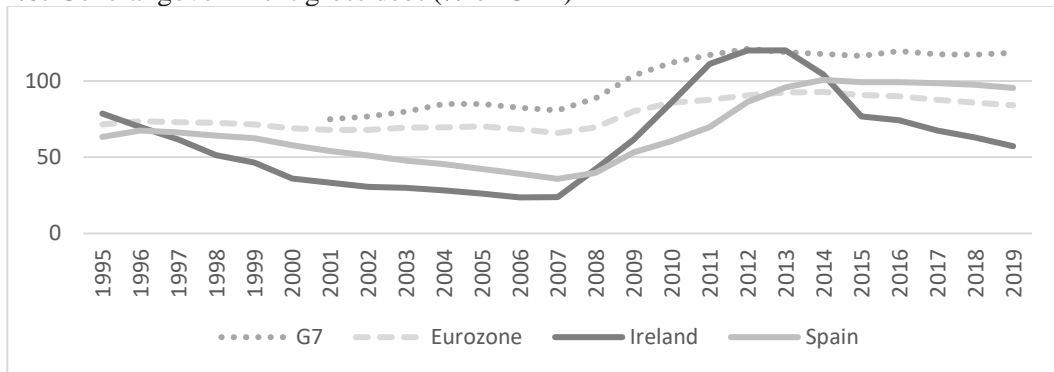
**Figure 2.5:** General government net lending/borrowing (% of GDP)



Source: World Economic Outlook.

The GDP growth and the public budget surpluses were responsible for the huge reduction of the general government gross debt in Ireland. In 1995, the government debt was 78,6% of the GDP in Ireland, while in 2007 it was only 23,9%, a reduction of two-thirds, as shown in Figure 2.6. In the same period, the average government debt in the Eurozone was reduced from 73,5% of the GDP to only 65,9%.

**Figure 2.6:** General government gross debt (% of GDP)



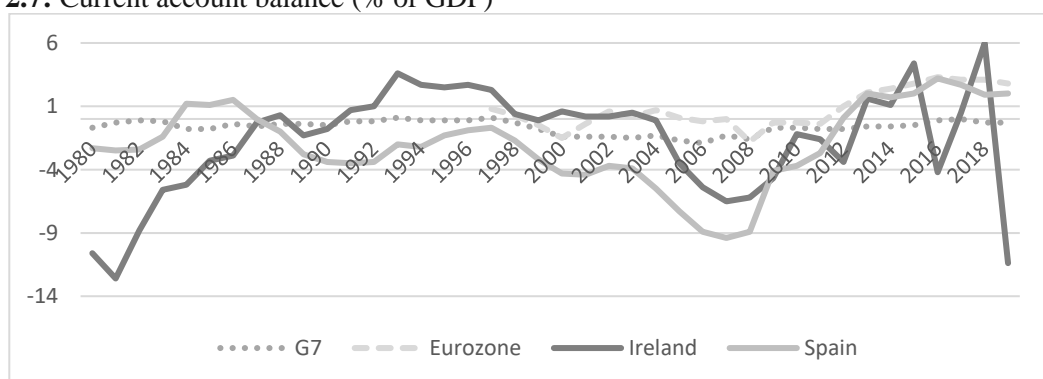
Source: World Economic Outlook.

In contrast with what happened in countries of the European periphery, like the neighbour Portugal, in the Eurozone countries in general, and in the more advanced countries, the public debt was under control in Spain, having been reduced from more than 60% of GDP, in 1999, to less than 40%, in 2007.

The positive evolution of the Irish economy, in the last years of the twentieth century, can also be viewed in the performance of the current account balance in percentage of GDP. At the beginning of the 1980s the balance was highly negative, more than 10% per year, but it became positive in 1988, between 1991 and 1998, and from 2000 to 2003, which was a better performance than the average of the Eurozone partners, as can be seen in Figure 2.7. In 1999 and 2004, the Irish current account balance was negative, but only by 0,1%. However, the performance of the current account balance started to deteriorate since the introduction of the Euro. The European single currency reduced the risk and the costs of the movements of capital within the Eurozone, allowing a huge increase in foreign direct investment flows. Ireland was one of the main recipients of these funds, which was particularly notorious in the period before the crisis. As an example, Ireland had a current account deficit of 5.4% of GDP in 2006, and of 6.5% in 2007.

In Spain, since 1999, year after year there was an increase in the size of the current account deficits, until they reached the extreme value of -9.4% of GDP in 2007. This was a very poor performance when compared with the average value of the Eurozone, and a demonstration of some fragility of the Spanish economy.

**Figure 2.7:** Current account balance (% of GDP)



Source: World Economic Outlook.

Despite the robust growth rate in the so-called Celtic Tiger period and the fact that mortgage securitization was not a problem as significant as in the USA, these macroeconomic imbalances made Ireland the first Eurozone country to officially enter in recession in the last quarter of 2007. Ireland was also one of the most affected by the financial crisis that started in the USA, having to deal with a severe banking crisis. In 2008 and 2009, the GDP decreased by 4,6% and 5%, respectively.

In addition, even before the start of the Great Recession, the Irish economic policies were the target of criticism. For instance, Murphy (2000) points out that the success of some of the established high-tech multinational corporations attracted their competitors to establish in Ireland, and that the boom of the 1990s had an imbalance element, being predominantly a multi-national phenomenon rather than an indigenous Irish one. In Kirby's opinion (2004), the Celtic Tiger phase resulted also from prioritizing economic growth over social development, and the benefits of this growth were reaped mostly by an elite. For Rae and Noord (2006), the Irish housing market prices may have become overvalued, because of a strong bias of the tax system towards housing and relatively easy credit policies by banks, that have allowed an excessive drawing of resources into residential construction. In addition, these authors alert to the fact that the banks must remain cautious in their lending and provisioning policies, and that the government should introduce a property tax. Even some EU partners started to accuse Ireland of unfair tax competition, transfer pricing, and various internal pricing stratagems. Some economists also disagreed with the mainstream view. Table 2.2 presents different contributions and views about what have been the main factors that provoked and exacerbated the Great Recession in Ireland.

**Table 2.2:** Different views on the factors that have aggravated the Irish financial crisis

For Honohan (2009), since 2000, Irish policymakers neglected the basics of public finance, wage policy, and bank regulation, and it was the property price and the construction bubble, fuelled by the banks and by the sharp fall in interest rates following the introduction of the Euro that sustained employment and output growth in Ireland until 2007, despite a loss of wage competitiveness.
According to Kelly (2010), the end of the bubble left Ireland with deeply indebted firms and households, uncompetitive wage levels, and a very fragile banking system. The reaction of the Irish government was to absorb all losses itself, increasing the sovereign debt crisis risk.
The study of O'Sullivan and Kennedy (2009) points out that the collapse of the domestic property sector, the inadequate risk management practices of the financial institutions, and the failure of the regulator to supervise the bank practices were the three main causes of the Irish crisis. This situation was even aggravated by the pro-cyclical monetary and public policy initiatives enacted by the Irish government, which amplified by the international financial sub-prime crisis, and resulted in a loss of confidence in the performance of the Irish economy.
The report of Regling and Watson (2010) starts to highlight that Ireland had never experienced a property crash before and that this was a period of high liquidity, low-risk premium, and unprecedented access to cross-border funding, resulting from the single currency. Then, the

<p>authors discuss that in the Irish case the fiscal policy, very dependent on taxes driven by the property sector and by high consumer spending, the insufficient financial supervision, and the weak bank governance and risk management, left the economy vulnerable to a deep crisis, exacerbated the credit and property booms, with strong negative social impacts. Finally, it is done an alert for the need to have more proactive external surveillance institutions.</p>
<p>If Ireland had an appropriate fiscal policy and regulation, on the opinion of Bergin et al. (2011) the property market bubble and related financial collapse could have been avoided, because it would have restricted the availability of credit and the size of the property market boom.</p>
<p>McGowan (2011) highlights that the adoption of the Euro and the increased financial integration allowed Irish banks to obtain access to a greater amount of funds. The insufficient prudential supervision, and the competition for market share among banks, fuelled a housing market bubble and the expansion of the banking system. Finally, the change in risk aversion in international financial markets has created funding problems for the Irish banks.</p>
<p>According to Kitchin et al. (2012), the Irish government implemented in the 1990s a neoliberal agenda, promoting the free market, minimizing regulation, privatizing public goods, and keeping direct taxes low. The laissez-faire planning system led to a problem of clientelism and allowed the property sector to be driven by developers, speculators, and banks, rewarding them with tax incentives and fewer tax obligations, making the crash inevitable.</p>
<p>The excessive financialization of the Irish economy, classified by Ó Riain (2012) as disastrous, specifically the fiscal and financial deregulation of the 1990s, gave banks excessive power to decide the destination of investments. With the consent of international creditors, property lending was sawed as a rational investment strategy and was preferred over technology.</p>
<p>Paus (2012) highlight that the association between the loss of control over key macroeconomic policy instruments resulting from membership in the Eurozone, as the interest rate level, and misguided microeconomic incentives, like the lax supervision of the banking sector or the neglect of local producers for many decades and extreme dependence on foreign investors and transnational corporation performance, have led to the economic crisis in Ireland.</p>

Despite not having a level of mortgage securitization as significant as in the USA, the macroeconomic and financial imbalances weakened the Spanish economy and made the country more vulnerable to the effects of the financial crisis that began in the USA. The Spanish banking crisis that started in 2008 lasted until 2014.

In Spain, the financial crisis had a brutal impact, and the years between 2009 and 2012 were a period of recession. In addition, the adjustment of the current account balance and the state support for banks was followed by rises of the public deficit, to more than 10%

of GDP in 2009 and 2011, increasing the public debt from less than 40% of GDP in 2008 to more than 85% in 2012.

The list of authors that studied the factors that have enhanced the effects of the Great Recession in Spain is also vast. Table 2.3 synthesizes several relevant views about this matter.

**Table 2.3:** Different views on the factors that contributed to the crisis in Spain

López and Rodríguez (2011) claim the Eurozone has guaranteed Spain an economy with an international umbrella, allowing strong purchasing capacity abroad, what by the other hand marginalized the importance of responsible and careful management of external deficits.
Ortega and Peñalosa (2012) highlight specifically the non-sustainable level of private debt, constant current account balances deficits, loss in competitiveness, and the real estate boom, accumulated since the participation in the EMU.
The amount of credit after the introduction of the Euro and a predominantly construction-based economy, according to Roy (2012) have created a brutal consumer “fever” in Spain.
For Hornero (2013) the crisis showed not only the European single currency vulnerabilities, but also the lack of regulation and supervision mechanisms for control the macroeconomic imbalances and public finances of the Eurozone members, that the response to exogenous shocks is not enough and, given the interconnection between the financial systems of the Eurozone, that more steps need to be done to implement a banking union.
From their analysis of the mortgage loans in Spain, Akin et al. (2014) conclude that not only lending standards are weaker in the boom, but also that banks with worse corporate governance problems, like the Spanish savings banks, the Cajas, soften even more the lending standards.
According to Ferreiro et al. (2014), the financialization process of the Spanish economy mainly in the 2000s led to greater indebtedness of households and non-financial corporations, and the dependency of Spain on external funding contributed to more serious real consequences after the collapse of international financial markets in 2008.
Although assuming that the crisis was complex, for Quaglia and Royo (2015), the banks in Spain, mainly the Cajas, in contrast with what happened in Italy, have been responsible for the property bubble and funded that through short-term capital inflows, which resulted in high net foreign debt.
Royo (2014) concluded that the crisis not only uncovered an unsustainable economic model, but also that the crisis is rooted in the process of institutional degeneration that preceded the crisis, clientelism, corruption, and impunity.
For Serrano and Pavía (2015) the huge amount of loss of some banks, like BFA-Bankia, the flaws in banks regulations and supervisory bodies, the concealment of losses of nonperforming loans, and the lack of updating the assets at market value had originated the crisis.

Navarrete (2016) points out that many flaws and errors have affected the solvency and credibility of Spain: inefficient policies and misuse of resources exacerbated by cases of corruption; lack of control of the Banco de España; excessive indebtedness; housing bubble, and lack of control of savings banks Cajas.

According to Santos (2018), the crisis results from the interaction of large international credit inflows with the incorrect governance of the Cajas sector, which made them subject to capture by the powerful political regional elites, and that led to investment and housing booms. It is also stressed the unclear procedures for private recapitalization and that the Lender of Last Resort tools was not directly controlled by the Bank of Spain.

Rajoy, the new PP leader, and Prime Minister of Spanish between the end of 2011 and 2018, who previously argued against raising taxes because stifling consumer spending could deep the recession, implemented several austere measures that had a strong impact on the economy. The sales tax was raised by 3 percentage points to 21%. The salaries of public employees and politicians were reduced. Access to unemployment allowance was changed, reducing the benefits. Some state-owned companies were closed.

In Ireland, it was Prime Minister Cowen, in office since the middle of 2008<sup>11</sup>, that faced the impacts of the beginning Irish banking crisis. In response to the decline in house prices, increase in credit defaults, and funding difficulties of the Irish banks, the government, intending to preserve the Irish banking system, issued in September an Irish National guarantee, valid for two years, covering debts estimated in € 440 billion, in favour of six Irish financial institutions: Allied Irish Bank, Bank of Ireland, Anglo Irish Bank, Irish Life & Permanent, and building societies EBS and Irish Nationwide. However, this was not enough, and it was followed by many billions of euros in assistance to the banks. For instance, at the end of 2008, it was announced the intention to pump €5.5 billion into its three largest banks, taking the control of Anglo Irish Bank, the third-largest bank. At the beginning of 2009, the government abandoned the plan to inject €1.5 billion into Anglo Irish Bank, and instead nationalized the bank, an operation that resulted in a total cost of more than €36.4 billion. Despite the creation of the National Asset Management Agency, with the task of managing and obtaining the best achievable return on the assets acquired by the State because of the financial system assistance programs, in the end, the government bailout to the Irish banks costed nearly €64 billion, as detailed in Healy (2013).

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<sup>11</sup> The Irish government was led by Fianna Fáil Between the middle of 1997 and the beginning of 2011.

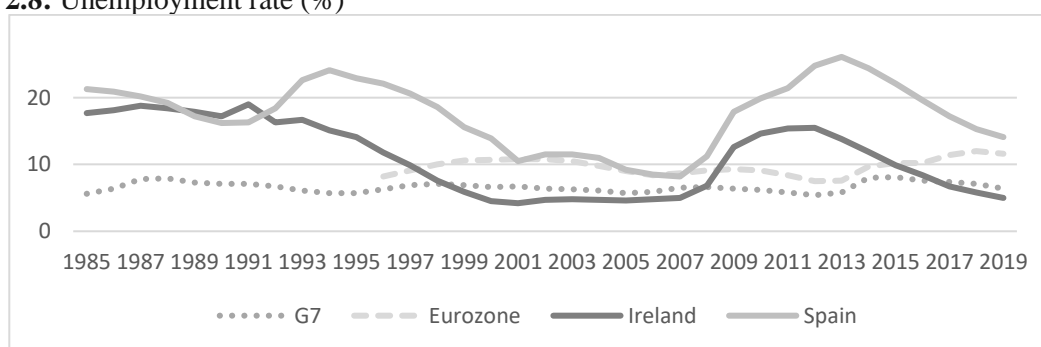
Recalling Figures 2.5 and 2.6, the impact on the public finances of recapitalizing the banks was simply brutal. Between 2008 and 2013 the government deficit was on average 13% of GDP per year, reaching the maximum deficit of 32.1% in 2010. And the public debt, which was around 24% of GDP in 2007, increased to 120% in 2013.

One of the macroeconomic variables where the impact of the crisis and of the austerity measures is very clear is the unemployment rate.

The unemployment rate in Ireland, as shown in Figure 2.8, was reduced from more than 18% in the middle of the 1980s to less than 5% in the twenty-first century (a period when the net migration was positive<sup>12</sup>), but reached more than 15% in 2012.

In Spain, contrasting with the reduction since the middle of the 1990s, the unemployment rate increased from 8.2% in 2007 to the maximum of 26.1% in 2013, the highest value in the last decades. These very high unemployment rates have affected particularly the young generations, leading to a huge increase in immigration. From a survey of the consequences of the austerity measures of internal devaluation and fiscal consolidation implemented in the Southern Countries after the Great Recession, Perez and Matsaganis (2018) concluded that these policies were responsible for a rise in lasting inequality, social exclusion, and emigration.

**Figure 2.8:** Unemployment rate (%)



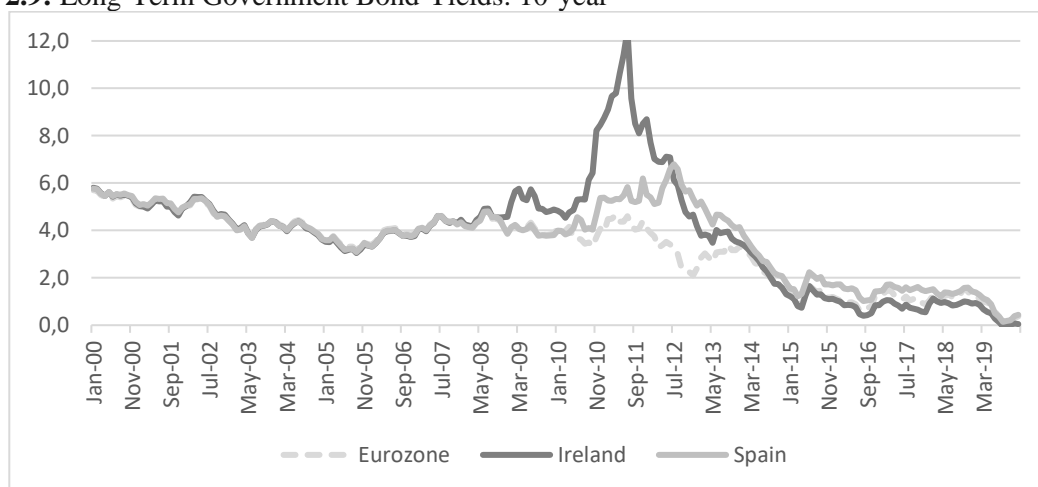
Source: World Economic Outlook.

The problematic situation of the Irish economy was aggravated by the fears about the repayment capacity of the government, by the contagion of the sovereign debt crisis that affected the southern European countries, and by the downgrade of Ireland's sovereign bonds, which contributed to the rise of the long-term government Irish bond yields, from

<sup>12</sup> According to the World Bank, in 2002 and 2007, the number of people that arrived from abroad to live in Ireland was more 200 thousand in comparison with the number Irish that left Ireland to live abroad.

4.5% in April 2010 to an astonishing rate of 12.5% in July 2011, as can be seen in Figure 2.9.

**Figure 2.9:** Long-Term Government Bond Yields: 10-year



Source: Federal Reserve Bank of St. Louis

According to Santos (2018), the banking crisis can be divided into five separate stages: Phase 1, from September 2008 to April 2010, the initial steps of the crisis; Phase II, from April 2010 to February 2011, restructuring; Phase III, from March 2011 to December 2011, market tests; Phase IV, from December 2011 to June 2012, “the flood”, and Phase V where there was a transfer of part of the banking crisis management from the Spanish authorities to the European ones. This was the peak of the Spanish banking crisis, when the Banco Financiero y Ahorro (BFA) and its subsidiary Bankia – at that time the fourth largest bank of Spain with 12 million customers –, after many years marked by difficulties and lack of transparency, as discussed in Gallizo and Sabi (2013), requested a bailout of more than €19 billion, the largest bank bailout in the nation's history. Although Spain has never lost the investment grade, the downgrade of the Spanish debt by the rating agencies, the fear of contagion, and the focus of financial markets on large fiscal deficits, increase the bond yields to a non-sustainable level, above 6%.

The Spanish government was unable to bail out its financial sector and applied in 2012 for a rescue package provided by the European Stability Mechanism (ESM), becoming the first Eurozone member state to request a rescue program only for the financial sector. The ESM program was a financing envelope of up to €100 billion, from which Spain used



€41.3 billion to recapitalize and restructure weak banks, and allowed the transfer of impaired assets to asset management companies<sup>13</sup>.

In 2013, at the end of the application of the ESM financial assistance program, the Spanish bond yields had been reduced to less than 4%, a reduction trend continued in the subsequent years. The famous speech of the European Central Bank's President, Mario Draghi, at the end of July 2012, stating that "the ECB is ready to do whatever it takes to preserve the Euro. And believe me, it will be enough", and the unconventional monetary policy implemented by the European Central Bank, such as the Outright Monetary Transactions program that allowed the indirect recapitalization of the European banks, were crucial for the stabilization of the banking sector in Spain. The positive effect of this program on the banking system, as discussed in Acharya et al. (2018), was not fully converted into economic growth.

The impacts of the financial crisis on the organization of the Spanish banking sector were studied by Baeza and López (2013). The authors concluded that more relevant than the number of institutions that received assistance (10 Cajas and Bankia), was the fact that from the 45 Cajas that existed before the crisis, 28 have been merged into other financial institutions. In addition, Betrán and Pons (2017) highlight that in opposition to the 1977 crisis that had an impact mainly on small and medium financial institutions, the 2008 crisis hit mainly medium-sized and large savings banks.

As an alert to the Spanish authorities, Cruz-Garcia et al. (2018) argue that Spanish market concentration, after the crisis, was above the European average, although still below the thresholds used to define an excessively concentrated market. In addition, from the analyses of the financial crises and regulatory regimes in Spain in the last 150 years, Beltrán et al. (2012) conclude that regulation and supervision of financial institutions have been responsible for a safer financial system and that, despite the improvements made in terms of regulation and supervision, such as the European Union directives and the Basel accords, financial crises do re-emerge from time to time. Betrán et al. (2012) showed that crises in Spain have been more frequent than in the rest of the World and have been becoming more and more severe. And finally, Betrán et al. (2012) stress that it should be not ignored that the private debt was still very high, above 150% of GDP.

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<sup>13</sup> Czubala (2015) discusses the legal structure, configuration, funding model, and ability to act of ESM.

In turn in Ireland, one of the last acts of Prime Minister Cowen at the end of 2010<sup>14</sup>, was to formally request financial aid to the European Union and the International Monetary Fund, at the end of 2011. A package of €85 billion was approved to be used until the end of 2013 and was associated with the implementation of some austerity measures, such as cuts in public sector wages and employment, cuts in social welfare payments, and health spending, as well as new and higher taxes. Keane (2015) has analysed the major tax changes that occurred during this period, and the impact of each measure in the total revenue as a percentage of GDP. Just to give some examples, the author estimated that the increase of the standard rate of the value-added tax by 1 percentage point in 2013 and again in 2014, to 23%, had an impact of 0.02%. The reintroduction of the property tax of 0.25%, and the reduction by around 7% of the standard income tax rate band, had an impact of 0,3%. On the other hand, these measures aggravated even more the unemployment rate, which reached 15.5% in 2012.

Ireland exited its bailout program at the end of 2013, with bond yields below 4%. According to Whelan (2014), Ireland's economy, despite the mistakes that were done, has several fundamental factors, including high productivity and a relatively flexible labour market, that helped Ireland to perform better under austerity measures than other Eurozone member states. In addition, other factors have been important for this positive outcome: the recovering construction sector; the compromise of the European Central Bank's President Draghi do to whatever it takes to preserve the Euro and the subsequent quantitative easing measures, and the positive impact for the Irish economy of the low oil prices.

The high growth rates since 2014 (8.5% in 2014, around 9.3% in 2017 and 2018 – recall Figure 2.4) led some commentators to call this period the Celtic Phoenix phase. This performance allowed a fast reduction of the unemployment rate to 5% and of public debt to less than 60% of GDP in 2019. It is important to mention that the GDP growth rate of 25,4% in 2015 resulted from tax inversion practices and restructuring by multinationals. The EU forced Ireland to close the Double Irish, a base erosion and profit shifting corporate tax tool (or tax avoidance technique) employed by certain large corporations to shift profits to low or no-tax jurisdictions. This led to some multinationals switching domiciles and relocating intangible assets to Ireland. This was possible because there are two other base erosion and profit shifting corporate tax tools still active in Ireland: the Single Malt, a small variation of

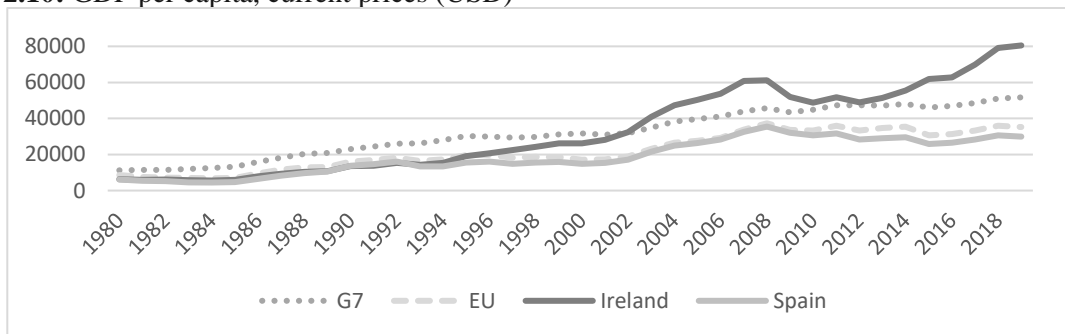
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<sup>14</sup> The elections in the first quarter of 2011 were won by the Fine Gale led by the new prime minister Kenny, who formed a coalition government with the Labour Party.

the Double Irish, and the Capital Allowances for Intangible Assets, which provide the allowances for the purchase of intangible assets, and especially intellectual property assets where the owner of the intangible assets is a connected party. This last technique was used by American multinational technology company Apple in 2015.

On one hand, from the analysis of the performance of the GDP per capita, presented in Figure 2.10, it is clear the extraordinary performance of the Irish economy since the integration in the European Union, and mainly during the Celtic Tiger phase: from a GDP per capita of circa 5,800 USD at the beginning of the 1980s to 19,000 in 1995, and 61,100 USD in 2008, more than 40% above the average of the Eurozone, 37,300 USD, and even above the average of the G7, 45,700 USD. The impact of the crisis was felt in the reduction of the Irish GDP per capita to 48,800 USD in 2012. However, since 2014, the GDP of the Celtic Phoenix has increased again, and reached the maximum of more than 80,000 USD in 2019, well above the pre-crisis value.

**Figure 2.10:** GDP per capita, current prices (USD)



Source: World Economic Outlook.

On the other hand, in Spain, it is also clear that the GDP per capita in the last years of the twentieth century increased more than the average level of the European Union. In addition, the GDP per capita was above 5 thousand USD in the middle of the 1980s, but had tripled to more than 15 thousand in 1992, when the Maastricht Treaty was signed. The fulfilment of the criteria to be part of the Economic and Monetary Union and all the adjustments that the Spanish economy needed to do, were responsible for a period of slight divergence in comparison with the average performance of the advanced economies. However, since the introduction of the common currency, and until the beginning of the financial crisis, the GDP per capita of Spain has more than doubled to 35 thousand USD. However, in the last years, Spain has diverged not only from the average GDP per capita of the more developed countries, but also from the average GDP per capita of the European

Countries, which shows that the effects of the Great Recession were more strongly felt in Europe, and particularly in the southern European countries like Spain.

To conclude the analysis of the Irish economy it is important to highlight that although the private debt has been reduced from 325% of GDP in 2011 to 234% in 2018, it is still one of the highest in the World. This, associated with the 11.4% current account deficit in 2019, and with the new real appreciation of the residential property's prices (75% between the middle of 2012 and the end of 2019), should work as an alert to the risks of another property bubble. In addition, there is another event that should be taken into consideration in future analyses: the impact of Brexit.

In the referendum of 2016, almost 52% of the voters decided that the UK should withdraw from the EU. After a transition period, and long negotiations, the UK officially left the EU on January 31, 2020. In the briefing paper of Ward (2021), Ireland was mentioned as the UK's fifth-largest export market and the seventh-largest source of imports, representing 40 billion pounds of UK exports and 30 billion pounds of all UK imports in 2019. Although Brexit is a recent situation, and its total effects are still uncertain, given that Ireland is uniquely exposed to Brexit due to a very high trade intensity with the UK, all the studies about this issue point to a strong negative impact of Brexit on the performance of the Irish economy. The report of the consulting firm Copenhagen Economics (2018) about this issue, used a computable general equilibrium (CGE) model and estimated that, in 2030, Brexit is going to lower Irish GDP by between 2.8% (a scenario where there is an agreement between the EU and the UK like the deals that the EU has with Norway and Iceland) and 7% (a no-deal scenario with the application of the World Trade Organization rules). Bergin et al. (2019) have reached a similar conclusion. These authors generated alternative paths using a global macroeconomic model (NiGEM) and assessed the impacts on Ireland using a consortium for small-scale model (COSMO). They estimate that the fall in the Irish output resulting from Brexit will be between 2.6% and 5.0% in the long run, depending on the scenario considered. The risk of a worst-case scenario of no-deal was overcome for now, with the signature of the EU–UK Trade and Cooperation Agreement, a free trade agreement, at the end of 2020.

At the end of 2019, rumours began to emerge that a new virus had appeared in the city of Wuhan in China. With the spread to other countries, the World Health Organization (WHO) would come to declare this new coronavirus disease a pandemic, in March 2020. Covid-19 has already infected hundreds of millions and caused millions of deaths around the world, a situation that had not happened since the so-called Spanish flu pandemic of 1918-

1920. Despite the great advances in science and the record time in which the vaccines were produced, the more developed countries are far from achieving group immunity, and the situation is still more uncertain in the other countries. What has been clear is the negative impact of this extraordinary situation on the world economy. To reduce the spread of contagions, most of the countries, including Ireland, applied containment measures, including restrictions on trading activity and even strict shutdowns.

One of the first studies of this issue was McQuinn et al. (2020). The authors' analyses the economic impacts of the pandemic in Ireland and estimate that the contraction of the GDP in 2020 was 1.8%, a reduction of 7 percentage points in comparison with the estimates before the appearance of Covid-19. The effects of the big estimated declines in consumption (9.2%) and investment (17%) would be mitigated by a strong performance of exports (an increase of 1.7%), mainly of medical and pharmaceutical products and computer services.

Regarding the impacts of the Covid-19 pandemic in the Spanish economy, Boscá et al. (2020), using a dynamic stochastic general equilibrium model, estimate that this event could reduce the GDP growth in 2020 by 6 to 10 percentage points, depending on the duration of the lockdown and the real effects on production.

The European Commission, in the recent interim European Economic Forecast - Winter 2021, estimates that the Eurozone has faced an average contraction of 6.8% in 2020. As one of the most affected countries during the first wave of contagion, the contraction was even higher in Spain, with a decrease of the GDP of around 11%. In contrast with all the other Eurozone members that have faced recessions, the European Commission estimates that the GDP in Ireland, despite the pandemic, has increased 3% in 2020. However, if the impact of the multinational companies were not considered, the Irish GDP would have shrunk 5.5% in 2020.

Under these circumstances, there are questions that it is important to try to answer: Is a new banking crisis likely to happen in Ireland in the next years? Was Spain, before the Covid-19 pandemic, better prepared to avoid a banking crisis, in comparison with 2014, when the last crisis ended? What are the impacts of the Covid-19 pandemic on the probability of both countries having a financial banking crisis?

#### **2.4. Literature review: logit models and banking crises**

As summarized by Frankel and Saravelos (2012), the early warning systems literature normally uses four different modelling approaches. First, the probit or logit model, relating

crises (dummy variables) to a set of variables. Second, the non-parametric indicators, also known as signals approach or KLR model<sup>15</sup>, uses thresholds to identify countries at risk of a crisis. Third, an approach that employs qualitative and quantitative analyses and splits countries into a crisis group and a non-crisis group - see, e.g., Edwards and Montiel (1989). Finally, a more recent strand that uses modern techniques to assess the likelihood of crises, such as various machine learning techniques. Frankel and Saravelos (2012) highlight various works, among them Nag and Mitra (1999), and their use of neural network models in the prediction of a currency crisis.

In this chapter, we are going to focus our analysis on the first approach, the logit model, mainly because it is the most suitable approach given the goals of our research, namely, the discussion of the factors behind the occurrence of financial crises. Concerning the authors that have used this technique for the prediction of financial crises, the list is vast, and we are just going to highlight what we consider to be the more relevant works.

Demirguç-Kunt and Detragiache (1998) used a multivariate logit model for 45 developed and developing countries, between 1980 and 1994, for the prediction of a banking crisis. The authors considered 13 macroeconomic variables: rate of growth of real GDP; change in the terms of trade; rate of change of local currency in terms of USD; real interest rate; rate of change of the GDP deflator; the ratio of central government budget surplus to GDP; the ratio of broad money to foreign exchange reserves; the ratio of domestic credit to the private sector to GDP; the ratio of bank liquid reserves to bank assets; rate of growth of real domestic credit (lagged two periods); a dummy variable for the presence of an explicit deposit insurance scheme; real GDP per capita, and one index of the quality of tax enforcement. The dependent variable was a dummy variable that takes the value zero if there is no banking crisis in that year, and the value one if in that year there was a banking crisis. The main conclusion of this study was that banking crises tend to emerge when the macroeconomic environment is weak, particularly when the GDP growth rate is low, and inflation is high. In addition, the authors associated a high level of real interest rates, a large degree of financial liberalization, and vulnerability to a balance of payments crises with systemic banking sector problems.

