

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

SCHOOL OF ECONOMIC SCIENCES

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**Sovereign Debt Crises and Banking Crises:
A test in the case of Eurozone**

Matthaios Tsitouras

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We approve the dissertation of Matthaïos Tsitouras

Sakellaris Plutarchos

AUEB

Sapountzoglou Gerasimos

AUEB

Tzavalis Elias

AUEB

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Abstract

Banking crises constitute a type of financial crises. Financial crises can be classified into currency crises, sudden stops, debt crises, and banking crises. A sovereign debt crisis is the situation when a country cannot handle its public debt in a sustainable way. In this dissertation I present the types of financial crises and sovereign debt crises. I also analyze data concerning the case of the current Eurozone crisis, where I check the relation between the non-performing loans (NPLs) and the government bond spreads against Germany. It becomes clear that there is great relation between them in the majority of the examined countries. Moreover, the NPLs may constitute an indicator for the prediction of sovereign debt crises.

Keywords: Financial crises, Banking crises, Sovereign debt crises, Non-Performing Loans, Government Bond Spread.

JEL classification: E32, E44, F31, F34, G01, G28,

Table of Contents

A. Introduction	p. 6
B. Literature Review.....	p. 7
B. 1. Banking Crises and Financial Crises.....	p. 7
B. 2. Sovereign Debt Crises and Sovereign Defaults.....	p. 41
B. 3. Sovereign Debt Crises and Banking Crises.....	p. 47
C. Empirical Part.....	p. 65
C. 1. Non-Performing Loans.....	p. 65
C. 2. Long-term government bonds.....	p. 67
C. 3. Presentation of the approach and the model.....	p. 69
C. 4. Results and Discussion.....	p. 73
D. Conclusions.....	p. 95
Appendix.....	p. 96
Bibliography.....	p. 101

A. Introduction

We are experiencing a global economic crisis since 2007 and it has not been resolved yet. This economic crisis was produced by the financial sector and the mortgage loans which could not be performed as they were expected to. The severity of the financial collapse was so strong that it could not be compared with other previous crises, except the one in 1929. The financial crises are not constrained to the financial sector but infuse the real economy, thus causing many problems, such as the output drop and the unemployment increase. This has happened during the last years in many countries of the Eurozone, whose banking crisis and sovereign debt crisis are examined in the empirical part of the dissertation.

The first section of the dissertation is divided in three parts and it focuses on the literature concerning the topic of the dissertation. Financial crises are presented here as a whole because banking crises constitute a type of them. Next, I summarize sovereign debt crises; that is situations when a country cannot handle its public debt in a sustainable way. This includes problems in paying back the accumulated public debt or difficulties in receiving funds. The last part ends with the researchers' effort to try and shed light on the relation between sovereign debt crises and banking crises.

The second section focuses on the banking crisis and the sovereign debt crisis in the Eurozone during the last decade and it constitutes an attempt to enlighten this interaction. This takes place based on the non-performing loans (NPLs) and the spread of the government bonds over the German government bond. First I present the two variables and the method of approach. In the second part empirical data are used for each country to reveal that there was great interaction between the banking crisis and the sovereign debt crisis in the majority of the Eurozone countries. I also show that the NPLs may constitute an indicator of a sovereign debt crisis and they can be used for the prediction of a sovereign crisis. The second section concludes with the measures which can be enforced in order for the policymakers to reduce the impact of financial crises in sovereign stability.

The last section consists of a brief summary of the results and the main conclusions derived from the dissertation. An Appendix with the results of the econometric estimation and the Bibliography can be found in the last pages of this dissertation.

B. Literature Review

B.1. Banking Crises and Financial Crises

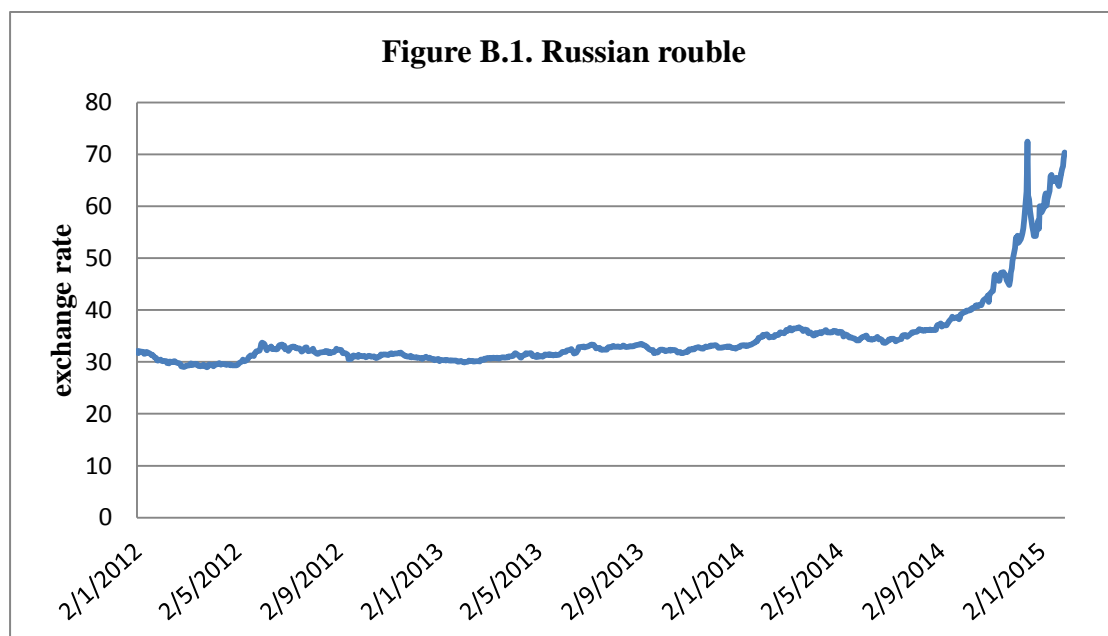
Banking crises constitute a type of financial crises. Financial crises emerge in or affect countries all over the world. But, developing countries appear more vulnerable in financial crises than developed ones, presumably because the latter have taken measures to avoid those phenomena. Based on Claessens and Kose (2013) financial crises are classified in the following categories: currency crises, sudden stops, debt crises and banking crises. Currency crises include inflation crises, while sudden stops are also known as capital account crises or balance of payments crises.

Following the perspective of Goldstein and Razin (2013), financial crises can be distinguished in three categories: credit frictions and market freezes, banking crises and currency crises. The difference is that in the latter case debt crises and market freezes form a combined category. This is not really serious because, as it is described latter on, sudden stops lead to debt crises, credit expansion becomes impossible and finally market freezes.

In either case, the categorization of crises should not be strict because either classification does not exclude the possibility that more than one types exist together, and this is the most usual phenomenon, as one type of crisis gives rise to another. However, it would be important that each type be presented alone, before we specify the banking crises.

Currency Crises

Even if financial crises constitute a combination of the categories above, it is worth to examine the specific characteristics of each type. Currency crises are the crises which are mainly derived from the role of currency. A currency crisis usually concerns the exchange rate depreciation usually due to a speculative attack. An alternative version of a currency crisis is the struggle of monetary authorities to defend the exchange rate level using the following tools: expending international reserves, raising the (domestic) interest rates or raising capital controls. Russia constitutes a recent example of currency crisis because its currency has been extremely devaluated and the Central Bank of Russia has raised its main interest rate from 10.5 % to 17 % to defend the rouble (RUB). The European Union was at risk because many countries were almost ready to quit the monetary union and adopt their own currencies. From the point of view of Laeven and Valencia (2012), approximately 218 currency crises have happened from 1970 to 2011, ten of them between the years 2008-2011. An alternative type of currency crises is the inflation crisis where the fundamental problem is the high inflation rate instead of the exchange rate itself. The following graph presents the currency crisis that Russia faces. The following is the exchange rate of the Russian rouble to the US dollar. During the last years the exchange rate used to be stable and 30 roubles were equivalent to 1 USD. However, recently the exchange rate depreciation requires 70 roubles to be exchanged for one USD.



Source: Author's calculations

Exchange rate regimes and the Central bank's trilemma

There are numerous exchange rate regimes but all of them belong to a two-edged spectrum: the fixed exchange rate and the free-floating exchange rate. Currency crises typically surface when there are severe fluctuations of the exchange rate, in a way that the currency exchange rate cannot be held at the desired level. For example, in the case of fixed-exchange rate the exchange rate may collapse or in the case of free-floating exchange rate the currency crisis may lead to significant undesirable appreciation or depreciation. The fixed exchange rate is the appropriate regime for the stabilization of the economy but those regimes suffer from speculative attacks.

The monetary policy of the Central Bank is characterized by a trilemma. The Central Bank has three choices but only two of them are feasible whereas the third one cannot be controlled. The first aim is independent monetary policy. National monetary policy is useful because a country has the opportunity to intervene in the market and to mitigate the current obstacles. This fact is possible when monetary authorities can intervene in the market and change the interest rates, altering the money supply. The second issue is the free capital mobility which means that there are no currency barriers. Each agent may import or export any possible amount of this currency. This is beneficial because it facilitates international trade. The third target is fixed exchange rate because extreme fluctuations impede the international trade. For example, when domestic firms cannot afford imports or their profitability from a branch abroad collapses. Each Central Bank can satisfy two of the previous and loses the one that is left.

If a country uses free capital movement and has fixed exchange rates, then it must follow the international interest rates and thus it is impossible to exercise its monetary policy. This is because there will be capital movements in order for the uncovered interest parity to hold again, in case the domestic monetary authorities alter the domestic interest rates. On the other hand, the limited capital mobility will enable the government to achieve both controlled exchange rate and national monetary policy. In any case the monetary authorities can control two of those elements while the other one is abandoned. Thus, a currency crisis cannot be easily avoided. The uncovered interest rate parity is given by the following equation:

$$1 + i = (1 + i^*) \left(\frac{S^e}{S} \right)$$

where i is the domestic interest rate, i^* denotes the foreign interest rate, S denotes the current exchange rate, and S^e is the expected exchange rate.

Models

There have been three generations of models for currency crises. The researchers who formed the first generation focused on the fundamentals behind every speculative attack. Specifically, the speculators held the currency when they knew that the Central Bank was willing to support the exchange rate and they sold the currency when the Central Bank was unable to maintain the exchange rate. In the second generation of models the researchers did not focus only on the fundamentals because in the models speculators were not sure if the Central Bank wanted to support the exchange rate. Thus, in those models there were solutions with multiple equilibria. Those models were enriched because speculators attacked the currency not only based on the fundamentals, but also because they believed that the rest agents would do the same, leading to self-fulfilling prophecies. In the third generation of models researchers try to explain currency crises with the macroeconomic imbalances and the fluctuations in asset prices sometimes combined by with the operation of banks.

The first generation of models emerged in the 1970's when the golden rule failed, the Bretton Woods system collapsed due to speculative attacks and countries moved to flexible exchange rates. The second one was deeply influenced by the speculative attack in the UK currency when the UK tried to adopt the Euro. The last generation began with the Asian crises and the currency devaluation of many countries in Southeast Asia. In the first case countries had to support their currencies because they were committed by an international agreement. In the second one the UK monetary authorities were forced to give up supporting the exchange rate because there were strong problems with the British. In this case the models tried to present the authorities' decision to support of the existing exchange rate or their decision to let it collapse. Usually those models end up in multiple equilibria because the expectations of collapse are enough for the exchange rate to collapse. In the previous category there was no room for the government's decision but the result was driven exclusively by the speculative attack. Moreover, the devaluation was not driven by the

fundamentals, but by the expectations. Researchers started to focus on the last generation of models during the Asian currency crises in 1997, which happened because there were severe macroeconomic imbalances such as large current account deficits. In the last generation of currency models researchers try to merge the collapse of fixed exchange rate regimes with banking system and credit. The currency crises usually appear together with banking crises and this is known as the “twin crises”. Furthermore, currency crises, banking crises, and sovereign debt crises sometimes exist together forming the “triplet crises” (Laeven and Valencia 2012).

Identification

The identification and the specification of the duration of crises present many difficulties for two main reasons. The first one is that some financial crises are examined on qualitative criteria and quantitative analysis is almost impossible. For example, banking crises are identified on qualitative issues whereas sudden stops and currency crises can be estimated quantitatively. On top of this, financial crises derive from a fusion of currency, sudden stops and banking crises, thus making researchers’ job becomes further complicated.

The identification of currency crises is sometimes obvious from either the strong fluctuations of the exchange rate or the soaring of the inflation rate. According to Reinhart and Rogoff (2009) exchange rate depreciation more than 15% per year or the rise of inflation more than 20% per annum imply financial crisis. Based on Frankel and Rose (1996) a currency crisis emerges when there is at least 25% cumulative depreciation for a 12-month period which must be at least 10 percentage points greater than that of the previous year. The measurement of the crisis constitutes an extra riddle because in many cases the exchange rate is not left to the market forces. The financial authorities enforce measures to mitigate this tendency using the international reserves of the Central Bank or using the interest rates properly. Those movements are not easily documented and do not allow us to estimate the exact extend of the crisis.

Sudden Stops

Sudden stops crises begin when a specific country cannot receive adequate foreign capital or at least there are considerable difficulties in absorbing foreign capital. Sudden stops are more frequent in emerging markets instead of advanced ones. This problem becomes stronger when the government debt consists of short-term bonds and thus those countries do not have enough time to pay off the existing capital. The “residual” maturity, which is “the remaining time until the expiration” of debt (OECD), is related to the reversal of capital. Moreover, the refinancing of debt makes this situation more severe and in many cases this hindrance is accompanied with a credit spreads upturn.

Capital inflows equal current account deficit and international reserves. Thus, the collapse of capital inflows implies the reduction of the current account deficit or less international reserves. This can be better understood in Calvo (1998). In his simple model, capital inflows (KI) equal to current account deficit (CAD) plus the international reserves per unit of time (RA).

- $KI = CAD + RA$

Next, the CAD is analyzed in aggregate demand (Z), demand for tradable goods (Z^*), gross national product (GNP), gross domestic product of tradable goods (GDP^*) and net factor transfers abroad (NFTA).

- $CAD = Z - GNP = Z^* - GDP^* - NFTA$

A potential reduction of capital inflows can be followed by the reduction of international reserves instead of solely dropping the current account deficit.

- $R + NDA = H$

The equation above depicts the balance-sheet identity of a Central Bank, where R presents the international reserves, H presents the high-powered money (monetary base) and NDA are the net domestic assets.

If KI drops, the Central Bank may reduce R and thus mitigate the decrease of CAD. This can happen through lending companies that cannot receive funding from abroad due to the sudden stop crisis (increasing the NDA). Sudden stops are usually followed

by increased domestic rates and for this reason Central Banks prefer to raise the NDA in order to mitigate this rise. The increased NDA produce increased monetary base and devaluation of the nominal exchange rate which do not suffice to restrain the sudden stop. The only thing the Central Bank can do so is to reduce the international reserves, but the effects of the sudden stops cannot be easily avoided in any exchange rate regime.

As it was explained before, the fixed exchange rate regimes suffer from speculative attacks. As a result, demand for assets underlying to the local currency reduces and agents exchange their liabilities and move from the strong currencies to the ones whose value decreases. The interest rates rise not only in this country but also globally and thus the capital inflows are further reduced.

The drop in the current account deficit reduces the output based on the Keynesian transmission channel. On the other hand, the counter cyclical policy may block the output reduction through the exchange rate devaluation. But the problem here is the debt issued in foreign currency. A potential devaluation makes tradable goods relatively costlier to the non-tradable ones, companies accumulate debt issued in strong foreign currency, and the problem of a sudden stop becomes the same as before.

However, even if debt of the non-tradable goods firms was issued in the domestic currency, the devaluation would not be helpful. The devaluations cause worry about the macroeconomic condition of a country and thus they are followed by increased nominal and real interest rates producing debt deterioration. Summing up, the difference between debt issued in foreign currency and debt issued in local currency is that in the first case the financial problems arise immediately after the devaluation while in the second case problems arise long-term.

As a result, output drops while unemployment increases. Reinhart and Calvo (2000) show this with two alternative ways. Based on the Keynesian approach, the economy is characterized by nominal rigidities and for this reason prices and wages cannot be adjusted immediately. The decrease of the demand will produce output drop and consequently higher unemployment. The Fisherian approach is related to the financial sector. More specifically, financial contracts are influenced by macroeconomic variables where the macroeconomic conditions also affect the ability of borrowers to

pay back their loans. Borrowers receive loans relying on their expectations but a decline in aggregate demand makes goods less tradable, agents cannot pay back their loans and non-performing loans increase. In this case sudden stops produce collapse of output through the financial sector which may produce greater problems than the Keynesian approach.

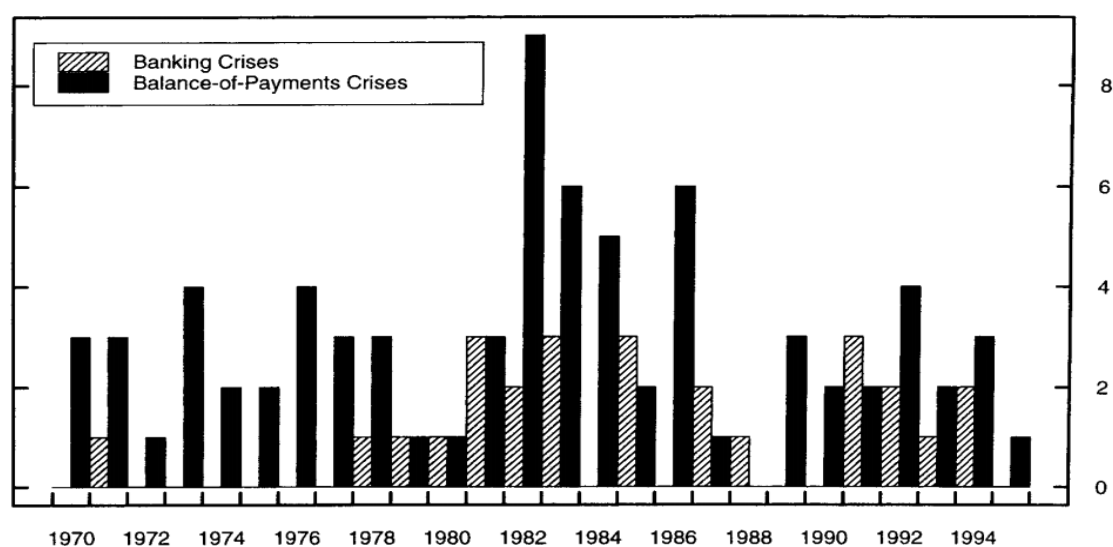
The last approach justifies another interesting phenomenon. Sudden stops are usually related to banking crises because sudden stops are marked by reduced capital inflows. Typically banking crises precede sudden stops crises but the capital outflow and the output loss worsen the banking system and lead to prolonged banking crises. In the following table and figure, both taken by Kaminsky and Reinhart (1999), it becomes clear that sudden stops are closely related to banking crises.

Table B.1. Balance-of-payments crises and banking crises

Type of crisis	Number of crises					
	1970–1995		1970–1979		1980–1995	
	Total	Average per year	Total	Average per year	Total	Average per year
Balance-of-payments	76	2.92	26	2.60	50	3.13
Twin	19	0.73	1	0.10	18	1.13
Single	57	2.19	25	2.50	32	2.00
Banking	26	1.00	3	0.30	23	1.44

Note: Episodes in which the beginning of a banking crisis is followed by a balance-of-payments crisis within 48 months are classified as twin crises.

Figure B.2. Number of crises per year



Source: Kaminsky and Reinhart (1999)

Models

Models created to deal with sudden stops are similar to the third generation models of currency crises because in both cases the macroeconomic situation is of paramount importance. At the beginning, the majority of models which focused on sudden stops concluded that a sudden stop increases output. This misleading outcome was overcome when models were enriched with a variety of frictions such as frictions in labor markets, Fisherian channels and financial accelerator mechanisms. The financial frictions present the dynamic results in output in case of sudden stops. Financial frictions such as paying in advance or collateralized debt may reflect the dynamic year to year reduction of output.

Calvo (1998) constructed a model in order to prove that the fall in CAD reduces the non-tradable goods' prices and thus financial crises are produced. His model assumes the following:

- Three-period model without monetary endowment: $t = 0,1,2$
- A single tradable good
- Perfect capital market and zero real interest rate
- Small country with no barriers in capital mobility
- The endowment: y_t where $t = 1,2$ and $y_1 = 0$ and $y_2 > 0$.
- There is representative individual with utility function:

$$(1) \quad u(c_1) + u(h) + u(c_2)$$

where u is strictly increasing and concave and c_t denotes the consumption for each period. The non-tradable good is symbolized by h and it presents home goods in the first period. One unit of h comes from one unit of tradable in the previous period. He assumes that there is no initial wealth and a Social Planner maximizes the individual's welfare:

$$(2) \quad \text{Max } L = u(c_1) + u(h) + u(c_2) + \lambda(y_2 - c_1 - h - c_2)$$

$$(3) \quad \text{Interior solution: } 0 < c_1 = c_2 = h = \frac{y_2}{3}$$

In the equilibrium, there is a CAD for the first two periods and a current account surplus in period 2. The agents may borrow h units in period 0 to make h units of non-tradables in the first period. The relative price of non-tradables to tradables in the first period is

$$(4) \quad p = \frac{u'(h)}{u'(c_1)} = 1$$

The ratio equals to 1 due to the solution in (3). So, at the equilibrium: $CAD = c_1 = \frac{y_2}{3}$.

If individuals cannot borrow the intended amount of h , $c_1 < \frac{y_2}{3}$ and

$$p = \frac{u'(h)}{u'(c_1)} = \frac{u'(\frac{y_2}{3})}{u'(c_1)} < 1. \text{ Expected profits at period 0 are given by:}$$

$$(5) \quad \pi = (p - 1)h$$

According to (4), expected profits at the initial period are zero. If the individuals cannot borrow as they want, $p < 1$ and $\pi < 0$. This means that if firms face limited borrowing capacity, those firms will default in the first period. Individuals cannot pay back in the first period because their endowment is zero.

In order to highlight the bankruptcy cost, Calvo assumes that there is a fixed bankruptcy cost. Thus, on top of the principal h , there is bankruptcy cost k . So, after the default of the first period, the budget constraint of the individuals becomes:

$$(6) \quad c_1 + c_2 = y_2 - h - k = 2\frac{y_2}{3} - k$$

Solving again the maximization problem:

$$(7) \quad c_1 = c_2 = \frac{y_2}{3} - \frac{k}{2} < \frac{y_2}{3}$$

$$(8) \quad p = \frac{u'(h)}{u'(c_1)} = \frac{u'(\frac{y_2}{3})}{u'(\frac{y_2}{3} - \frac{k}{2})} < 1$$

which implies bankruptcy. Moreover, given that c_1 is smaller than the one of the no-bankruptcy solution, the bankruptcy is related to smaller CAD in period 1. Even if the reasons which produce bankruptcy cost are not clear in this model, the model explains the financial problems produced by decreasing the CAD. The bankruptcy cost is the same no matter if the investment in the non-tradable goods occurs by foreign or

domestic residents. This is because this cost cannot be transferred to foreign citizens. However, this does not hold in the following two cases. The first one is the case when the investment is financed by equity. This means that in the first period losses can be transferred to shareholders, decreasing the probability of default. The second case is when original investment is materialized by bonds which last for two periods, and default occurs only in the second period. Summing up, equity and long-term bonds reduce the likelihood of a sudden stop.

Identification

Sudden stops and balance-of-payments can be easily identified when we observe output collapse and a significant decline in absorbing foreign capital. Sudden stops can be identified mainly on quantitative analysis instead of qualitative criteria, making their identification somehow easy. However, further details about the definition of a sudden crisis vary among the researchers.

Debt Crises

A debt crisis happens when a country cannot or is reluctant to pay off its debt or even if it is able to serve its debt but this is really difficult. Greece along with many other countries of the Eurozone constitutes a typical case of debt crisis. The debt crisis is not constrained only on the sovereign debt but it includes the private debt. In particular, debt crises can be distinguished in external and domestic debt crises. A special case is the domestic public debt crisis where a country cannot pay off the inland debt either defaulting or devaluating its currency and thus creating inflation crisis. The debt crises and banking crises are examined based on qualitative issues while the previous crises can be treated numerically.

Models

Unlike the case of private borrowers, countries may deny paying back the sovereign debt without facing serious consequences. Thus, more sophisticated reasons are needed in order to justify why lenders buy government bonds.

Models produced to cover this area usually enforce a way of punishment for countries reluctant to pay off their debt. In case that a country defaults, it will be unable to borrow funds from abroad in the future. For example, if an unexpected event happens and the output reduces, then country's residents will not be able to overcome this problem and they cannot make intertemporal consumption smoothing. The forthcoming closure of the international markets makes countries willing to serve their debt, but default comes from other reasons. Models have also been designed to highlight the country's borrowing capacity. However, those models cannot explain the sovereigns default and the over-lending. Another issue is that models predict that countries default when the economic situation is problematic which is not always necessary. Models do not reveal the willingness of investors to excessive lend whilst the interaction between economics, politics, and probability of default lacks.