The same authors have also applied a multivariate logit empirical model to estimate banking crises probabilities two years later. Demirguç-Kunt and Detragiache (2000) used data between 1980 and 1995, for 65 countries and for 9 macroeconomic variables: GDP;

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<sup>15</sup> Additional details can be found in Appendix A.

terms of trade; the rate of depreciation of the exchange rate (relative to the USD); real interest rate; inflation; fiscal surplus / GDP; M2 / reserves; rate of growth of bank credit lagged two periods, and GDP per capita, which is used as a proxy for the structural characteristics of the economy. The authors have also used as dependent variable the same dummy variable that takes the value zero if there is no banking crisis, and the value one otherwise. In addition, in a second moment, they have applied his method to the analysis of banking crises that occurred in 1996 and 1997. Although economic growth and a stable exchange rate could offset part of the negative impact of other variables, the model indicated an impending crisis in Jamaica and signs of fragility in Thailand and the Philippines.

Hardy and Pazarbasioglu (1999) applied a multinomial logit model in the prediction of a banking crisis. The authors used a dummy variable that takes value two in a period when banking sector difficulties emerge, one in the preceding period, and zero otherwise. They also use another dummy variable which takes the value two at the start of a full-fledged banking system crisis, one at the start of an episode of severe but limited banking system distress, and zero if there are no banking crises. In their study, the authors worked with a sample of 50 countries, including countries with different degrees of vulnerability to a banking crisis, observed for at least eight years, and considered the following explanatory variables: real growth rates of GDP; private consumption; investment; incremental capital-output ratio; change in the deposit liabilities of the banking system as a percent of GDP; the ratio of total bank credit to the private sector to GDP; change in the ratio of gross foreign liabilities of the banking system to GDP; inflation rate (GDP deflator); real deposit interest rate; changes in the real exchange rate; growth of imports in real terms; terms of trade developments, and a dummy variable equal to one in a repeat crisis and its lead-up, and zero otherwise. Most of the explanatory variables were in first differences and logarithms, and some were lagged. Their work found that banking crises are associated with a large fall in real GDP growth, boom-bust cycles in inflation, credit expansion, capital inflows, rising real interest rates, deterioration of the capital-output ratio, a sharp decline in the real exchange rate, and adverse trade shocks.

Demirguç-Kunt and Detragiache (2005) studied the application of the signals approach and of probability models to the prediction of banking crises, for 94 countries between 1980 and 2002. Again, the authors used as the dependent variable a dummy variable that takes the value zero if there is no banking crisis, and one if there is a crisis. Regarding the macroeconomic variables, the authors used the rate of growth of real GDP, change in terms of trade, real interest rate, the rate of change of GDP deflator, the ratio of broad money

to international reserves, the ratio of the USD to local currency exchange rate, the rate of growth of real, domestic credit to the private sector rate, the ratio of private credit to GDP, real GDP per capita, and a dummy that equals one if the country has explicit deposit insurance and zero otherwise for the giving year. Using logit models, the authors found that low GDP growth, high real interest rates, and high inflation are significantly correlated with the occurrence of a banking crisis, and that exposure to real interest rate risk is also a source of banking fragility. In contrast, from the application of the KLR model to six crisis episodes (Jamaica, Indonesia, Korea, Malaysia, Philippines, and Thailand), the authors highlight that although there were some signs of fragility in Thailand and the Philippines, overall (and mistakenly) the KLR model would not indicate high vulnerability of these countries.

Von Hagen and Ho (2007) used a conditional fixed-effects logit estimator to compute the likelihood of a banking crisis occurring for given values of the explanatory variables, specifically, the rate of growth of the real GDP, dummy for severe recessions, dummy for large inflation rates, short-term real interest rate, government budget surplus relative to GDP, growth rates of the monetary base, growth rate of real domestic credit, ratio of credit to the private sector to GDP, ratio of bank liquid reserves to bank assets, stock market price change variable, rate of depreciation of the nominal exchange rate, deviation of the real exchange rate from its trend, dummy variable taking the value of one in periods during which interest rates were liberalized, real GDP per capita in USD, dummy variable for the existence of explicit deposit insurance schemes, and also add a currency crisis dummy as an explanatory variable together with interactive terms of this dummy and the macroeconomic variables. To avoid problems of simultaneity, all explanatory variables are used with a lag of one year. As the dependent variable, they used a binary index of banking crises. The data set included 47 countries, between 1980 and 2001. The authors found that slowdown of real GDP, extremely high inflation, and large fiscal deficits were the more relevant macroeconomic variables in the prediction of banking crises.

Aizenman and Noy (2013) investigated the incidence of banking crises in high-income and middle-income countries, separately and together, using a probit model. The data set used included 28 high-income countries and 74 middle-income countries between 1981 and 2010, and considered as independent variables, with a one-year lag specification, the GDP per capita, the real GDP growth rate, a binary variable denoting hyperinflation, the de facto floating exchange rate regime, the deposit money bank assets as a percentage of GDP, the growth rate of deposit money bank assets, the Chinn-Ito de jure index as the degree of openness of the capital account. In addition, it was also used a binary indicator of whether



an episode of banking crisis occurred in the previous decade and another binary indicator of whether an episode of currency crisis occurred also in the previous decade. The main conclusion of that work was that, despite having been shown that a banking crisis is associated with a higher likelihood of a future crisis, the magnitude of the crisis impacts is not affected by historical experience with past crises.

Duca and Peltonen (2013) computed a financial stress index<sup>16</sup> for identifying the starting date of a systemic financial crisis and created a discrete choice logit model, using data between 1990 and 2009 for 28 emerging and advanced countries. The authors found that the simultaneous use of domestic and global macro indicators of vulnerabilities can improve the prediction of the systemic financial crisis and that a multivariate model can improve upon univariate models.

The prediction of systemic banking crises for low-income countries in Sub-Saharan Africa was developed by Caggiano et al. (2014). The authors used a sample of 35 countries, between 1980 and 2008, and considered both a binomial logit model and a multinomial logit approach. In the multinomial logit, the dependent variable was a dummy that took the value one on the first year of the crisis, the value two on crisis years other than the first, and zero at all other times. The baseline model used 8 explanatory variables: annual percentage change of real GDP; rate of change of the nominal exchange rate relative to the USD; annual percentage change of the GDP deflator; rate of growth of the ratio of real domestic private credit to GDP; the ratio of M2 to foreign exchange reserves of the Central Bank; net open foreign exchange risk position (ratio of net foreign assets to GDP); leverage (ratio of banking system capital to assets), and liquidity (ratio of banking system private credit to deposits). All the variables used a lag of one period, with exception of the GDP growth for which a lag of two periods was used. The authors concluded that the multinomial logit model is more effective in the prediction of banking crisis than the binomial logit model, and that a decline in economic growth, banking system illiquidity and large net open positions were solid predictors of banking crises for the countries studied.

Caggiano et al. (2016) also compare the performance and differences between binomial and multinomial logit models, but this time using a large and heterogeneous sample of 92 world economies observed between 1982 and 2010. Some commonly used control

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<sup>16</sup> Regarding financial stress indexes, it is important to refer the Country Level Index of Financial Stress (CLIFS), which can be found in the Statistical Data Warehouse of the European Central Bank. The CLIFS includes six financial stress measures that capture three financial market segments: equity markets, bond markets and foreign exchange markets. More details can be found in Duprey et al. (2017). In addition, the European Central Bank publishes twice a year the Financial Stability Review.

variables are included in this study as potential predictors: annual percentage change of real GDP; the log of real GDP per capita; annual percentage change of the GDP deflator; rate of change in terms of trade of goods and services; the ratio of M2 to foreign exchange reserves of the Central Bank; lending interest rate adjusted for inflation as measured by the GDP deflator; rate of growth of the ratio of real domestic private credit to GDP; net open foreign exchange position - the ratio of net foreign assets to GDP, and liquidity - the ratio of banking system private credit to deposits. All the variables were lagged one period. In the multinomial logit model, the dependent variable takes on the value one on the first year of the crisis, the value two on crisis years other than the first, and zero at all other times. In that work, the multinomial logit outperforms the binominal logit model in predicting systemic banking crises. In addition, the longer the average duration of the crisis in the sample the larger the improvement. Furthermore, the credit to GDP growth rate, the ratio of the money supply to reserves, the rate of inflation, the liquidity position, and the net open position of the banking system are the best predictors of the arrival of a systemic banking crisis.

It should be highlighted, as well, the work of Detken et al. (2017), developed under the umbrella of the ESRB<sup>17</sup>. Although the main contributions of that study were the presentation of the new database for financial crises in European countries and the confirmation that multivariate models can provide higher accuracy in comparison to univariate signalling models, the authors also concluded that combined credit and asset price indicators can improve the early warning properties regarding systemic crisis.

Finally, Kiley (2021) uses a data set covering the period from 1870 to 2012 for 17 developed countries, including the incidence of financial crises, total loans to the non-financial private sector, the consumer price index (CPI), the ratio of the current account to gross domestic product, and house and equity prices. By applying a logit regression model, the author concludes that house prices, equity prices, and current account deficits have substantial leading information in econometric models to predict the occurrence of a financial crisis.

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<sup>17</sup> European Systemic Risk Board, in this case specifically the Financial Stability Committee.

## 2.5. Data

We collected data from 1960 to 2016 for 69 countries. Regarding the selection of these countries<sup>18</sup>, we tried not only to have a representative sample of countries of each continent (see Table 2.4) but also a balanced set of countries regarding the proneness to financial crisis events (see Table 2.5).

**Table 2.4:** Distribution of sample countries by continent

Continents	Europe	America	Africa	Asia and Oceania
Number of countries	22	20	14	13
Percentage	31.88%	28.99%	20.29%	18.84%

Source: Author's calculations.

**Table 2.5:** Relation between the number of countries and number of years of a banking crisis

Years of crisis between 1960 and 2016	0 - 5	6 - 10	11 or more
Number of countries	22	32	15
Percentage	31.88%	46.38%	21.74%

Source: Author's calculations.

Regarding the macroeconomic variables to be used, they are listed in Table 2.6.

**Table 2.6:** Macroeconomic variables and sources

Variable	Main source
GDP growth (annual %)	World Development Indicators from the World Bank and IMF World Economic Outlook
Terms of trade	IMF International Financial Statistics and OECD National Accounts at a Glance
Rate of depreciation of the exchange rate	World Development Indicators from the World Bank and IMF International Financial Statistics and Federal Reserve Economic Data
Real interest rate	World Development Indicators from the World Bank; AMECO; IMF International Financial Statistics; World Bank International Debt

<sup>18</sup> Algeria, Angola, Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Canada, Central African Republic, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hungary, Iceland, India, Indonesia, Ireland, Italy, Japan, Kenya, Malaysia, Mauritius, Mexico, Morocco, Myanmar, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Republic of Korea, Romania, Russia, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Thailand, Tunisia, Turkey, UK, United USA, Uruguay, Venezuela, Zambia, Zimbabwe.

	Statistics; Braun et al. (2000); Bank of Greece (2014); Reserve Bank of New Zealand; Tafunell and Carreras (2005); OECD Main Economic Indicators; Hanson and Neal (1985).
Inflation, GDP deflator (annual %)	World Development Indicators from the World Bank and IMF World Economic Outlook
Fiscal surplus (% of GDP)	World Development Indicators from the World Bank, IMF Historical Public Finance Data set, and IMF <i>Historical Public Debt Database and IMF Global Debt Database</i>
Domestic credit to the private sector (% of GDP)	World Development Indicators from the World Bank and Federal Reserve Economic Data
GDP per capita (constant 2010 USD)	World Development Indicators from the World Bank and IMF International Financial Statistics and IMF World Economic Outlook

All the variables used in our analysis are lagged once, that is, the variation in the performance of any macroeconomic variable is going to impact the risk of having a financial crisis in the next year.

## 2.6. Results

We are going to develop our analysis in three separate steps.

In the first step, we construct the dummy that indicates the occurrence of a banking crisis. The number “1” represents the occurrence of a banking crisis in a certain country in a certain year, and “0” means there was no crisis in that country in that year. Regarding the definition of the dummy variable, our references are Reinhart and Rogoff (2011) and the webpage on Global Crises by Country, Behavioral Finance & Finance Stability, from the Harvard Business School<sup>19</sup>.

In step two, we use a logit model, with the macroeconomic variables detailed above in Table 2.6. In the computations we used the software Gretl, version 2021b.

Finally, in the third step, we calculate our financial crisis warning index for Ireland and Spain, using the estimated coefficients, and considering a normal distribution.

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<sup>19</sup> <https://www.hbs.edu/behavioral-finance-and-financial-stability/data/Pages/global.aspx>

The estimates concern a model which has as explanatory variables the GDP growth rate, the terms of trade (tot) and its first difference (FD), the exchange rate depreciation, inflation rate, fiscal surplus / GDP (what we will call “deficit”), the rate of growth of bank credit (which we will call “credit”), and first difference of the credit, and finally GDP per capita (GDPpc).

**Table 2.7:** Logit model estimates: version 1

	Coefficient	p-value <sup>20</sup>
Constant	-0.527876	0.4187
GDP growth rate	-0.127121	0.0000 ***
FD_tot	1.16201	0.6677
Tot	-1.19593	0.0673 *
Exchange rate	0.00442067	0.7403
RIR	0.00273547	0.2757
Inflation	0.000188061	0.462
Deficit	0.0126348	0.0000 ***
FD_credit	-0.0246841	0.0005 ***
Credit	0.00948211	0.0000 ***
GDPpc	-1.14779e-05	0.0035 ***

The number of observations: 3189.

The number of cases “correctly predicted”: 2701 (84.7%).

The number of banking crises “correctly predicted”: 41 (8%).

Source: Authors calculations.

The main results of the estimation of the logit model are reported in Table 2.7. We highlight the fact that GDP growth rate, deficit, credit growth rate, the first difference of the credit growth, and GDP per capita are statistically significant at the 1% significance level, while the terms of trade are statistically significant at the 10% significance level. Almost all the estimated coefficients display the expected sign, i.e., lower real GDP growth, GDP per capita and terms of trade rate increases the probability of a crisis, and likewise for higher deficit and credit. The exception was the first difference of credit growth, which is in part justified by the fact that we are not working only with the first year of the banking crises,

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<sup>20</sup> If the p-value is less than our level of significance we reject the null hypothesis. In this case, in our model, the corresponding variable is apparently not relevant for the prediction of the financial crisis. In Gretl, following standard practice, low enough p-values are highlighted with asterisks: “\*” means that we can reject H0 at the 10% level of significance (the p-value is less than 0.1); “\*\*” means that we can reject H0 at the 5% level of significance (the p-value is less than 0.05); “\*\*\*” means that we can reject H0 at the 1% level of significance (the p-value is less than 0.01).

and the beginning of a banking crisis is normally accompanied by a sudden break in credit, which has a direct impact in the performance of the economy.

After testing the null hypothesis that the parameters of the first difference of the terms of trade, depreciation of the exchange rate, real interest rate, and inflation rate, are jointly zero, and given that the hypothesis was not rejected, we estimated a reduced version of the model, presented in Table 2.8.

**Table 2.8:** Logit model estimates: version 2

	Coefficient	p-value
Constant	-0.443739	0.4884
GDP growth rate	-0.132578	0.0000 ***
Tot	-1.31692	0.0397 **
Deficit	0.0142098	0.0000 ***
FD_credit	-0.0253188	0.0003 ***
Credit	0.0100712	0.0000 ***
GDPpc	-1.17532e-05	0.0028 ***

The number of observations: 3328.

The number of cases “correctly predicted”: 2836 (85.2%).

The number of banking crises “correctly predicted”: 48 (9.3%).

Source: Authors calculations.

It should be noticed that in the new estimation the terms of trade become statistically significant at a 5% significance level.

As expected, when GDP growth accelerates, when the terms of trade improve or when the average GDP per capita of the country increases, the probability of having a financial crisis diminishes. Again, as expected, when the deficit and credit decreases, the probability of having a financial crisis also decreases.

What does the model say regarding the probabilities of Ireland and Spain facing banking crises in the last decades? To answer these questions, we present Table 2.9 and Table 2.10 and Figure 2.11 and Figure 2.12, our results in the case of Ireland and Spain, respectfully.

In the Irish case, the risk of having a banking crisis was low during the 1970s, 1980s, and 1990s and the first year of the twenty-first century. However, in Figure 2.11, it is also clear the deterioration of the financial conditions in 2008 and 2009. Between 2008 and 2010 the probability of having a financial crisis was increased from 3.2% to the peak of 55.8%.

The probability of having a banking crisis was still above the average of the period of analysis until 2014.

Finally, it should be also highlighted the small impact that the Covid-19 pandemic has on our model of the Irish case, with the risk of having a new banking crisis estimated to be less than 1%.

**Table 2.9:** Crisis index and estimated probabilities for Ireland, between 1975 and 2021

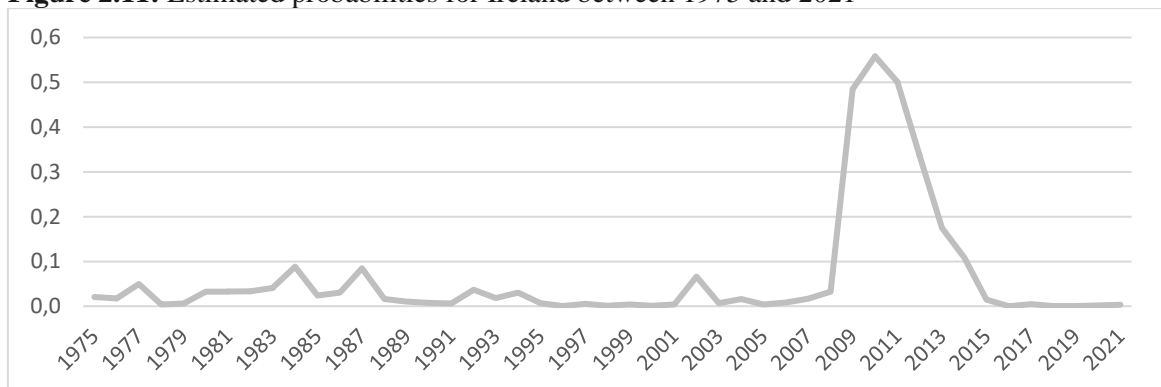
Year	Data x Coefficient <sup>21</sup>						Constant	Total	Probability <sup>22</sup>
	GDP	Tot	Deficit	Credit	FD_credit	GDPpc			
1975	-0.56	-1.36	0.17	0.37	-0.04	-0.17	-0.44	-2.04	0.02
1976	-0.75	-1.36	0.20	0.35	0.07	-0.18	-0.44	-2.11	0.02
1977	-0.18	-1.36	0.17	0.35	0.00	-0.18	-0.44	-1.65	0.05
1978	-1.09	-1.35	0.10	0.36	-0.04	-0.19	-0.44	-2.65	0.00
1979	-0.95	-1.36	0.13	0.40	-0.11	-0.20	-0.44	-2.53	0.01
1980	-0.41	-1.35	0.17	0.41	-0.03	-0.20	-0.44	-1.85	0.03
1981	-0.41	-1.34	0.14	0.41	0.01	-0.21	-0.44	-1.84	0.03
1982	-0.44	-1.34	0.19	0.41	0.00	-0.21	-0.44	-1.84	0.03
1983	-0.30	-1.34	0.18	0.43	-0.05	-0.21	-0.44	-1.74	0.04
1984	0.03	-1.34	0.19	0.44	-0.01	-0.21	-0.44	-1.35	0.09
1985	-0.58	-1.35	0.16	0.43	0.02	-0.22	-0.44	-1.98	0.02
1986	-0.41	-1.35	0.10	0.41	0.05	-0.23	-0.44	-1.87	0.03
1987	0.06	-1.37	0.21	0.42	-0.01	-0.22	-0.44	-1.37	0.08
1988	-0.62	-1.37	0.09	0.41	0.02	-0.23	-0.44	-2.14	0.02
1989	-0.69	-1.37	0.07	0.43	-0.05	-0.25	-0.44	-2.32	0.01
1990	-0.77	-1.37	0.02	0.44	-0.04	-0.26	-0.44	-2.42	0.01
1991	-1.12	-1.36	0.30	0.46	-0.04	-0.28	-0.44	-2.49	0.01
1992	-0.26	-1.37	0.07	0.43	0.07	-0.29	-0.44	-1.79	0.04
1993	-0.44	-1.37	0.04	0.44	-0.02	-0.30	-0.44	-2.10	0.02
1994	-0.36	-1.37	0.13	0.42	0.05	-0.30	-0.44	-1.88	0.03
1995	-0.76	-1.37	0.02	0.44	-0.04	-0.32	-0.44	-2.49	0.01
1996	-1.28	-1.36	0.05	0.68	-0.61	-0.35	-0.44	-3.31	0.00
1997	-0.98	-1.36	-0.02	0.72	-0.11	-0.37	-0.44	-2.56	0.01
1998	-1.45	-1.36	0.01	0.81	-0.23	-0.41	-0.44	-3.07	0.00
1999	-1.15	-1.37	-0.03	0.86	-0.12	-0.44	-0.44	-2.69	0.00

<sup>21</sup> We multiplied the data that we collected for each macroeconomic variable and for each year by the corresponding coefficient, estimated in our empirical analysis (see Table 2.7). The sum of these and of the constant gives the values in column "Total".

<sup>22</sup> In the column "probability" we calculated the probability of a financial crisis in the country, in each year, considering a normal distribution and the index values (column "Total").

2000	-1.39	-1.36	0.03	1.00	-0.35	-0.48	-0.44	-3.00	0.00
2001	-1.25	-1.35	-0.05	1.03	-0.09	-0.52	-0.44	-2.67	0.00
2002	-0.70	-1.36	0.03	0.72	0.78	-0.54	-0.44	-1.51	0.07
2003	-0.78	-1.35	0.00	0.76	-0.09	-0.56	-0.44	-2.47	0.01
2004	-0.40	-1.35	0.01	0.86	-0.26	-0.57	-0.44	-2.14	0.02
2005	-0.89	-1.34	0.01	1.06	-0.49	-0.59	-0.44	-2.69	0.00
2006	-0.76	-1.33	0.00	1.26	-0.50	-0.61	-0.44	-2.39	0.01
2007	-0.67	-1.33	-0.01	1.46	-0.50	-0.63	-0.44	-2.12	0.02
2008	-0.71	-1.32	0.02	1.59	-0.34	-0.65	-0.44	-1.85	0.03
2009	0.59	-1.31	0.26	1.67	-0.20	-0.61	-0.44	-0.04	0.48
2010	0.67	-1.33	0.18	1.70	-0.07	-0.57	-0.44	0.15	0.56
2011	-0.24	-1.32	0.34	1.34	0.90	-0.57	-0.44	0.00	0.50
2012	-0.05	-1.32	0.35	1.17	0.42	-0.57	-0.44	-0.42	0.34
2013	-0.03	-1.32	0.18	1.12	0.12	-0.57	-0.44	-0.94	0.17
2014	-0.18	-1.32	0.04	1.05	0.19	-0.57	-0.44	-1.24	0.11
2015	-1.13	-1.33	-0.07	0.81	0.60	-0.62	-0.44	-2.19	0.01
2016	-3.34	-1.35	0.01	0.53	0.70	-0.77	-0.44	-4.65	0.00
2017	-0.49	-1.35	-0.14	0.48	0.13	-0.79	-0.44	-2.61	0.00
2018	-1.21	-1.34	0.01	0.45	0.10	-0.85	-0.44	-3.30	0.00
2019	-1.13	-1.33	0.00	0.41	0,09	-0,92	-0,44	-3,33	0,00
2020	-0.74	-1.34	0.00	0.36	0,12	-0,95	-0,44	-2,99	0,00
2021	-0.45	-1.35	0.07	0.33	0,09	-1,00	-0,44	-2,76	0,00

**Figure 2.11:** Estimated probabilities for Ireland between 1975 and 2021



Source: Data used in the empirical analysis, and authors' computations.

In Spain, in the first place, the model shows that the second half of the 1970s and the first half of the 1880s was a period of volatility in our index, which matches the reality, because the period between 1977 and 1985 was a period of a banking crisis.



Secondly, we have another peak in 1994. However, as explained in Section 2, this was associated with the end of the economic cycle, and the worst-case scenario of having a banking crisis did not materialize.

In the third place, since 2000 the probability of a financial crisis increased year after year, and then there was the brutal impact of the financial crisis between 2008 and 2014. The probability of a banking crisis was around 2.5% in 2001, but increased to 12.4% in 2008, 28.5% in 2009, and 55.7% in 2010. At the end of the period of crisis, the risk was still very high. For example, at the beginning of 2015, the risk of having a banking crisis was still around 25%.

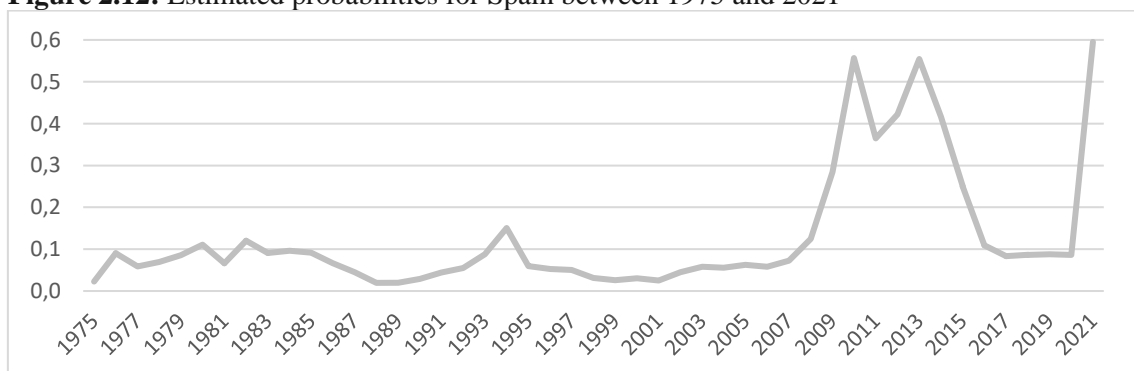
Finally, in contrast with the Irish case, the Spanish economy was one of the most affected by the negative impacts of the Covid-19 pandemic in Europe, increasing the risk of a financial crisis from 8.6% in 2020 to 59.5% in 2021, a higher probability than during the Great Recession.

**Table 2.10:** Crisis index and estimated probabilities for Spain, between 1975 and 2021

Year	Data x Coefficient						Constant	Total	Probability
	GDP	Tot	Deficit	Credit	FD_credit	GDPpc			
1975	-0.71	-1.24	0.00	0.71	-0.04	-0.19	-0.53	-2.00	0.02
1976	-0.07	-1.24	0.00	0.74	-0.05	-0.19	-0.53	-1.34	0.09
1977	-0.42	-1.23	0.09	0.76	-0.03	-0.20	-0.53	-1.56	0.06
1978	-0.36	-1.23	0.06	0.73	0.04	-0.20	-0.53	-1.48	0.07
1979	-0.19	-1.24	0.02	0.68	0.08	-0.20	-0.53	-1.37	0.09
1980	-0.01	-1.22	0.04	0.68	0.01	-0.20	-0.53	-1.22	0.11
1981	-0.28	-1.22	0.05	0.69	-0.02	-0.20	-0.53	-1.51	0.07
1982	0.02	-1.22	0.09	0.72	-0.05	-0.20	-0.53	-1.17	0.12
1983	-0.16	-1.22	0.07	0.74	-0.04	-0.20	-0.53	-1.34	0.09
1984	-0.23	-1.22	0.10	0.70	0.07	-0.20	-0.53	-1.30	0.10
1985	-0.23	-1.23	0.13	0.64	0.09	-0.21	-0.53	-1.33	0.09
1986	-0.30	-1.23	0.11	0.62	0.03	-0.21	-0.53	-1.50	0.07
1987	-0.41	-1.25	0.08	0.61	0.02	-0.22	-0.53	-1.70	0.04
1988	-0.71	-1.25	0.05	0.64	-0.05	-0.23	-0.53	-2.06	0.02
1989	-0.65	-1.26	0.01	0.70	-0.10	-0.24	-0.53	-2.06	0.02
1990	-0.61	-1.25	0.07	0.73	-0.06	-0.25	-0.53	-1.90	0.03
1991	-0.48	-1.25	0.07	0.72	0.01	-0.26	-0.53	-1.71	0.04
1992	-0.32	-1.25	0.05	0.74	-0.02	-0.26	-0.53	-1.60	0.05
1993	-0.12	-1.26	0.07	0.72	0.03	-0.27	-0.53	-1.35	0.09
1994	0.13	-1.26	0.15	0.70	0.03	-0.26	-0.53	-1.03	0.15

1995	-0.30	-1.26	0.07	0.67	0.05	-0.27	-0.53	-1.56	0.06
1996	-0.35	-1.26	0.11	0.67	0.01	-0.27	-0.53	-1.62	0.05
1997	-0.34	-1.25	0.10	0.67	-0.01	-0.28	-0.53	-1.64	0.05
1998	-0.47	-1.25	0.03	0.72	-0.08	-0.29	-0.53	-1.86	0.03
1999	-0.56	-1.27	0.03	0.78	-0.10	-0.30	-0.53	-1.94	0.03
2000	-0.57	-1.26	0.03	0.83	-0.07	-0.31	-0.53	-1.88	0.03
2001	-0.67	-1.24	0.02	0.90	-0.12	-0.33	-0.53	-1.95	0.03
2002	-0.50	-1.24	0.01	0.90	0.00	-0.33	-0.53	-1.70	0.04
2003	-0.35	-1.24	0.01	0.94	-0.07	-0.34	-0.53	-1.57	0.06
2004	-0.38	-1.24	0.00	1.01	-0.11	-0.34	-0.53	-1.59	0.06
2005	-0.40	-1.23	0.01	1.10	-0.14	-0.35	-0.53	-1.53	0.06
2006	-0.46	-1.22	0.00	1.29	-0.30	-0.36	-0.53	-1.58	0.06
2007	-0.52	-1.21	0.00	1.49	-0.32	-0.36	-0.53	-1.46	0.07
2008	-0.46	-1.21	-0.01	1.59	-0.17	-0.37	-0.53	-1.15	0.12
2009	-0.11	-1.20	0.06	1.62	-0.05	-0.37	-0.53	-0.57	0.28
2010	0.48	-1.21	0.15	1.65	-0.04	-0.35	-0.53	0.14	0.56
2011	-0.02	-1.20	0.10	1.63	0.03	-0.35	-0.53	-0.35	0.36
2012	0.10	-1.19	0.11	1.59	0.06	-0.35	-0.53	-0.20	0.42
2013	0.38	-1.20	0.17	1.50	0.15	-0.34	-0.53	0.14	0.55
2014	0.18	-1.19	0.09	1.39	0.18	-0.33	-0.53	-0.21	0.42
2015	-0.18	-1.20	0.08	1.24	0.24	-0.34	-0.53	-0.68	0.25
2016	-0.49	-1.22	0.05	1.13	0.17	-0.35	-0.53	-1.23	0.11
2017	-0.39	-1.23	-0.06	1.06	0.11	-0.36	-0.53	-1.38	0.08
2018	-0.38	-1.22	0.04	1.00	0.09	-0.37	-0.53	-1.36	0.09
2019	-0.31	-1.21	0.03	0.94	0.10	-0.38	-0.53	-1.35	0.09
2020	-0.25	-1.21	0.04	0.90	0.07	-0.38	-0.53	-1.37	0.09
2021	1.38	-1.23	0.14	1.03	-0.21	-0.34	-0.53	0.24	0.60

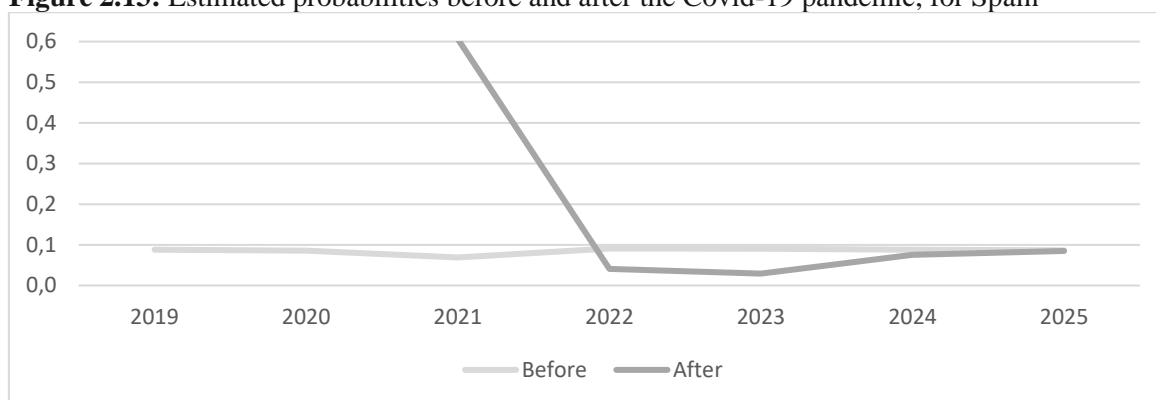
**Figure 2.12:** Estimated probabilities for Spain between 1975 and 2021



Source: Data used in the empirical analysis, and authors' computations.