On the other hand, domestic debt crises have been examined much less. It is believed that governments always satisfy their obligations towards the domestic residents because the Ricardian equivalence holds and government assets constitute risk-free debt. However, sometimes governments fail to pay off the local residents, in particular after periods of hyperinflation.

Identification

Debt crises can be categorized into two categories: external sovereign debt crises and domestic debt crises. The dating of an external sovereign debt crisis is related to defaults but there is no agreement about what types of default. The starting date of the default cannot be approached easily. The end of the default is thought as the date when countries can borrow again money from private financial markets. However, domestic debt crises cannot be precisely identified. Countries do not have analytical historical data for the domestic public debt and there are many ways for default.

Banking Crises

Banking crises constitute the last type of financial crises previously explained. It is extremely difficult to provide a definition for this type of crises. However, a banking crisis is characterized by bank runs, panics, defaults, mergers and acquisitions, undercapitalized banks or government support in order for the problems to be mitigated. The banking crises are examined mainly on qualitative issues because quantitative analysis is opaque.

A bank in crisis is more dangerous than the default of a common company not involved in the financial system. The reason is that banks constitute a network where each financial institution lends and borrows funds each other. The assets of one institution are reflected on the liabilities of the other, thus the default of the latter will cause problems to the former. Moreover, the citizens' panic is not solely focused on the problematic institution, but it mushrooms to the whole system, thus forming systemic risk. Consequently, a potential individual bank crisis may be infectious for other banks which belong to the same network with the problematic one and finally this calamity threatens the whole banking system endemically or universally. The inherent danger of a financial institution has inspired people to look for ways in order to avoid those phenomena.

Following strictly Laeven and Valencia (2012), in order to characterize a banking crisis as systemic crisis, two necessary conditions must hold. First, there must be substantial financial distress involving bank runs or liquidations. Secondly, there must be great monetary or fiscal policy in order for the losses of the banking system to be covered. Supposed that both of them hold, then we say that the banking crisis is systematic. The government intervention is considered significant if at least three of the following hold: substantial liquidity support, nationalization of financial institutions, guarantees, asset purchases, limited deposit withdraw or bank holidays, costly bank restructuring. Government intervention may also be significant even if less than three from the above exist, but at a greater extend.

Why are banks so vulnerable?

Financial institutions constitute companies which provide funds to the borrowers receive funds from the lenders. Typically depositors lend the bank short-term and banks lend money long-term. This fact enables investors to realize a project, otherwise impossible. This is because of the fact that lenders prefer to avoid long-run commitment and borrowers cannot pay off their debt quickly. Moreover, banks reduce the uncertainty between lenders and borrowers and so lenders are more and more confident to offer their funds.

This simplified activity described above can sometimes not be realistic. This is because financial crises reveal the vulnerable side of the financial institutions. A financial crisis appears with currency crises e.g. the collapse of an exchange rate regime, sudden stops in credit, banking crises such as bank runs, banks' default, etc. Those situations occur frequently and many cases have been recorded during the last century.

Financial Institutions risks

Banks are exposed to several types of risk which affect their profitability and the financial stability of an economy. According to Sapountzoglou and Pentotis (2009), we can follow the next classification.

The most traditional risk one is credit risk. In this case a bank may lose money due to the fact that borrowers cannot pay back their loans or they cannot pay back the full amount of the loan. Credit risk is also a serious problem when banks follow the Mark-to-Market system. In this case a potential devaluation of the borrower's solvency decreases the value of the loan and finally bank's assets are decreased.

The next one is the interest rate risk. This problem comes from unexpected fluctuations of the yield curve. Loan interest rates and deposit interest rates are not fixed in the long-run and thus they are sensitive in the upturns and downturns of the yield curve. The ordinary problem in this case is the increase of the interest rates instead of their fall. This is because financial institutions usually finance long-term loans with short-term deposits, leaving them exposed to the refinancing risk. Unlike the previous case, fluctuations of the yield curve may increase the banks' profitability.

The next threat is the foreign exchange risk which is derived from the fluctuations of the exchange rate. Banks issue loans related to the domestic currency and to foreign currencies. Moreover, they hold securities the pay-off of which is in foreign currency. A significant devaluation of the exchange rate may produce a significant decrease in the banks' revenues and they might be unable to cover their needs. As it happened in the previous case, the fluctuations may not be catastrophic for the financial institutions, depending on which are the securities of the bank balance sheet.

Liquidity risk is defined as the case where the financial institutions lack the necessary funds to cover their payments. The financial institutions may not face reduced profitability but they cannot match the inflows and outflows. In this case financial institutions are required to borrow funds in order to continue their operation or to avoid fire sales.

Market risk is related to the volatility of the financial markets. Financial institutions have securities in their balance sheet and their value is influenced by the fluctuations of the financial markets. When banks need to acquire liquidity by selling bonds they may not receive the expected amount and this fact reduces the bank's revenues.

Operational risk contains some events related to the operation of the financial institutions which may provoke losses. According to Hull (2012), operational risk includes internal and external frauds, employment and business practices, physical damages, and system failures. The serious problem with this type of risk is that the most severe losses occur rarely and thus the unexpected losses might be huge.

The last type of risk is the sovereign risk. This risk concerns the risk that a country faces either financially or politically. It includes the debt servicing capacity of this country and its macroeconomic condition.

Apart from the classification above, it is important to be said that the financial risks are not isolated from each other. In many cases, one type of risk produces the other types and in this case more than one types of risk exist together.

History

Bank runs have been repeatedly recorded in almost any country, in particularly in the past. Banking crises have been occurred in London, Amsterdam and New York before the end of the 18th century. In the US this phenomenon was usual during the 19th century and during the Great Depression of the previous century (Claessens and Kose 2013). The imposition of deposit insurance in 1933 mitigated the situation in the US. Developing countries are more vulnerable than developed ones due to the lack of preventive measures and their macroeconomic fragility. For instance, the Asian financial crisis, which started as a currency crisis in 1997, caused serious problems at many countries of the Southeast Asia and many economists worried about the dimensions of this crisis. Finally, the crisis did not affect the worldwide economy but at least 7 countries from this area were damaged.

Developed countries are not exempted from banking crises because many financial institutions in advanced economies were hit by the financial crisis of 2007. A typical example is the British bank Northern Rock, which defaulted a little after the outburst of the current crisis. Northern Rock, which was specialized in housing loans, used to receive short-term deposits to finance long-term loans. The depositors, terrified from the financial crisis, withdrew their deposits making it was almost impossible for the bank's managers to cover the liquidity gap and so it finally defaulted. It is worth mentioning that the guarantee of deposits in England was much smaller in comparison to the US and thus deemed insignificant in the effort to stop the depositors' worry. The collapse of Lehman Brothers and Bear Stearns is grounded on similar reasons but in a more sophisticated context. Those investment banks drew resources from the repo market, an alternative way of short-term financing (Goldstein and Razin 2013). When panic overwhelmed the financial markets, investors were reluctant to lend each other funds and so those banks could not cover their needs. Both investment banks collapsed in 2008 and the case of Lehman Brothers constitutes the biggest bankruptcy in the USA.

The following table from Laeven and Valencia (2012) presents the recent banking crisis events per country. The banking crises are characterized systematic if there are at least two components of the ones explained before.

Table B.2. Systemic Banking Crises

Country	Start of crisis	Date when systemic	Extensive liquidity support	Significant guarantees on liabilities	Significant restructuring costs	Significant asset purchases	Significant nationalizations
<i>Systemic Cases</i>							
Austria	2008	2008	✓	✓	✓		✓
Belgium	2008	2008	✓	✓	✓		✓
Denmark	2008	2009	✓	✓			✓
Germany	2008	2009	✓	✓			✓
Greece	2008	2009	✓	✓	✓		
Iceland	2008	2008	✓	✓	✓		✓
Ireland	2008	2009	✓	✓	✓	✓	✓
Kazakhstan	2008	2010	✓		✓		✓
Latvia	2008	2008	✓	✓			✓
Luxembourg	2008	2008	✓	✓	✓		✓
Mongolia	2008	2009	✓	✓	✓		✓
Netherlands	2008	2008	✓	✓	✓		✓
Nigeria	2009	2011	✓	✓	✓	✓	✓
Spain	2008	2011	✓	✓	✓		
Ukraine	2008	2009	✓		✓		✓
United Kingdom	2007	2008	✓	✓	✓	✓	✓
United States	2007	2008	✓	✓	✓	✓	✓
<i>Borderline Cases</i>							
France	2008		✓	✓			
Hungary	2008		✓	✓			
Italy	2008		✓	✓			
Portugal	2008		✓	✓			
Russia	2008		✓	✓			
Slovenia	2008		✓	✓			
Sweden	2008		✓	✓			
Switzerland	2008		✓			✓	

Source: Laeven and Valencia (2012)

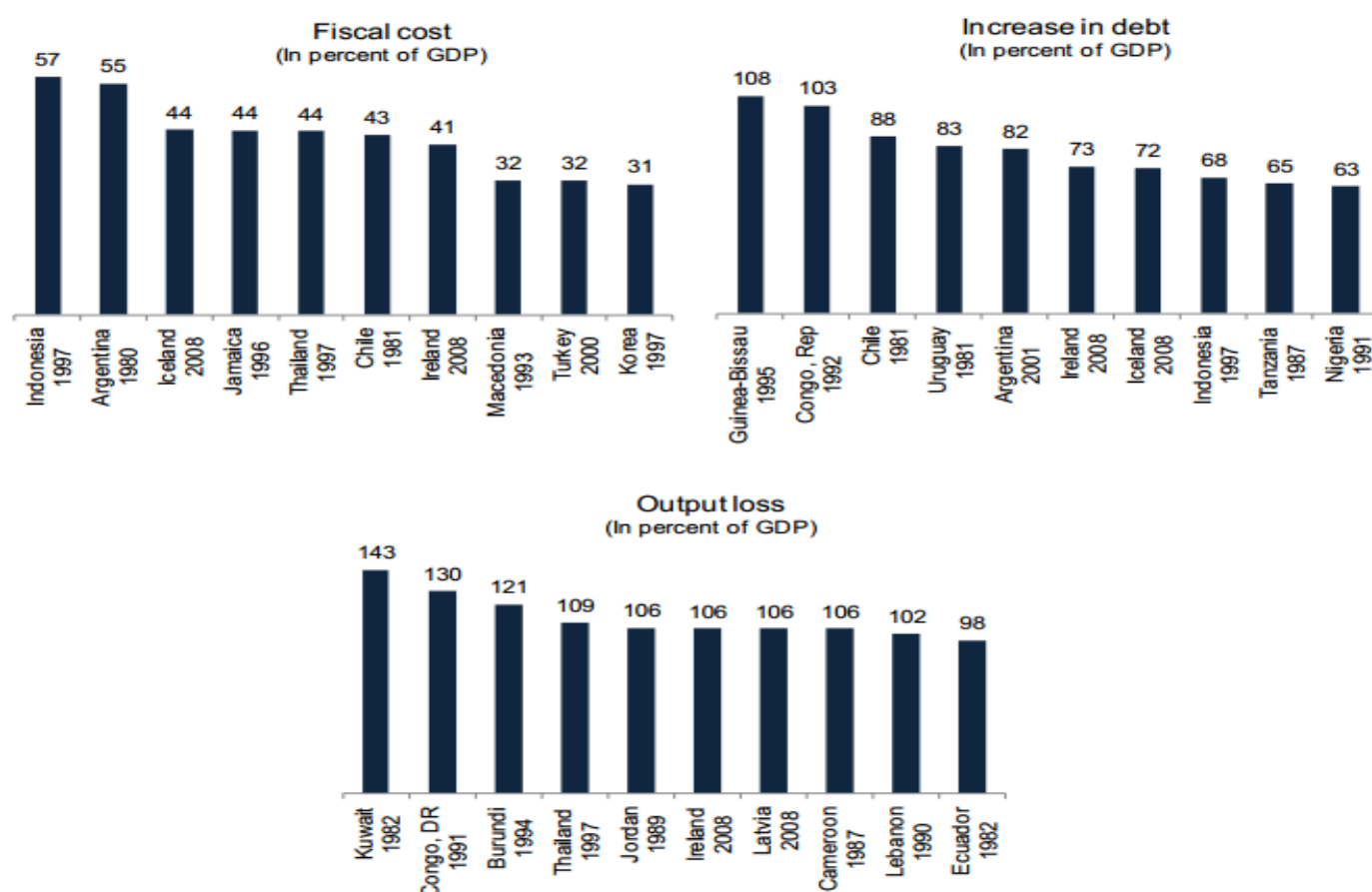
Identification

Banking crises cannot be easily identified because their examination relies on qualitative criteria. Researchers study a variety of events, such as undercapitalization of banks, defaulted banks and government control in order to determine when a banking crisis starts. The end of a banking crisis is hard to be recognized due to the fact that the above phenomena may or may not last long causing a misunderstanding. Those problems are reflected on the great differences among researchers about the onset of a banking crisis.

Typically, banking crises last longer than sudden stops and currency crises, because sudden stops and currency crises develop quickly whereas banking crises require more time. Moreover, currency crises and sudden stop crises can be identified immediately and it is possible to come up with countermeasures to resolve them more quickly.

Banking crises are more dangerous than currency crises mainly because of the Fisherian channels pointed out by Calvo (1998). According to Reinhart and Calvo (2000) a banking crisis decreases the GDP more than a currency crisis and for this reason the recovery in the first period requires twice the time. Another difference is that interest rates stay higher after the end of the banking crises but this is not the case for currency crises. The following graph presents the harshest banking crises since 1970.

Figure B.3. The hardest banking crises since 1970



Source: Laeven and Valencia (2012)

Banking crises and Bank runs

A typical bank earns profit by purchasing money from the depositors and by selling them at a higher interest rate to creditors of any type such as households, companies, bonds etc. Banks tend to borrow money with a short-term commitment whilst they lend money on a long-term basis. This gap is of paramount importance for the banks' profitability and derives from the preferences of their customers. A typical depositor

has a predilection in lending short-term because it is likely that their money will be needed in the immediate future, while borrowers prefer to have many years in their disposal to pay off their debt. This act is known as the maturity transformation.

When the harmonic system is violated, the financial institution is in danger. A potential lender's fear about the sustainability of the banking system may provoke total collapse of a bank with further consequences to the whole banking system. In case that the bank's lenders believe there is a substantial probability that the bank will fail to pay off their deposit, the vast majority will withdraw their money. This individualistic behavior will cause deterioration of the bank's current situation while more and more depositors will do the same. This process, known as a bank-run, is a self-fulfilling prophecy and is one of the most serious threats of financial stability.

Countermeasures

A lot of mechanisms have been designed in order for the banking system to become more robust. The first types of measures are related with the financial authorities either at a local level or globally. Bank supervision aims to restrict the inherent danger of financial intermediation. Many Central Banks guarantee that, even if a bank defaults and it belongs to their responsibility, depositors will not lose their whole amount of deposits, but they will receive a part of their lending. For the banks under the supervision of the ECB, each depositor receives from the authorities up to 100,000 Euros per bank. This guarantee prevents many depositors from withdrawing their funds, or at least the majority of the citizens who have small deposits. The establishment of the Central Bank's a lender of last resort is another parameter which lowers the liquidity gap of the commercial banks. Apart from this, the banks' risky portfolio is regulated by a great number of indicators. Basel I, II and the forthcoming Basel III endeavor to diminish the excessive danger of some financial institutions. Moreover, banks have set their own measures in order to avoid bankruptcy. It is obvious that the executives understand that the bank's failure will terminate their career and this works in favor of the stabilization of the system.

Moreover, financial institutions make profound usage of financial products in order to avoid the financial risks described above. They try to hedge their risk using derivative products. Those are options, forward contracts, futures, and swaps. Each one of them can be further specified according to the type of the market that it aims to cover. For

example, financial institutions make extensive use of swaps in order to cover their needs for a longer period. Swaps can be analyzed in credit default swaps (CDS), interest rate swaps, and currency swaps. All of them are contracts which provide cash flow exchanges and make the financial markets more stable.

Unfortunately, even those sophisticated measures described above are sometimes inadequate to prevent a banking crisis. The first reason is that the Central Bank's guarantee is not always adequate to placate the citizens' fear especially for those having large deposits. Not only is the central banker's commitment fruitless, but also this buffer motivates managers to take on more dangerous projects. The problem of moral hazard emerges and executives tend to overdo it due to the fact that they have nothing to lose. The problem of moral hazard will be further explained later on. The last problem is that indicators are designed based on erstwhile knowledge and it cannot prevent the unforeseen banking crises. So, the financial institutions are not as immunized as they seem.

Which are the real problems?

A frivolous examination of a bank run may give us the misleading conclusion that a bank run and the liquidity paucity emerges from the liabilities of the bank. Actually, it is not the liability side which suffers, but the other side of the balance sheet because loans or securities lose their value. The problems begin when loans are not served as they are expected. The financial institution lacks the necessary capital and in order for the banking system to be stable financial support is offered. People tend to feel anxious about their deposits and finally the bank run is the symptom of the non-performed loans. The ongoing crisis in Europe discloses that problematic loans are the cause of the banking crisis and not the withdrawal of deposits.

Another issue provoking banking crises is the structural problems of the banking system, and specifically the excessive deposit insurance. Excessive deposit insurance and government support cause excessive risk taking. The bank managers understand that they have nothing to lose and they prefer to take on huge risks. This is because, if the results are problematic, public funds will rescue the bank (bailout) whereas in case of a success they will receive great bonuses.

Why countermeasures are not entirely effective?

The fragility of a bank and of the banking system in general has made governments to prescribe regulations in order for the destabilizing phenomena to be eliminated. The oldest and most known measure is the deposit insurance. But, the deposit insurance may be harmful for the banking system. The deposit insurance in general creates the problem of moral hazard which means that the agent who receives insurance prefers not to maintain their risk attitude as if insurance didn't exist. In our case, the bank's managers may offer deposits with higher rates because there is no risk of default (Calomiris 1990). The deposit insurance is beneficial up to a point but excessive use of it becomes catastrophic. Hence, there is a trade-off between the pros and cons and there exists an optimum amount of deposit insurance. The optimal deposit insurance policy, though, has not received the appropriate attention yet.

The problem of moral hazard and systematic risk deteriorates when the market is dominated by big banks. Whenever there is an enormous bank its position constitutes a significant part of the economy and it is thought of as "too big to fail". Government support is almost sure in case that this bank faces difficulties because its potential collapse will produce severe problems in real economy. This fact makes their executives prone to more leverage and excessive risk taking, expecting a high-return.

"Regulatory arbitrage" constitutes an extra problem for the regulatory authorities. The regulatory arbitrage is a mixture of the typical arbitrage in the framework of bank supervision. Arbitrage is the profit-making process derived from purchasing and selling the same product to different markets when the price of the underlying assets differs from one another. In the case of financial institutions, regulatory arbitrage concerns the regulatory capital that banks have to hold in order to deal with financial difficulties. However, not all the facts of a bank's operation are regulated with the same burden. This difference motivates executives to hide some activities behind other positions in order to reduce the capital requirements. For example, the trading book of a bank has different regulations from the banking book. During the last financial crisis many mortgages were recorded in the trading book instead of the banking book and for this reason the regulatory capital was less than appropriate (Hull 2012). Moreover, "regulatory arbitrage" is not constrained into the financial institution but in different countries. The regulatory capital is not subject to the same

rules worldwide and in some cases executives transfer activities from one country to the other in order to reduce the regulated amount of capital. It is clear that this issue needs international coordination in order for this problem to eclipse.

The problems of moral hazard and adverse selection

Even if the banking crises are generally grounded on bank runs and the impatience of depositors, problems usually come from the side of liabilities. The frictions related with loans determine their quality while they may make a bank's lending to collapse, thus leading to market freeze (Goldstein and Razin 2013). There are two types of frictions: the moral hazard and the adverse selection. The former emerges when the bank's lending rate is so high that borrowers are reluctant to develop a profitable project to pay off the loan. The latter occurs when lending rates are high, but in this case borrowers with normal projects will not take loans and only high risk borrowers will take loans, which means the probability of paying off is scant. In either case, credit is limited and agents who need funds cannot be funded. Credit collapse is not related only with firms and households but it is also known in the interbank market because one bank cannot know whether there are phenomena of moral hazard or adverse selection.

The problem of moral hazard is ubiquitous in economics, particularly in financial and insurance markets. Moral hazard is generated by the asymmetric information in the market. Suppose that an agent needs funds to finance a project. The payoff of the loan is related with the debtor's effort which constitutes their personal endeavor. If the interest rate is high, the final profits of the project are negligible and the entrepreneur will not struggle to pay off. This problem can be solved with the appropriate collateral but those restrictions constrain the credit volume because collateral is not always found. Those frictions are unavoidable but when the situation is stretched to the limits and credit collapses then crises occur. This situation is known as credit boom and bust and it will be presented next in detail.

The other aspect of the asymmetric information is adverse selection. Adverse selection constitutes a credit friction and limits credit in a way that reminds us Akerlof's analysis with "lemons". Akerlof (1970) pointed out that the hypothesis of

symmetric information is not always realistic because buyers have less knowledge than sellers. The result of his study was that asymmetric information hampers trade and only the low-quality products constitute market. Following the same analysis, bankers cannot distinguish the type of the potential borrowers i.e. if they are efficient entrepreneurs with high probability of successful pay off or untrustworthy creditors with tiny probability of pay back. So, the average interest rate will thwart solvent creditors and because bankers understand this they increase the interest rates. Then only the bad type of creditors will remain in the loan market. Finally, a significant amount of good type creditors does not receive funding thus limiting credit volume and only the bad type of entrepreneurs get loans. The credit collapse during the last financial crisis is related to this problem because many banks were exposed to toxic worthless assets and for this reason it was impossible for one financial institution to lend to another in the interbank market.

Models

According to Allen and Gale (2007), researchers started creating models for banking crises in the 1980s. The first models, produced by Bryant (1980) and Diamond and Dybvig (1983), tried to justify deposit insurance as a sufficient tool in order to eliminate bank runs. A few years later, new models were produced, their main goal being to point out the sense of panic in the banking system. Another category constitutes models with real shocks. There are numerous models which belong to this category. Some of them include asymmetric information about loan risk, noisy signals to depositors, need for higher liquidity, random reinvestment rate and other phenomena. The majority of models with banking crises end up with multiple equilibria and those models do not offer significant results about sensitivity analysis. Moreover, a limited number of models rely on money to explain banking crises. The role of money in these banking crisis models began with Allen and Gale (1998), and literature in the field was enriched mainly during the following decade.

Empirical Literature on Financial Crises

Financial crises from the perspective of booms, bubbles, and busts

Financial crises are not caused by one reason only but usually they are provoked by a combination of phenomena such as substantial changes in credit volume and asset prices, problems in financial intermediation like sudden stops, macroeconomic imbalances, and large scale government support (in the form of liquidity support and recapitalization). However, the majority of financial crises are preceded by asset and credit booms that eventually turn into busts.

The first reason, related to asset price booms, is the situation where the asset prices soar for unexplainable reasons and this boom cannot be justified by the usual widely accepted models. This situation is known as a bubble where a bubble may be formally termed as the asset prices raise which cannot be explained by the fundamentals. Bubbles almost always burst suddenly leading to the de-escalation of the financial activity. According to Claessens and Kose (2013), the biggest bubbles, which lead to severe crashes, are those of the Dutch Tulip Mania (1634-1637), the French Mississippi Bubble (1719-1720) and the South Sea Bubble in the United Kingdom (1720). A more recent paradigm of bubble is the Japanese asset price bubble from 1986 to 1991. The real estate prices in Japan were increasing due to excessive money supply but this increase stopped abruptly.

The second reason concerns the credit booms. Sometimes credit volume increases and surpasses the normal level and this phenomenon usually coincides with the increase of the asset prices. The financial leverage plays a key role in this case because credit reduces the interest rates and increases the asset prices which are used for collaterals. This enhances credit and this process is known as a positive feedback rule. The predominant paradigms of this case are those of the Australian boom and bust (1880-1890), the United States credit expansion from the 1920's to 1930's and the banking crises in the Nordic countries.

The financial crises and real economy

The busts, either coming from asset prices or credit booms, influence the real economy because the financial institutions' ability to lend is affected by two main reasons. The first one is that loans are usually collateralized by financial assets and the financial market decline reduces the borrowing ability. This fact reduces credit and investment causing problems in the real economy. Apart from this, many banks prefer making fire sales to avoid bankruptcy and those liquidations do not allow banks to finance investments. Again, the reduction of credit deteriorates the real economy. The asset price booms caused by extreme leverage are really harmful for the economy. On the other hand, booms related to equity market activities may not be as destructive as the financial leverage booms. For example, the internet bubble of the 1990s was not catastrophic for the economy whereas bank loans relying on assets may severely affect credit expansion and thus the real economy. Hence, when bubbles of the second type burst, real economy suffers.