In Figure 2.13 we can see the effect of restrictive measures imposed during the first year of the pandemic in Spain, using our model of prediction of banking crises. We have considered the projections for 2021-2025 published by the IMF in October 2019 and October 2021, more specifically the IMF's World Economic Outlooks, for the GDP, deficit, and the GDP per capita.

**Figure 2.13:** Estimated probabilities before and after the Covid-19 pandemic, for Spain



Source: Authors calculations.

The effect of the pandemic of Covid-19 in the performance of GDP growth, public deficit, and GDP per capita, *ceteris paribus*<sup>23</sup>, have increased the risk of Spain having a banking crisis by 53.8 percentage points, from less than 7% to more than 60%.

However, it should be also referred that the fiscal and monetary responses of the European Union institutions, in this context of a symmetric crisis provoked by the Covid-19, were very different from the response to the Great Recession. There was not only a massive injection of capital into the economy, allowing the reduction of the borrowing cost of the most vulnerable countries of the Eurozone and preventing problems in the banking institutions in these countries, but also a suspension of the need to comply with fiscal rules of the Stability and Growth Pact. The best example of this mindset change was the increase of solidarity within the Eurozone, with the historical approval of the first instruments of European debt emission, also known as Next Generation EU. This is an exceptional debt facility that will make €800 billion available to Member States to fund the Recovery and Resilience Plans.

<sup>23</sup> For the terms of trade and credit, between 2021 and 2025, we have used the average values observed between 2017 and 2020.

## 2.7. Conclusion

In this chapter, we studied the issue of which macroeconomic variables are relevant to the prediction of a banking crisis. Following the main references in the economic literature, using a large data set and a binomial logit model, we have constructed a financial crisis index, with the estimates of the coefficients of the logit model.

We have concluded that GDP growth rate, terms of trade, public government deficit, domestic credit to the private sector, and GDP per capita are relevant macroeconomic variables for the prediction of banking crises.

We used our model to analyse in more detail the cases of Spain and Ireland. We showed that our banking crisis index was useful regarding the prediction of the Spanish crises between 1977 and 1985 and that it was even more reliable in the prevision of the Great Recession in both Spain and Ireland.

Our results indicate that, in Ireland, the risk of a banking crisis in 2010 was very high, specifically 55.8%. However, it was continuously reduced over the next years, and became very close to zero since 2016. The Covid-19 pandemic had a very weak impact on this index, which in 2021 was still around 0.3%.

In the case of Spain, there was a different outcome. The reduction of the risk of a banking crisis was not as substantial as in Ireland, but still was very large, from 55.4% in 2014 to 8.6% in 2021. The predictions before the Covid-19 pandemic pointed to a reduction to 6.89% in 2022. However, Spain was one of the European countries most affected by the Covid-19 pandemic, and in the end, the risk of a financial crisis jumped to 59.5% in 2022. Nevertheless, the worst-case scenario of a new banking crisis did not happen in Spain, largely because of the action of the European authorities. Although the forecasts of IMF indicate a return to the level of economic performance of before the pandemic, this is a scenario with plenty of risks. A major risk is the fact that uncertainty remains very high, because, although the vaccination is advancing at a good pace in Europe, new Covid-19 variants, more dangerous and contagious, can have disastrous effects on the finances of the Eurozone countries. But there are also other reasons for concern.

For example, Eichengreen (2014) - who is one of the authors that exhaustively studied the Great Depression and the Great Recession and the economic policies implemented in both periods – argues that little was done about the problem of too-big-to-fail financial institutions, because the argument for radical action was weakened by the success of policymakers in preventing the worst-case scenario in the Great Recession. The

author also argues that the USA and Europe did just enough to prevent the collapse of the monetary system and avoid another Great Depression, and that too little was done to make the world a safer financial place.

In addition, in the case of the European countries, it should be also referred that, despite the many advances in integration (of which the European recovery funds and the steps taken on the debt mutualization are good examples), the banking union is far from concluded, and that the Eurozone is still distant from being considered an optimal currency area, as defined by Mundell (1961)<sup>24</sup>.

And finally, it should also be highlighted the importance of the good management of the bank moratoria and other forms of economic stimulus provided by the authorities, and the adequate use of the European recovery funds by Governments.

### **Appendix A: the KLR model**

The “signal approach” method, also known as the non-parametric indicators approach or KLR model, was developed by Kaminsky, Reinhart, and Lizondo. This methodology, as discussed in Kaminsky et al. (1998), involves monitoring the evolution of several economic variables that tend to exhibit unusual behaviour in the periods preceding a crisis. In that paper, the authors use a sample of 15 developing and 5 industrial countries, monthly data between 1970 and 1995, including 76 events of a currency crisis, and a vast list of variables, listed in Table 2.11.

**Table 2.11:** List of variables used in Kaminsky et al. (1998)

<p><b>External:</b> Capital account (1) international reserves/base money (2) international reserves/GDP (3) stock of international reserves (4) reserves/imports (5) growth in reserves (6) central bank foreign assets/base money (7) growth of central bank net foreign assets (8) net foreign assets/M1 (9) net foreign assets/M1 squared (10) errors and omissions plus short-term capital (11) share capital flows in the form of short-term borrowing (12) short-term capital flows/GDP (13) FDI/debt (14) capital account balance/GDP (15) domestic-foreign real interest rate differential (16) domestic-foreign nominal interest rate differential</p>
<p><b>Debt profile:</b> (1) foreign aid (2) external debt/GDP (3) public debt/GDP (4) share of commercial bank loans (5) share of concessional loans (6) share of variable-rate debt (7) share</p>

<sup>24</sup> According to Mundell, there are four main criteria that define an optimal currency area: high labour mobility throughout the area; capital mobility and price and wage flexibility; a currency risk-sharing or fiscal mechanism to share risk across countries in the optimal currency area, and similar business cycles.

of short-term debt (8) share of public sector debt (9) share of multilateral development bank loans (10) debt service/GDP adjusted for GDP growth
<b>Current account:</b> (1) change in real exchange rate (2) level of the real exchange rate (3) drift of the real exchange rate (4) variance of the real exchange rate (5) deviations from PPP in the real bilateral exchange rate (6) deviations from trend in the real exchange rate (7) deviations from the historical average of the real exchange rate (8) real exchange rate squared (9) trade balance/GDP (10) current account/GDP (11) exports/GDP (12) exports/imports (13) change in exports (14) change in imports (15) saving/GDP (16) investment/GDP (17) change in the terms-of-trade (18) change in export prices (19) exchange rate expectations
<b>International:</b> (1) OECD real GDP growth (2) international interest rates (3) U.S. interest rates (4) foreign price level
<b>Financial:</b> Financial liberalization (1) real interest rates (2) credit growth (3) growth in credit/GDP (4) lending-deposit interest rate spread (5) growth in M2 multiplier (6) growth of credit/reserve money relative to the United States
<b>Other financial:</b> (1) “shadow” exchange rate (2) parallel market premium (3) central parity (4) position within the band (5) central bank credit to the banking system (6) money demand-supply gap (7) M1 growth (8) M1 level (9) M1 growth relative to the United States (10) broad money growth relative to the United States (11) change in bank deposits (12) bond-yields (13) inflation (14) inflation relative to the US (15) M2/international reserves
<b>Real sector:</b> (1) real GDP growth (2) per-capita growth (3) output level (4) output gap (5) manufacturing real wages (6) wage growth (7) unemployment rate (8) employment growth (9) changes in stock prices
<b>Fiscal:</b> (1) fiscal deficit/GDP (2) fiscal deficit/government spending relative to the United States (3) government consumption/GDP (4) domestic credit to public sector/total credit (5) growth in public sector credit (6) public sector credit growth/GDP
<b>Institutional/structural:</b> (1) multiple exchange rate dummy (2) exchange controls dummy (3) relative GDP per capita (4) financial liberalization dummy (5) banking crisis dummy (6) openness (7) trade concentration (8) months spent on the peg (9) past foreign exchange market crisis (10) past foreign exchange market event
<b>Political:</b> (1) government victory dummy (2) government loss dummy (3) elections (4) change in government (5) legal executive transfers (6) illegal executive transfers (7) degree of political instability (8) left-wing government (9) new finance minister
<b>Contagion:</b> (1) crisis elsewhere

When an indicator exceeds a certain value, this should be interpreted as a warning signal that a currency crisis may take place within a specific predefined time (the next 24

months in the case of a currency crisis). For each macroeconomic variable, it is necessary to determine the threshold value, assuming that the signal is only issued if the indicator exceeds that limit. The indicator on a given month was normally defined as the percentage change in the level of the variable from its level a year earlier. The optimal threshold level was calculated as the percentile that minimizes the noise-to-signal ratio, given by the ratio of false signals ( $B/[B+D]$ ) over good signals ( $A/[A+C]$ ), where the letters are defined in the following matrix.

	A crisis within 24 months (12 for banking crisis)	No crisis within 24 months (12 for banking crisis)
Signal was issued	A <sup>25</sup>	B <sup>26</sup>
No signal was issued	C <sup>27</sup>	D <sup>28</sup>

As explained by the authors, a good indicator will behave in a way that will place it primarily in the quadrants A and D, and a value close to zero of the noise-to-signal ratio indicates that a variable is useful in predicting a crisis.

The paper concludes that output, exports, deviations of the real exchange rate from its equilibrium value, equity prices, and the ratio of broad money to gross international reserves, were the most relevant variables for the prediction of a currency crisis.

The relation between balance-of-payments problems and banking crises is studied by Kaminsky and Reinhart (1999). The authors used a KLR model, a data set with more specifically 76 currency crises and 26 banking crises, for 20 countries between 1970 and 1995, including developed and underdeveloped countries, and 16 macroeconomic variables: M2 multiplier; domestic credit / GDP; real interest rate; lending-deposit rate ratio; excess M1 balances; M2 / reserves; bank deposits; exports; imports; terms of trade; the real exchange rate; reserves; real interest-rate differential; output; stock returns; and deficit as a share of GDP. In contrast with the assumption of the 24 months of the interval between signals and balance-of-payments crises, for banking crises, it is assumed a time horizon 12 months before and 12 months after the beginning of the banking crisis. That work confirmed that most of the episodes of currency crises are followed by banking crises and that crises occur as the economy enters a recession, following a prolonged boom in economic activity that was fuelled by credit, capital inflows, and accompanied by an overvalued currency.

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<sup>25</sup> A = Number of months in which the indicator issued a correct signal.

<sup>26</sup> B = Number of months in which the indicator issued a wrong signal or “noise”.

<sup>27</sup> C = Number of months in which the indicator failed to issue a signal which would have been a correct signal.

<sup>28</sup> D = Number of months in which the indicator did not issue a signal that would have been a wrong signal.

Goldstein et. al (2000) used a sample of 87 currency crises and 29 banking crises that occurred in a sample of 25 emerging economies and smaller industrial countries between 1970 and 1995. The macroeconomic variables used in the KLR model were real output, equity prices, international reserves, domestic/foreign real interest rate differential, excess real M1 balances, M2/international reserves, bank deposits, M2 multiplier, domestic credit/GDP, real interest rate on deposits, lending interest rate/deposit interest rate, real exchange rate, exports, imports, terms of trade, Moody's sovereign credit ratings, institutional investor sovereign credit, general government consumption, overall budget deficit/GDP, net credit to the public sector/GDP, central bank credit to public sector/GDP, short term capital inflow/GDP, foreign direct investment/GDP, current account imbalance/GDP, and current account balance/investment. The indicators that have the best performance in the prediction of currency crisis were real exchange rate, banking crisis, equity prices, exports, M2 / international reserves, international reserves, current account imbalance / GDP, and current account imbalance/investment. In the case of banking crises the indicators were real exchange rate, equity prices, M2 multiplier, real output, exports, the real interest rate on deposits, short-term capital inflows/GDP, and current account imbalances/investment.

Edison (2003) has extended the KLR model to develop an operational early warning system that can detect financial crises. The author used a sample of 20 countries, both developed and emerging market economies, between 1970 and 1995, with 94 episodes of crisis. That study used 18 macroeconomic variables: foreign exchange reserves; exports; real exchange rates; index of equity prices; commercial bank deposits; output index; excess real M1 balances; M2 Multiplier; M2 / reserves; domestic credit / GDP ratio; real interest rate; real interest rate differential; lending to deposit ratio interest rate; imports; foreign G-7 growth weighted average of G-7 real GDP growth; US interest rate; World oil price; and, short-term debt/reserves. This new version of the KLR model was able to anticipate the crises in 1997/1998 but produced many false alarms. The author concluded that the early warning model helps to identify the countries that are more vulnerable to crisis, but that it is relatively poor at predicting the exact timing of crises. In addition, Edison found that marked appreciation of the real exchange rate relative to the equilibrium value, high ratios of short-term debt to reserves, high ratios of broad money to reserves, substantial losses of foreign exchange reserves, and sharply declining equity prices were the most relevant indicators of vulnerability.



Despite the characteristics of our data set, namely the use of annual data, we also experimented the KLR methodology for the prediction of banking crises.

For the calculation of the threshold, we considered the behaviour of the macroeconomic variables in the year before the banking crisis, defined as in the Global Crises Data by country from the Harvard Business School. After the calculation of the percentile, we checked country by country, and year by year, if any signal is emitted. And then, using the matrix corresponding to banking crises, we calculated the optimal threshold, which corresponds to the percentile that minimizes the noise-to-signal ratio, given by the ratio of false signals ( $B/[B+D]$ ) over good signals ( $A/[A+C]$ ). Table 2.12 synthesizes the more important results of the use of our KLR model.

**Table 2.12:** KLR model and performance of indicators

	GDP_gr	FD_tot	Exch rate	RIR	Inflation	Deficit	FD_credit	GDPpc_gr
<b>Therefore</b>	6%	14%	13%	2%	2%	1%	1%	5%
	-6,807	-0,011	-0,064	-73,074	-3,260	-12,682	-34,733	-0,086
Good Signals as Percentage of Possible Good Signals: $A/(A+C)$	6,0%	14,1%	13,0%	2,1%	2,1%	1,2%	1,1%	5,1%
Bad Signal as Percentage of Possible Bad Signals: $B/(B+D)$	1,0%	11,7%	10,5%	0,1%	1,6%	0,5%	0,1%	0,9%
<b>Noise-to-signal ratio</b> <sup>29</sup>	15,9%	82,5%	80,7%	5,1%	75,4%	41,3%	5,2%	18,0%
P(Crisis / Signal) <sup>30</sup> : $A/(A+B)$	51,6%	16,0%	16,7%	78,6%	18,0%	30,0%	75,0%	48,2%
P(Crisis): $(A+C)/(A+B+C+D)$	14,5%	13,5%	14,0%	15,6%	14,2%	15,0%	13,5%	14,3%
P(Crisis / Signal) - P(Crisis)	37,1%	2,4%	2,8%	62,9%	3,8%	15,0%	61,5%	33,9%

Source: Authors' computations

The first highlight is the very small percentage of good signals as a percentage of possible good signals. For example, the terms of trade (first difference) produced the highest percentage, and it is only 14,1%.

<sup>29</sup> Ratio of false signals (measured as a proportion of cases in which false signals could have been issued) to good signals (measured as a proportion of cases in which good signals could have been issued).

<sup>30</sup> Percentage of the signals issued by the indicator that were followed by a crisis after one year.

Secondly, influenced by the previous conclusion, the noise-to-signal ratio is, except for the real interest rate and the first difference of credit, very high for our macroeconomic variables.

And finally, when we calculate the difference between the probability of having a crisis that was preceded by a signal and the probability of a crisis, the KLR has always a worse performance than the logit model. Even in the cases of the real interest rate and first difference of credit, these percentages are above 60%.

## **Chapter 3 - Did they ask for it? Determinants of the Greek and Portuguese financial crises.**

### **3.1. Introduction**

The development of macroeconomic analysis is intrinsically connected with the Wall Street crash of 1929 and the subsequent Great Depression. The impact of the Great Depression was deeply and tragically felt on the living conditions of millions of people in the United States of America and around the World. Economic thinking could not fail to give specific attention to an event of this magnitude. The Great Depression is therefore the most important example of a financial crisis.

However, there have been many other financial crises throughout history, as documented for the last eight centuries by Reinhart and Rogoff (2009). The authors argue that, despite the succession of financial crises, namely in the second half of the twentieth century, the “this time is different” view is dominant. The “this time is different” view is the conviction that financial crises are events that happen to others, in other countries, and at other times. Therefore, agents are blind to the possibility that the current expansion gives way to a crisis. In addition, they also believe that developed economies do not need to apply the standard toolkit used by developing economies in periods of crisis<sup>31</sup>.

In his overview of the most important features of a financial and currency crisis in emerging markets, Dornbusch (2001) distinguishes “old-style crises” from “new-style crises”. While the old ones involve an overspending and real appreciation and their negative effect on the current account, the new ones are more related to bad balance sheets that make the country more vulnerable to speculative attacks. The important role of balance sheet imbalances in the financial crisis is the most relevant conclusion of his work.

In developed economies, however, policymakers usually think that this will not be a problem and that they have implemented all the necessary economic policies and established all the necessary instruments to guarantee the development of a robust and adequately regulated financial system, making it almost impossible the occurrence of a severe financial crisis in these countries.

But the “this time is different” syndrome sufferers were wrong once again. The Lehman Brothers bankruptcy in 2008 marked the start of the worst phase of the Great Recession. Although the world has lived one of the biggest growth periods of the modern

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<sup>31</sup> These included debt restructuring, inflation, capital controls, and significant financial repression.

history between crisis, known as the period of Great Moderation, it is now clear not only that the authorities ignored important warning signals, but also that the (few) alerts to this problem were underestimated (Roubini and Mihm, 2010). The Great Recession, sometimes called the subprime crisis, quickly became global and led to a dramatic increase in public debt in many developed economies, contributing to the debt crises that affected, in particularly severe ways, some of the Eurozone countries, such as Greece, Portugal, Spain and the Republic of Ireland.

In the Greek case, the high public indebtedness and remaining structural weakness of the economy, exacerbated by revelations of wrongly reported levels of public deficits by the Government, provoked a loss of confidence in the Greek economy and an unsustainable and sharply rising bond yield spread, which transformed the crisis started in late 2009 in the longest recession of any advanced economy in modern history. The three Economic Adjustment Programmes of the Troika<sup>32</sup> and respective loans of more than 300 billion euros, the austerity measures that aggravated the negative impacts economic, social, and political, and the haircut on debt owed to private banks, are only some examples of what happened in this period. The last of the three Economic Adjustment Programmes started in August 2015 and had a duration of three years.

The Greek crisis had also a strong contagion effect across the Eurozone and showed flaws and limitations in the European project, jeopardizing the Eurozone itself.

In Portugal, the crisis reached the country when, given the huge budget deficits and a fast-increasing public debt stock, investors became wary about the Portuguese debt instruments, especially of those issued by banks or public entities. This fear led to a sudden stop in capital flows to Portugal. The Portuguese government tried to correct the course. The first Stability and Growth Program (SGP)<sup>33</sup> was presented in March 2010. Three more SGPs followed, all without success. In April 2011, the Portuguese Finance Minister, Teixeira dos Santos, when interviewed by Reuters, revealed that funding was only ensured until May. Beyond that, financial assistance, provided by the Troika would be indispensable. The Financial Assistance Program, with the total amount of 78 billion euros, was signed in May 2011 and lasted for three years.

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<sup>32</sup> The Troika was composed by the European Commission, the European Central Bank, and the International Monetary Fund.

<sup>33</sup> The SGPs were budgetary plans (packed with “austerity measures”) that aimed at restoring the credibility of the Portuguese public debt issuers and the confidence of the international investors in the Portuguese economy.

In this chapter, we intend to describe the road that led to the crises in Greece and Portugal. This will be done in the context of the study of the determinants of financial crises more generally, given that we need panel data to provide a better empirical treatment of the topic. Based on the empirical analysis we will attempt to answer several questions in this study: Could the financial crises have been predicted in time for them to be avoided or at least mitigated? Is a (severe) financial crisis in these countries more likely or less likely to happen nowadays than it was ten years ago when the international financial crisis paved the way to the Eurozone's sovereign debt crisis? Which macroeconomic variables indicate that a crisis has become more likely? Which policies are responsible for a higher decrease (increase) in the probability of a new crisis? Given the architecture of the Eurozone, what are the policy options available to national policymakers seeking to reduce the likelihood, or the impact, of a new crisis? And finally, what can be the implication of the Covid-19 pandemic, in both economies?

A pure time series analysis would be unlikely to identify macroeconomic indicators of an impending crisis, given the reduced number of observations. Therefore, we opted to carry out the econometric analysis on a panel of countries. The dependent variable is a dummy that indicates whether there was a crisis in that year, in a certain country. This data comes from Reinhart and Rogoff (2011) and the Global Crises by Country, Behavioral Finance & Finance Stability, from the Harvard Business School. The panel used in the estimation contains 69 countries over the period 1960-2016. The explanatory variables in our binomial logit and multinomial logit models were GDP growth rate, terms of trade, rate of depreciation of the exchange rate, real interest rate, inflation, fiscal surplus, domestic credit to the private sector, GDP per capita, government debt, and current account balance. The availability of data constrained the choice of the countries, the period that was used, and the selection of the macroeconomic indicators included in the econometric analysis.

The main contribution of this chapter to the economic literature is the use of this specific methodology in the evaluation of the probability of a crisis occurrence in Greece and Portugal, since the end of the Financial Assistance Programs of both countries. The issue of whether these countries have been moving towards or away from a new crisis has been a controversial topic among economists, politicians, and commentators. As an example, there is the negative view expressed by Neves (2018) regarding Portugal. Neves (2018) describes the period following the end of the Financial Assistance Program as an "interlude" between crises, however, without backing this view with empirical analysis. If the model is successful in identifying determinants of financial crises, then it may also help assess alternative policy

proposals. In addition, it is important to study the initial impacts of the Covid-19 pandemic on the probability of Greece and Portugal being confronted with a new robust financial crisis.

Apart from the introduction, the paper is structured as follows. In sections 3.2 and 3.3 we briefly review the evolution of the Greek and the Portuguese economies in recent decades, with an emphasis on the latest period of crisis. In section 3.4 we are going to highlight the previous studies that we consider to be the most relevant on the issue of financial crisis prediction using logit techniques. In section 3.5 we present the macroeconomic variables and the data used in the empirical analysis, as well as the methodology that is going to be used. In section 3.6 we report and discuss the results from the estimations. Finally, in section 3.7 we summarize the main conclusions of the chapter.

### **3.2. A brief history of the main financial crises in Greece since its independence**

After long centuries under occupation, firstly from Rome and finally from the Ottoman Empire<sup>34</sup>, the Greek people only regained their freedom with the national uprising and the declaration of independence in 1821, with the intervention of three major European powers, the United Kingdom, France, and Russia, and after the signature of the treaties of Adrianople in 1829 and Constantinople<sup>35</sup> in 1832.

The creation of the Modern Greek nation-state, although based on liberal and democratic principles, was not the last chapter of a troubled history, but the beginning of a period of wars and sovereign defaults. As well documented by Reinhart and Trebesch (2015), between 1821 and 1964, Greece was more than half of the time in a situation of default, without access to the financial markets, more specifically for eighty years.

In 1826 Modern Greece faced the first period of default, because of the heavy borrowing by the provisional Government from foreign private creditors, known as “independent loans”. These loans, with a total value of 2.8 million British pounds, with the support of the London Philhellenic Committee, were more than 100% of its annual Gross Domestic Product (GDP) at the time, and had extremely high commission fees making the issue price less than half of the nominal value. More specifically approximately 60% would be for commissions, upfront payment, and sinking funds. Regarding this issue,

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<sup>34</sup> The Ottoman Empire, for example, ruled most of the areas which today are within modern Greece since the middle of the fifteenth century.

<sup>35</sup> The treaty of Adrianople ends the so called “war of Greek Independence”, and the treaty of Constantinople (modern Istanbul) is the treaty in which the Ottoman Empire recognize the definitive boards of the new Greek independence country, under the protection of the empires of Britain, France, and Russia, and that established the Prince Otto of Bavaria as his first king. For more details see Paroulakis (2000).

Christodoulakis (2013) points out that the nascent Central Bank of Greece at the time was not fully independent from the Government and was not adequate for maintaining stability. The declaration of default at the end of 1832 was followed by the restrictive conditions of the guaranteed loan of 1833, which gave Great Britain, France, and Russia legal control over Greek revenues. This new loan of 60 million francs from the Rothschild of Paris, had again commissions close to 50%. After a new period of partial default, repayment was completely suspended by the Greek Government in 1843. In this period of economic crisis, drastic budgetary cuts, high taxes, political instability, and revolts, a famous episode was the blockade of the port of Piraeus by the British and French navy as a pressure to the payment of the debt<sup>36</sup>. In 1867 there was the first renegotiation of the independence loans, but only in 1878, after long periods of disagreement and unsuccessful renegotiations, it was possible to conclude the process of renegotiation of the debt, with a substantial haircut<sup>37</sup>.

However, the restructuring process was not completely successful. Needing to meet the obligations of restructuring of the debt agreement, and to modernize its infrastructures, Greece borrowed again a huge amount from foreign investors. Until 1893 the Greek Government managed to collect from Paris, London, and Berlin loans which totalled more than 500 million francs. This fact, associated with the deterioration of the international situation<sup>38</sup>, led to the second period of default in 1893. The difficulty to manage this large stock of external debt was exacerbated by a new period of war against the Ottoman Empire in 1897 and subsequent war indemnity<sup>39</sup>.

The Greek debt, in the percentage of GDP, over the period for each there is data in the IMF data set, is presented in Figure 3.1.

It is clear the huge increase of debt in the last decade of the nineteenth century and beginning of the twentieth century when the Government debt has reached historical values above 200% of GDP. In this period the Greek debt is more than double in comparison with the average debt of Belgium, France, Germany, Italy, and the Netherlands (which is represented by the line CEE), something that will only be repeated in the twenty-first century.

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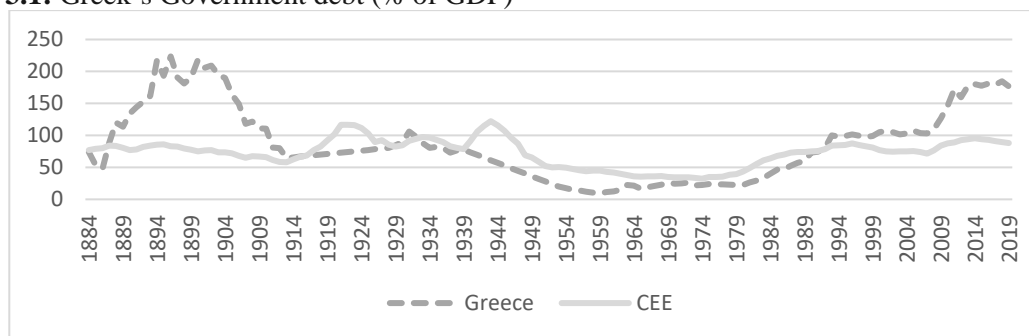
<sup>36</sup> These revolts culminated in the overthrow of King Otto in 1862, and his substitution by the Danish Prince who became King George I. He accepted a democratic constitution, allowing Greece to be one of the first parliamentary democracies in the world.

<sup>37</sup> Face-value reduction of 40% and of 91% including cancelation of interest arrears, according to Reinhart and Trebesch (2015).

<sup>38</sup> Protectionist measures such as increasing of duties, reduction of exports and recession.

<sup>39</sup> Nevertheless, British protection ensured that Greek territory remained intact.

**Figure 3.1:** Greek's Government debt (% of GDP)



Source: Historical Public Debt Database and since 2014 IMF; authors calculations<sup>40</sup>.

The negotiation with the creditors lasted until 1898. A new guaranteed loan of 150 million francs, equivalent, at the time, to more or less one-quarter of Greek annual GDP, were issued again by Great Britain, France, and Russia. In addition, the lenders, before accepting a new haircut<sup>41</sup>, imposed the creation of an International Finance Commission, to control Greek fiscal and budget management and assure compliance with debt service payments.

The Balkan War of 1912 and 1913<sup>42</sup>, the political instability associated with the first World War<sup>43</sup>, the new war with Turkey between 1919 and 1922, and the refugee crisis that followed this last war, with a mass-inflow of more than one million refugees from Turkey, were followed by several loans, with a total value equivalent to approximately three-quarters of Greek annual GDP in 1928<sup>44</sup>.

This problem was aggravated by the international context with the start of the Great Depression in 1929 in the United States of America, and 1931 and 1932 were years of currency regime collapse and banking crisis. The strong decline of exports and the increase in inflation were responsible for a very sharp reduction in foreign exchange reserves. This situation led Greece to exit from the Gold Standard, depreciate its currency by around 50%,

<sup>40</sup> The line CEE is an annual average of the founding countries: Belgium, France, Germany, Italy, and Netherlands. Luxembourg was not included due to lack of data.

<sup>41</sup> Reinhart and Trebesch (2015) calculate that the value of the new haircut was between 37% and 53%.

<sup>42</sup> A military alliance between Greece, Bulgaria, Serbia, and Montenegro, against the Ottoman Empire, that allowed Greece to capture Thessalonica and control southern Macedonia.

<sup>43</sup> Greece was neutral in the beginning of the First World War. However, from 1915 to 1936, the country was completely divided between King Constantin I supporters (King George's son ascended the throne in 1913, after his father's assassination, becoming the first king born in Greece and raised as a Greek-Orthodox) and Vanizelos supporters (Eleftherios Venizelos, Cretan politician and former revolutionary, that dominated Greek politics for 25 years), and after 1924, when the second Greek Republic was proclaimed, between royalists and republicans. For more details, see the historical political review of the Modern Greece in Hatzis (2019).

<sup>44</sup> Reinhart and Trebesch (2015) have listed the "refuges" and "war time" loans of this period: 23.5 million pounds by the United Kingdom, 20 million USD by the United States of America, 8 million Canadian dollars by Canada, 144 million Francs by France, and 94 million USD by the League of Nations.

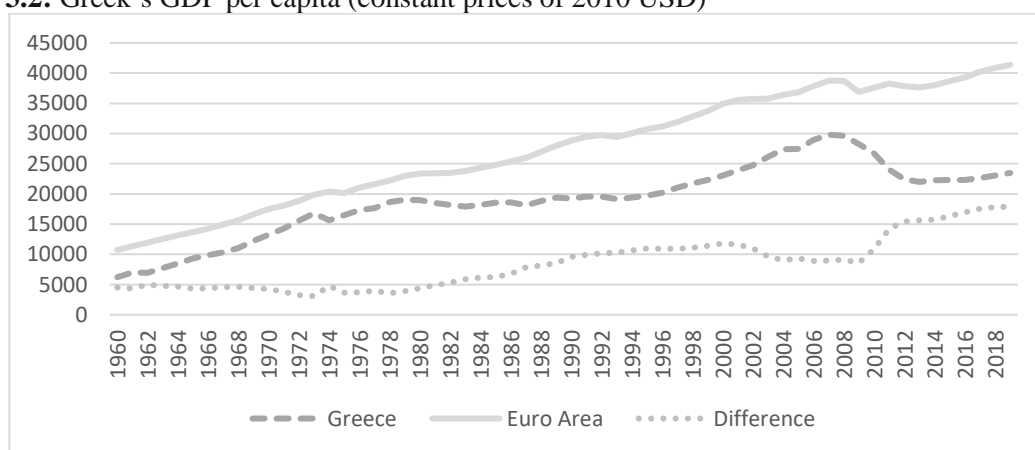


and declare the third default of Greek modern history in 1932. Recalling Figure 3.1, the debt (% GDP) curve has a peak in the year 1931 with a debt level higher than 100% of GDP.

In the following decades, Greece continued to be an unstable country, fertile land of coups and dictatorship regimes<sup>45</sup>. It was occupied during Second World War first by Fascist Italy since the end of 1940, then by Nazi Germany, and finally was in a civil war from 1946 to 1949, which was a key starting point of the Cold War. At the end of the first half of the twentieth century, Greece was a country destroyed by a decade of wars and was an illiberal democracy, still very polarized between the leftist and rightist sections.

We are going to divide our analysis of this period into four different moments: Great Expansion, between 1951 and 1973; Long Stagnation, from 1974 to 1993; Illusory Recovery, between 1994 and 2007, and Great Recession, from 2008 to 2016.

**Figure 3.2:** Greek`s GDP per capita (constant prices of 2010 USD)



Source: World Bank.

According to World Bank data, in 1960, the GDP per capita in Greece was 6,260 USD, at constant prices of 2010, which represent only 58% of the average GDP per capita of the Eurozone<sup>46</sup>, see Figure 3.2. There was a period of fast convergence until 1973; in this year the GDP per capita in Greece was 84% of the average GDP per capita of the Eurozone countries. In the period between 1974 and 1993, the GDP per capita of Greece diverged and to 65% of the Eurozone average. From 1994 to 2007, there was a period of convergence, but not as strong as in the period until 1993. In 2007 the GDP per capita in Greece was 77% of the average GDP per capita of the Eurozone. And finally, there was the period of crisis,

<sup>45</sup> The coup of 1935 that tried to prevent, without success, the restoration of king George II, marks the end of the second Greek Republic, which would lead to a dictatorship regime under Metaxas, in 1936.

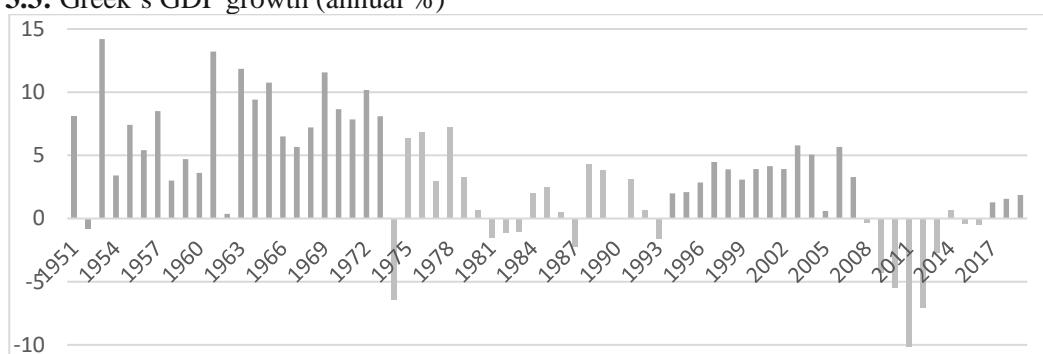
<sup>46</sup> Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.

during which the Greek GDP per capita fell to the level of 1960: 57% of the average GDP per capita of the Eurozone countries.

The Marshall Plan<sup>47</sup> and the fact that Greece remained a country of the western democratic world as a member of the North Atlantic Treaty Organization (NATO) since 1952, allow the Greek participation in international trade, and created the foundations for the post-war development of the Greek economy.

Like for most European countries, this was a golden period for Greece in terms of economic growth. Between 1951 and 1973 (almost a quarter of a century), the annual GDP growth rate was on average higher than 7%<sup>48</sup>, and in some years was above 10%, as shown in Figure 3.3.

**Figure 3.3:** Greek's GDP growth (annual %)



Source: Adapted from Gerominakis (1965) between 1951 and 1960, and World Bank.

For this scenario, the vision of the conservative reformist Karamanlis, Prime Minister since 1955, was essential. He was responsible for the plan of rapid industrialization, important investments in infrastructures, credible monetary policies, decreasing the

<sup>47</sup> The US Marshall Plan of economic aid with grants and lending for reconstruction and development of the European Countries after the destruction of World War II, was particularly important for the Greek economy, which had been destroyed not only by World War II but also by the Greek Civil War. The plan's implementation, between 1948 and 1952, and the correspondent stabilization program, was the origin of the Greek economic miracle according to Vetsopoulos (2002). The Marshall Plan, according to the same author, also required strong production efforts, the establishment of internal financial stability and valid rates of exchange, the expansion of foreign trade and reduction of trade barriers, and the efficient and practical use of all the resources of the participating countries.

<sup>48</sup> The exceptions to this positive trend were the years of 1952 and 1962. In 1952, there was a decrease in farming and manufacturing output and a contraction of demand for capital goods, as explain by Gerominakis (1965). In 1962, the rigorous winter substantially damaged agriculture production and affected industrial production. For more details, see the Economic Survey by the Organization for Economic Cooperation and Development (OECD), Greece, 1963.

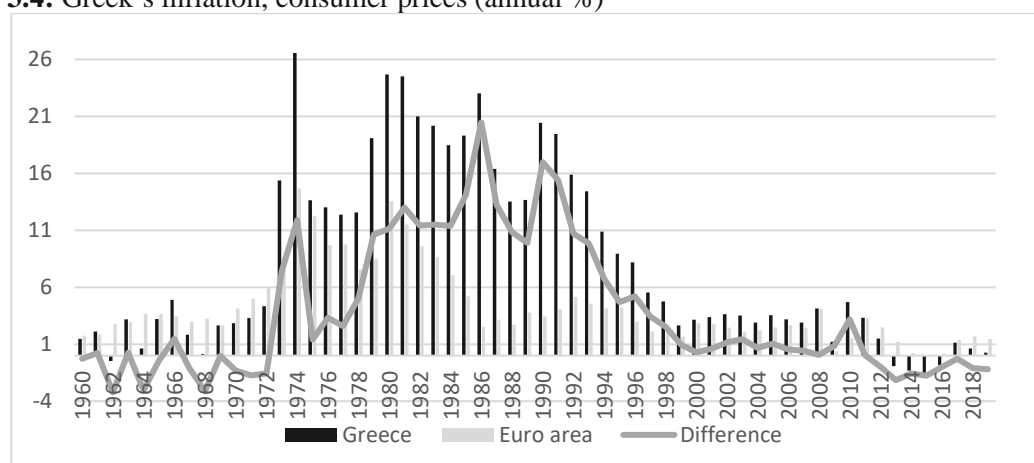
restrictions on trade, and implementation of a favourable tax regime. After years of renegotiation, Greece regained full access to financial markets in 1964<sup>49</sup>.

However, a new period of political turmoil<sup>50</sup> would pave the way to the military coup of 1967. The dictatorship regime ruled Greece for seven years; however, it did not change this positive trend in terms of economic growth.

In 1974, in addition to the negative impacts of the adverse situation resulting from the first oil shock of the previous year, the total discredit that followed the events in Cyprus<sup>51</sup> and the bloody suppression of Athens Polytechnic uprising in Athens would mark the end of the dictatorial regime and a year of economic contraction. That year, the GDP growth rate was minus 6.4%, and the inflation rate reached the historical level of 25.6%, Figure 3.4.

Democracy was restored, the third Greek Republic was implemented after the referendum in 1974, a new constitution was approved in 1975, and Karamanlis returned from exile to find the conservative party New Democracy and to lead again the destinies of Greece and the negotiations for the entrance of Greece in the European Economic Community<sup>52</sup>.

**Figure 3.4:** Greek`s inflation, consumer prices (annual %)



Source: World Bank.

<sup>49</sup> There was a new haircut with a value between 64% and 86% that did not include any face-value reduction. For more details, see Reinhart and Trebesch (2015).

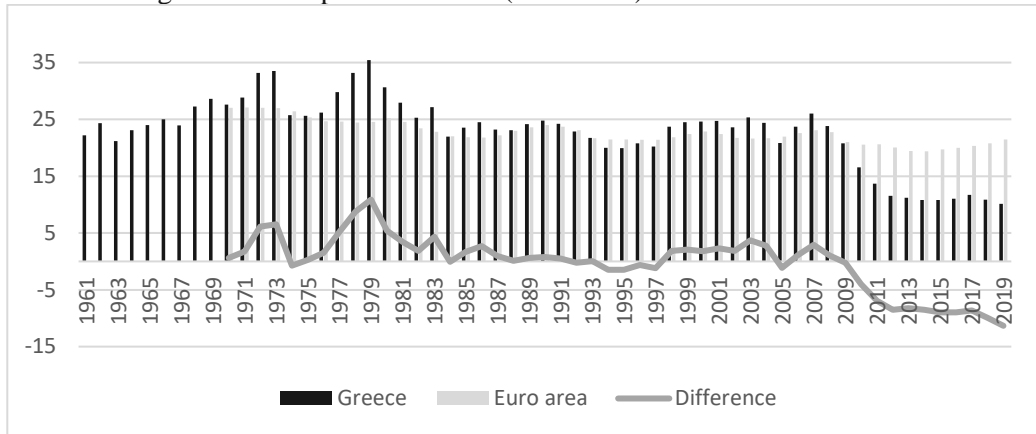
<sup>50</sup> After eight years, Karamanlis left the Government in 1963 in disagreement with King Paul, King George II's successor. The government that followed would last only until 1965, again because of problems with the royalty, at this time Constantin II, the son of King Paul.

<sup>51</sup> An unsuccessful attempt of assassination of the President of the Republic of Cyprus was put in place by the military junta, with the goal of annexing Cyprus to Greece. This was a pretext for the Turkish invasion of Cyprus.

<sup>52</sup> The Economic European Community was established in 1957 with the signature of the Treaty of Rome by France, West Germany, the Netherlands, Belgium, Luxembourg, and Italy (organization that substituted the European Coal and Steel Community, created after the war as an antidote to avoid future confrontations in Europe). It wanted to bring more economic integration to these countries, and was substantiated initially in a common market and a customs union.

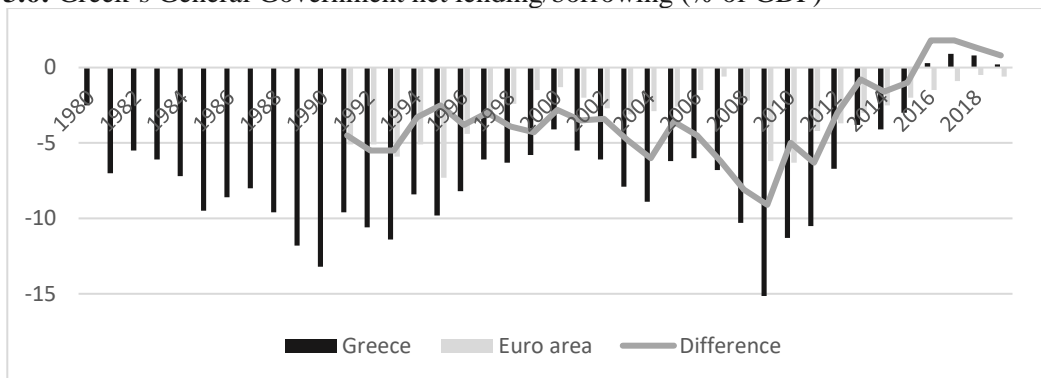
In this period the Gross Fixed Capital Formation, in percentage of GDP, grew more in Greece than in the Eurozone. However, since 1979, this difference started to fade, as illustrated in Figure 3.5.

**Figure 3.5:** Greek's gross fixed capital formation (% of GDP)



Source: World Bank

**Figure 3.6:** Greek's General Government net lending/borrowing (% of GDP)



Source: IMF Data Mapper.

In 1981, not only did Greece join the European Economic Community, but also there was an especially important political shift in the government. The socialist party PASOK won the election with a more populist platform. PASOK would govern Greece from 1981 to 1989, being replaced by New Democracy until 1993. Both parties have invested in the welfare state, however, often in an inefficient way, with wasteful and excessive expenditure, causing huge deficits. The 1970s average government deficit per year, was around 2.3% of the GDP according to Nikiforos et al. (2013); in the period between 1981 and 1993, the deficit was on average 9% GDP, as Figure 3.6 shows. As a result, the Government debt in percentage of GDP, which was around 22.5% in 1974, reached the impressive value of 100% in 1993.

In addition, Leounakis and Sakellaris (2014) highlight as a decisive factor for this poor financial performance in the 1980s, the differences in terms of total factor productivity growth. For the period between 1974 and 1979, the authors calculate an average total factor productivity growth of 1.11%, while for the period between 1980 and 1993, the same indicator was minus 0.58%<sup>53</sup>.

The year 1992 is a particularly important year regarding European integration. The change from European Economic Community to European Union was much more than a simple name change. The signature of the Treaty on European Union established the criteria<sup>54</sup> - regarding the inflation rate, the budget deficit, government debt, exchange rate stability, and the nominal long-term interest rate - for the European Union member states to be part of the Economic and Monetary Union and to join the future Eurozone.

The Maastricht Treaty entered into force at the end of 1993 and had a lasting impact on economic policy. To be part of the single currency, the Greek Government adopted economic policies more in line with the Maastricht criteria, and there was a substantial liberalization of the economy. In this period, GDP grew on average 3.6%. Even more relevant, the inflation rate fell consistently from two digits to less than 5% in 1998 (remember Figure 3.4).

However, in 1999, when the Euro was launched, Greece was unable to adopt the European single currency because of a government deficit above 3% and of debt close to 99% of GDP - Greece did not fulfil the Maastricht criteria.

Given that the Greek public opinion was mostly favourable to the euro membership, the Government implemented an austerity program, strongly reduced the public spending, and, in a non-transparent way, misrepresented its finances<sup>55</sup>. The truth is that the European Union allowed Greece to join the eurozone without fully complying with the Maastricht criteria, in 2001.

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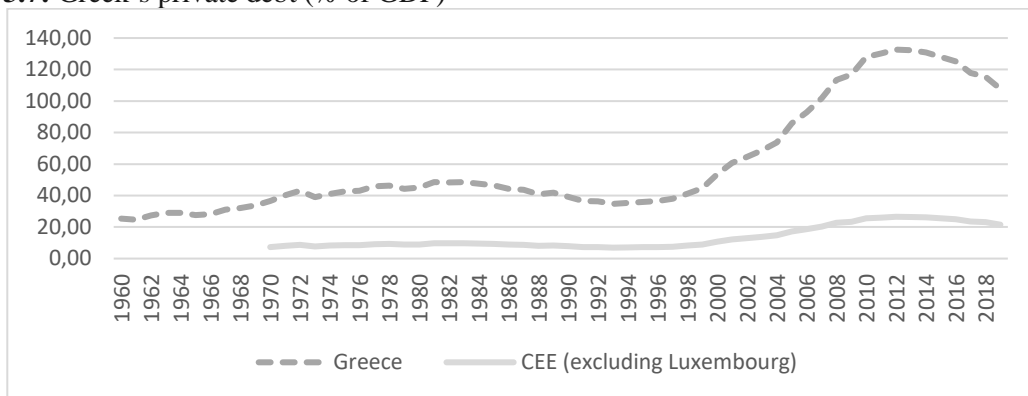
<sup>53</sup> Leounakis and Sakellaris (2014) also calculate the average total factor productivity growth from 1961 to 1973 to have been 5.71%, 1.85% between 1994 and 2017, and minus 2.44% from 2008 to 2013.

<sup>54</sup> The criteria are the following. The ratio of the annual government deficit to GDP must not exceed 3%. The ratio of gross government debt to GDP must not exceed 60%. The inflation rate must not exceed the average of the three lowest inflation rates of the European Union in more than 1.5 percentage points. Applicant countries must have joined the exchange-rate mechanism of the European Monetary System for two consecutive years and should not have devalued its currency during the period. The nominal long-term interest rate must be no more than 2 percentage points in comparison with the average interest rate of the three member states with the lowest inflation rates.

<sup>55</sup> The Greek Government not only deceptively publicly claimed that the deficit was below the Maastricht limit, but also implemented a complex credit swap transaction, with the help of the bank Goldman Sachs, to hide part of its debt in 2001, something that would only be discovered in 2004.

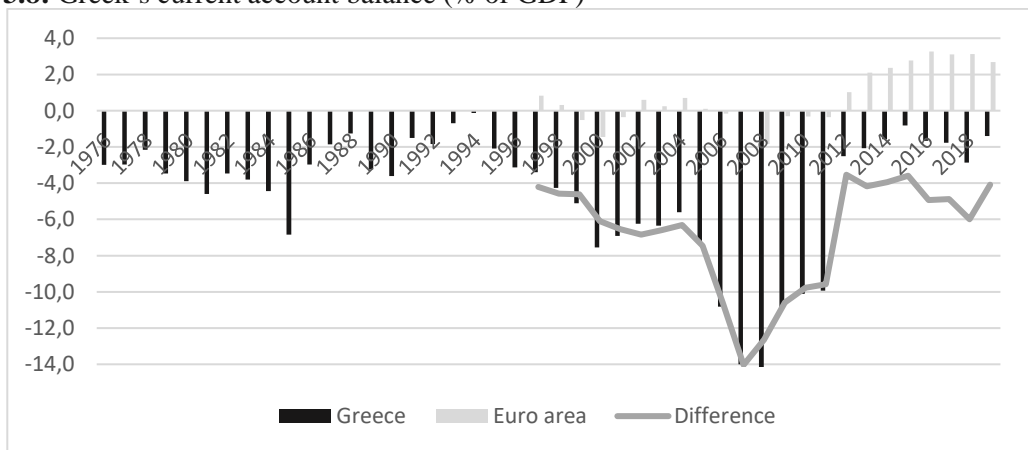
The year 2004 witnessed the return of New Democracy to the Government, and the return of the Olympic Games to Athens, with a cost of more than 9 billion euros. The government debt did not change substantially in this period, but the same conclusion is not true in terms of private indebtedness. Although the values of the private debt in percentage of GDP were still much lower than in other Eurozone countries (represented in Figure 3.7 by the line CEE<sup>56</sup>), the private debt, which had been stable around 35% of the GDP circa 1994, increased substantially to more than 100% in 2007.

**Figure 3.7:** Greek's private debt (% of GDP)



Source: IMF Data Mapper.

**Figure 3.8:** Greek's current account balance (% of GDP)



Source: World Bank.

More worryingly, this period was marked by a strong deterioration of the Greek external position. The deterioration of the current account is a good example of this problem. The balance has turned more unstable, and year after year, the deficit constantly increased, from 0.7% of GDP in 1994 to 14.5% in 2008, as illustrated in Figure 3.8.

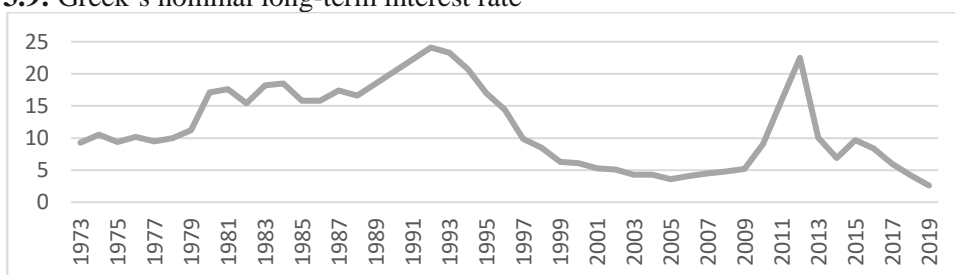
<sup>56</sup> Weighted average between Belgium, France, Germany, Italy, Luxembourg, and Netherlands.

The banking crisis in the United States of America in 2007, in a globalized and financially interconnected World, rapidly became an international financial crisis. Greece was a very vulnerable country, with enormous public debt (the second highest debt in the world, in percentage of the GDP, only behind Japan), and structural weaknesses (such as current account deficits of two digits). Greece would come to be the most affected country in Europe.

In this dark period of Greek history, a time of banking and sovereign crisis, of austerity measures, the GDP decreased 3.3% per year, almost amounting to an impressive 30% in total, the highest decline in Europe in modern history in a period of peace. The increase in poverty was unimaginable for a European Union country.

In this period of extreme social and political instability, the change of Government was a constant: PASOK from the end of 2009 to 2012; National Unity Government in the first half of 2012; New Democracy from the middle of 2012 to the beginning of 2015; Syriza, on a left anti-austerity platform, between 2015 and 2019, with a one month Caretaker Government in the middle.

**Figure 3.9:** Greek`s nominal long-term interest rate



Source: AMECO.

The revelation that the government deficit of 2009 had been underreported by the Greek government, that instead of 6.7% of the GDP it would be more than double – in the end, recall Figure 3.6, it was calculated to be more than 15% – erased the already low confidence of investors in Greek institutions. As a result, the rating agencies lowered Greece`s credit rating and the yield of the Greek bonds increased from 5.2% in 2009 to 9.1% in 2010, to 15.7% in 2011, and to 22.5% in 2012, as shown in Figure 3.9.

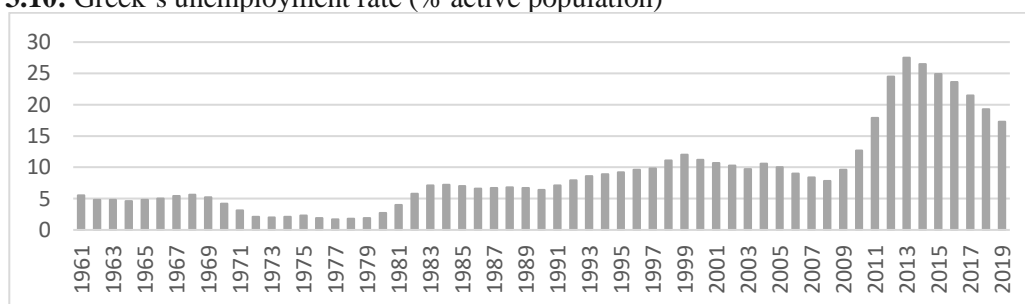
This increase of the interest rates at which the Greek Government finances itself, and loss of access to the markets, a situation of a sudden stop, associated simultaneously with the unsustainable debt and the lack of sufficient price adjustments, provoked the collapse of the Greek bond markets, the crisis of the banking sector, and a very real fear of bankruptcy.

Between 2010 and 2016, the Government implemented more than a dozen plans of tax increases and spending cuts, which provoked protest and social unrest all around Greece. However, these reforms have proved to be always insufficient, and made clear the need for external help. Greece required bailout loans in 2010, 2012, and 2015 from the Troika – the biggest financial rescue of bankruptcy in history – and as a condition had to implement additional austerity programs. Greece was not only the first OECD member to default on its sovereign debt, but this was also the largest default in the history of the world.

The impact of the financial crisis and the austerity policies were particularly notorious in the increase of the unemployment rate and in the reduction of population in Greece for the first time since the beginning of the second half of the twentieth century.

The unemployment rate has always been above 10% since 2010 and reached the peak in 2013, when 27.5% of the active population was unemployed (Figure 3.10).

**Figure 3.10:** Greek`s unemployment rate (% active population)



Source: Statistical Data Warehouse, European Central Bank.

Next, we are going to present and discuss the main events related to the three bailouts or Economic Adjustment Programmes.

The first bailout occurred in 2010. It was a three-year loan of 110 billion euros, almost 50% of the GDP in 2010, with a 5.5% interest rate and seven years to be repaid. It avoided the default of Greece, but came with conditions, specifically the demand for primary surpluses, structural reforms, privatization of government assets and the implementation of austerity measures, including 30 billion euros in spending cuts and tax increases, which increased the social instability and deteriorated even more the economic performance of Greece.

In addition, in the same year, the European Central Bank launched the Securities Market Program, allowing the purchase of government bonds on the secondary market, and the finance ministers of the Eurozone countries agreed on rescue measures up to 750 billion euros.



The second bailout, necessary given that the first one was insufficient, was approved in 2012. This contract represented an additional loan of 130 billion euros, with an interest rate of 3.5%, and a repayment period increased to fifteen years. In addition, there was a private debt restructuring, where the private banks accepted a substantial haircut of Greek debt<sup>57</sup>.

In this period, it was relevant not only the action of the Greek Central Bank, but also the developments in terms of politics at a European level. We highlight two different moments. First, the announcement by the President of the European Central Bank, Mario Draghi, that it would “do whatever it takes to preserve the euro,” a strong commitment that was successful in bringing down borrowing costs. Second, the signature of the Treaty on Stability, Coordination, and Governance in the Economic and Monetary Union, more commonly known as the Fiscal Compact Treaty, between the European Union members, apart from the United Kingdom and the Czech Republic. The Fiscal Compact Treaty implied the transposition into the national legal order of a fiscal rule which requires that the general government budget be balanced or in surplus, the more visible requirements being the commitment to limit the structural budget deficit to 0.5% of GDP, the automatic correction mechanism, and a national independent monitoring institution, to be defined by the European Commission<sup>58</sup>.

Greece returned to international financial markets in 2014, raising 3 billion euros in five-year bonds, with a yield of around 5%; two years before the ten-year bonds had a yield above 22% (recall Figure 3.9). However, this is not the end of the story.

When the bailout expired, in the middle of 2015, the Greek Government was unable to repay 1.6 billion euros. It was the first time that a developed country effectively defaulted to the International Monetary Fund. During the renegotiation between Syriza and the creditors, Greece needed to impose emergency capital controls, such as the limit to bank withdrawals of 60 euros per day.

The third and last bailout was approved in the middle of 2015, under the threat that the country might be forced to exit the Eurozone. The bailout was agreed despite the Greeks have voted in a referendum in August against the conditions proposed by the lenders and for

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<sup>57</sup> Reinhart and Trebesch (2015) calculate the final present value of the haircut between 59% and 65%, depending on the assumptions, a reduction of more than 100 billion euros, equivalent of more than 50% of the GDP in 2012.

<sup>58</sup> For more details, the Bank of Greece has published a detailed report with the measures implemented to safeguard financial stability and overcome the crisis, with the title “The Chronicle of the Great Crisis, The Bank of Greece 2008-2013”.

the end of the austerity measures. It was a three-year loan of 86 billion euros and came again with conditions, such as the implementation of additional cuts on public spending, more privatizations of state assets, and more reforms regarding pensions, labour laws, product markets and taxes.

The Greek financial crisis was a topic of study of many authors. Table 3.1 summarizes a list of important contributions to this subject.

**Table 3.1:** Authors and their more relevant views about the Greek crisis

Authors	Views
Kouretas and Vlamis (2010)	The architecture of the Eurozone is responsible in part for the Greek problem; the need for mechanisms to promote convergence and the evolution of the Economic and Monetary Union (EMU) to a more robust political union.
Schularick (2012)	A close link between financial liberalization, the frequency, and severity of the crisis, and the massive deterioration of government balance sheets.
Baltas (2013)	The fiscal and monetary framework of the EMU is still incomplete and does not include arrangements to prevent and correct imbalances.
Chryssoloras (2013)	Not only does the economy and public administration of Greece need to be a complete overhaul, but there is also a need for a mini-Marshall Plan.
Zettelmeyer et al. (2013)	The large relief of Greek debt in 2012, over 50% of the GDP, was the right thing to do but should have been conducted earlier.
Galenianos (2014)	The EMU was responsible, in part, for a large amount of cross-border capital flows to the peripheral countries, a large increase in wages, and loss of competitiveness; as currency devaluation is not possible, internal devaluations in nominal wages is needed; other Eurozone countries need to increase imports.
Nikiforos et al. (2015)	Design flaws of the Maastricht Treaty and common European currency; austerity imposed since 2010 has been unsuccessful in stabilizing the public debt; austerity led to a fall of GDP; debt restructuring is needed.
Lapavistas (2019)	Disastrous effects of the bailout policies, enormous debt, and economic policies that are unlikely to support growth soon.
Stoungaras (2019)	The labour cost competitiveness was improved, and the banking sector was restructured and recapitalized. However, there was still a high level of public debt, non-performing loans and unemployment, and the need for EMU completion.
Vlados et al. (2019)	Need for a new development model, that contemplates a set of structural reforms focus on the systemic stimulation of competitiveness.

Zoega (2019)	Despite the inefficient financial supervision and the fact that the financial markets mispriced the sovereign risk, the cost of a countercyclical adjustment falls almost entirely upon the Greek Government and other borrowers.
Pagoulatos (2020)	Capital tends to fly from core to periphery in the boom period, and back to safety during the crisis, and labour flows are not symmetric either; although the architecture of the Euro is today more robust than in 2010, the EMU is still insufficient equipped to face the next major crisis.

The Covid-19 pandemic, and all its impacts at an economic level in the World, was a game-changer. Therefore, it is important not only to evaluate how prepared was Greece to face this adverse scenario but also to quantify how much was the deterioration of the performance of the main macroeconomic variables and the risk of facing a prolonged financial crisis, something that we are going to do after our empirical analysis.

### **3.3. Brief description of the Portuguese financial crises in modern history**

The nineteenth century was a troubled period in the history of Portugal, full of financial crises. Portugal's refusal to accept to participate in the Continental Blockade brought by France to England, led to the Napoleonic invasions between 1807 and 1810, to the flight of king D. João VI and the court to Brazil, with Rio de Janeiro becoming the capital of the United Kingdom of Portugal, Brazil and Algarves. With the King outside Europe, the effective ruler of Portugal was the Englishman Beresford. This situation remained until the revolution of 1820, started in Porto, and which implemented a constitutional regime. D. João VI was summoned to return to Portugal and to swear the new constitution. Pedro IV, the eldest son of D. João VI, proclaimed the independence of Brazil, which had a very strong impact because Portugal was very dependent on the re-exportation of commodities. At that time, Brazil was the biggest gold producer in the world, and that was one of the main sources of revenue of the Portuguese Government<sup>59</sup>.

In addition, the death of D. João VI in 1826 opened a succession crisis and led to a civil war, from 1832 to 1834, between constitutional liberals and conservatives grouped around prince D. Miguel I. Even before, in 1828, Banco de Lisboa, the first bank created in Portugal, in 1821, with the right to print convertible notes although very dependent on the Government, suspended payment.

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<sup>59</sup> Additional details about the more relevant events of this period can be found in Ramos et al. (2009).

Nunes et al. (1989) analysed the Portuguese economic growth between 1833 and 1985. The authors divide this long period into eight subperiods: i) near-stagnation between 1833 and 1859; 2%; ii) moderate and irregular from 1860 to 1888; iii) near-stagnation between 1889 and 1913; iv) serious setbacks during the WWI and the post-war years, from 1914 to 1921; v) moderate and irregular growth in the inter-war period, from 1922-1941; vi) new period of serious setbacks during the WWII, specifically between 1942 and 1945; vii) important and continuous growth between 1946 and 1973, and viii) moderate and irregular growth from the implementation of the democratic regime in 1974 until 1985<sup>60</sup>. Next, we are going to discuss the particulars of the various periods, and the situations of financial crises.

In 1832, D. Miguel I negotiated a loan of 40 million francs, approximately 6500 contos de reis, through the bankers Outrequin and Jauche, with a repayment period of 32 years and an interest rate of 5%, which became known as D. Miguel's loans. After the defeat of the conservative army, and the exile of D. Miguel I, D. Maria II, daughter of D. Pedro IV and niece of D. Miguel I, definitively ascended to the throne of Portugal and suspended the payment of the interest in 1835-36. It should be highlighted also that despite having this dispute, Portugal managed to issue new loans<sup>61</sup>. The financial vulnerability of Portugal was aggravated by the financial crisis of the USA and the United Kingdom, and it was in this context that Portugal faced the first bankruptcy in contemporary history and the first one in two centuries, in 1837, when D. Maria II finally repudiated the D. Miguel's loans, with the justification that the lenders should not have lent to D. Miguel I, because he had usurped the crown<sup>62</sup>. As explained in Rodrigues (2012), the holders of the debt securities, mainly French, formed a committee and for decades deployed initiatives to obtain repayment, but only in 1891, the Portuguese Government accepted to liquidate 2.5 million francs, little more than 6% of the total D. Miguel loan.

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<sup>60</sup> The authors have calculated the average real gross domestic product growth rate for each period: period i) -0,2%; ii) +2.8%; iii) +0.9%; iv) -7.1%; v) +4.7%; vi) -3.8%; vii) +5.4%, and viii) +2.9%.

<sup>61</sup> For example, in 1835 the Government took out a loan in the City of London, of 1 million pounds, corresponding to 4100 contos de reis, under the intermediation of the financial group Mendizábal.

<sup>62</sup> Reinhart and Rogoff (2011) catalogued the list of financial crises for the last eight centuries for sample of countries including Portugal. Regarding the cases of default, the first official default took place in 1560 during the regency period of D. João III's widow, Catarina of Austria, because of unsustainable accumulation of public debt in the Portuguese commercial interposition of Antwerp, and the contagion effect of the Spanish bankruptcy of 1557. In addition, other authors also mention the default of 1605, when the king Phillip III of Spain (Filipe II of Portugal), ruled both Iberian countries during the Philippine dynasty from 1580 to 1640. For example, Azevedo (1929) highlights that the end of the Portuguese spice monopoly created treasury problems that led the king Filipe II to order the suspension of the interest imputed to "Casa das Indias", a Portuguese organization created in the beginning of the sixtieth century to administer the Portuguese territories overseas.

The country's financial situation continued to deteriorate, especially in 1841, 1846, and 1850. In 1846 there was a banking crisis. The government decreed the suspension of payments of notes of Banco de Lisboa and of Companhia Confiança Nacional. In his book about the history of modern banks, Conant (1915) describes how Banco de Portugal was created in 1846 from the merger between Banco de Lisboa and Companhia Confiança Nacional. The total default in 1850 on the external debt was the corollary of a situation of economic and political instability in Portugal in those decades, with revolts and counter revolts, and the Patuleia War in 1847<sup>63</sup>. The revision of the Constitutional Charter in 1852, brought a period of more political stability, allowing the implementation of a program of public debt consolidation and restructuring, that culminated in an agreement, at the end of 1855, between the Portuguese Government and the English banks. In Lains and Silva (2012) it is estimated that the debt services were reduced by approximately one-third.

In the middle of 1876, already during the reign of D. Luís I, the banking sector would be shaken again, an episode that was known at the time as the “bank spasm of August 18”. This banking crisis was the result of the high growth in the number of banking institutions, the speculative behaviour supported by remittances from the emigrants in Brazil, and the contagion effect. According to Paixão (1964), the financial crisis in the neighbour Spain and the depreciation of debt securities gave rise to a generalized distrust, which contributed to a run on the banks in Portugal, to a lack of liquidity, and to a suspension of payments by some banks. This context led to a greater concentration in the banking sector<sup>64</sup> and to the disappearance of one-fifth of the existing banking institutions. However, the banking activity continued not to be specifically regulated.