The impact of financial crises was examined by Schularick and Taylor (2009) and their results were really interesting. They focused on financial crises in combination with money and credit based on a 14-country dataset from 1870 to 2008. They focused on the following issues: which key facts can be drawn about money and credit, which was the monetary policy, and how money and credit affect financial crises.

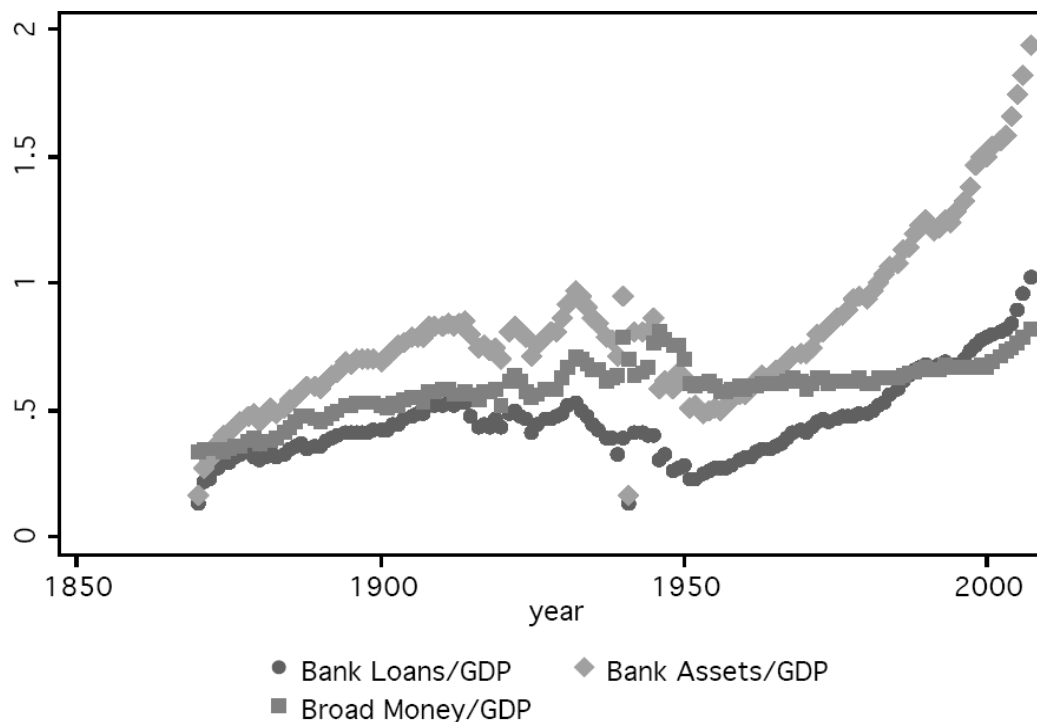
They split the recent financial history into two periods where the first one, starting from 1870 to 1939, and the second one, starting from 1945 to date. During the first period, money and credit were not stable in the short-run but in the long-run they formed a stable ratio, except for the period of the Great Depression. During the second period, both of them had an increasing trend but the one of credit expansion was much more profound than money expansion. This happened due to the leverage of the financial system which started mainly after the collapse of Bretton Woods.

The financial era born after the Second World War is characterized by different monetary and regulatory policies. The larger financial sector of our days produces greater real effects in the economy, thus the banking crises in our era produce greater output losses. Even if the current financial era is characterized by great monetary expansions in order for the banking system to get over the problems, financial crises

cause problems to the real economy. The inflation rate has become higher in the aftermath of crises during the last financial era. This may be due to the fact that governments do not use the Fisherian mechanism which was greatly used during the first financial period. This difference provokes higher inflation and greater output loss.

The following graph depicts three ratios. The first one is the bank loans to GDP, the second one is the bank assets to GDP, and the third one is the monetary base to GDP.

Figure B.4. Aggregates relative to GDP



Source: Schularick and Taylor (2009)

From the graph it is clear that the 140 year period can be divided into two financial periods; the first one ends with WWII and the second one covers the post-WWII period. During the first period, money and credit were not stable in the short-run but formed an almost stable ratio in the long-run. Both ratios were increasing during the last decades of the 19th century but they remained almost steady for the last part of the first financial era. The growth of loans and assets as a ratio of money is presented in the following graph. None of them presented significant alterations before WWII, except for the Great Depression when both collapsed. As far as the first financial era is concerned, the path of credit coincides with the path of money.

After the Second World War, credit has been gradually increasing. The monetary base has remained almost stable for many decades and it increased after 2000. However, there is a great upturn of bank assets. The ratios of loans to money and assets to money have been continuously rising during the second financial era. Even if loans and assets have been plummeting at the end of the first era, they reached this level in 1970, and they escalated further thereafter. The ratio of credit to GDP marked the most profound increase mainly based on the higher leverage and the alternative funding sources which emerged during the last four decades. Those include debt securities which produce liabilities not strictly related to the monetary base. During the first years of the second financial era, loan books were grew larger in comparison to the deposits and as a result credit growth was not related to the monetary liabilities of the financial institutions.

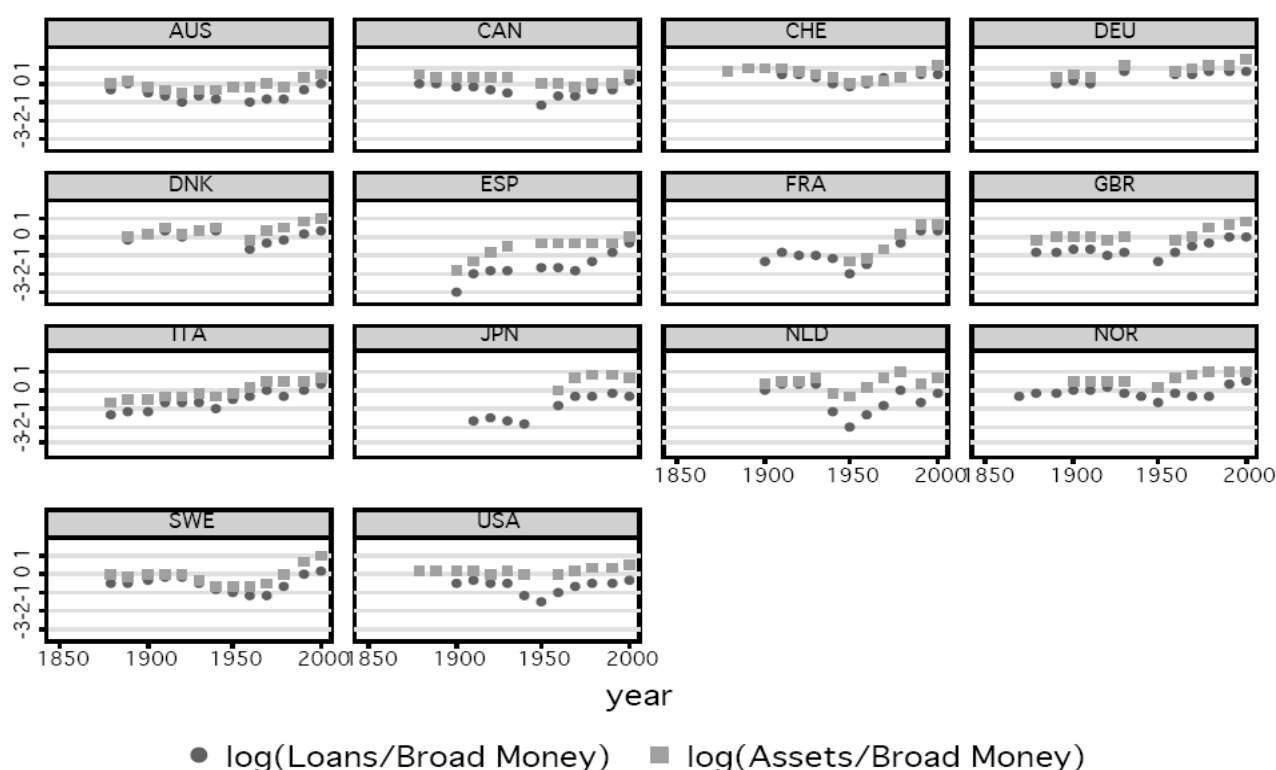
Figure B.5. Aggregates Relative to Broad Money



Source: Schularick and Taylor (2009)

The cumulative data above are categorized by country in the next tables. Shularick and Taylor reveal the rate of growth of those ratios for 14 countries. In almost any country the second financial era is marked by higher rate of the assets to money ratio.

Figure B.6. Aggregates Relative to Broad Money (By Country)



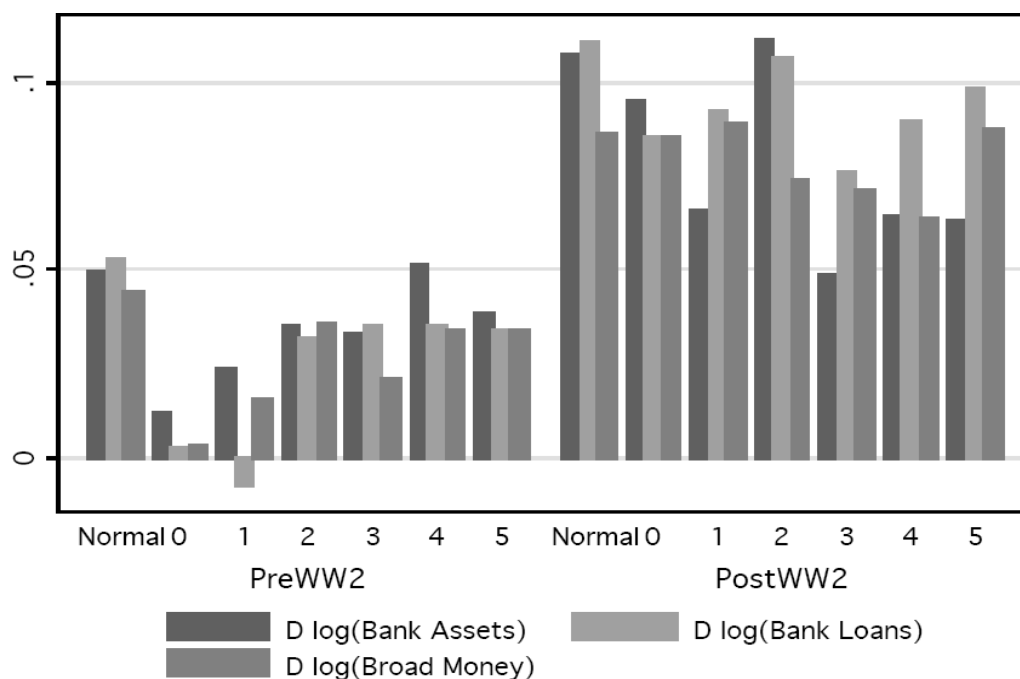
Source: Schularick and Taylor (2009)

As it was mentioned before, banks' assets have increased during the last decades because financial institutions are more and more reliable to sources unrelated to the amount of money. The credit creation is linked to the financial market condition, such as confidence and liquidity, and all-the-more financial stability influences credit expansion born out of the banking system. The traditional transmission mechanisms have been reduced and they are influenced by a potential financial turmoil. For this reason, the role of central banks must be enhanced in order to guarantee the appropriate market conditions which are necessary for the banks' funding. The traditional measures of the deposit insurance and Lender of Last Resort cannot block a banking crisis in our era.

Schularick and Taylor also examined what the effects of Financial Crises in credit, money, and output were. The financial period before the Second World War was characterized by the golden rule, macroeconomic policy measures were scarce, and measures for banking stability were scant (deposit insurance started after the financial crisis of 1929). The second era started with the Bretton Woods and it continued with a free-floating exchange rate regime. Monetary policy has become usual and banking

regulation was established. The following graph shows the pathway credit and money after the financial crises of the last 140 years.

Figure B.7. Aggregates (Post Crisis Periods Relative to Normal)

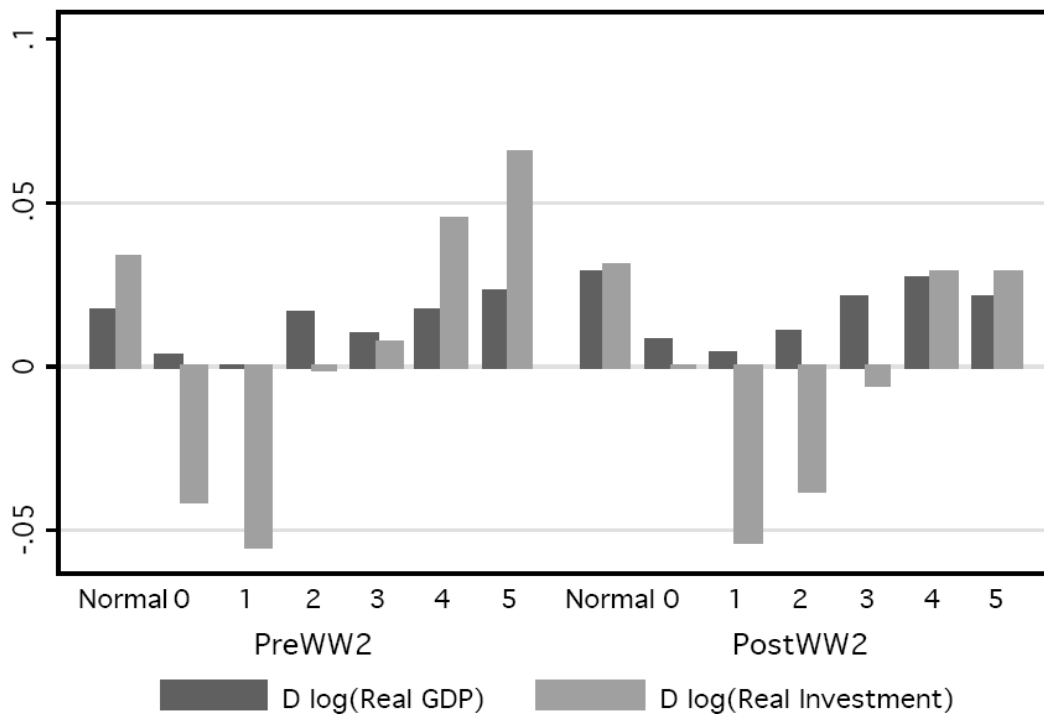


Source: Schularick and Taylor (2009)

Again there are great differences between the two eras. During the first period, money and credit growth plummeted after financial crises, much lower than normal levels. Typically five years were needed in order for those growth rates to reach the previous levels. On the other hand, the reduction of money and credit cannot be clear in the case of the second financial era. This is mainly because of the monetary policy enforced by the central banks which do not let money supply fall and credit is also supported. However, assets held by financial institutions are marked in a different way.

The next bar chart shows the effect of financial crises in the real GDP and real investment. The GDP reduction is less harsh during the second examined period and the fall in real investments is also stronger during the first period.

Figure B.8. Real Variables (Post Crisis Periods Relative to Normal)



Source: Schularick and Taylor (2009)

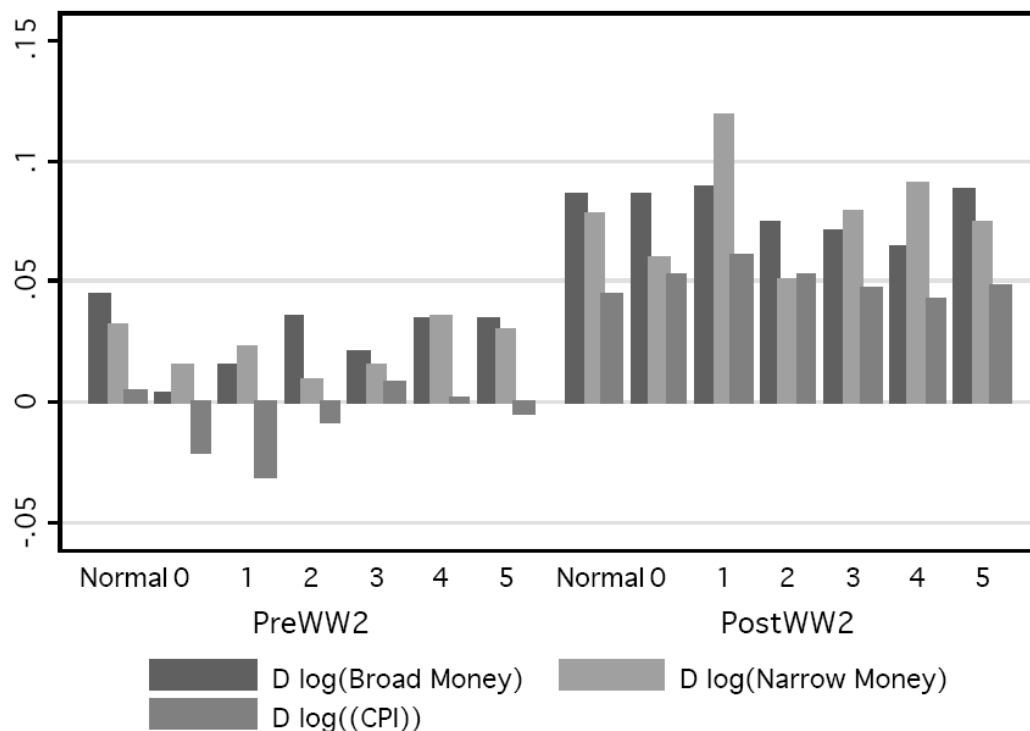
The next graph presents the pathway of Broad Money, of Narrow Money (physical form of currency) and of CPI after financial crises. Before WWII, financial crises produced strong deflation rate which lasted approximately three years. The growth rate of money, of either nature, was reduced, and then reached a stable level. After WWII, financial crises did not produce deflation rate and the inflation rate is slightly enhanced even immediately after the crises. The narrow money booms the first year after the onset of a financial crisis which typically comes from the expansive monetary policy. The broad amount of money initially remains stable and is gradually reduced. This is related to the imposition of deposit insurance which prevents the financial system from deleverage.

The dissimilarities between the two financial eras are based on the deposit insurance. This measure has made both broad and narrow monetary base steadier after crises. On the other hand, bank assets have been more unstable because they are not linked to monetary circulation.

As far as the real economy is concerned, the impact of financial crises in the real economy is harsher during the second financial era. The GDP is marked by a

cumulative drop almost equal to 8% in comparison to the relative trend whereas real investments are reduced by 25%. During the first financial period (without taking into account the Great Depression) the relative percentages were much lower and not statistically significant. According to Romer (1999), the financial crises of the second era are less frequent and harsher, except for the case of the 1930s.

Figure B.9. Money and Inflation (Post Crisis Periods Relative to Normal)



Source: Schularick and Taylor (2009)

In general, there is close connection between financial crises and expanded credit. Financial crises as the result of an expanded credit have its origins in Minsky (1977) and Kindleberger (1978). However, there was not any empirical proof about this until Schularich and Taylor (2009). During the first financial era broad money and credit used to move in the same way. After WWII those two notions followed separate ways and the credit volume is more valuable in order to understand a country's macroeconomic condition. This result has great significance for policymakers.

Instead of focusing solely on the money supply and price stability, it would be useful that central banks pay attention to the amount of credit in order to prevent financial instability. Credit constitutes a more precise indicator of a forthcoming financial crisis than broad money. Since the end of WWII and the onset of the current financial era

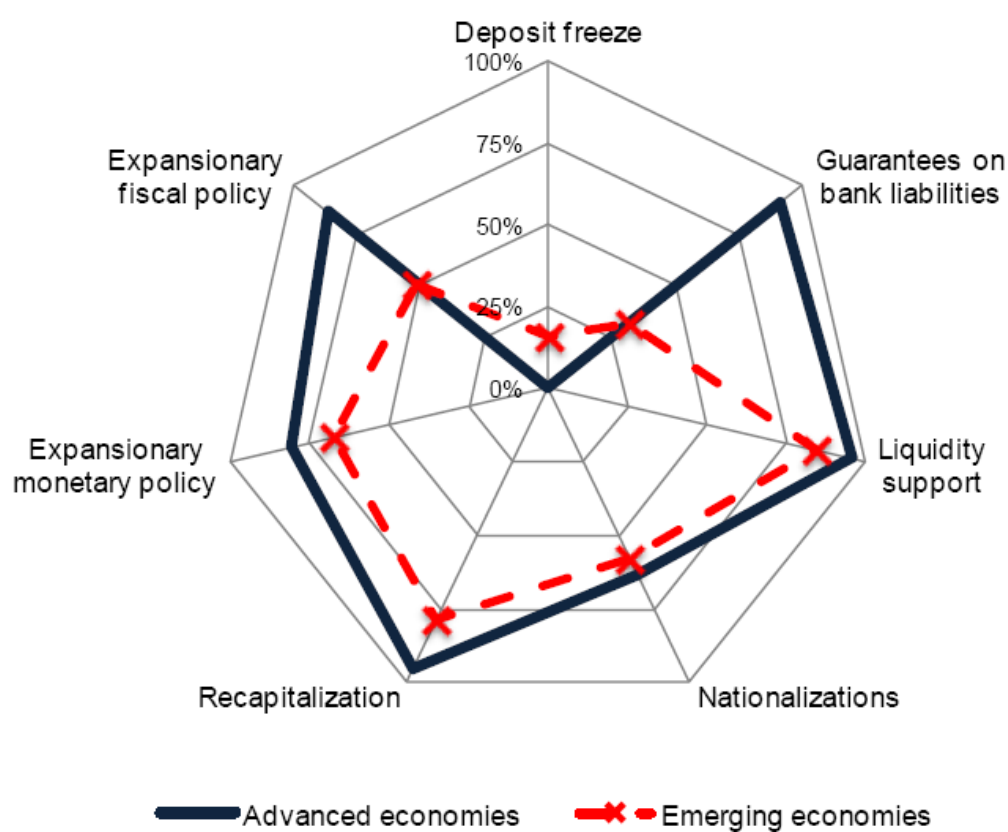
there is no close connection between credit volume and money supply as it used to be in the past. Thus, credit must be seriously examined by the policymakers.

The size of the banking system is an important factor for financial crises. This is because prices increase and a possible bust is more dangerous as the banking sector is greater. Moreover, greater banking sectors are more vulnerable and financial crises are more probable. Boom and busts are getting more and more problematic in countries with large financial sector. This is mainly due to the raised moral hazard and the incomplete financial regulation, but further research is needed.

Measures taken by developed and developing countries

In developed countries the authorities make a profound usage of monetary and fiscal policies while emerging economies are not really willing to enforce those measures. Presumably, this happens because in developed countries the countercyclical fiscal policy is more efficient and the monetary policy is less hazardous. As far as banking crises are concerned, developed countries suffer more than the emerging economies because the GDP loss is greater and their public debt increases more. The relatively greater banking sector in advanced economies requests greater fiscal intervention and thus the public debt rises. An interesting fact is that monetary and fiscal expansions may mitigate the banks' problems but the bank restructuring process is hampered. The following graph is taken from Laeven and Valencia (2012) and it shows the differences between advanced and developing countries.

Figure B.10. Differences in the Mix of Crisis Policies



Source: Laeven and Valencia (2012)

B.2. Sovereign Debt Crises and Sovereign Defaults

Sovereign debt crises are the crises related to the public debt, which is constituted by government bonds issued in a foreign currency. In order to have a sovereign debt crisis, a country must be unable to pay off its debt or at least to face severe difficulties to do so. A sovereign default is the situation where a country cannot meet its obligations, which means that lenders do not receive the full amount of credit.

Sovereign debt crises constitute a type of sovereign risk, one of the two categories of country risk. According to Nagy (1984), “country risk is the exposure to a loss in cross-border lending, caused by events which are under the control of the government but definitely not under the control of a private enterprise or individual”. This means that country risk includes any type of lending such as government, financial system, and individuals. Sovereign risk consists of the risk of government lending of a sovereign nation excluding the private sector. The other category of country risk is the transfer risk. Transfer risk is the risk originated by the private sector and it consists of the inability of firms and individuals to meet their obligations as a result of government actions. Transfer risk is not involved in the case of sovereign debt crises because this type is affiliated to sovereign risk. According to Canuto et al. (2004), the sovereign risk is really close to the country risk because a credit event of the sovereign debt affects the external private debt, causing transfer risk and country risk.

The sovereign debt crises are not isolated from the financial crises described above. In particular, sovereign debt crises constitute a fraction of debt crises. The only difference is that debt crises include the whole amount of credit which exists in an economy. That is debt crises include the private debt and the public debt of an economy. In this section more emphasis will be given in the sovereign debt and sovereign defaults.