D. Carlos I's reign, between 1889 and 1908, was again a period of political and financial instability in Portugal<sup>65</sup>. It was a period of international recession, triggered by the crisis in the English bank Baring Brothers, in 1890, one of the main partners of the Portuguese government in the City of London. There was also the republican revolution in Brazil, where Portugal had substantial investments and which reduced the remittances from the emigrants. And in Portugal, it was the period of the British ultimatum in 1890, that

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<sup>63</sup> The Patuleia or “Little Civil War”, as explained by Ramos et al. (2009), lasted 8 months and opposed the supporters of a more conservative trend of liberalism that emerged after the revolution of 1820 (also known as “Cartistas” in reference to the Constitutional Charter of 1826, who had the support of D. Maria II and won the war) to a coalition formed between two former opposing groups, the “Miguelistas” (the supporters of D. Miguel) and the “Setembristas” (the left current of the liberal movement that defended the replacement of the Constitutional Charter and the need for a constitution approved by a congress democratically elected by the people).

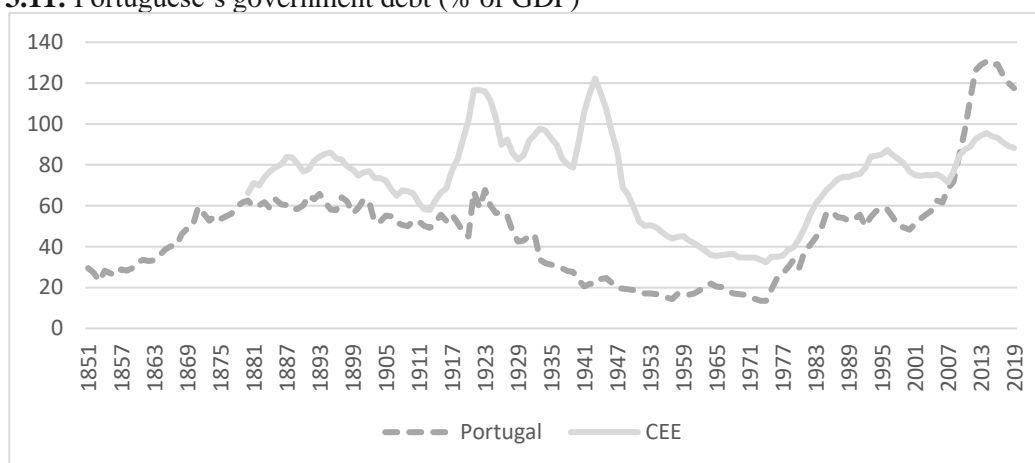
<sup>64</sup> The public bank Caixa Geral de Depositos was created in 1876.

<sup>65</sup> For exhaustive details we recommend Costa et al. (2016).

limited the Portuguese colonial ambitions, and a time of financial crises that have contributed to the discredit of the monarchy and the expansion of republicanism<sup>66</sup>.

The second half of the nineteenth century was also a period of large investments, increased public spending, and a subsequent strong increase of the debt in percentage of GDP, from 29.5% in 1951 to 63.2% in 1901 – see Figure 3.11. It should also be referred that the expansion of the State was still very incipient, was accompanied by cases of waste and mismanagement. Despite the increase, the Portuguese debt level remained below the average of the founding countries of the European Economic Community until 2010.

**Figure 3.11:** Portuguese’s government debt (% of GDP)



Source: Historical Public Debt Database and since 2014 IMF; authors calculations<sup>67</sup>.

This context of economic deterioration and a strong increase of the budget deficits and debt led to a new episode of bankruptcy and banking crisis in Portugal. In 1891, the Government authorised a general moratorium in the banking sector, the inconvertibility of some banknotes, a reduction on the coupon payments of the internal debt of around 30%, and the emission of money up to three times the paid-in capital of the banks. The problems remained and were even aggravated by a loss of credibility of the Portuguese Government, which in 1892 unilaterally decided to reduce the foreign debt interest rates by almost 50%. The Government reached an agreement with the lenders only in 1902. The debt was transformed into a loan redeemable in 99 years with an interest rate of 3%, which allowed a reduction of the annual service debt of 50%. It should be also emphasized that this was a

<sup>66</sup> The First Portuguese Republic would be implemented in 1910, two years after the assassination of D. Carlos I.

<sup>67</sup> The line CEE is an annual average of the European Economic Community founding countries: Belgium, France, Germany, Italy, and Netherlands. Luxembourg was not included due to lack of data.

period of major change in the composition of the banking system<sup>68</sup>, in which Banco de Portugal assumed the role of lender of last resort. The crisis of 1891 / 1892 was, according to Bordo and Eichengreen (1999), a good example of a twin crisis, given that the banking crisis was accompanied by a brutal currency devaluation of more or less 85%. In addition, the crisis led to the implementation of austerity measures, worsening the economic downturn.

As argued in Lains (2003a), from 1870 to 1913, the Portuguese economy expanded slowly and diverged from the European core<sup>69</sup>: from 1870 to 1890 the Portuguese real income per capita has diverged at an annual rate of 0,41%, and between 1890 e 1913 at 0,92%.

The scenario of economic fragility did not change during the First Republic, between 1910 and 1926. The consequences of World War I, from 1914 to 1918, were particularly severe to Portugal, not only because of its effects on the international economy, but also because Portugal had directly participated in the conflict since 1916<sup>70</sup>. This was followed by a long period of a very high inflation rate<sup>71</sup>. In addition, it was also a troubled period for the banking sector. According to Marques (1986), the new international financial crisis between 1920 and 1922, revealed the speculation and uncontrolled multiplication of banks that took place in Portugal during the Great War and was responsible for the bankruptcy of fourteen banks in the first half of the 1920s. Another result of the financial crisis was the creation in 1923 of the first body dedicated exclusively to the inspection of banking activity, the Banking Trade Inspection, directly dependent on the Minister of Finance.

In 1926 a military coup implemented a dictatorial regime in Portugal. The new regime came to be known as Estado Novo, since the approval of the new constitution in 1933. In practice, it was a dictatorial, presidential, authoritarian, autocratic, anti-parliamentary, and corporatist political regime. However, as discussed in Lains (2003b) the coup occurred in a non-particularly negative phase, when the financial and social instability had already been surpassed because of the improvement of the situation in world financial markets and of the fiscal and financial reforms implemented by the republican governments.

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<sup>68</sup> Highlights: the merger of Banco União and Banco Português into Banco Portuense; the absorption of Banco Comércio e Indústria, Banco Mercantil Portuense, Nova Companhia de Utilidade Pública and Banco Portuense by Banco Comercial do Porto; and the bankruptcy of Banco Lusitano.

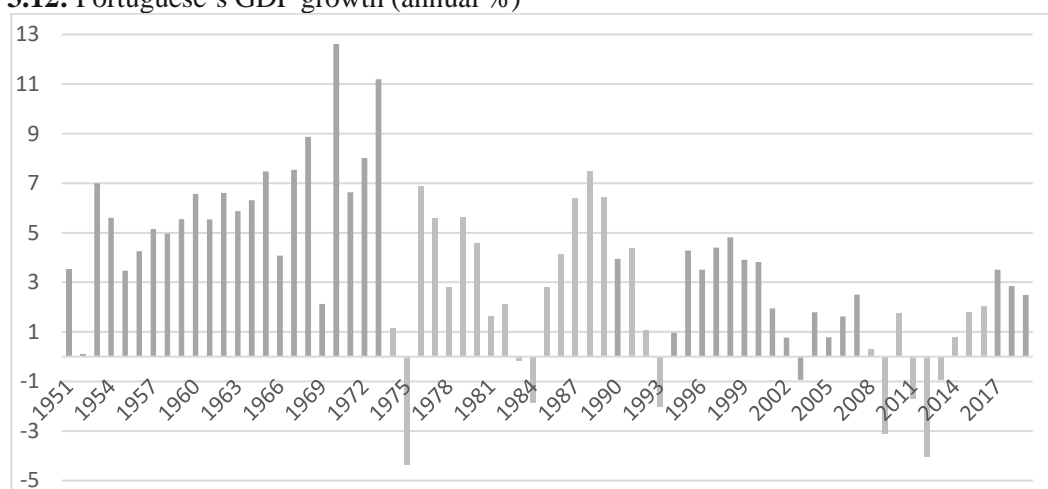
<sup>69</sup> Comparison with the average for United Kingdom, France, Germany, Belgium, the Netherlands, Italy, Sweden, Denmark, and Norway.

<sup>70</sup> Ferraz (2019) presents an estimation of the financial costs associated with Portugal's participation in the Great War (1914-1918), as well as, subsequently, in the Colonial War (1961-1974).

<sup>71</sup> In the period between 1918 and 1924, only in 1919 was the inflation rate below 20%.

The new regime knew how to take advantage of the favourable situation to consolidate its power. In addition, Lains (2003b) also points out that Portugal, like other developed economies in the European periphery, was less affected by the consequences of the Great Depression from 1929 to 1933 in comparison with countries that were more open to international trade and more developed. According to Valério et al. (2006), the Great Depression led to the liquidation of several banks in Portugal<sup>72</sup>, but neither seriously affected the biggest banks in Portugal, nor was responsible for generalized bank runs.

**Figure 3.12:** Portuguese´s GDP growth (annual %)



Source: Adapted from Nunes et al. (1989) between 1951 and 1960, and World Bank.

After 41 years of a dictatorial regime, a revolution on the 25<sup>th</sup> of April 1974 put Portugal on the way to a democratic regime. At the time of the revolution, despite the high GDP growth rates of the sixties, Portugal was a poor country in comparison with the Western European democracies, not only economically but also socially. The year 1975 marks the beginning of the implementation of a welfare state in Portugal. In addition, it was a year of political instability, characterized by nationalizations, strikes, agrarian reform, and wage shocks, that were responsible in part for the recession and strong decrease of the real GDP (very clear in Figure 3.12), and for the first intervention of the IMF, in 1977. The second and third financial assistance programs, respectively in 1983/1984 and between 2011 and 2014, were also marked by periods of recession.

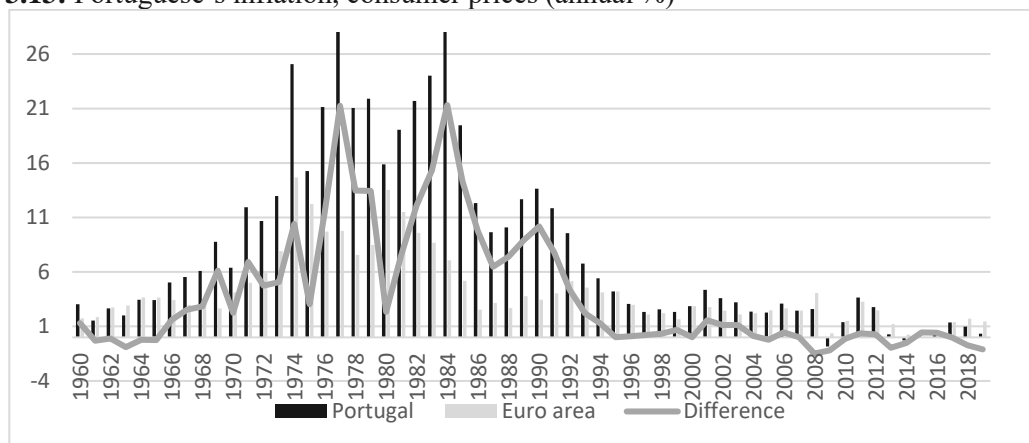
The second IMF intervention became necessary as a result not only of the negative international situation (particularly the increase in oil prices), but also of the populist policies

<sup>72</sup> For example, Banco do Minho and Banco Comercial do Porto.



implemented in a year of elections, that harmed substantially the foreign accounts<sup>73</sup>. These events have contributed to a period of strong inflation, with rates always above 15%, as can be seen in Figure 3.13.

**Figure 3.13:** Portuguese's inflation, consumer prices (annual %)



Source: World Bank.

Not long after the second IMF intervention, in 1986, Portugal joined the European Economic Community. A period of fast economic growth and convergence towards the standards of living of the rest of the European Union ensued (Mateus, 2006). This period of growth and convergence was punctuated by recessions in 1993 and 2003, with the average growth rate falling after each recession - recall Figure 3.12.

In 1992, the Maastricht Treaty established the criteria for European Union member states to be part of the European Economic and Monetary Union<sup>74</sup>. These criteria have shaped economic policies in the European Union since the second half of the 1990s. Although the crisis of the Euro, which reached Portugal in 2010, revealed weaknesses in the Eurozone architecture, the changes introduced because of the crisis have essentially tried to ensure that the principles underlying the Maastricht criteria are indeed implemented by the member states.

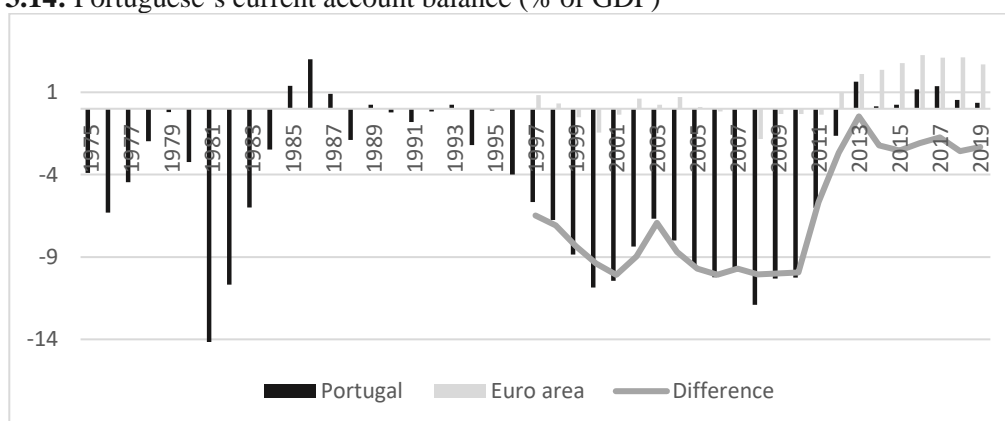
As we mentioned above, Portugal was growing fast in the 1990s. At the same time, compliance with the Maastricht criteria required stabilization of the exchange and inflation rates, with one contributing to the other. Nominal stability has persisted into the twenty-first century, but not fast growth.

<sup>73</sup> The budget deficit reached 13% of GDP in 1982.

<sup>74</sup> Recall chapter 2.

Portugal has started to diverge from its European partners and worse than that was the accumulation of large current account deficits. In the period covered in Figure 3.14, the Portuguese current account balance was always negative until 2012. It is also clear that since 1999, when the Euro was launched, the annual current account deficit became bigger and bigger. The largest deficits occurred in the years just before the international financial crisis of 2008. The crisis reduced the availability of credit and constrained the magnitude of the deficits. Between 2013 and 2017, the balance has been positively leveraged by the good performance of the exports and tourism sector. However, the year 2018 has reversed this trend, mainly because the policy implemented by the Portuguese Government, namely favouring public sector wage increases and social benefits (reverting cuts from the Troika period), has also increased imports.

**Figure 3.14:** Portuguese`s current account balance (% of GDP)



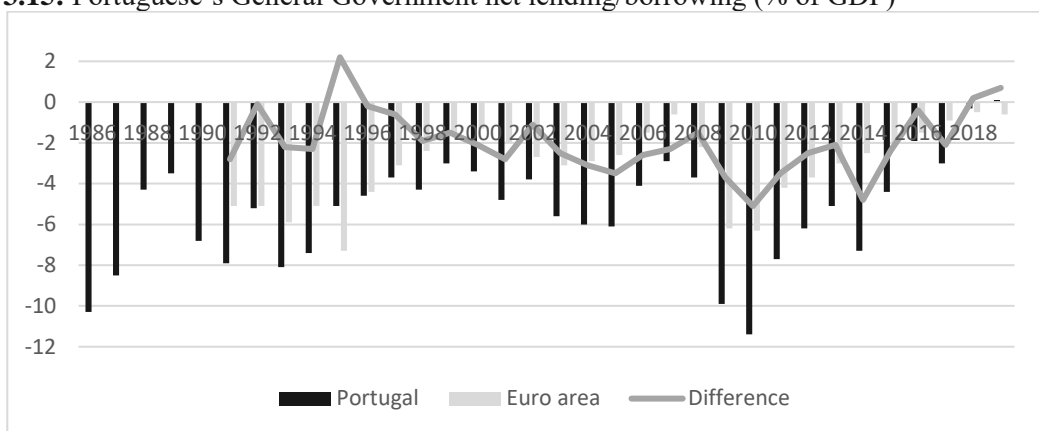
Source: World Bank.

Two additional and separate events affected the Portuguese economy: the integration of the Chinese economy into the world economy, since 2001, and the enlargement of the European Union mainly to the eastern European countries since 2004<sup>75</sup>. Regarding the first issue, Martins (2005) alerted to the fact that Portugal and other countries relatively specialized in exporting goods like those produced in China, in which the cost of labour is crucial, would tend to suffer losses in the markets for these products. On the second issue, Caetano et al. (2005) emphasized that Portugal would be one of the countries to benefit the least from the enlargement, mainly due to the high similarity of its export structure, the

<sup>75</sup> Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia became members of the EU in 2004, Bulgaria and Romania in 2007, and Croatia in 2013.

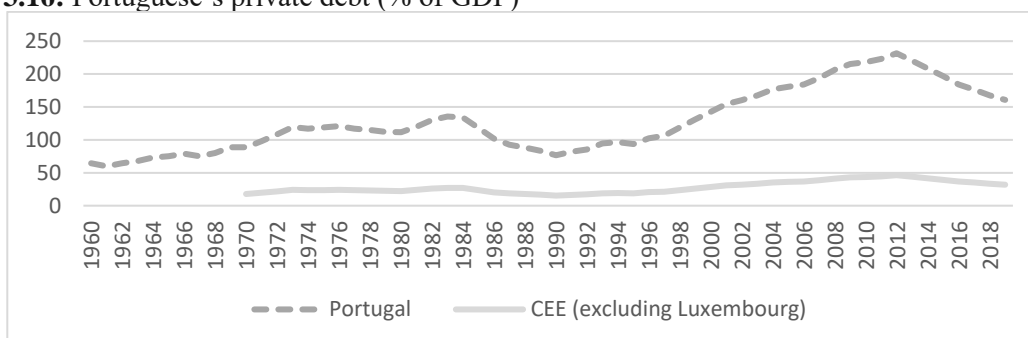
possible diversion of investment flows, the likely displacement of some multinationals, and the expected dispersion of the Structural and Cohesion Funds.

**Figure 3.15:** Portuguese's General Government net lending/borrowing (% of GDP)



Source: IMF Data Mapper.

**Figure 3.16:** Portuguese's private debt (% of GDP)

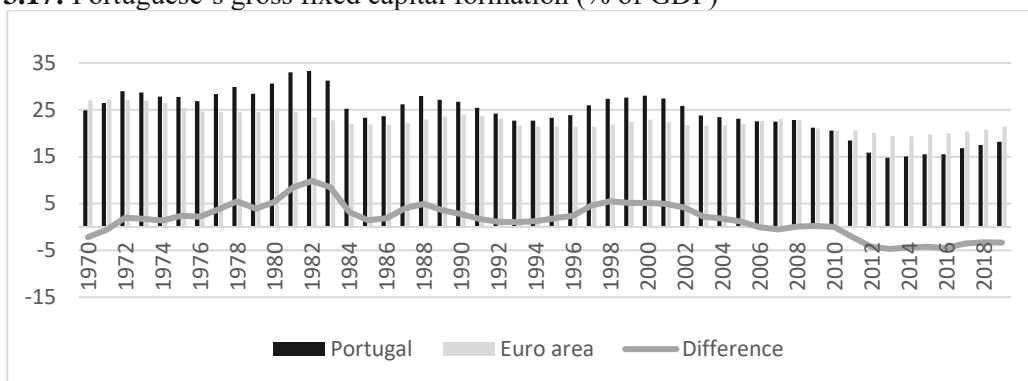


Source: IMF Data Mapper.

In parallel with the deterioration of the current account balance, there was a very strong deterioration of public finances, represented in Figure 3.15, and a substantial increase of the private debt in percentage of GDP, as can be seen in Figure 3.16. The general government deficit, in percentage of GDP, was not only always negative, but also always exceeded the limit of 3% established by the Maastricht Treaty. The highest value has reached in 2010, when it was higher than 11%. The private debt in percentage of GDP, which at the beginning of the new century was around 142%, constantly increased to the maximum of 231% in 2012.

In addition, in this period of high indebtedness, Portugal started to diverge from the average of the Eurozone in terms of gross fixed capital formation in percentage of GDP (Figure 3.17), which seems to demonstrate that the available capital was used for purposes other than investment in improving the country's productive capacity.

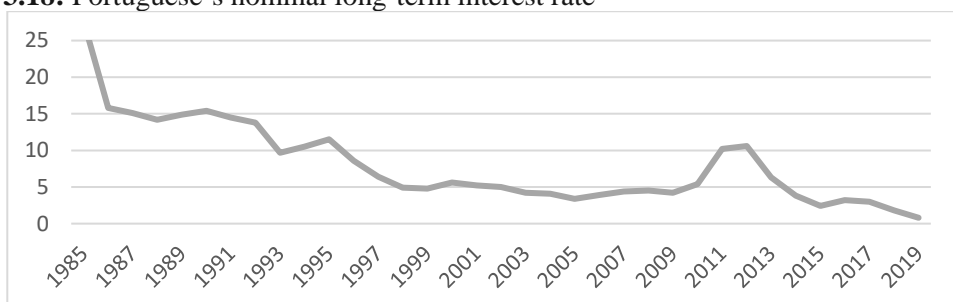
**Figure 3.17:** Portuguese's gross fixed capital formation (% of GDP)



Source: World Bank.

The variables mentioned above are usually listed as determinants of financial crises. There are, however, other variables that can contribute to an increase in the vulnerability to a crisis.

**Figure 3.18:** Portuguese's nominal long-term interest rate



Source: AMECO.

As explained before, this scenario of the vulnerability of the Portuguese economy was aggravated by the international financial crisis and by the costs incurred while providing financial assistance to the financial sector. The problems reached a critical level in 2011 when the external financiers cut the credit to Portugal. The long-term nominal interest rate increased from 5,4% in 2010 to 10.2% one year after (Figure 3.18).

However, the explanations for the beginning of the Portuguese 2011's crisis are vaster and more complex, and the opinions on what caused the crisis vary considerably.

Table 3.2 synthesizes very briefly what we consider to be some of the most interesting contributions to this discussion.

**Table 3.2:** Authors and different views about the Portuguese crisis

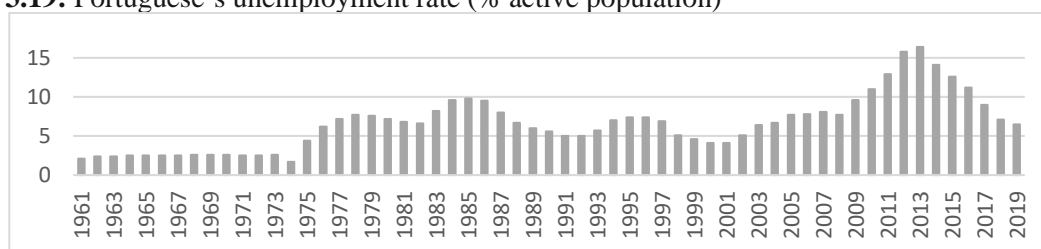
Authors	Views
Bento (2009)	Focus their analyses on the problems of competitiveness, the rigidity of the labour market, and the predominance of the non-tradable sector.
Mateus (2009)	Refers, in an interview conducted by Lusa News Agency, that the crisis is due mainly to regulatory failures of the financial system.
Louçã (2011)	Prefer to highlight, not only the inefficient regulation of financial activities but also the “tremendous amount of speculation” that occurred in the period before the crisis.
Krugman (2012)	Emphasizes the problems associated with a liquidity trap that affected some of the South European Countries.
Quelhas (2012)	Highlights the concepts of systemic risk and contagion effect.
Do Amaral (2013)	Stresses the problems associated with the fact that Portugal does not have an independent monetary policy since it joined the Eurozone.
Reis (2013)	Points out the misallocation of abundant capital flows from abroad because the gradual increase in capital inflows was used mainly on the unproductive non-tradable sector.
Eichenbaum et al. (2016)	On the evaluation of the response of the IMF to the 2011 Portuguese financial crisis, the authors have highlighted the success on the re-establishment of the access of Portugal to international capital markets, but they have also concluded that the sustainability of the Portuguese government debt remains fragile and that the necessary institutions to mitigate the negative impacts of disruptive sudden stops that can affect the more vulnerable countries of the Eurozone were not yet satisfactorily developed by the International Community.
Blanchard and Portugal (2017)	Emphasis the need of solving the problem of non-performing loans, through recapitalization and, if necessary, increasing the fiscal deficit, and the need for product market reforms and labour market flexibility.
Reis (2018)	Stresses the fragility of a persistently peripheral economy, his structural imbalances, and the excessive deindustrialization that followed the Maastricht agreement.

The Financial and Economic Assistance Program agreed with the troika was the solution for the funding problem. The financial assistance package provided, for the period 2011 to 2014, a total of 78 billion euros, of which 52 billion euros corresponded to financing through European mechanisms (European Financial Stabilization Mechanism and European

Financial Stability Fund) and 26 billion euros in IMF assistance under an Extended Fund Facility. Of this total, 12 billion euros were allocated to the public support mechanism for the solvency of the banking sector (Bank Solvency Support Facility). The Program expired at the end of June 2014, with a usage rate of around 97% of the total amount that was agreed<sup>76</sup>.

The financial crisis led to the fall of the government led by Prime Minister José Socrates, from the Socialist Party, and the election of the social democratic party leader Pedro Passos Coelho, with the support of the People’s Party, in June 2011.

**Figure 3.19:** Portuguese`s unemployment rate (% active population)



Source: Statistical Data Warehouse, European Central Bank.

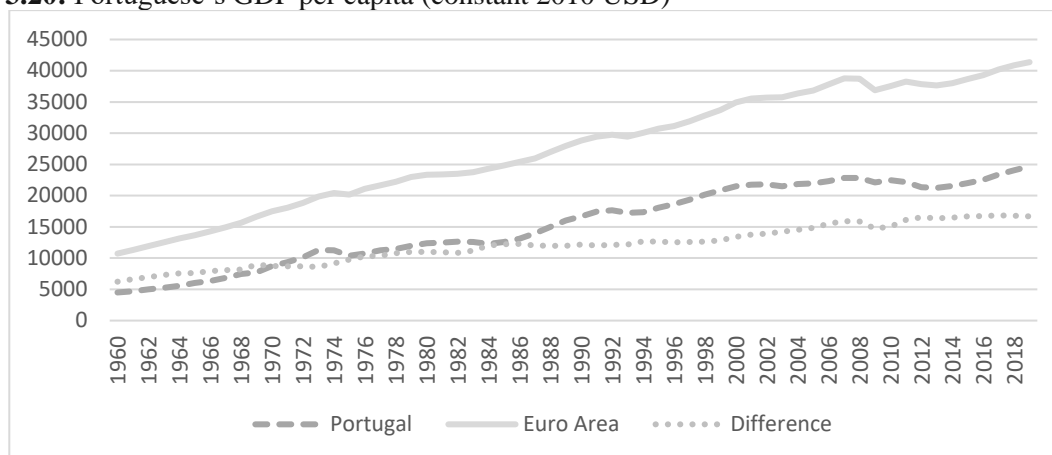
At an economic and social level, the crisis and the austere measures imposed by the troika have contributed to a recession between 2012 and 2014 (recall Figure 3.12) and to an increase in the unemployment rate to a maximum of 16.4% in 2012, as can be seen in Figure 3.19.

According to World Bank data, in 1974, the GDP per capita in Portugal was 11,252 USD, at constant prices of 2010, which represent only 55% of the average GDP per capita of the Eurozone<sup>77</sup>, as shown in Figure 3.20. Until the end of the century there was convergence, but at a very small rate; in 2000 the GDP per capita in Portugal was only 62% of the average GDP per capita of the Eurozone countries. After the period of crisis, in 2014 the Portuguese GDP per capita was 57% of the average GDP per capita of the Eurozone countries.

<sup>76</sup> More details on the implementation of the assistance program can be found in Alexandre et al. (2016) and Ferraz and Duarte (2016).

<sup>77</sup> Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain.

**Figure 3.20:** Portuguese's GDP per capita (constant 2010 USD)



Source: World Bank.

### 3.4. Literature review: logit models and financial crises

As mentioned in chapter 2, according to Frankel and Saravelos (2012), the economic literature normally uses four different groups of modelling approaches to the prediction of financial crises: the probit or logit model; the signal approach or KLR model; an approach that not only uses qualitative and quantitative analyses but also splits countries into a crisis group or non-crisis group<sup>78</sup>, and more recently modern techniques, such as the different types of machine learning techniques<sup>79</sup>.

Several authors have used probit or logit models, relating a set of variables on the prediction of financial crises.

Regarding the causes and consequences of episodes of turbulence in foreign exchange markets, Eichengreen et al. (1995) used a multivariate, dynamic multinomial logit model of exchange rate crises, for 20 OECD countries, between 1959 and 1993. The authors concluded that there are no clear early warning signals of many speculative attacks, and there are no easy solutions for policymakers.

Frankel and Rose (1996) used probit models, a crisis index, and panel data for 100 developing countries, from 1971 until 1992, to analyse currency crashes. The authors conclude that currency crashes tend to occur when output growth is low, and the growth of domestic credit and the level of foreign interest rates are high. They also observe that a low

<sup>78</sup> Example of Santaella and Edwards (1992).

<sup>79</sup> Apoteker and Barthelemy (2000), as an example, have used genetic algorithms techniques on the prediction of financial crises in emerging markets.

ratio of foreign direct investment to debt is consistently associated with a high likelihood of a currency crash.

The prediction of the banking crisis was studied by Demirguç-Kunt and Detragiache (1998) using a multivariate logit model for 45 developed and developing countries, between 1980 and 1994. The authors conclude that banking crises tend to emerge when the macroeconomic environment is weak, particularly when the Gross Domestic Product (GDP) growth rate is low. In addition, the authors associated high real interest rates and vulnerability to a balance of payments crises with systemic banking sector problems.

Berg and Pattillo (1999) used both a KLR model and a probit model for the prediction of currency crises. The authors used a sample of 20 countries, between 1970 and 1995, and 15 macroeconomic variables. The main conclusion of this paper was that for the currency crisis of 1997 in countries like Korea, Indonesia, Malaysia, Thailand, and Brazil, generally the probit model provides better forecasts than the KLR model.

Another early warning system for the prediction of financial crises, more specifically currency crises, was developed by Bussiere and Fratzscher (2006). The authors based their approach on a multinomial logit model, using data for 20 emerging countries for the period between 1993 and 2001, and seven macroeconomic variables. The authors concluded that the use of a multinomial logit model, which allows distinguishing between the tranquil, pre-crisis regime and post-crisis periods, improves the ability to forecast financial crises, and more specifically that this model would have correctly anticipated most of the Asian crisis in 1997 and 1998, the Russian and Brazilian crises in 1998 and the Turkish crisis in 2001.

A discrete-choice panel analysis was used by Gourinchas and Obstfeld (2012) for the prediction of financial crises: currency crises, banking crises, and government default crises. The study uses data from 1973 to 2010, for 57 emerging markets and 22 advanced economies. The main conclusion was that domestic credit expansion and real currency appreciation have been the most robust and significant predictors of financial crises, regardless of whether it is an emerging or an advanced country.

Louzis and Vouldis (2013) proposed a new financial systemic index using variables of five main groups of macroeconomic variables: i) Fundamentals of the Greek economy; ii) Banking sector; iii) Banking; iv) Equity markets, v) Money markets. They considered the period between 1998 and 2010 and incorporated a time-varying correlation between different market segments and a BEKK correlation specification model to improve the ability of the financial systemic stress index in the identification of the period of crisis. In a second stage, the authors used a probit model to test whether escalation of the financial systemic stress



index culminates in actual financial crises and concluded that the financial systemic stress index can timely identify the crisis periods, as well as the level of systemic stress in the Greek financial system.

Amaral et al. (2014) have used a spatial probit model to study the effects of contagion between banking systems of different countries, during the 1990s banking crisis in Asia. The authors' main conclusion is that the recession periods and poor banking sector performance are favourable to the occurrence of a banking crisis, and that increasing public expenditure (% of GDP) has a stabilizing effect.

A dynamic probit model was used by Antunes et al. (2014) for the prediction of banking crises, for the 28 European countries, considering data for the period between 1970 and 2010. The authors conclude that the credit to GDP gap ratio and the growth of the debt service ratio are very useful variables in the prediction of a banking crisis.

Caggiano et al. (2016) compare the performance and differences between binomial and multinomial logit models for the prediction of systemic banking crises. The authors used data for 92 countries between 1982 and 2010. The main conclusion of that study is that the multinomial logit outperforms the binomial logit model in predicting systemic banking crises, and that the longer the average duration of the crisis in the sample the larger the improvement.

Gourinchas et al. (2016) used a Dynamic Stochastic General Equilibrium Model to analyse the dynamics before and during the Greek crisis. They compared this crisis with 56 other episodes of sudden stops, sovereign defaults, lending booms, and busts, and used data for 22 advanced countries and 57 emerging markets between 1980 and 2014. The macroeconomic variables considered in this study were output, consumption, investment, exports and imports of goods and services, the current account balance, credit to the non-financial sector, and public debt. The paper presents four main conclusions: i) the Greek crisis and GDP reduction were significantly more severe and protracted than in the average crisis episode; ii) an unusually large drop in GDP was followed by an unusually large drop in the investment (% of GDP); iii) there were negative effects of the high levels of Greek government, private, and foreign debt levels before the crisis, and iv) fiscal shocks, sudden stop, and the subsequent funding costs, appear to have been responsible for the large output drop at the beginning of the Greek crisis.

### 3.5. Data

We have added two new variables – government debt, and current account balance – to the database used in Chapter II.

Table 3.3 gives information about the sources of these two new variables.

**Table 3.3:** Macroeconomic variables

Variable	Main source
Government debt (% of GDP)	AMECO
Current account balance (% of GDP)	World Development Indicators from World Bank and IMF International Financial Statistic

In addition, we also maintained a balance between the number of countries more and less prone to financial crisis, as documented in Table 3.4.

**Table 3.4:** Relation between the number of countries and number of years of a financial crisis

Years of crisis between 1960 and 2016	0 - 10	11 - 20	21 - 30	31 or more	Total
Number of countries	15	27	17	10	69
Percentage	21.74%	39.13%	24.64%	14.49%	100%

Source: Authors calculations.

**Table 3.5:** Types of financial crises

Types	Definition
Sovereigns' debt	<ul style="list-style-type: none"> <li>External, when there is a failure to meet a principal or interest payment on the due date or when a rescheduled debt is ultimately extinguished in terms less favourable than the original</li> <li>Domestic, when in addition to the external debt restructuring, it involves the freezing of bank deposits or forcible conversions of such deposits from USD to the domestic currency</li> </ul>
Inflation	An annual inflation rate of 20 percent or higher
Currency	An annual depreciation versus the USD (or in some cases the Euro) of more than 15 percent
Banking	Bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions; when there are no runs, but closure, merging takeover, or large-scale government assistance of at least an important financial institution with risk of contagion

Source: Reinhart and Rogoff (2011).

We assume that the variation in the performance of any macroeconomic variable is going to impact the risk of having a financial crisis in the next year, and because of that, all the variables with exception of the variable credit use a one-year lag in our model. In the case of the variable domestic credit to the private sector, following Demirgüç-Kunt and Detragiache (1998), we use a two-year lag. Table 3.5 defines the four types of financial crises that were considered.

### **3.6. Results**

In a similar way to chapter 2, our econometric analysis proceeds in three stages.

In stage one, we construct the dependent variable - the dummy that indicates the occurrence of at least one type of financial crisis. In the binomial logit model, “1” represents a crisis in a certain country in a certain year, and “0” means there was no crisis in that country in that year. In the first multinomial logit model, the number “2” represents the first year of the occurrence of a financial crisis in a certain country in a certain year, “1” represents the subsequent years of financial crisis, and “0” means there was no crisis in that country in that year. In the second multinomial logit model, the number “2” represents more than one type of financial crisis in a certain country in a certain year, “1” represents the subsequent years of financial crises, and “0” means there was no crisis in that country in that year. For the construction of the dummy variable, our references are Reinhart and Rogoff (2011) and the *Global Crises by Country, Behavioral Finance & Finance Stability*, from the Harvard Business School.

In stage two, we estimated a binomial and a multinomial logit model. In this process, we used the software Gretl, version 2021b.

Finally, in stage 3, we calculate our financial crisis warning index for Greece and Portugal, using the estimated coefficients and considering a normal distribution.

The main results of the estimation of version 1 of the binomial logit model are reported in Table 3.6. This model, as explained before, uses as explanatory variables the macroeconomics variables GDP growth, terms of trade, exchange rate, real interest rate, inflation, deficit, credit, GDP per capita, debt and current account balance.

**Table 3.6:** Binomial logit model<sup>80</sup>: version 1

	Coefficient	p-value <sup>81</sup>
Constant	-1.01733	0.1115
GDP growth rate	-0.0930067	0.0000 ***
FD Terms of trade	-2.72304	0.2382
Terms of trade	-0.392205	0.5262
Exchange rate	0.0117019	0.2747
Real interest rate	0.0129028	0.0011 ***
Inflation	0.0710272	0.0000 ***
Deficit	0.000499733	0.9335
FD credit	-0.00851660	0.2259
Credit	0.00261336	0.0566 *
GDPpc	-1.95520e-05	0.0000 ***
Debt	0.0129778	0.0000 ***
Current account balance	-0.0394078	0.0000 ***

Number of observations: 3074

Adjusted R squared: 0.183270

Number of 'correctly predicted' cases: 2235 (72.7%)

Number of crises "correctly predicted": 630 (49.8%).

Source: Authors calculations

Our model correctly predicted 72.7% of the cases, but some variables are not statistically significant at a 1% level of significance, more specifically: the first difference of the terms of trade; the terms of trade; the rate of depreciation of the real exchange rate; the public deficit; and the first different of credit.

In Table 3.7 we presented version 2 of the binomial logit model, a shorter version that excludes the variables that previously were reported as non-significant. This new model slightly improves the number of cases that are correctly predicted from 2235 to 2268. All the variables are significant at the 1% level of significance with exception of the first difference of credit, which is significant at the 5% level of significance. The estimated coefficients display the expected sign, i.e., lower real GDP growth or lower GDP per capita increases the probability of a crisis, and likewise for higher inflation, negative current

<sup>80</sup> As explain previously we are using a lag 1 to all the variables, with exception of the variable "Credit", that uses a lag of two periods (lag 2).

<sup>81</sup> If the p-value is less than our level of significance we reject the null hypothesis, in our case that a specific macroeconomic variable is not relevant on the prediction of a financial crisis. In practice, in Gretl, low levels of p-values are highlighted with asterisks: "\*" means that we can reject H0 at a 10% level of significance or that p-value is less than 0.1; "\*\*\*" means that we can reject H0 at a 5% level of significance or that p-value is less than 0.05; "\*\*\*\*" means that we can reject H0 at a 1% level of significance or that p-value is less than 0.01.

account balances, depreciation of the real exchange rate, an increase in the first difference of the credit or an increase in public debt.

**Table 3.7:** Binomial logit model: version 2

	Coefficient	p-value
Constant	-1.43203	0.0000 ***
GDP growth rate	-0.0950880	0.0000 ***
Real interest rate	0.0138243	0.0004 ***
Inflation	0.0719248	0.0000 ***
FD credit	0.00275273	0.0425 **
GDPpc	-1.97464e-05	0.0000 ***
Debt	0.0129379	0.0000 ***
Current account balance	-0.0407420	0.0000 ***

Number of observations: 3112

Adjusted R squared: 0,185827

Number of 'correctly predicted' cases: 2268 (72.9%)

Number of crises "correctly predicted": 639 (50.1%).

Source: Authors calculations

In addition to the binomial logit models, we have applied different versions of multinomial logit models.

Tables 3.8 and 3.9 present the results of the version that considers that the dummy variable takes the value "2" when there is more than one-time financial crisis in that specific year, and the value "1" when there is just one type of financial crisis. The main conclusion is that this model has the worst performance regarding the correct prediction of cases in our data set. More specifically, in the model that uses more variables (version 1), there was a reduction from 72.7% to 67.4%, and for the model with fewer variables (version 2) the reduction was from 72.9% to 67.9%.

**Table 3.8:** Multinomial logit model: version 1

- For dummy variable equal to "1"

	Coefficient	p-value
Constant	-2.95016	0.0005 ***
GDP growth rate	-0.0796939	0.0000 ***
FD terms of trade	0.241301	0.9401
Terms of trade	0.446941	0.5863
Exchange rate	0.000617371	0.9590

Real interest rate	0.00736045	0.0664 *
Inflation	0.0507364	0.0000 ***
Deficit	-0.00252398	0.6891
FD credit	0.00107734	0.8982
Credit	0.00452193	0.0154 **
GDPpc	-2.56821e-05	0.0000 ***
Debt	0.0149321	0.0000 ***
Current account balance	-0.0590048	0.0000 ***

- For dummy variable equal to “2”

	Coefficient	p-value
Constant	-0.450869	0.4939
GDP growth rate	-0.0963296	0.0000 ***
FD terms of trade	-2.46141	0.3171
Terms of trade	-0.906454	0.1588
Exchange rate	0.000602419	0.9600
Real interest rate	0.00710526	0.0547 *
Inflation	0.0508392	0.0000 ***
Deficit	0.00777911	0.2058
FD credit	-0.0178095	0.0232 **
Credit	-0.000321976	0.8373
GDPpc	-1.78582e-05	0.0000 ***
Debt	0.0102316	0.0000 ***
Current account balance	-0.0281962	0.0036 ***

Number of observations: 3074

Number of 'correctly predicted' cases: 2073 (67,4%)

Source: Authors calculations

**Table 3.9:** Multinomial logit model: version 2

- For dummy variable equal to “1”

	Coefficient	p-value
Constant	-2.46081	0.0000 ***
GDP growth rate	-0.0811196	0.0000 ***
Real interest rate	0.00875559	0.0254 **
Inflation	0.0505278	0.0000 ***
FD credit	0.000148420	0.9858

Credit	0.00508031	0.0057 ***
GDPpc	-2.47388e-05	0.0000 ***
Debt	0.0128231	0.0000 ***
Current account balance	-0.0594080	0.0000 ***

- For dummy variable equal to “2”

	Coefficient	p-value
Constant	-1.35903	0.0000 ***
GDP growth rate	-0.0990495	0.0000 ***
Real interest rate	0.00658504	0.0708 *
Inflation	0.0512582	0.0000 ***
FD credit	-0.0178099	0.0230 **
Credit	-0.000707190	0.6512
GDPpc	-1.83375e-05	0.0000 ***
Debt	0.0115656	0.0000 ***
Current account balance	-0.0312308	0.0006 ***

Number of observations: 3111

Number of 'correctly predicted' cases: 2111 (67,9%)

Source: Authors calculations

Tables 3.10 and 3.11 present the results of the version that considers that the dummy variable takes the value “2” in the first year of the financial crisis, and the value “1” when the crisis financial persists in subsequent years. These versions of the multinomial logit model, versions 3 and 4, improve the result regarding the number of 'correctly predicted' cases, but are again worse than the binomial logit model. The percentage of cases that are correctly predicted is 71.6% in both versions 3 and 4 of the multinomial logit models.

**Table 3.10:** Multinomial logit model: version 3

- For dummy variable equal to “1”

	Coefficient	p-value
Constant	-0.929819	0.1735
GDP growth rate	-0.121228	0.0000 ***
FD Terms of trade	-2.86019	0.2495
Terms of trade	-0.434561	0.5140
Exchange rate	5.36801e-06	0.9146
Real interest rate	0.00730968	0.0406 **

Inflation	0.0508690	0.0000 ***
Deficit	0.00254555	0.6852
FD credit	-0.0263424	0.0020 ***
Credit	0.000130456	0.9339
GDPpc	-2.93145e-05	0.0000 ***
Debt	0.0163523	0.0000 ***
Current account balance	-0.0334185	0.0007 ***

- For dummy variable equal to “2”

	Coefficient	p-value
Constant	-1.77539	0.0703 *
GDP growth rate	-0.00795096	0.6815
FD Terms of trade	3.16743	30.3904
Terms of trade	-0.261092	0.7841
Exchange rate	8.56572e-08	0,9995
Real interest rate	1.35751e-05	0.9969
Inflation	0.0172785	0.0182 **
Deficit	0.0133846	0.2483
FD credit	0.00869183	0.3417
Credit	0.00190598	0.3589
GDPpc	-1.96816e-06	0.7117
Debt	-0.00464846	0.1140
Current account balance	-0.0501971	0.0003 ***

Number of observations: 3074

Number of 'correctly predicted' cases: 2202 (71,6%)

Source: Authors calculations

**Table 3.11:** Multinomial logit model: version 4

- For dummy variable equal to “1”

	Coefficient	p-value
Constant	-1.34332	0.0000 ***
GDP growth rate	-0.122922	0.0000 ***
Real interest rate	0.00799855	0.0239 **
Inflation	0.0509535	0.0000 ***
FD credit	-0.0272388	0.0012 ***
GDPpc	-2.90004e-05	0.0000 ***



Debt	0.0160533	0.0000 ***
Current account balance	-0.0365268	0.0000 ***

- For dummy variable equal to “2”

	Coefficient	p-value
Constant	-2.00924	0.0000 ***
GDP growth rate	-0.0116115	0.5456
Real interest rate	0.000140213	0.9671
Inflation	0.0209668	0.0010 ***
FD credit	0.00829820	0.3661
GDPpc	4.93344e-07	0.9107
Debt	-0.00299040	0.2486
Current account balance	-0.0505304	0.0002 ***

Number of observations: 3111

Number of 'correctly predicted' cases: 2229 (71,6%)

Source: Authors calculations

What can our model say about the probability of Greece or Portuguese facing a new financial crisis? To answer this question, we are going to use the results of the binomial logit model, version 2, as it was the model that had the best performance in terms of cases that were correctly predicted.

Table 3.12 shows the calculation of our crisis index and the probabilities in the case of Greece. Table 3.13 does the same for the case of Portugal.

Regarding Greece, it should be highlighted that our model points to the financial crises of 1975, with a peak of 80%. It was a period of transition from the dictatorial regime to democracy and a year of economic contraction and high inflation. And it should also be noted that the 1980s and the first half of the 1990s were a period of very high inflation (recall Figure 3.4), and of some banking sector distress. According to Hutchison (2002), in the period between 1991 and 1995, there were localized problems that have required large injections of public funds into specialized lending institutions.

**Table 3.12:** Crisis index and estimated probabilities for Greece, from 1970 to 2021

Year	Data*Coefficient <sup>82</sup>							Constant	Index	Probability <sup>83</sup>
	GDP	RIR	Inflation	FD_credit	GDPpc	Debt	CAB			
1970	-1.10	0.02	0.23	0.00	-0.24	0.33	0.12	-1.43	-2.06	0.02
1971	-0.85	0.02	0.27	0.00	-0.26	0.32	0.13	-1.43	-1.81	0.04
1972	-0.75	0.03	0.21	0.00	-0.28	0.32	0.10	-1.43	-1.80	0.04
1973	-0.97	0.00	0.36	0.00	-0.31	0.34	0.09	-1.43	-1.91	0.03
1974	-0.77	-0.14	1.50	-0.01	-0.33	0.28	0.22	-1.43	-0.67	0.25
1975	0.61	-0.15	1.64	0.00	-0.31	0.29	0.18	-1.43	0.84	0.80
1976	-0.61	-0.05	0.94	0.00	-0.32	0.31	0.14	-1.43	-1.02	0.15
1977	-0.65	-0.08	1.18	0.00	-0.34	0.26	0.12	-1.43	-0.94	0.17
1978	-0.28	-0.06	0.99	0.00	-0.35	0.26	0.12	-1.43	-0.74	0.23
1979	-0.69	-0.05	0.99	0.05	-0.37	0.33	0.09	-1.43	-1.08	0.14
1980	-0.31	-0.11	1.45	-0.01	-0.37	0.29	0.14	-1.43	-0.35	0.36
1981	-0.06	-0.03	1.38	0.00	-0.37	0.29	0.16	-1.43	-0.07	0.47
1982	0.15	-0.05	1.55	0.01	-0.36	0.35	0.19	-1.43	0.39	0.65
1983	0.11	-0.09	1.96	0.00	-0.36	0.38	0.14	-1.43	0.70	0.76
1984	0.10	-0.05	1.48	0.00	-0.35	0.43	0.15	-1.43	0.34	0.63
1985	-0.19	-0.07	1.58	0.00	-0.35	0.52	0.18	-1.43	0.22	0.59
1986	-0.24	-0.02	1.37	0.00	-0.36	0.60	0.28	-1.43	0.19	0.58
1987	-0.05	0.01	1.36	0.00	-0.36	0.61	0.12	-1.43	0.26	0.60
1988	0.21	0.00	1.10	-0.01	-0.35	0.68	0.08	-1.43	0.27	0.61
1989	-0.41	-0.01	1.20	0.00	-0.37	0.74	0.05	-1.43	-0.23	0.41
1990	-0.36	0.05	1.04	0.00	-0.38	0.77	0.13	-1.43	-0.17	0.43
1991	0.00	-0.01	1.49	-0.01	-0.37	0.95	0.15	-1.43	0.76	0.78
1992	-0.29	0.03	1.42	0.00	-0.38	0.97	0.06	-1.43	0.37	0.64
1993	-0.07	0.11	1.06	0.00	-0.38	1.03	0.08	-1.43	0.40	0.65
1994	0.15	0.11	1.04	-0.01	-0.37	1.30	0.03	-1.43	0.82	0.79
1995	-0.19	0.17	0.80	0.00	-0.38	1.27	0.01	-1.43	0.25	0.60
1996	-0.20	0.08	0.70	0.01	-0.38	1.28	0.09	-1.43	0.15	0.56
1997	-0.27	0.08	0.55	0.00	-0.39	1.31	0.13	-1.43	-0.02	0.49
1998	-0.43	0.08	0.47	0.00	-0.40	1.29	0.14	-1.43	-0.28	0.39
1999	-0.37	0.12	0.37	0.00	-0.42	1.26	0.11	-1.43	-0.36	0.36
2000	-0.29	0.09	0.26	0.02	-0.43	1.28	0.21	-1.43	-0.30	0.38

<sup>82</sup> We multiplied the data that we collected for each macroeconomic variable and for each year by the corresponding coefficient, estimated in our empirical analysis (see Table 3.6). The sum of these and of the constant gives the values in column “Total”.

<sup>83</sup> In the column “probability” we calculated the probability of a financial crisis in the country, in each year, considering a normal distribution and the index values (column “Total”).

2001	-0.37	0.08	0.11	0.02	-0.44	1.36	0.31	-1.43	-0.36	0.36
2002	-0.39	0.01	0.25	0.01	-0.46	1.39	0.28	-1.43	-0.34	0.37
2003	-0.37	0.00	0.24	0.01	-0.47	1.36	0.25	-1.43	-0.42	0.34
2004	-0.55	-0.02	0.25	0.01	-0.50	1.31	0.26	-1.43	-0.67	0.25
2005	-0.48	-0.01	0.22	0.01	-0.52	1.33	0.23	-1.43	-0.65	0.26
2006	-0.06	0.00	0.16	0.03	-0.53	1.39	0.30	-1.43	-0.14	0.44
2007	-0.54	-0.01	0.25	0.01	-0.56	1.34	0.44	-1.43	-0.49	0.31
2008	-0.31	0.01	0.25	0.02	-0.58	1.33	0.57	-1.43	-0.14	0.45
2009	0.03	0.00	0.31	0.01	-0.58	1.42	0.59	-1.43	0.35	0.64
2010	0.41	-0.02	0.18	0.00	-0.56	1.64	0.44	-1.43	0.66	0.75
2011	0.52	0.01	0.05	0.06	-0.53	1.89	0.41	-1.43	0.99	0.84
2012	0.87	0.01	0.06	0.02	-0.49	2.23	0.40	-1.43	1.66	0.95
2013	0.69	0.01	-0.03	0.00	-0.45	2.06	0.10	-1.43	0.96	0.83
2014	0.31	0.03	-0.17	0.00	-0.44	2.30	0.08	-1.43	0.68	0.75
2015	-0.07	0.03	-0.13	-0.01	-0.45	2.33	0.06	-1.43	0.34	0.63
2016	0.04	0.00	-0.02	-0.01	-0.45	2.29	0.03	-1.43	0.45	0.68
2017	0.02	0.00	-0.02	-0.01	-0.45	2.36	0.07	-1.43	0.54	0.71
2018	-0.12	-0.01	0.03	-0.02	-0.45	2.32	0.07	-1.43	0.39	0.65
2019	-0.15	0.00	-0.01	-0.03	-0.46	2.41	0.12	-1.43	0.46	0.68
2020	-0.18	-0.01	0.01	-0.03	-0.47	2.34	0.06	-1.43	0.30	0.62
2021	0.78	0.01	-0.10	0.00	-0.43	2.67	0.27	-1.43	1.76	0.96

Source: Data used in the empirical analysis, and authors' computations.

Concerning Portugal, it is also clear the troubled period during the implementation of democracy, more specifically the deterioration of the financial conditions in the years that preceded the financial crisis of 1977, with probabilities above 50%. It is also notorious the problems that were faced by Portugal in the first half of the 1980s, from which we should highlight the very high inflation rates of this period (recall Figure 3.13); these difficulties culminated in the financial instability of 1983/1984, with the crisis probability around 80%.

Figure 3.21 is the graphical representation of the results for both countries. In this joint analysis, it is interesting to notice that although our model shows that both countries faced a deterioration in the risk of having a financial crisis in the twenty-first century, this increase in the probability of having a financial crisis was much sharper in the Greek case. On one hand, it is clear in the graph the Great Recession in Greece, which in our model reached the peak in the period between 2010 and 2013, with the peak close to 100% in 2012. On the other hand, in Portugal, the Great Recession arrived one year later, which seems to

demonstrate the risk of contagion within the Eurozone for countries facing similar fragilities. However, in the Portuguese case, the probability was smaller, around 60%. This result seems to confirm also that the vulnerability of the Greek economy was much bigger when compared with Portugal.

**Table 3.13:** Portuguese crisis index and estimated probabilities, from 1970 to 2021

Year	Data*Coefficient							Constant	Index	Probability
	GDP	RIR	Inflation	FD_credit	GDPpc	Debt	CAB			
1970	-0.20	-0.02	0.53	0.01	-0.15	0.22	-0.10	-1.43	-1.15	0.13
1971	-1.20	0.00	0.24	0.00	-0.17	0.21	-0.03	-1.43	-2.39	0.01
1972	-0.63	-0.01	0.36	0.01	-0.18	0.20	-0.06	-1.43	-1.74	0.04
1973	-0.76	-0.03	0.56	0.01	-0.20	0.19	-0.12	-1.43	-1.79	0.04
1974	-1.07	-0.10	0.68	0.02	-0.22	0.18	-0.08	-1.43	-2.02	0.02
1975	-0.11	-0.12	1.36	0.00	-0.22	0.17	0.25	-1.43	-0.10	0.46
1976	0.41	-0.17	1.17	0.04	-0.20	0.25	0.16	-1.43	0.22	0.59
1977	-0.66	-0.10	1.17	-0.04	-0.21	0.32	0.26	-1.43	-0.70	0.24
1978	-0.53	-0.12	1.90	-0.01	-0.22	0.35	0.18	-1.43	0.12	0.55
1979	-0.27	-0.01	1.61	-0.01	-0.23	0.39	0.08	-1.43	0.13	0.55
1980	-0.54	-0.03	1.40	0.02	-0.24	0.43	0.01	-1.43	-0.38	0.35
1981	-0.44	-0.09	1.50	0.00	-0.25	0.38	0.13	-1.43	-0.18	0.43
1982	-0.15	-0.02	1.27	0.01	-0.25	0.48	0.60	-1.43	0.51	0.69
1983	-0.20	-0.02	1.49	0.00	-0.25	0.53	0.43	-1.43	0.55	0.71
1984	0.02	-0.06	1.77	0.00	-0.25	0.58	0.24	-1.43	0.87	0.81
1985	0.18	-0.02	1.77	0.00	-0.24	0.63	0.10	-1.43	0.99	0.84
1986	-0.27	0.00	1.56	-0.02	-0.25	0.73	-0.06	-1.43	0.26	0.60
1987	-0.39	-0.03	1.47	-0.02	-0.26	0.74	-0.12	-1.43	-0.06	0.48
1988	-0.61	0.06	0.73	-0.01	-0.28	0.70	-0.04	-1.43	-0.88	0.19
1989	-0.71	0.00	0.80	-0.01	-0.30	0.70	0.08	-1.43	-0.88	0.19
1990	-0.61	0.04	0.76	-0.01	-0.32	0.68	-0.01	-1.43	-0.91	0.18
1991	-0.38	0.07	0.95	0.00	-0.33	0.69	0.01	-1.43	-0.43	0.33
1992	-0.42	0.08	0.73	0.01	-0.35	0.72	0.03	-1.43	-0.62	0.27
1993	-0.10	0.09	0.82	0.01	-0.35	0.65	0.01	-1.43	-0.31	0.38
1994	0.19	0.10	0.53	0.01	-0.34	0.71	-0.01	-1.43	-0.24	0.41
1995	-0.09	0.06	0.52	0.00	-0.34	0.74	0.09	-1.43	-0.45	0.33
1996	-0.41	0.05	0.25	0.02	-0.35	0.76	0.00	-1.43	-1.11	0.13
1997	-0.33	0.07	0.17	0.02	-0.37	0.75	0.16	-1.43	-0.96	0.17
1998	-0.42	0.02	0.28	0.02	-0.38	0.70	0.23	-1.43	-0.97	0.17
1999	-0.46	0.01	0.28	0.03	-0.40	0.65	0.28	-1.43	-1.05	0.15

2000	-0.37	-0.01	0.24	0.05	-0.41	0.64	0.36	-1.43	-0.92	0.18
2001	-0.36	0.01	0.25	0.05	-0.42	0.63	0.44	-1.43	-0.85	0.20
2002	-0.18	0.01	0.27	-0.03	-0.43	0.66	0.43	-1.43	-0.72	0.24
2003	-0.07	-0.01	0.30	0.01	-0.43	0.69	0.34	-1.43	-0.60	0.27
2004	0.09	-0.01	0.25	0.00	-0.43	0.72	0.27	-1.43	-0.54	0.29
2005	-0.17	0.00	0.17	0.00	-0.43	0.74	0.33	-1.43	-0.80	0.21
2006	-0.07	-0.02	0.24	0.01	-0.43	0.81	0.39	-1.43	-0.51	0.31
2007	-0.15	0.00	0.23	0.02	-0.44	0.80	0.42	-1.43	-0.56	0.29
2008	-0.24	0.02	0.21	0.02	-0.45	0.89	0.39	-1.43	-0.59	0.28
2009	-0.03	0.04	0.12	0.03	-0.45	0.93	0.49	-1.43	-0.31	0.38
2010	0.30	0.00	0.08	0.02	-0.44	1.08	0.42	-1.43	0.03	0.51
2011	-0.17	0.00	0.05	-0.01	-0.44	1.24	0.42	-1.43	-0.34	0.37
2012	0.16	0.02	-0.02	0.00	-0.44	1.44	0.24	-1.43	-0.02	0.49
2013	0.39	0.01	-0.03	-0.01	-0.42	1.63	0.07	-1.43	0.21	0.58
2014	0.09	-0.03	0.16	-0.03	-0.42	1.67	-0.07	-1.43	-0.05	0.48
2015	-0.08	-0.01	0.05	-0.04	-0.43	1.68	-0.01	-1.43	-0.25	0.40
2016	-0.17	-0.03	0.15	-0.03	-0.44	1.67	-0.01	-1.43	-0.29	0.39
2017	-0.19	-0.03	0.12	-0.02	-0.45	1.69	-0.04	-1.43	-0.35	0.36
2018	-0.33	-0.02	0.11	-0.02	-0.46	1.63	-0.06	-1.43	-0.59	0.28
2019	-0.27	-0.03	0.13	-0.02	-0.48	1.57	-0.02	-1.43	-0.54	0.29
2020	-0.24	-0.03	0.13	-0.02	-0.49	1.51	-0.02	-1.43	-0.59	0.28
2021	0.72	-0.03	0.17	0.03	-0.45	1.75	0.05	-1.43	0.80	0.79

Source: Data used in the empirical analysis, and authors' computations.

**Figure 3.21:** Estimated probabilities for Greece and Portugal, between 1970 and 2021



Finally, it should be mentioned that, despite the reduction in the probability of a financial crisis in Greece in 2020, our model calculates that the risk of Greece facing a

financial crisis was still very high, close to 62%. In comparison, in Portugal, the economic performance has systematically improved. Between 2013 and 2018, the probability of having a financial crisis was reduced from 60% to less than 30%. For this reduction, we must highlight the performance of the GDP growth between 2017 and 2020, which was always above 2%, and the reduction of the government debt, in percentage of GDP, by almost 15 percentage points in the same period.

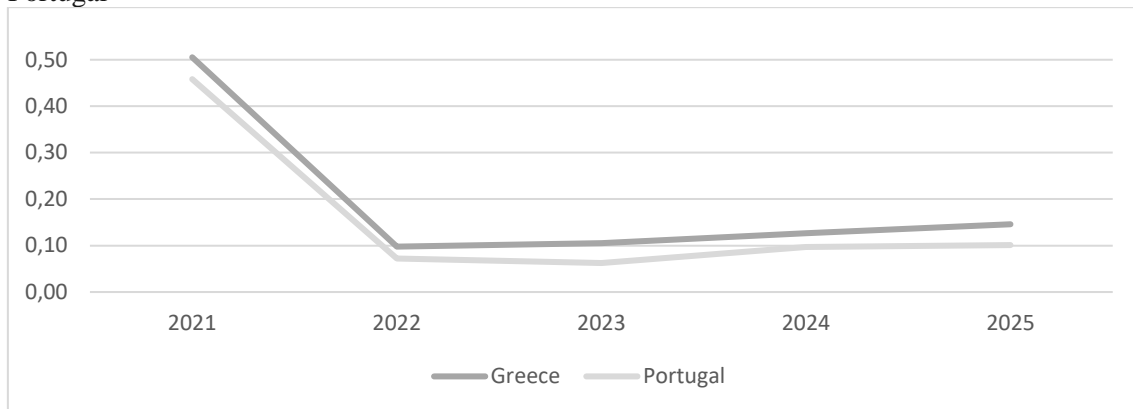
In conclusion, our model seems to show that, despite the vulnerabilities of the Portuguese economy, Portugal has had a better economic performance, and is far from the level of vulnerability of Greece.

And the world has changed. What started as a local health problem, in Asia, at the end of 2019, has escalated to a global pandemic in 2020, with millions of contagions and deaths.

To contain the propagation of the Covid-19 pandemic, and save lives, all around the globe, the Governments have implemented compulsory population confinements, which have a catastrophic impact on the world's economic performance. Countries that are very dependent on tourism, like Greece and Portugal, were particularly affected by the negative effects of the pandemic. The catastrophic impacts of Covid-19 in the Greek and Portuguese economies are represented in our graphic by the exponential increase in the probability of a financial crisis in these countries, mainly because of the abrupt fall in GDP and increase of the debt.

In a period of high uncertainty, as the period that we are living right now, the task of forecasting is more difficult. However, we wanted to try to quantify the impact of the Covid-19 pandemic on the probability of having a financial crisis. With this goal, we used the IMF's World Economic Outlooks, published in October 2019 and in October 2021. All the variables after 2020 are projections. Because of data limitations, we have used only the projections for six variables, specifically GDP growth, inflation, deficit, GDP per capita, debt, and current account balance. For credit and the rate of depreciation of the exchange rate, between 2021 and 2025, we used the average values observed between 2017 and 2020. Figure 3.22 presents the main results of this experiment.

**Figure 3.22:** The impact of Covid-19 pandemic in the (estimated) probabilities for Greece and Portugal



Source: FMI projections, and authors' computations.

The Covid-19 pandemic, and the subsequent great confinement, increased the probability of a financial crisis in Greece in 2021 by more than 50 percentage points. For Portugal, the probability increased about 46 percentage points. It is also important to notice that the pandemic has lastingly increased the probability of a financial crisis. For example, given the projections of the FMI for GDP growth, inflation, GDP per capita, debt, and CAB, the probability of a financial crisis in Greece and Portugal in 2025 increased by almost 15 percentage points in Greece, and 10 percentage points in the Portuguese case. Thus, although both countries were seriously affected by this symmetric crisis, the impact in Greece was higher mainly because of the much stronger vulnerabilities of the Greek economy.

Finally, it should be referred that the impacts of Covid-19 on the Portuguese and Greek banks, and/or in the confidence in debt repayment by these countries, were not as notorious as during the Great Recession. To a large extent, this is due to the action of the international institutions, such as the European Central Bank, which increased substantially the public debt purchase programs, and the European Commission and European Council, which have not only suspended the fiscal rules<sup>84</sup>, but also taken large steps to increase the solidarity among the European Union members, with the historical approval of the first instruments of European debt emission, also known as Next Generation EU.

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<sup>84</sup> Brussels is going to maintain the suspension of fiscal rules at least until the end of 2022.

### 3.7. Conclusion

The objective of this chapter was to evaluate the main macroeconomic variables that can be used in the prediction of a financial crisis, and to analyse the evolution of the risk of a financial crisis in Portugal and Greece, before and after the Covid-19 pandemic.

With this objective, we have used both a binomial logit model and multinomial logit models, and we have constructed a new financial crisis index.

We concluded that, in our sample, the binomial logit model had a better performance in the prediction of financial crises than the multinomial logit models that we have used. In addition, GDP growth, real interest rate, inflation rate, variation of credit, GDP per capita, government debt, and current account balance, were the most relevant macroeconomic variables in the prediction of a financial crisis.

We have shown that our financial crisis index would have been helpful in the prediction of the financial crisis events in the middle of the 1970s in Greece, between the 1980s and the middle of the 1990s, and during the Great Recession. Regarding the Portuguese case, our index was also useful for the prediction of the financial crises after the implementation of the democratic regime in 1974, in 1983/1984, and during the period of the Great Recession.

In addition, we saw that, although Greece and Portugal were the most affected Eurozone countries during the Great Recession, the weakness of the Greek economy was much higher in comparison with the vulnerabilities of the Portuguese economy. In addition, the performance after the crises was still better in the Portuguese case. For example, in 2020, our model demonstrated that the probability of Greece being confronted with a financial crisis was more than double of Portugal, more specifically 62% against 28%.