History

Sovereign debt crises and sovereign defaults have appeared numerous times in history. According to Reinhart et al. (2003), France has declared bankruptcy 8 times from 1500 to 1800 and Spain 13 times from 1500 to 1900. According to Tomz and

Wright (2007), 250 sovereign defaults have happened by 106 countries from 1820 to 2004. The following table from Reinhart et al. (2003) gives us significant information about the history of sovereign defaults.

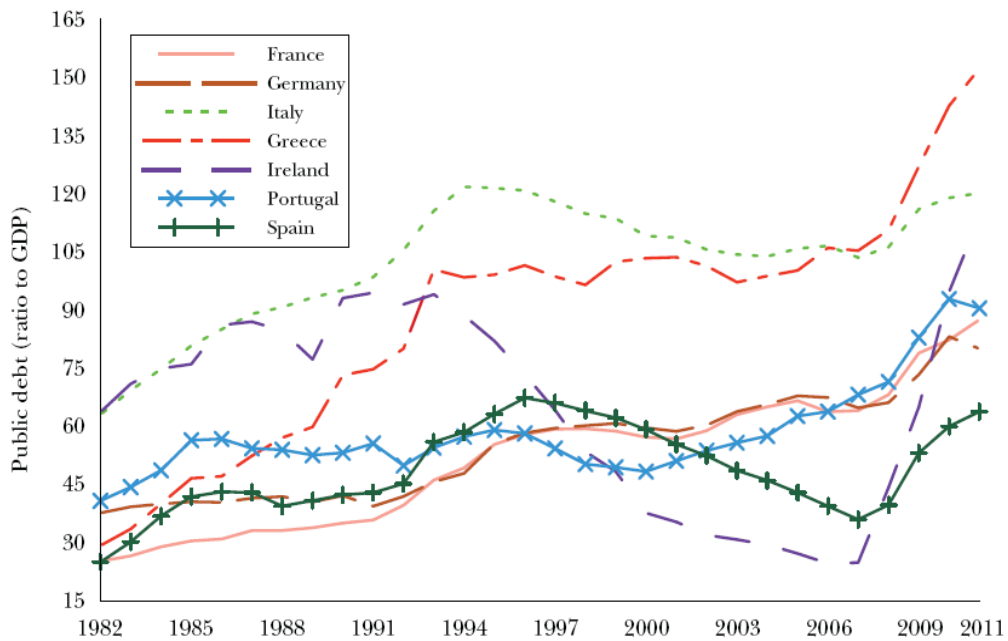
Table B.3. An Early History of External Debt Defaults

	1501-1800		1801-1900 ^a		Total defaults
	number of defaults	years of default	number of defaults	years of default	
Spain	6	1557, 1575, 1596	7	1820, 1831, 1834, 1851	13
		1607, 1627, 1647		1867, 1872, 1882	
France	8	1558, 1624, 1648, 1661	n.a.		8 ^b
		1701, 1715, 1770, 1788			
Portugal	1	1560	5	1837, 1841, 1845	6
				1852, 1890	
Germany	1	1683	5	1807, 1812, 1813	6
				1814, 1850	
Austria	n.a.	n.a.	5	1802, 1805 1811	5
				1816, 1868	
Greece	n.a.	n.a.	4	1826, 1843, 1860, 1893	4
Bulgaria	n.a.	n.a.	2	1886, 1891	2
Holland	n.a.	n.a.	1	1814	1
Russia	n.a.	n.a.	1	1839	1
<i>Total</i>	<i>8</i>		<i>33</i>		<i>49</i>

Source: Reinhart et al. (2003)

The vast majority of countries, even the more advanced ones, have experienced at least one default in their history. However, the majority of the developed countries have not experienced a default in their recent history, in stark contrast with the developing ones which are prone to this phenomenon. Many sovereign defaults in developing countries happened during the 1980s. A more recent default episode is the one of the Russian public debt in 1998. Moreover, the Eurozone faced a strong problem concerning sovereign debt during the period 2009-2012. Defaults also reveal a persistence effect because they occur more than once in a short time span. Argentina constitutes a recent example because it defaulted again in 2014 after its default in 2001. An additional fact is that sovereign crises are not constrained in one country but they spread to other countries. The most recent paradigm here is the one of the Eurozone crisis. The next graph presents the ratio of public debt to GDP for many countries of the Eurozone.

Figure B.11. The Evolution of Public Debt, 1982-2011



Source: Lane (2012)

Differences between private debt and government debt

There are great differences between private debt and government debt. Sovereign debt is thought as the safest investment because government bonds are characterized by little probability of default and their payoffs are almost certain. For example, government bond purchasers know the cash flows of government bonds derived by the principal of the bonds, their coupon, and the timeline of the pay offs. On the other hand private credit is not deemed so safe because a company may declare bankruptcy without covering the debtors. Countries usually avoid bankruptcy because they are afraid of future consequences in case they need international funds.

However, sometimes countries do not serve their debts either due to the fact that they are unable or because they are unwilling to do so. A fact that eases this phenomenon is the mild legislation of the government bonds, whereas private credit is subject to strict legislation. A default event cannot be defined precisely because it varies from the complete default to a small haircut. However, according to Aguiar and Amador (2013), a default can be defined as “the failure to make the specific payment at the required date”.

Empirical Literature

Sovereign defaults usually happen when an economy is in recession instead of expansion. According to a prolonged study of Tomz and Wright (2007), defaults happen when output is below its long-term trend, but many defaults have happened in cases where the GDP was significantly above this trend. Reinhart and Rogoff (2009) reveal that sovereign debt crises are closely related to financial crises mainly because governments support the fragile financial system and thus the fiscal situation of the country is exacerbated. This can be better understood if we pay attention to the fact that banks retain government bonds as their assets. Thus a potential sovereign debt crisis deteriorates the banking stability.

Another point is that sovereign crises are followed by a haircut of debt. Based on Sturzenegger and Zettelmeyer (2008), sovereign defaults from the 1990s to 2000s were accompanied by bond restructuring programs whose investors loss ranged from 13%, in the case of Uruguay (2003), to 73% in Argentina (2005). The majority of the examined cases belonged to the range of 25% to 35%.

Sovereign defaults are also linked with prolonged periods of negotiation. According to a study of Benjamin and Wright (2008), bond renegotiations are really lengthy. In their 26 year survey they found that debt restructuring lasted approximately 8 years and there is a positive correlation between the negotiation time and the loss. Furthermore, the larger the output loss is the lengthier the negotiation becomes and it usually ends when the GDP pathway coincides with its long-term trend. They also concluded that restructuring stops by increasing public debt to GDP ratio by 5%.

As far as government bond spreads are concerned, Broner et al. (2011) have made a significant contribution. They relied on emerging countries bonds and that of the USA for a twenty year period (1990-2009). They found that spreads rise during crises and mostly concerning government bonds of short-term maturity or medium-term maturity. The yield curve adopts a different shape than the ordinary one. The governments of those countries prefer not to issue long-term bonds because spreads are rising and thus lending is more costly.

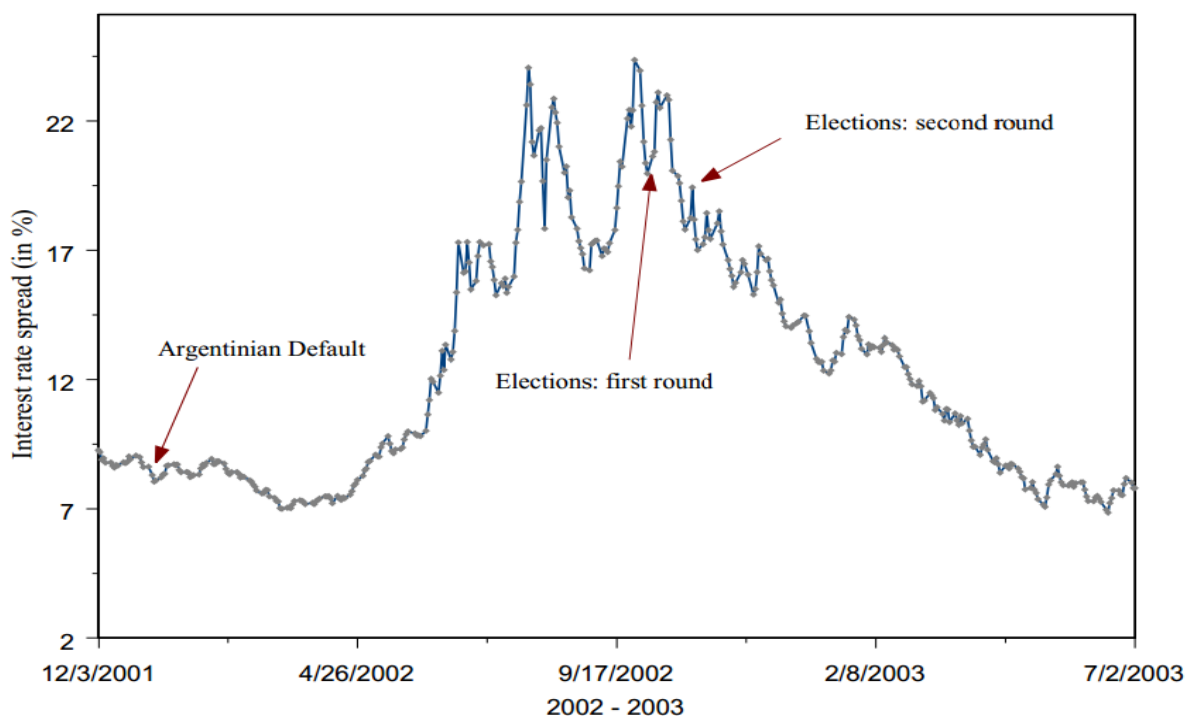
Studies have shown that development is grounded on reducing public debt and enhancing the foreign assets instead of accumulating sovereign debt. Moreover,

Reinhart et al. (2012) revealed that high public debt constitutes a burden for the growth of an economy. In particular, when the ratio of public debt to GDP is greater than 90%, the growth rate is reduced, leading to output loss.

Which are the reasons for sovereign debt crises and defaults?

According to Correa and Sapriza (2014), a first reason due to which countries face sovereign crises is political risk. According to Cuadra and Sapriza (2008), increased levels of political unrest and political instability are positively correlated to sovereign crises and sovereign defaults. Typically, economies characterized by political risk are more likely to declare default and thus to finance them would be more costly. There is strong correlation between the sovereign spreads and political uncertainty, which is more usual in emerging economies than in developed ones.

Figure B.12. Elections and sovereign bond spread in Brazil



Source: Hatchondo et al. (2009)

The figure above is taken by Hatchondo et al. (2009) and it presents the interest rate spreads in Brazil one year before and one year after the elections of 2002. During that period there was intense disagreement about the existing country's debt while debt

repudiation was really probable. The figure reveals that sovereign debt crises are sensitive to political uncertainty.

Apart from this, global problems may increase the lending rate of a country and thus produce a sovereign debt crisis. Arora and Cerisola (2001) have shown that the cost of lending in emerging markets is affected by the monetary policy in the USA. The capital inflows in emerging economies during the last decades decreased the local interest rates but they became more sensitive to sudden stop crises. Using the difference between sovereign bonds and USA government bonds interest rates of the same maturity, they estimated the country's risk. They found that the two interest rates used to move in the same way and the monetary policy in the USA affected the funding cost of emerging markets. According to Uribe and Yue (2006), an upturn in the USA interest rates decreased countries spreads, but then they rose significantly higher.

Sovereign defaults also happen more frequently when the economy is in recession and thus its output is reduced. This is mainly because a government cannot receive substantial funding during the recessions. This is verified by Tomz and Wright (2007) because 62% of the sovereign defaults of the last 2 centuries occurred when GDP was below the growth trend. Moreover, problems with trade may produce sovereign debt crises. Based on Mendoza (1995), shocks in trade persist and emerging markets suffer more from problems in international trade. Those issues are accompanied by severe fluctuations in the real exchange rate which makes sovereign debt more vulnerable. Finally, according to Sturzenegger and Zettelmeyer (2006), wars reduce the GDP and make economies more vulnerable.

The reasons above are affiliated with real economy, but monetary reasons also play a key role in sovereign debt crises. For example, in the case that the sovereign debt is issued in foreign currency, and the local currency is devaluated, then the pay off of the existing debt is more difficult. However, this problem is less severe if a great portion of government revenues comes from traded commodities. The sovereign debt crises are also caused by banking crises. This analysis follows in greater extension in the next section.