This scenario has plenty of risks, not only because the Eurozone is not an optimal currency area, as defined by Mundell (1961), but also because Portugal and Greece were very dependent on exports and tourism activity, and a more restrictive international context is expected for the next years, with topics like Brexit and commercial “war” between the USA and China on the top of the agenda.

What was not expected was the global pandemic. Covid-19 was responsible for a recession in 2020 only comparable with the Great Depression, with the Greek and the Portuguese economies among the most affected countries in Europe. Using the projections of FMI, our index suggests that, in 2021, the Covid-19 pandemic has increased the risk of



Greece to have a financial crisis to more than 95%, while the probability in the Portuguese case rose to 79%.

Although the answer of the European authorities to this shock has avoided the worst-case scenarios of banking crises or sovereign debt crises<sup>85</sup>, it is still impossible to account for all the impacts of Covid, not only because a new wave cannot be put aside despite the high vaccination rates, but also because the Recovery and Resilience Plans have not started to be applied yet.

In this context it is also important to recover the conclusions of Bordo et al. (2001), more specifically the need to strengthen financial institutions' regulation and supervision, and that authorities should be more careful with the provision of liquidity, ensuring that it is not used to support insolvent institutions and to delay the recognition of financial distress.

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<sup>85</sup> An inflation crisis or / and a robust currency crisis were unlikely scenarios, given the characteristics of the Eurozone.



## **Chapter 4 - Support Vector Machines and the prediction of crises in Ireland, Spain, Greece, and Portugal.**

### **4.1. Introduction**

As very well documented by Reinhart and Rogoff (2009) for eight centuries and more than six dozen countries, the list of currency crashes, hyperinflation, banking panics, and/or government defaults, is vast contains events that occurred not only in underdeveloped countries but also in developed countries.

In the previous chapters, we have the financial crises in Ireland, Spain, Greece, and Portugal. There we used the more common models of crisis prevision, specifically the binomial logit model, the multinomial logit model, and the KLR model. Among the various models used so far, the one that performed best in our dataset was the binomial logit model, but even in the case of this model, the performance was not completely satisfactory.

In this chapter, we are going to apply a modern machine learning technique known as Support Vector Machine (SVM) to the prediction of financial crises, to investigate whether this modern technique has a better performance than the traditional models. We continue to use the same large dataset that contains data for 69 countries, between 1960 and 2016, for ten macroeconomic variables: GDP growth; terms of trade; rate of depreciation of the exchange rate; real interest rate; inflation; public deficit; domestic credit provided to the private sector; GDP per capita; government debt, and current account balance.

Apart from the introduction, the chapter is structured as follows. In section 2, we explain the methodology to be used in our empirical analysis, the machine learning technique known as Support Vector Machine. Section 3 presents the most relevant papers in the literature that have previously used this technique in the prediction of financial crises. In section 4 we describe the database and the macroeconomic variables that are going to be used in our stochastic analysis. Section 5 shows the main results of the application of the SVM model to our dataset. In section 5 we also compare our outcomes with those reported in the previous chapters where we used different logit techniques. Finally, section 6 summarizes the main conclusions of our study.

### **4.2. SVM methodology**

The SVM method, as it is known today, was developed by Vapnik and collaborators at the AT&T Bell Labs. Vapnik (1995) provides one of the first important presentations of

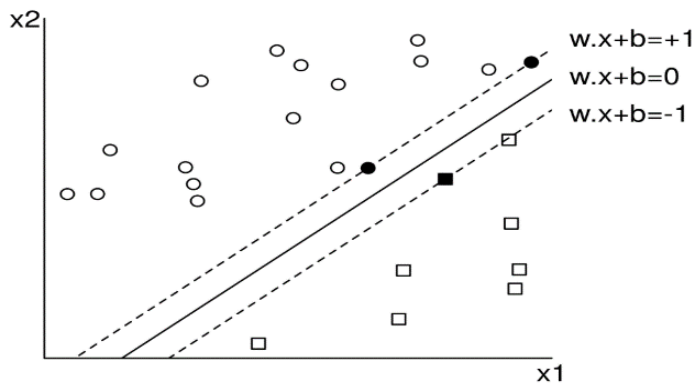
SVMs, while Vapnik (2005) provides a very brief summary of the approach. Vapnik (2005) argues that SVMs have very important properties, such as always converging to the best possible solutions, minimizing the probability of misclassification error on a finite number of observations, easily incorporating more complex cases through the use of kernels, and the applicability to non-numerical data.

The goal of the SVM approach is to provide an approximation to the behaviour of a “classifier”. The typical example is that of a doctor classifying the patients as ill or not ill. We can view this as being the outcome of a function  $f$  which relates some characteristics of the patients to the diagnostic:  $y = f(x)$ . The SVM approach will use some data that has been classified, say  $(y_1, x_1), (y_2, x_2), \dots, (y_i, x_i)$ , where  $y_i$  is equal to +1 if the patient is ill and equal to -1 otherwise, and  $x_i$  is data related to patient  $i$  which may help decide on the classification.

Given that data, the SVM attempts to find hyperplanes that separate the data, possibly with a tolerance for possible classification errors, although here we assume the data can be perfectly separated. In other words, the SVM attempts to find a vector  $w$  and a constant  $b$  such that  $y = \text{sign}(w \cdot x + b)$ , where “sign” is the sign function and  $w \cdot x$  is the inner product of  $w$  and  $x$ . There is an infinite set of  $(w, b)$  associated with different “margins”, i.e., the value  $\Delta$  such that  $w \cdot x + b \geq \Delta$  when  $y=+1$  and  $w \cdot x + b \leq -\Delta$  when  $y=-1$ . The SVM solution maximizes the margin, which implies minimizing the norm of the vector  $w$ .

Figure 4.1 presents an example of the graphical application of the SVM approach. In that figure, the circles correspond to the cases where  $y=+1$ , while the squares correspond to the cases where  $y=-1$ . The dotted lines are the hyperplanes that maximize the margin of separation of the two sets of points. The three points filled in black correspond to the three support vectors that are used to separate the data.

**Figure 4.1:** Hyperplane and margins for the SVM model



Source: Constructed by the authors.

When the data points can only be separated using non-linear functions, it is necessary to transform the data in a way that the transformed data can be linearly separated. In practice, this corresponds to using a certain kernel function in the computations involved in the SVM approach. There are four types of common kernel functions used in the context of the SVM approach<sup>86</sup>:

- i. The linear kernel:  $K(x_i, x_j) = x_i^T x_j$ ;
- ii. The polynomial kernel:  $K(x_i, x_j) = (\gamma x_i^T x_j + r)^d$ ;
- iii. The radial basis - RBF kernel:  $K(x_i, x_j) = \text{exponential}(-\gamma \|x_i - x_j\|^2)$ ;
- iv. The sigmoid kernel:  $\tanh(\gamma x_i^T x_j + r)$ .

In the expressions above,  $d$ ,  $r$  and  $\gamma$  are constants for which the researcher may choose values, and “tanh” is the hyperbolic tangent function.

### **4.3. Literature review: SVM models and crises**

Regarding the previous works that used SVM models for the prediction of financial crises, we begin by highlighting Ahn et al. (2011). The authors used the SVM model for the prediction of financial crises for South Korea. The authors used monthly data from the beginning of 1997 until the end of 2002, and have considered the following financial variables: note default rate; size of the run of increasing note default rate during the latest 12 months; change rate of foreign exchange holdings; change rate of money stock; change rate of producer price index; change rate of consumer price index; change rate of balance of trade; change rate of index of industrial production; size of the run of decreasing index of industrial production during the latest 12 months; change rate of index of producer shipment; change rate of index of equipment investment; factor endowment hypothesis (FEH) per gross domestic products; size of the run of decreasing of FEH during the latest 12 months; size of the run of decreasing monthly change of FEH during the latest 12 month; change rate of FEH per GDP; balance of trade per GDP; size of the run of increasing balance of trade during the latest 16 months; size of the run of negative balance of trade during the latest 16 months; difference between loan and deposit rates; trade terms; difference between domestic and foreign interest rates, and portfolio investments. The main conclusion of this work was that

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<sup>86</sup> For additional details about the SVM methodology and the different kernels we recommend Cristianini and Shawe-Taylor (2000), Schölkopf et al. (2002), Jakkula (2006) and / or Ben-Hur and Weston (2010).

the SVM technique was appropriate for the prediction of the financial crises in the South Korean case.

Erdogan (2013) implemented an SVM model to study the prediction of bankruptcy of banks. The study uses data for forty-two Turkish commercial banks from 1999 and 2000, and the following variables: (shareholders' equity + total income)/total assets; (shareholders' equity + total income)/(deposits + non-deposit funds); net working capital/total assets; (shareholders' equity + total income)/total assets; total loans/total assets; non-performing loans/total loans; permanent assets/total assets; fixed assets/fixed liabilities; liquidity assets/total assets; liquidity assets/(deposits + non-deposit funds); fixed liquid assets/fixed liabilities; net income (loss)/average total assets; net income (loss)/average shareholders' equity; net income (loss)/average share-in capital; net interest income after provision/average total assets; interest income/interest expenses; non-interest income/non-interest expenses; total income/total expenditure, and loan loss provision/total loans. When the author uses data from one year before the bank failure, the bankruptcy classification error of the model is only 10%. Thus, the study concludes that the SVM model with Gaussian kernel can be used as part of an early warning system.

Li et al. (2013) applied an SVM model to predict systemic risk for Chinese banks. The variables that were used were capital adequacy ratio, nonperforming loan ratio, the proportion of a single maximum loan, return on assets, cost-to-income ratio, liquidity ratio, loan-to-deposit ratio, leverage, interdependence, external linkages, year-on-year growth of GDP, year-on-year growth of CPI, year-on-year growth of fixed asset investment, year-on-year growth of national real estate index, volatility of the Shanghai index, the ratio of growth of M2 to the growth of GDP, volatility of benchmark lending rates. The study analysed the period between the first quarter of 2004 and the second quarter of 2008. The authors conclude that this technique performs well in the prediction of banking crisis in the Chinese case (with an accuracy of 94%) when compared with other techniques, like the logistic regression analysis, the multiple discriminant analysis, or the backpropagation neural network. The authors use an SVM with the radial basis function kernel.

Papadimitriou et al. (2013) studied the likelihood of the collapse of banking institutions in the USA through an SVM model. With this goal, the authors used annual financial statements of 300 USA banks, between 2003 to 2011. From the list of variables used, we should highlight the equity capital to assets ratio, the returns on earning assets, the core capital ratio, the net interest margin, the returns on earning assets, and the goodwill and other intangibles. The main conclusion of this work was that the SVM model with RBF

kernel exhibits significant ability in bank default forecasting, with an out-of-sample forecasting accuracy of 92%.

Chaudhuri (2014) applied an SVM model to the study of the currency crisis in Argentina during the period between 1999 and 2002. The variables used were real domestic credit, international reserves, inflation, oil prices, index of industrial equity prices, exchange rate, and exchange rate over-valuation. The author concluded that the third and fourth-order polynomial kernels both have a good performance in the prediction of the currency crisis in Argentina, with an accuracy of more than 96%.

Ramli et al. (2014) is another study that applied the support vector machine classifiers to the prediction of currency crises. The authors used an ensemble model that combined the different methodologies: nearest neighbour classifier and the SVM model. For the SVM they used the RBF Kernel and the polynomial Kernel of level four. The dataset covers twenty-seven countries<sup>87</sup>, between 1980 and 2012, with 12 macroeconomic indicators for each country: unemployment, consumer price index, export, import, foreign direct investment, real GDP per capita, terms of trade, money supply, real effective exchange rate, government consumption, industrial production index and foreign exchange reserves. The main conclusion of this work was that the ensemble method with polynomial kernel had the best performance in the prediction of the currency crises. The percentage of accuracy of this model was above 90% in twenty-two countries, and was even above 99% in five of them.

Zhang (2014) also used a support vector machine model for the prediction of a currency crisis. The author specifically studies the case of two Asian countries, South Korea and Thailand, and for that, it uses the daily exchange rate data for the South Korean won and the Thai baht against the USD, from the beginning of 1996 until the end of 1997. The main conclusion of this work was that the SVM methodology can perform significantly better than some popular forecasting methods, like the logit model, the signal approach or the generalized regression neural network.

Samitas et al. (2020) applied machine learning algorithms to investigate contagion risks during shock events and periods of crisis in stock exchange markets. The authors used monthly data of stock indices, sovereign bonds, and credit default swaps, for 33 countries<sup>88</sup>, from the beginning of 2004 until the end of 2016. Among the several machine learning algorithms that were used – decision trees, discriminant analysis, logistic regression

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<sup>87</sup> 10 European countries, 9 countries from Central and South America, 7 Asian countries and South Africa.

<sup>88</sup> 19 European countries, 4 countries from the American continent, 8 from Asia, and Australia and South Africa.

classifiers, SVM (with linear, quadratic, and cubic kernel) – the SVM with quadratic kernel was the most accurate in the prediction of financial crises in the network of stock indices, with an accuracy rate of 98.8%.

Shrivastav and Ramudu (2020) used SVM techniques to study the prediction of bankruptcy of Indian banks. The authors used data for 59 banks, between January 2000 and December 2017, and the following list of banking variables: total earning assets (TA); cash and due from depository institutions/TA; net loans /TA; total deposits/TA; subordinated debt/TA; average assets till 2017/TA; tier 1 risk-based capital/TA; tier 2 risk-based capital/TA; total interest expense/total interest income (TII); provision for loan and lease losses/TII; total noninterest income/TII; Salaries and employee benefits/TII; net operating income/TII; cash dividends/TII; net operating income/TII; net interest margin earned by a bank; return on total assets of a firm; equity capital to assets; return on total assets of banks; noninterest Income earned by banks; net income attributable to bank/TII; net loans and leases to deposits; net interest income expressed as a percentage of earning assets; salaries and employee benefits/TII; total assets per employee of the bank. The main conclusion of this work was that the SVM with linear kernel (with an accuracy of more than 92%) has a better performance in the prediction of a banking crisis in India than the SVM with radial basis function kernel (which has an accuracy of less than 72%).

#### **4.4. Data**

In our SVM we use the macroeconomic variables GDP, terms of trade, rate of depreciation of the exchange rate (relative to the USD), real interest rate, inflation, ratio of fiscal surplus to GDP, rate of growth of bank credit, GDP per capita (recall that the main sources of these variables can be consulted in Table 2.6, page 41, chapter 2), and also government debt and current account balance (the details regarding the main sources of these variables can be found in Table 3.3, page 88, chapter 3).

We use a one-year lag in our model because we are investigating whether the variation in the performance of any macroeconomic variable impacts the risk of having a financial crisis in the next year. The only exception is in the case of financial crises for the variable domestic credit to the private sector, where following Demirgüç-Kunt and Detragiache (1998) we use a two-year lag.

It should be mentioned that following our previous estimations using the logit methodologies, we decided not to use the variables government debt and current account



balance in the case where we study only the banking crises. More specifically, these will not be used in the analysis of the Irish and Spanish cases.

We use two different dummy variables. In the case of the first one, “1” represents a banking crisis in a certain country in a certain year, and “0” means there was no banking crisis in that country in that year. In the case of the second dummy variable, “1” means that at least one of four different types of financial crisis occurred in a certain country in a certain year (more details are presented in Table 3.4, page 88, in chapter III).

The computations regarding the SVM models with the five different types of kernel functions used in our research (linear, quadratic polynomial, cubic polynomial RBF, and sigmoid), were done using the software Gretl, version 2021b.

#### 4.5. Results

As in the previous chapters, we analyse separately banking crises and financial crises more generally. We start with the first version of the model for banking crisis, where we use the following variables: GDP; the first difference of the terms of trade; the terms of trade; exchange rate; the real interest rate; inflation; budget deficit; the first difference of credit; credit, and GDP per capita. As mentioned in the previous section, in this model all the variables are lagged once. Table 4.1 shows the percentage of cases “correctly predicted” of the binomial logit model from chapter 2, and of the SVM models with different kernel functions.

**Table 4.1:** Banking crises: Version 1

Model	Percentage of cases “correctly predicted”	Percentage of crises “correctly predicted”
Binomial logit model	84.7%	8%
SVM - Linear Kernel	84.3%	2.1%
SVM - Polynomial Kernel (quadratic)	85.7%	12.7%
SVM - Polynomial Kernel (cubic)	85.9%	12.9%
SVM - RBF Kernel	87.7%	24.6%
SVM - Sigmoid Kernel	84.1%	1.2%

Source: Authors calculations

The SVM model with RBF kernel has the higher percentage of cases “correctly predicted”, followed by the SVM models with polynomial kernels, and, in fourth place, by

the binomial logit model. It should be mentioned that the difference in terms of all cases (crises and no-crises) between the best SVM model and the logit model was only 3 percentage points. However, in terms of the percentage of crises “correctly predicted”, the difference is much larger. In this case, in terms of the accuracy rate, the SVM model with RBF kernel has a performance that is more than three times better than that of the logit model (24.6% versus 8%).

The second version of the model for banking crises has a smaller set of inputs. Namely, it includes as explanatory variables GDP, the terms of trade, budget deficit, the first difference of credit; credit, and GDP per capita. Again, the SVM model with RBF kernel is the model that has the best performance – see Table 4.2. In this second version, the difference between the SVM model with RBF kernel and the binomial logit model increases to 4 percentage points regarding the percentage of cases “correctly predicted”, and to 22.5 percentage points regarding the percentage of crises “correctly predicted” (again a three-fold improvement). It should be also noticed that in this second version the results are better than in version 1 for the binomial logit model and for the SVM with RBF kernel.

**Table 4.2:** Banking crises: Version 2

Model	Percentage of cases “correctly predicted”	Percentage of crises “correctly predicted”
Binomial logit model	85.2%	9.3%
SVM - Linear Kernel	84.5%	0
SVM - Polynomial Kernel (quadratic)	84.8%	2.1%
SVM - Polynomial Kernel (cubic)	86%	10.3%
SVM - RBF Kernel	89.2%	31.8%
SVM - Sigmoid Kernel	84.6%	0.2%

Source: Authors calculations

Now we move to the joint analysis of the four types of crises – sovereign debt, inflation, currency, and banking. In version 1 we used the following variables: GDP; the first difference of the terms of trade; the terms of trade; exchange rate; the real interest rate; inflation; budget deficit; the first difference of credit; credit; GDP per capita; debt; and the current account balance. As mentioned in the previous section, in this model all the variables are lagged once, apart from the variable credit, that enters with two lags.

The SVM with RBF kernel is again the model with the best performance not only in terms of the percentage of cases “correctly predicted” but also in terms of the percentage of

crises “correctly predicted”. In this case, the SVM with RBF kernel has an accuracy rate that is 8 percentage points higher than the accuracy rate of the binomial logit model in terms of the percentage of cases “correctly predicted”, and 14.3 percentage points in the case of the percentage of crises “correctly predicted”. The full set of results can be found in Table 4.3.

**Table 4.3:** Financial crisis: Version 1

Model	Percentage of cases “correctly predicted”	Percentage of crises “correctly predicted”
Binomial logit model	72.7%	49.8%
SVM - Linear Kernel	70%	33.8%
SVM - Polynomial Kernel (quadratic)	76%	54.9%
SVM - Polynomial Kernel (cubic)	77.4%	56.8%
SVM - RBF Kernel	80.7%	64.1%
SVM - Sigmoid Kernel	68.4%	32.9%

Source: Authors calculations

**Table 4.4:** Financial crisis: Version 2

Model	Percentage of cases “correctly predicted”	Percentage of crises “correctly predicted”
Binomial logit model	72.9%	50.1%
SVM - Linear Kernel	71.2%	36.7%
SVM - Polynomial Kernel (quadratic)	75.6%	53.1%
SVM - Polynomial Kernel (cubic)	76.5%	55.7%
SVM - RBF Kernel	82.6%	69.4%
SVM - Sigmoid Kernel	67.8%	34.2%

Source: Authors calculations

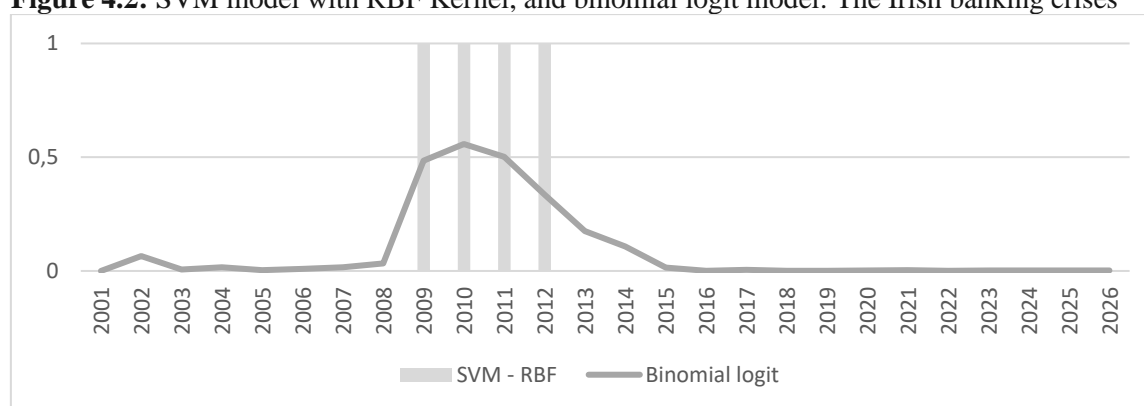
In the second version of the models we only use the variables GDP, real interest rate, inflation, first difference of credit, GDP per capita, debt, and current account balance. In this case, the difference between the SVM with RBF kernel and the binomial logit model increases to 9.7 percentage when we compare the percentage of cases “correctly predicted”, and to 19.3 percentage points when the indicator is the percentage of crises “correctly predicted” - see Table 4.4. Again, version 2 of these models provides better results than version 1.

In the remainder of this chapter, we are going to analyse the cases of Greece, Ireland, Portugal, and Spain, using the SVM model with the best performance, that is, the second

version of the banking crisis model in the cases of Ireland and Spain, and the second version of the financial crisis model in the cases of Greece and Portugal. Recall that in both instances, the best model is the SVM with the RBF kernel. The analysis considers the period starting in 2001, and FMI projections for the period between 2021 and 2026<sup>89</sup>.

We start with the case of Ireland, represented in Figure 4.2. We can see that the SVM model correctly predicted the banking crisis that affected the country during the Great Recession period. In addition, it is also clear that the SVM model and the logit model can be used in a complementary way. The main difference between the two models occurs in 2012 when the SVM shows in a more evident way that this was a year of crisis.

**Figure 4.2:** SVM model with RBF Kernel, and binomial logit model: The Irish banking crises

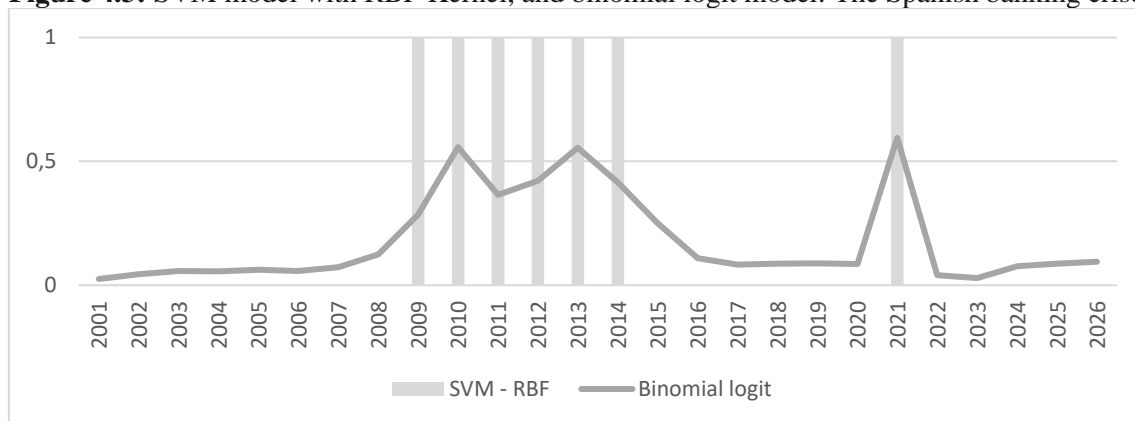


Source: Authors' computations.

The accuracy of the SVM model and the complementarity between this model and the logit analysis are also evident in the Spanish case, presented in Figure 4.3. Both models predict the Great Recession in Spain, but again the SVM model shows the beginning of the banking crisis in a clearer way. It should be also highlighted that both models pointed to the possibility of Spain facing a banking crisis in 2021, because of the negative impacts in the economy of the Covid-19 pandemic.

<sup>89</sup> We use the projections provided by the IMF's team, IMF's World Economic Outlooks of October 2021, for the GDP growth, inflation, the budget deficit, GDP per capita, debt, and the current account balance, for the years after 2020. For the variables terms of trade, rate of depreciation of the exchange rate and credit, after 2021 we use the average of the values observed in the period between 2017 and 2020.

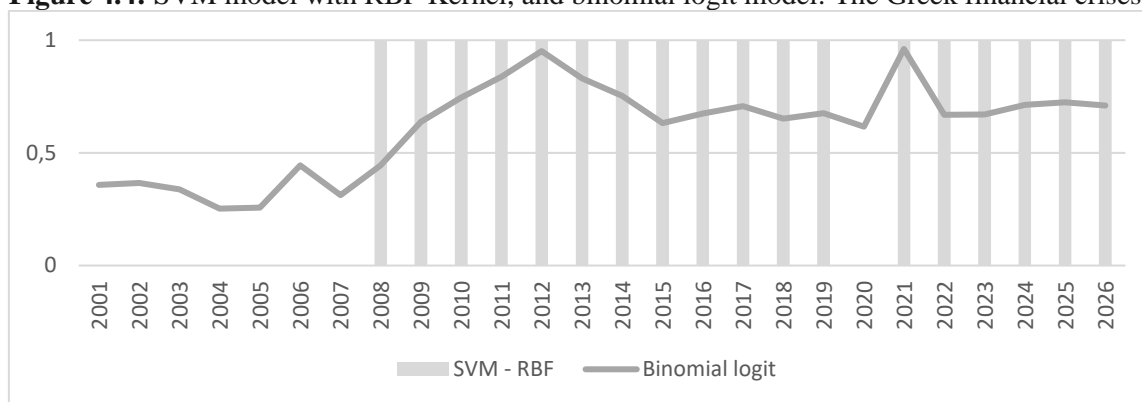
**Figure 4.3:** SVM model with RBF Kernel, and binomial logit model: The Spanish banking crises



Source: Authors' computations.

Regarding the case of Greece, Figure 4.4 shows how prone to financial crises the country has been since 2001. In addition, it also demonstrates how the Covid-19 pandemic has ended a trend of reduction of the risk of having a crisis. Finally, both models predict that the Greek economy is going to be very vulnerable to a new financial crisis in the coming years.

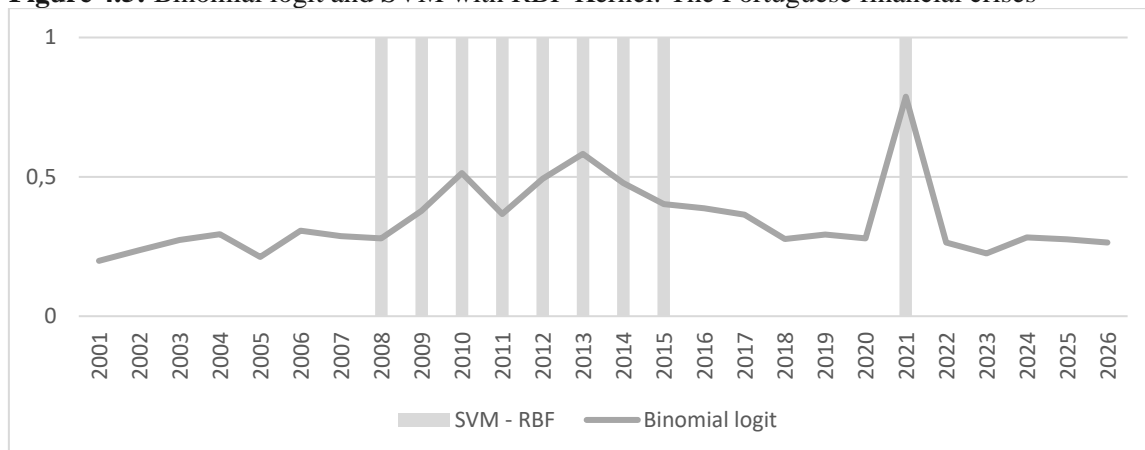
**Figure 4.4:** SVM model with RBF Kernel, and binomial logit model: The Greek financial crises



Source: Authors' computations.

As can be seen in Figure 4.5, in the Portuguese case, the SVM model with RBK kernel was faster to alert to the risk of a financial crisis, with the alarm sounding in 2008. Regarding the future, both models indicate that there should be a reduction in the risk of a crisis in 2022 and in the subsequent years.

**Figure 4.5:** Binomial logit and SVM with RBF Kernel: The Portuguese financial crises



Source: Authors' computations.

#### 4.6. Conclusion

In this chapter, we applied modern machine learning techniques – namely the SVM methodology – to construct an early warning system of crises. More specifically we have used the SVM with five different kernel functions: the linear kernel; the quadratic polynomial kernel; the cubic polynomial kernel; the RBK kernel, and the sigmoid kernel.

Using a large database, we have shown that the SVM is a useful technique for the prediction of banking crises, and of financial crises in general. In addition, we also confirmed that the SVM model with RBF Kernel can be more accurate as an early warning system than the probability calculated from the more common binomial logit model. The percentage of cases “correctly predicted” by the SVM model with RBF kernel is 89.2% for the dataset used in the analysis of the banking crises, and 82.6% for the database that was considered in the study of the events of financial crises.

We have also used the results of the SVM with RBF kernel to discuss and analyse the probability of Ireland and Spain being confronted with a banking crisis, and of Greece and Portugal being confronted with at least one type of financial crisis (banking, sovereign debt, currency, or inflation), since the beginning of the twenty-first century.

We saw that the SVM model correctly predicted that the Great Recession that started in 2008 would lead to crises in all the four countries. In addition, we analysed the impacts of the Covid-19 pandemic and confirmed that the country in this group that was less affected by this event was Ireland. On the contrary, regarding the likelihood of a new financial crisis, Greece was the most vulnerable country.

## Conclusion

This dissertation presented and discussed models of financial crisis forecasting, with a focus on Southern Europe and Ireland.

Despite the models of prediction of financial crises being an often studied and debated topic in the economic literature, it remains a central issue, given the negative impacts that financial crises have on the countries' economic performance and the well-being of their population.

What is uncommon in the related literature is the level of detail that we have given regarding the historical context of the financial crises in Ireland, Spain, Greece, and Portugal, and particularly the joint analysis of these countries, a feature that allowed a significant level of comparison to be made between these four countries.

We have applied several quantitative techniques, also including some techniques developed more recently, to investigate which one performs best in the prediction of a financial crisis in our large dataset.

Regarding the different methodologies that were used in our research, firstly, we observed that, for our annual data set, the binomial logit model performed better in the prediction of banking crises than the KLR model. We also concluded that the GDP growth rate, the terms of trade, the public budget deficit, the domestic credit to the private sector, and the GDP per capita are relevant macroeconomic variables for the prediction of the banking crises.

Secondly, our results indicate that, for the data that we have collected, the binomial logit model is more reliable in the prediction of financial crises in comparison with the two different multinomial logit models that we have estimated. In addition, we saw that the GDP growth, the real interest rate, the inflation rate, the variation of credit, the GDP per capita, the government debt, and the current account balance were the more relevant macroeconomic variables for the prediction of a financial crisis. It should be remembered that in the study of the financial crisis events we have used a broader concept of crisis; this broader concept includes any of the following events: sovereign debt crisis; inflation crisis; currency crisis, and banking crisis.

Thirdly, we have concluded that the machine learning technique known as the Support Vector Machine (SVM), with radial basis function (RBF) kernel, can be even more accurate, as an early warning system, than the index calculated from the more common

binomial logit model. In fact, the SVM with RBF kernel was the model with the highest percentage of cases “correctly predicted”.

And fourthly, our results suggest that the SVM with RBF kernel and the binomial logit model can be used in a complementary way. In other words, if used together, they can make the process of predicting financial crises even more accurate.

Moving on to the issues raised by the cases of Spain and Ireland, we discussed the reasons why both countries were in the group of the most affected countries in Europe during periods of the Great Recession and of the European Debt Crisis. Although, as we have seen, there were many different motives for that situation, we should highlight the excessive external imbalances and the increase in the indebtedness of these countries, public and private. This occurred since the Maastricht Treaty, but the scenario was aggravated with the introduction of the single European currency, the Euro.

We have tried to simplify our models, as much as possible, to allow their use in different contexts.

However, we showed that our banking crisis index, which resulted from the parameters estimated for the binomial logit model, was useful for the prediction of the Spanish crises between 1977 and 1985 and that it was even more reliable in the prediction of the Great Recession in both Spain and Ireland.

In addition, we saw that the Covid-19 pandemic had a very weak effect on our banking crisis index for Ireland, but in contrast, it had a substantial impact on the risk of Spain being confronted with a new banking crisis.

In the cases of Greece and Portugal, we have noticed that some of the vulnerabilities of these countries have been going on for centuries and that both countries were in the group of the less developed western European countries in the middle of the 1970s.

Even though these countries had substantial improvements after the entrance into the European Economic Community (today European Union), we have also noticed that the twenty-first century was a period in which both countries diverged, in terms of economic performance, from the more developed Eurozone countries. This was particularly notorious in the deterioration of the Greek and Portuguese public finances.

Regarding the crisis events in Greece, our financial crisis index, calculated with the parameters estimated for the binomial logit model, was useful for the prediction of the crisis of 1976 and of the period of high volatility between the 1980s and the first half of the 1990s.



In the Portuguese case, our crisis index shows the risk of a financial crisis was high in the years after the revolution of 1974, and in 1983-1984, when, as we have seen, the country needed to ask for financial assistance from the International Monetary Fund.

We have also found that, although both countries were the most affected Eurozone countries during the European sovereign debt crisis, the vulnerability of the Greek economy was much higher than the risk for the Portuguese economy. In addition, our results lead us to conclude that, although the probability of these countries being affected by a financial crisis has increased substantially with the Covid-19 pandemic, this scenario is more likely in the Greek case.

Moreover, it should not be forgotten that Greece and Portugal are still today in the group of developed countries with the highest levels of General Government debt in percentage of GDP<sup>90</sup> in the world.

In future research, it could be interesting to increase the number of macroeconomic variables used in our analysis. As we have seen in the literature review, many variables are good candidates to be included in the model. However, it is important to notice that there are at least two important trade-offs that should be considered. First, the use of more variables can reduce the sample size and the relevance of the sample, because the data collection is more complex for the more vulnerable countries, which are normally more prone to being confronted with a financial crisis. It should be remembered that the construction of the data set for 69 countries was a complex and lengthy process, mainly for the so-called developing countries. And second, there is always the risk that, by including more variables, the models will become too complex and of less general use, without this representing a significant gain in the improvement of the forecasts.

In addition, it would be interesting to study the accuracy of alternative types of machine learning techniques on the prediction of financial crises, using our database. To give some examples, Uthayakumar et al. (2018) have applied a hybrid model combining a K-means algorithm and a fitness-scaling chaotic genetic ant colony algorithm to the prediction of financial crises, Beutel et al. (2019) used neural networks for the prediction of banking crises, and Alaminos et al. (2021) utilized a fuzzy decision tree for the prediction of sovereign debt and currency crises.

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<sup>90</sup> According to the Organisation for Economic Co-operation and Development (OECD) the level of General Government debt in percentage of GDP was, in 2020, 238% in Greece (the second largest), and 157% in Portugal (the fifth largest).

Finally, we intend to extend our analysis to the case of Italy. Although the 2008/2009 crisis was not as severe in Italy as in other countries, even before the Covid-19 pandemic the country was pointed out by analysts, such as Ewing and Horowitz (2018), as the possible epicentre of the next global financial crisis due to its public debt levels, weak bank system, growth of populist parties and the increase of political instability<sup>91</sup>.

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<sup>91</sup> According with the Organisation for Economic Co-operation and Development (OECD) the level of General Government debt in percentage of GDP in Italy was 184% (the third largest).

## Bibliography

- Acharya, V. V., Eisert, T., Eufinger, C., & Hirsch, C. (2018). Whatever it takes: The real effects of unconventional monetary policy. *The Review of Financial Studies*, 32(9), 3366-3411.
- Ahn, J. J., Oh, K. J., Kim, T. Y., & Kim, D. H. (2011). Usefulness of support vector machine to develop an early warning system for financial crisis. *Expert Systems with Applications*, 38(4), 2966-2973.
- Aizenman, J., & Noy, I. (2013). Macroeconomic adjustment and the history of crises in open economies. *Journal of International Money and Finance*, 38, 41-58.
- Akin, O., Montalvo, J. G., Villar, J. G., Peydró, J. L., & Raya, J. M. (2014). The real estate and credit bubble: evidence from Spain. *SERIEs*, 5(2), 223-243.
- Alaminos Aguilera, D., Peláez Sánchez, J. I., Salas Compás, M. B., & Fernández Gámez, M. Á. (2021). Sovereign Debt and Currency Crises Prediction Models Using Machine Learning Techniques.
- Alexandre, F., Aguiar-Conraria, L., & Bação, P. (2016). Crise e Castigo: Os desequilíbrios e o resgate da economia portuguesa. Fundação Francisco Manuel dos Santos.
- Amaral, A., Abreu, M., & Mendes, V. (2014). The spatial Probit model-An application to the study of banking crises at the end of the 1990s. *Physica A: Statistical Mechanics and its Applications*, 415, 251-260.
- Andreu, J. H. (2004). *Económica política de la transición en España:(1973-1980)*. Editorial complutense.
- Antunes, A., Bonfim, D., Monteiro, N., & Rodrigues, P. M. (2014). Indicadores avançados de crises bancárias: exploração de novos dados e instrumentos1. *OLETIM EC*, 103.
- Apoteker, T., & Barthelemy, S. (2000). Genetic algorithms and financial crises in emerging markets. In *AFFI International Conference in Finance Processing*.
- Azevedo, J. (1929). *Épocas de Portugal económico; esboços de história*.
- Baeza, E. O., & López, F. J. V. (2013). Las crisis bancarias en España, 1977-2012. *Revista de la Historia de la Economía y de la Empresa*, (7), 277-317.
- Baltas, N. C. (2013). The Greek financial crisis and the outlook of the Greek economy. *The Journal of Economic Asymmetries*, 10(1), 32-37.
- Bank of Greece (2014) *The Chronicle of the Great Crisis, The Bank of Greece 2008-2013*, Centre for Cultural Research and Documentation.
- Ben-Hur, A., & Weston, J. (2010). A user's guide to support vector machines. In *Data mining techniques for the life sciences* (pp. 223-239). Humana Press.
- Bento, V. (2009). Perceber a crise para encontrar o caminho. *Bnomics*. Bernanke, B. (2005). The Global Saving Glut and the US Current Account Deficit, speech delivered for the Sandridge Lecture at the Virginia Association of Economists, Richmond. Blanchard, O. e F. Giavazzi (2002). Current Account Deficits in the Euro Area: The End of the Feldstein-Horioka Puzzle, 147-186.
- Berg, A., & Pattillo, C. (1999). Predicting currency crises:: The indicators approach and an alternative. *Journal of International Money and Finance*, 18(4), 561-586.
- Bergin, A., Economides, P., Garcia-Rodriguez, A., & Murphy, G. (2019). Ireland and Brexit: modelling the impact of deal and no-deal scenarios. *Quarterly Economic Commentary: Special Articles*.
- Bergin, A., Gerald, J. F., Kearney, I., & O'Sullivan, C. (2011). The Irish fiscal crisis. *National Institute Economic Review*, 217, R47-R59.
- Betrán, C., & Pons, M. A. (2017). Two great banking crises and their economic impact compared: Spain 1976/1977 and 2008. *Revista de Historia Economica-Journal of Iberian and Latin American Economic History*, 35(2), 241-274.

- Betrán, C., Martín-Aceña, P., & Pons, M. A. (2012). Financial crises in Spain: lessons from the last 150 years. *Revista de Historia Económica-Journal of Iberian and Latin American economic History*, 30(3), 417-446.
- Beutel, J., List, S., & von Schweinitz, G. (2019). Does machine learning help us predict banking crises?. *Journal of Financial Stability*, 45, 100693.
- Biescas, J. A., & Tuñón de Lara, M. (1980). en *España bajo la dictadura franquista (1939-1975)* Vol. X de la “Historia de España” dirigida por Muñón de Lara. Labor.
- Blanchard, O., & Portugal, P. (2017). Boom, slump, sudden stops, recovery, and policy options. Portugal and the Euro. *Portuguese Economic Journal*, 16(3), 149-168.
- Bordo, M., & Eichengreen, B. (1999). Is Our Current International Economic Environment Unusually Crisis Prone?| Conference–1999.
- Bordo, M., Eichengreen, B., Klingebiel, D., & Martinez-Peria, M. S. (2001). Is the crisis problem growing more severe?. *Economic policy*, 16(32), 52-82.
- Boscá, J. E., Domenech, R., & Ferri, J. (2020). El impacto macroeconómico del Coronavirus. *Fedea Apuntes*, 2.
- Braun, J., Braun, M., Briones, I., Díaz, J., Lüders, R., & Wagner, G. (2000). *Economía Chilena 1810–1995, Estadísticas Históricas*. Documento de trabajo, 187, 369.
- Broadberry, S., & Klein, A. (2012). Aggregate and per capita GDP in Europe, 1870–2000: continental, regional and national data with changing boundaries. *Scandinavian Economic History Review*, 60(1), 79-107.
- Burnham, J. B. (2003). Why Ireland Boomed. *The Independent Review*, 7(4), 537-556.
- Bussiere, M., & Fratzscher, M. (2006). Towards a new early warning system of financial crises. *Journal of International Money and Finance*, 25(6), 953-973.
- Caetano, J., Galego, A., & Costa, S. (2005). Portugal e o alargamento da União europeia: alguns impactos sócio-económicos. *Análise Social*, 255-278.
- Caggiano, G., Calice, P., & Leonida, L. (2014). Early warning systems and systemic banking crises in low-income countries: A multinomial logit approach. *Journal of Banking & Finance*, 47, 258-269.
- Caggiano, G., Calice, P., Leonida, L., & Kapetanios, G. (2016). Comparing logit-based early warning systems: Does the duration of systemic banking crises matter?. *Journal of Empirical Finance*, 37, 104-116.
- Callan, T., & Nolan, B. (1994). Income Inequality and Poverty in Ireland in the 1970s and 1980s (No. WP043). Economic and Social Research Institute (ESRI).
- Caprio, G., & Klingebiel, D. (1996). Bank insolvencies cross-country experience. World Bank Publications.
- Chaudhuri, A. (2014). Support vector machine model for currency crisis discrimination. arXiv preprint arXiv:1403.0481.
- Christodoulakis, N. (2013). Currency crisis and collapse in interwar Greece: predicament or policy failure?. *European Review of Economic History*, 17(3), 272-293.
- Chrysoloras, N. (2013). Rebuilding eurozone's ground zero: a review of the Greek economic crisis.
- Claessens, M. S., Kose, M. A., Laeven, M. L., & Valencia, M. F. (2014). Financial crises: Causes, consequences, and policy responses. International Monetary Fund.
- Conant, C. A. (1915). *A history of modern banks of issue* (Vol. 1). GP Putnam's Sons.
- Copenhagen Economics (2018). Ireland and the Impacts of Brexit. February. [www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/8/428/1520263183/copenhagen-economics-2018-ireland-and-the-impacts-of-brexite.pdf](http://www.copenhageneconomics.com/dyn/resources/Publication/publicationPDF/8/428/1520263183/copenhagen-economics-2018-ireland-and-the-impacts-of-brexite.pdf).
- Cortiña, R. M., & Rendueles, J. R. A. (1990). *La transición económica de España*. Ediciones Ciencias Sociales.
- Costa, L. F., Lains, P., & Miranda, S. M. (2016). *An economic history of Portugal, 1143–2010*. Cambridge University Press.

- Cristianini, N., & Shawe-Taylor, J. (2000). *An introduction to support vector machines and other kernel-based learning methods*. Cambridge university press.
- Cruz-García, P., Fernández de Guevara, J. F., & Maudos, J. (2018). Banking concentration and competition in Spain: the impact of the crisis and restructuring. *Financial Stability Review*. Issue 34 (May 2018), p. 57-76.
- Cuervo, Á. (1988). *La crisis bancaria en España: 1977-1985: causas, sistemas de tratamiento y coste*. Ariel.
- Czubala, M. (2015). *El Mecanismo Europeo De Estabilidad: Uno De Los Pilares Del Modelo De Gobernanza Económica De La UE Y Su Déficit De Legitimidad (The European Stability Mechanism: One of the Pillars of the EU's Model of Economic Governance and its Legitimacy Deficit)*.
- Daly, M. E. (2016). *Sixties Ireland: reshaping the economy, state and society, 1957–1973*. Cambridge University Press.
- Demirgüç-Kunt, A., & Detragiache, E. (1998). The determinants of banking crises in developing and developed countries. *Staff Papers*, 45(1), 81-109.
- Demirgüç-Kunt, A., & Detragiache, E. (2000). Monitoring banking sector fragility: a multivariate logit approach. *The World Bank Economic Review*, 14(2), 287-307.
- Demirgüç-Kunt, A., & Detragiache, E. (2005). Cross-country empirical studies of systemic bank distress: a survey. *National Institute Economic Review*, 192, 68-83.
- Detken, C.; Peltonen, T; Lo Duca, M.; Koban, A.; Basten, E.; Klaus, B.; Kusmierczyk, P.; Lang, J. (2017) *A new database for financial crises in European Countries, ECB / ESRB EU crises database, Occasional Paper 194*.
- Do Amaral, J. F. (2013). *Porque devemos sair do Euro: o divórcio necessário para tirar Portugal da crise*. Leya.
- Dornbusch, R. (2001). *A primer on emerging-market crises*.
- Duca, M. L., & Peltonen, T. A. (2013). Assessing systemic risks and predicting systemic events. *Journal of Banking & Finance*, 37(7), 2183-2195.
- Duncan, G. A. (1928). The currency system of the Irish Free State. *The Quarterly Journal of Economics*, 42(2), 263-277.
- Duprey, T., Klaus, B., & Peltonen, T. (2017). Dating systemic financial stress episodes in the EU countries. *Journal of Financial Stability*, 32, 30-56.
- Duque, L. A. R. (1987). *La crisis de la economía española 1973-1984*. In *La economía española en el siglo XX: una perspectiva histórica* (pp. 190-200). Ariel.
- Duque, L. A. R. (2010). *La economía española en la democracia (1976-2000)*. In *Historia económica de España: siglos X-XX* (pp. 397-436). Crítica.
- Edison, H. J. (2003). Do indicators of financial crises work? An evaluation of an early warning system. *International Journal of Finance & Economics*, 8(1), 11-53.
- Edwards, S., & Montiel, P. J. (1989). Devaluation crises and the macroeconomic consequences of postponed adjustment in developing countries. *Staff Papers*, 36(4), 875-903.
- Eichenbaum, M., Rebelo, S., & de Resende, C. (2016). *The Portuguese crisis and the IMF*.
- Eichengreen, B. (2014). *Hall of mirrors: The great depression, the great recession, and the uses-and misuses-of history*. Oxford University Press.
- Eichengreen, B., Rose, A. K., & Wyplosz, C. (1995). Exchange market mayhem: the antecedents and aftermath of speculative attacks. *Economic policy*, 10(21), 249-312.
- Erdogan, B. E. (2013). Prediction of bankruptcy using support vector machines: an application to bank bankruptcy. *Journal of Statistical Computation and Simulation*, 83(8), 1543-1555.
- Ewing, J., & Horowitz, J. (2018). *Why Italy Could Be the Epicenter of the Next Financial Crisis*. The New York Times.
- Ferraz, R. (2019). *Grande guerra e guerra colonial: Quanto custaram aos cofres portugueses? Gabinete de Estratégia e Estudos, Ministério da Economia*.

- Ferraz, R.; Duarte, A. P. (2016). Getting Out from the Crisis: An Assessment of Portuguese Policies in X. Richet & S. Redžepagic (Eds.), *Western Balkans Integrating the EU: Challenges, Policies, Issues* (pp. 161–174), CEMAFI International Association.
- Ferreiro, J., Gálvez, C., & Gonzalez, A. (2014). Financialisation and the financial and economic crises: The case of Spain (No. fstudy19). Financialisation, Economy, Society & Sustainable Development (FESSUD) Project.
- Fitzgerald, G. (2002). Ireland and the European Union. *Radharc*, 3, 123-135.
- Fitzgerald, J. (1999). Understanding Ireland's economic success (No. WP111). Economic and Social Research Institute (ESRI).
- Fitzgerald, J., & Kenny, S. (2018). Managing a century of debt.
- Fitzgerald, J., & Kenny, S. (2020). “Till debt do us part”: financial implications of the divorce of the Irish Free State from the United Kingdom, 1922–1926. *European Review of Economic History*, 24(4), 818-842.
- Frank Jr, W. C. (1987). The spanish civil war and the coming of the second world war. *The International History Review*, 9(3), 368-409.
- Frankel, J. A., & Rose, A. K. (1996). Currency crashes in emerging markets: An empirical treatment. *Journal of International Economics*, 41(3-4), 351-366.
- Frankel, J. A., & Saravelos, G. (2012). Can leading indicators assess country vulnerability? Evidence from the 2008–09 global financial crisis. *Journal of International Economics*, 87(2), 216-231.
- Frieden, J. (1998). The euro: Who wins? Who loses?. *Foreign Policy*, 25-40.
- Galenianos, M. (2014). The Greek crisis: Origins and implications. Available at SSRN 2505455.
- Gallizo, J., & Sabi, X. (2013). Bankia y la transparencia necesaria. *Revista de Contabilidad y Dirección*, 16, 263-290.
- Gerominakis, S. (1965). Post-War Economic Growth in Greece 1950-60, *Review of Income and Wealth*, International Association for Research in Income and Wealth.
- Goldstein, M., Kaminsky, G. L., & Reinhart, C. M. (2000). Assessing financial vulnerability: an early warning system for emerging markets. Peterson Institute.
- Gourinchas, P. O., & Obstfeld, M. (2012). Stories of the twentieth century for the twenty-first. *American Economic Journal: Macroeconomics*, 4(1), 226-65.
- Gourinchas, P. O., Philippon, T., & Vayanos, D. (2016). The analytics of the Greek crisis: celebratory centenary issue.
- Grubel, H. G. (Ed.). (2003). *Tax Reform in Canada: Our Path to Greater Prosperity*. The Fraser Institute.
- Hanson, J. A., & Neal, C. R. (1985). Interest rate policies in selected developing countries, 1970-1982 (Vol. 750). World Bank.
- Hardy, D. C., & Pazarbaşıoğlu, C. (1999). Determinants and leading indicators of banking crises: further evidence. *IMF staff papers*, 46(3), 247-258.
- Hatzis, A. (2019). A Political History of Modern Greece, 1821-2018, part of Springer Nature 2019, *Encyclopedia of Law and Economics*.
- Healy, T. (2013). Private Bank Debts and Public Finances: Some Options for Ireland. NERI.
- Honohan, P. (2009). What went wrong in Ireland. Prepared for the World Bank.
- Hornero, A. C. (2013). La arquitectura económica y financiera de la UEM y los efectos de la crisis. *Cuadernos Europeos de Deusto*, (49), 91-108.
- Hutchison, M. M. (2002). European banking distress and EMU: institutional and macroeconomic risks. *Scandinavian Journal of Economics*, 104(3), 365-389.
- Jakkula, V. (2006). Tutorial on support vector machine (svm). School of EECS, Washington State University, 37.
- Kaminsky, G. L., & Reinhart, C. M. (1999). The twin crises: the causes of banking and balance-of-payments problems. *American economic review*, 89(3), 473-500.

- Kaminsky, G., Lizondo, S., & Reinhart, C. M. (1998). Leading indicators of currency crises. *Staff Papers*, 45(1), 1-48.
- Keane, C. (2015). Irish public finances through the financial crisis. *Fiscal Studies*, 36(4), 475-497.
- Kelly, M. (2010). Whatever happened to Ireland?. Centre for Economic Policy Research.
- Kennedy, K. A. (1998). Irish Economy Transformed. *Studies: An Irish Quarterly Review*, 87(345), 33-42.
- Kiley, M. T. (2021). What macroeconomic conditions lead financial crises?. *Journal of International Money and Finance*, 111, 102316.
- Kirby, P. (2004). Development theory and the Celtic Tiger. *The European Journal of Development Research*, 16(2), 301-328.
- Kitchin, R., O'Callaghan, C., Boyle, M., Gleeson, J., & Keaveney, K. (2012). Placing neoliberalism: the rise and fall of Ireland's Celtic Tiger. *Environment and Planning A*, 44(6), 1302-1326.
- Kouretas, G. P., & Vlamis, P. (2010). The Greek crisis: causes and implications. *Panoeconomicus*, 57(4), 391-404.
- Krugman, P. (2012). *End this depression now!*. WW Norton & Company.
- Laeven, M. L., & Valencia, M. F. (2018). Systemic banking crises revisited. *International Monetary Fund*.
- Laffan, B., & O'Mahony, J. (2008). *Ireland and the European Union*. Macmillan International Higher Education.
- Lains, P. (2003a). Portugal's growth paradox, 1870-1950 (No. 135). Universidade do Porto, Faculdade de Economia do Porto.
- Lains, P. (2003b). Os progressos do atraso. *Uma Nova História Económica de Portugal*. Imprensa de Ciências Sociais.
- Lains, P.; Silva, A. (2012). *História Económica de Portugal 1700-2000 - Volume II - O Século XIX*, Imprensa de Ciências Sociais.
- Lapavistas, C. (2019). Political economy of the Greek crisis. *Review of Radical Political Economics*, 51(1), 31-51.
- Leounakis, N., & Sakellaris, P. (2014). Greek economic growth since 1960. AUEB, Department of Economics Working Paper.
- Li, S., Wang, M., & He, J. (2013). Prediction of banking systemic risk based on support vector machine. *Mathematical Problems in Engineering*, 2013.
- Lindgren, M. C. J., Garcia, M. G., & Saal, M. M. I. (1996). Bank soundness and macroeconomic policy. *International Monetary Fund*.
- López, C. B. (2002). Guerra civil y primer franquismo:(1936-1959). In *Historia económica de España: siglos X-XX* (pp. 331-368). Crítica.
- López, I., & Rodríguez, E. (2011). The spanish model. *New left review*, 69(3), 5-29.
- Louçã, F. (2011). *Portugal agrilhado: a economia cruel no era do FMI*. Bertrand Editora.
- Louzis, D. P., & Vouldis, A. T. (2013). A financial systemic stress index for Greece. Working Paper Series No 1563, Macprudential Research Network, European Central Bank.
- Manuel, P. C., & Royo, S. (Eds.). (2004). *Spain and Portugal in the European Union: The first fifteen years*. Routledge.
- Marques, A. (1986). *História de Portugal - Volume III: Das Revoluções aos Nossos Dias*, Editorial Presença.
- Martins, C. (2005). A economia chinesa e a sua integração na economia mundial, *Boletim Económico*, Banco de Portugal.
- Mateus, A. (2009). <https://tvi24.iol.pt/portugal/concorrencia/abel-mateus-crise-deve-se-sobretudo-a-falha-da-regulacao>
- Mateus, A. M., & da Concorrência, A. (2006). Portugals convergence process: Lessons for accession countries. *Living standards and the wealth of nations: Successes and failures in real convergence*, 231-50.

- McGowan, M. A. (2011). Overcoming the banking crisis in Ireland. OECD Economics Department Working Papers.
- McQuinn, K., O'Toole, C., Allen-Coghlan, M., & Coffey, C. (2020). Quarterly Economic Commentary, Autumn 2020. Economic and Social Research Institute Forecasting Series.
- Molina, J. L. M., & Martín-Aceña, P. (Eds.). (2011). *The Spanish Financial System: Growth and Development Since 1900*. Springer.
- Motes, J. M. (2015). La economía española en perspectiva histórica. *Pasado & Presente*, Barcelona, 187-242.
- Mundell, R. A. (1961). A theory of optimum currency areas. *The American economic review*, 51(4), 657-665.
- Murphy, A. E. (2000). *The 'Celtic Tiger': An Analysis of Ireland's Economic Growth Performance*, European University Institute, Robert Schuman Centre of Advanced Studies.
- Nag, A., & Mitra, A. (1999). Neural networks and early warning indicators of currency crisis. *Reserve Bank of India Occasional Papers*, 20(2), 183-222.
- Navarrete, D. (2016). La crisis económica española: una gran operación especulativa con graves consecuencias. *Estudios Internacionales (Santiago)*, 48(183), 119-151.
- Neary, J. P., & Gráda, C. Ó. (1991). Protection, economic war and structural change: the 1930s in Ireland. *Irish Historical Studies*, 27(107), 250-266.
- Neves, J. (2018) *As 10 Questões do Interlúdio - A Economia Portuguesa na Era António Costa*, D. Quixote.
- Nikiforos, M., Carvalho, L., & Schoder, C. (2013). Foreign and public deficits in Greece: In search of causality. *Levy Economics Institute of Bar College*.
- Nikiforos, M., Papadimitriou, D. B., & Zezza, G. (2015). The Greek public debt problem 1. *Nova Economia*, 25, 777-802.
- Nunes, A. B., Mata, E., & Valério, N. (1989). Portuguese economic growth 1833-1985. *The Journal of European Economic History*, 291-330.
- Ó Gráda, C. (2008). *The Irish Economy half a century ago* (No. WP08/18). UCD Centre for Economic Research Working Paper Series.
- Ó Riain, S. (2012). The crisis of financialisation in Ireland. *The Economic and Social Review*, 43(4, Winter), 497-533.
- O'Donnell, R. (1998). *Ireland's Economic Transformation*. Center for West European Studies Tel, 412, 648-7405.
- Organisation for Economic Cooperation and Development. (1963). *OECD Economic Surveys: Greece*. Organisation for Economic Cooperation and Development.
- O'Rourke, K. H. (2016). *Independent Ireland in comparative perspective*. UCD Centre for Economic Research.
- Ortega, E., & Peñalosa, J. M. (2012). Claves de la crisis económica española y retos para crecer en la UEM. *Documentos ocasionales/Banco de España*, 1201.
- O'Sullivan, K. P. V., & Kennedy, T. (2009). What caused the Irish banking crisis?. *Journal of Financial Regulation and Compliance*.
- Pagoulatos, G. (2020). EMU and the Greek crisis: Testing the extreme limits of an asymmetric union. *Journal of European Integration*, 42(3), 363-379.
- Paixão, B. (1964) *Cem Anos do Banco Nacional Ultramarino na Vida Portuguesa, 1864-1964* (Volume I), edição do Banco Nacional Ultramarino.
- Papadimitriou, T., Gogas, P., Plakandaras, V., & Mourmouris, J. C. (2013). Forecasting the insolvency of US banks using support vector machines (SVMs) based on local learning feature selection. *International Journal of Computational Economics and Econometrics*, 3(1-2), 83-90.
- Paroulakis, P. H. (2000). *The Greek War of Independence*. Hellenic International Press.



- Paus, E. (2012). The rise and fall of the Celtic tiger: when deal-making trumps developmentalism. *Studies in Comparative International Development*, 47(2), 161-184.
- Perez, S. A., & Matsaganis, M. (2018). The political economy of austerity in Southern Europe. *New political economy*, 23(2), 192-207.
- Quaglia, L., & Royo, S. (2015). Banks and the political economy of the sovereign debt crisis in Italy and Spain. *Review of International Political Economy*, 22(3), 485-507.
- Quelhas, J. M. G. S. (2012). Sobre as crises financeiras, o risco sistémico e a incerteza sistemática.
- Quintana, E. F. (1999). La economía española desde la transición hasta el presente. In *Historia económica de España: siglos XIX y XX* (pp. 717-750). Galaxia Gutenberg.
- Rae, D., & Van den Noord, P. (2006). Ireland's housing boom: What has driven it and have prices overshot?.
- Ramli, N. A., Ismail, M. T., & Woi, H. C. (2014). Currency crisis indication by using ensembles of support vector machine classifiers. In *AIP Conference Proceedings* (Vol. 1605, No. 1, pp. 1013-1018). American Institute of Physics.
- Ramos, R., e Sousa, B. V., & Monteiro, N. G. (2009). *História de Portugal*.
- Regling, K., & Watson, M. (2010). A preliminary report on the sources of Ireland's banking crisis (p. 27). Dublin, OH: Government Publications Office.
- Reinhart, C. M., & Rogoff, K. S. (2009). *This time is different*. Princeton university press.
- Reinhart, C. M., & Rogoff, K. S. (2011). From financial crash to debt crisis. *American Economic Review*, 101(5), 1676-1706.
- Reinhart, C. M., & Rogoff, K. S. (2013). Banking crises: an equal opportunity menace. *Journal of Banking & Finance*, 37(11), 4557-4573.
- Reinhart, C. M., & Trebesch, C. (2015). The pitfalls of external dependence: Greece, 1829-2015 (No. w21664). National Bureau of Economic Research.
- Reis, J. (2018). *A Economia Portuguesa-Formas de Economia Política numa periferia persistente (1960-2017)*. Leya.
- Reis, R. (2013). The Portuguese slump and crash and the euro crisis (No. w19288). National Bureau of Economic Research.
- Rodrigues, J. N. (2012). *Portugal na Bancarrota: Cinco séculos de história da dívida soberana portuguesa*. Centro Atlântico.
- Roubini, N., & Mihm, S. (2010). *Crisis economics: A crash course in the future of finance*. Penguin.
- Roy, J. (2012). La crisis en España: origen, trasfondo y remedio. *Letras Internacionales*, (163-6).
- Royo, S. (2014). Institutional degeneration and the economic crisis in Spain. *American Behavioral Scientist*, 58(12), 1568-1591.
- Sain, S. R. (1996). The nature of statistical learning theory.
- Samitas, A., Kampouris, E., & Kenourgios, D. (2020). Machine learning as an early warning system to predict financial crisis. *International Review of Financial Analysis*, 71, 101507.
- Santaella, J. A., & Edwards, S. (1992). *Devaluation Controversies in the Developing Countries: Lessons From the Bretton Woods Era*. National Bureau of Economic Research.
- Santos, T. (2018). El diluvio: the Spanish banking crisis. National Bureau of Economic Research.
- Schölkopf, B., Smola, A. J., & Bach, F. (2002). *Learning with kernels: support vector machines, regularization, optimization, and beyond*. MIT press.
- Schularick, M. (2012). Public debt and financial crises in the twentieth century. *European Review of History: Revue europeenne d'histoire*, 19(6), 881-897.
- Segura, J. (1990). *Del primer gobierno socialista a la integración en la CEE: 1983-1985*. JL García Delgado, *Economía Española de la Transición y la Democracia*, CIS, Madrid.
- Serrano, S. C., & Miralles, J. M. P. (2015). Bankia: ¿ Para qué sirven los estados contables y los órganos de control?. *Estudios de economía aplicada*, 33(1), 259-300.
- Shrivastav, S. K., & Ramudu, P. J. (2020). Bankruptcy prediction and stress quantification using support vector machine: Evidence from Indian banks. *Risks*, 8(2), 52.

- Stiglitz, J. (2016). *The Euro: And its threat to the future of Europe*. Penguin UK.
- Stournaras, Y. (2019). Lessons from the Greek crisis: Past, present, future. *Atlantic Economic Journal*, 47(2), 127-135.
- Tafunell, X., & Carreras, A. (2005). *Estadísticas históricas de España: siglos XIX-XX*. Bilbao, Fundación BBVA.
- Uthayakumar, J., Metawa, N., Shankar, K., & Lakshmanprabu, S. K. (2018). Intelligent hybrid model for financial crisis prediction using machine learning techniques. *Information Systems and e-Business Management*, 1-29.
- Valério, N., Nunes, A. B., Bastien, C., de Sousa, R. M., & Costa, S. D. (2006). *História do Sistema Bancário Português, Vol. I, Da Formação do Primeiro Banco Português à Assunção pelo Banco de Portugal das Funções de Banco Central, 1822–1931*. Lisbon: Banco de Portugal.
- Vapnik, V. (1995). *The nature of statistical learning theory*. Springer science & business media.
- Vetsopoulos, A. (2002). *The economic dimensions of the Marshall Plan in Greece, 1947-1952: The origins of the Greek economic miracle*. University of London, University College London.
- Vlados, C., & Chatzinikolaou, D. (2019). Crisis, institutional innovation and change management: Thoughts from the Greek case. *Journal of Economics and Political Economy*, 6(1), 58-77.
- Von Hagen, J., & Ho, T. K. (2007). Money market pressure and the determinants of banking crises. *Journal of Money, Credit and Banking*, 39(5), 1037-1066.
- Ward, M. (2021) *Statistics on UK trade with Ireland*, House of Commons Library
- Whelan, K. (2014). Ireland's economic crisis: The good, the bad and the ugly. *Journal of Macroeconomics*, 39, 424-440.
- Wu, C. H., Tzeng, G. H., Goo, Y. J., & Fang, W. C. (2007). A real-valued genetic algorithm to optimize the parameters of support vector machine for predicting bankruptcy. *Expert systems with applications*, 32(2), 397-408.
- Yoon, Y. (2018). *Spatial Choice Modeling Using the Support Vector Machine (SVM): Characterization and Prediction*. In *International Conference of the Thailand Econometrics Society* (pp. 767-778). Springer, Cham.
- Zettelmeyer, J., Trebesch, C., & Gulati, M. (2013). The Greek debt restructuring: an autopsy. *Economic Policy*, 28(75), 513-563.
- Zhang, Q. L. (2014). *Currency Crisis Prediction Using Wavelet-based Support Vector Machine*. In *Advanced Materials Research* (Vol. 989, pp. 2560-2564). Trans Tech Publications Ltd.
- Zoega, G. (2019). Greece and the western financial crisis. *Atlantic Economic Journal*, 47(2), 113-126.