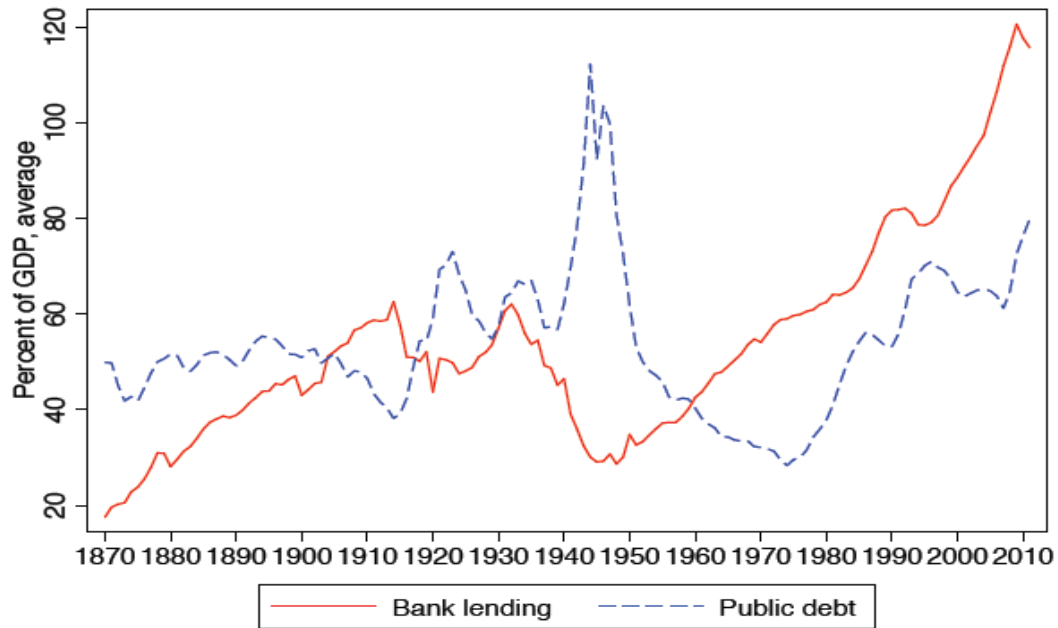
B. 3. Sovereign Debt crises and Banking Crises

In the past, researchers used to have a myopic view of the crises and they preferred to focus on each type of crisis alone. But this analysis lacks the opportunity to reveal the interaction between the sovereign debt and the banking system. The examination of the relation between the sovereign debt crises and banking crises started during the last decades and it has shown great results. Before analyzing the interaction between the two sides, we can understand the evolution of sovereign debt and private debt by Jorda, Schularick and Taylor. Relying on a time span close to 140 years they draw interesting conclusions, and they try to point out that there is close relation between sovereign debt and banking debt.

History

The following figure is taken from Jorda et al. (2014) and we can observe that in general the pathway of private lending is related to public debt. A distinct period is that of WWII when the public debt soared and exceeded 100% in many countries. In the case of countries which were deeply involved in WWII, such as Germany, Japan and the UK, this ratio exceeded 200%. From the following figure we can also verify the results of Schularick and Taylor (2012) about private credit in the two financial eras. The first one is marked by an almost stable amount of credit as a ratio to GDP whereas the second one is characterized by credit boom. The Bretton Woods period was characterized by reduced ratio of public debt to GDP. However, this ratio continued to increase since the collapse of Bretton Woods to the 1990s. On the other hand, private credit was limited before WWII. It ranged between 40% and 50% and it dropped during the 1929 depression, in contrast to the rising of public debt during WWII. Since the 1950s, private debt has risen; it surpassed the pre-WWII level and exceeded 100%.

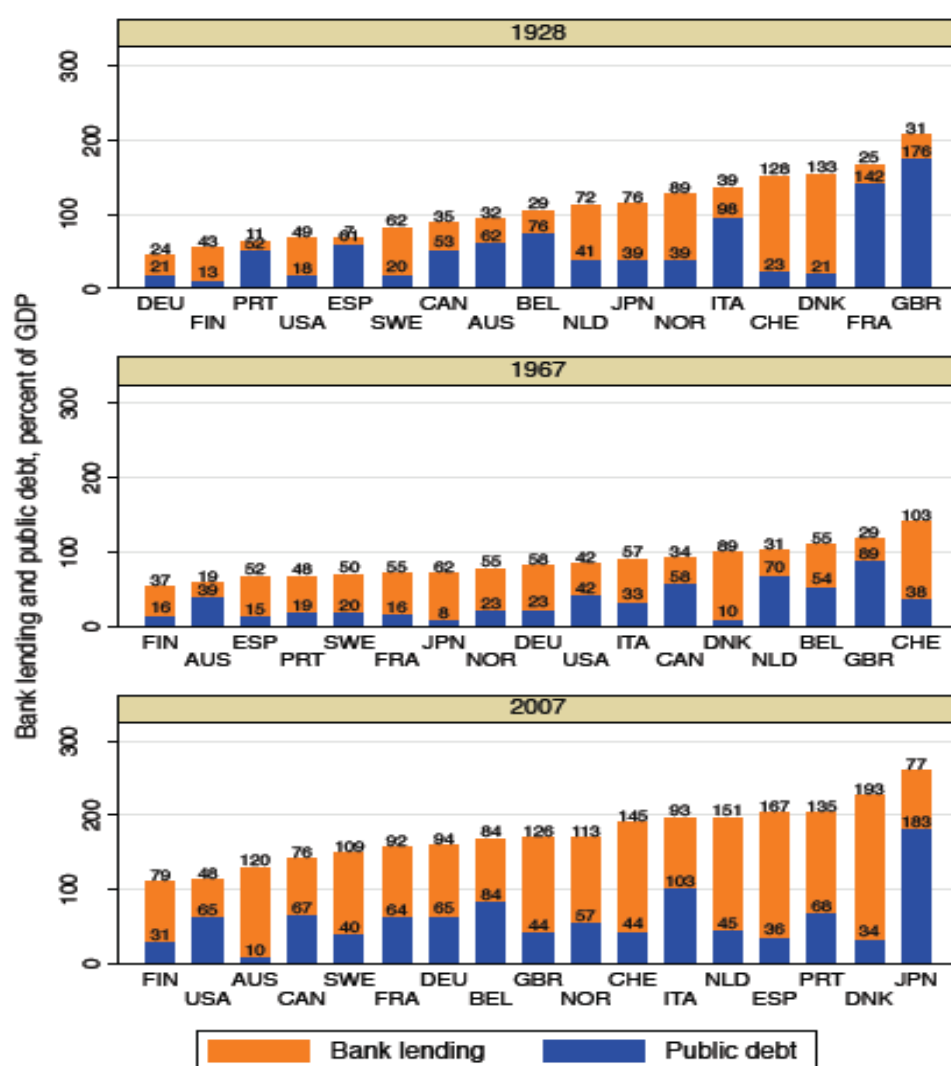
Figure B.13. Public debt and private bank credit



Source: Jorda et al. (2014)

They have also allocated the total debt per country and split it in public debt and private credit. The following graphs depict public debt and private debt as a ratio to GDP for each country for three distinct time periods. It is obvious that, apart from the dissimilarities among countries, public debt was shrinking while the bank credit was increasing. The ratio of public debt to GDP in the first year was approximately the same as the one in 2007. However, the ratio of private lending almost doubled through this period. The ratio of public debt to private debt is decreasing because it started from 1:1 and it reached 1:2 at the onset of the current financial crisis. Thus, the upturn of the total debt took place due to the accumulation of bank lending.

Figure B.14. Relative sizes of private and public balance sheet sizes across countries



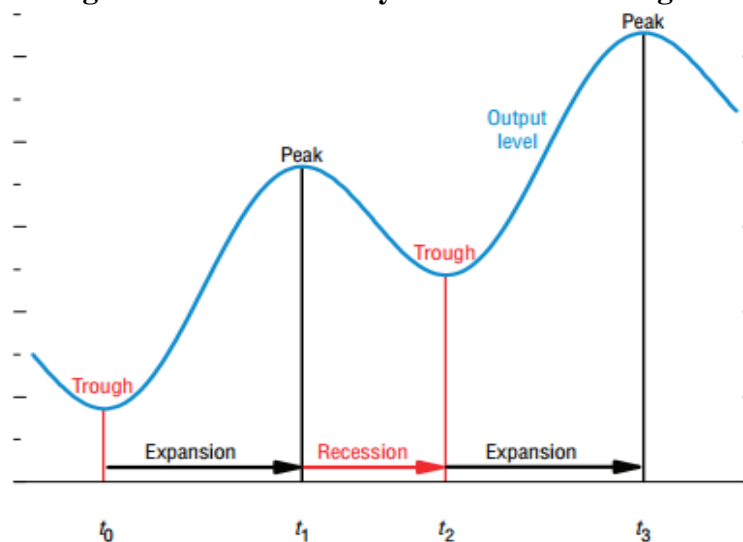
Source: Jorda et al. (2014)

Typically financial instability is produced by the private debt and this is verified by the current financial crisis. Great paradigms constitute the UK, Denmark, and Spain where the ratio of private credit to GDP exceeded 70%, whereas in Ireland this ratio reached 100% just five years before the crisis. The situation in Scandinavia and Japan during the previous century is not different because those financial crises were also a product of excessive credit. The economic crisis of 1893 in the USA was one of the worst financial crises in the history of this country and it was also produced by the sharp increase of mortgage lending. From 1883 to 1893 banks in the USA used to offer great amounts of loans, leading to a credit boom.

In the case of Eurozone, the banking sector caused problems in public debt, mostly due to bailout. This happened mainly in Ireland and Spain. Before the recent financial crisis the public debt of Spain was less than 40% as a ratio to its output. In 2012, this percentage doubled and reached 90% because real estate markets lead to a banking crisis and in turn to sovereign debt crisis. In Ireland, the situation was more or less the same. However, the case of Greece followed an opposite direction where the public debt produced problems in the banking sector.

Empirical Literature

Figure B.15. Business Cycle Peaks and Troughs



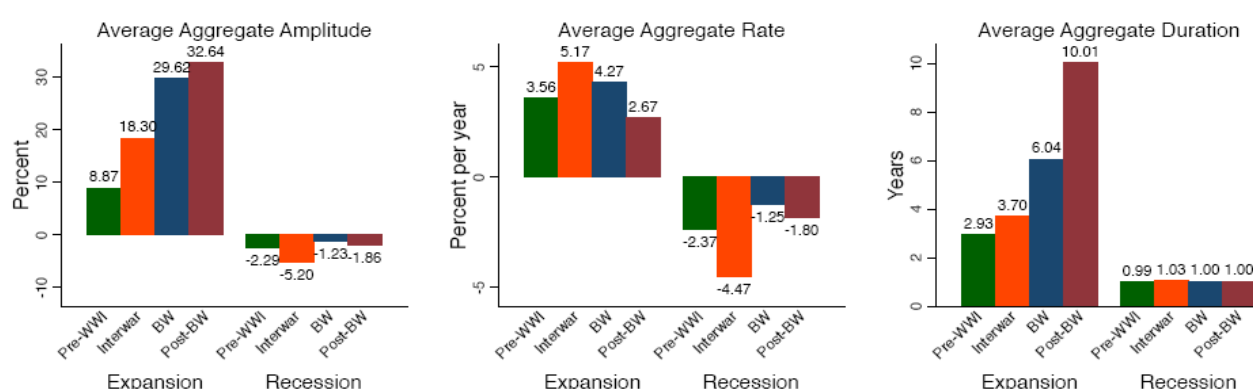
Source: Kannan et al. (2009)

The diagram above will be valuable in order to understand what Schularick, Taylor, and Jorda concluded on. It presents the fundamental parts of a business cycle, namely recession (from the peak to the next trough), recovery (from the trough to the previous peak) and expansion (from the moment when the previous peak is surpassed till the next peak). Moreover, it is important that the following terms be explained.

- **Amplitude:** Amplitude is defined as the difference between the peak of a business cycle and the trough.
- **Duration:** Duration is the time span between two turning points.
- **Rate:** Rate is defined as the ratio of amplitude to duration.

The first conclusion was that expansions are growing in duration. In particular, expansions before the First World War lasted for almost 3 years, and then gradually increased to 6 years during the Bretton Woods agreement, while expansions during the last financial era lasted approximately 10 years. For this reason, the shrinking of GDP per capita is getting more and more obvious in comparison with the past. Moreover, recessions typically last for 1 year except for the period between the two world wars which were marked by harsher recessions. The following graphs reveal the percentage change of the real GDP in recession and in expansion.

Figure B.16. Real GDP per capita Over the Business Cycle



Source: Jorda et al. (2014)

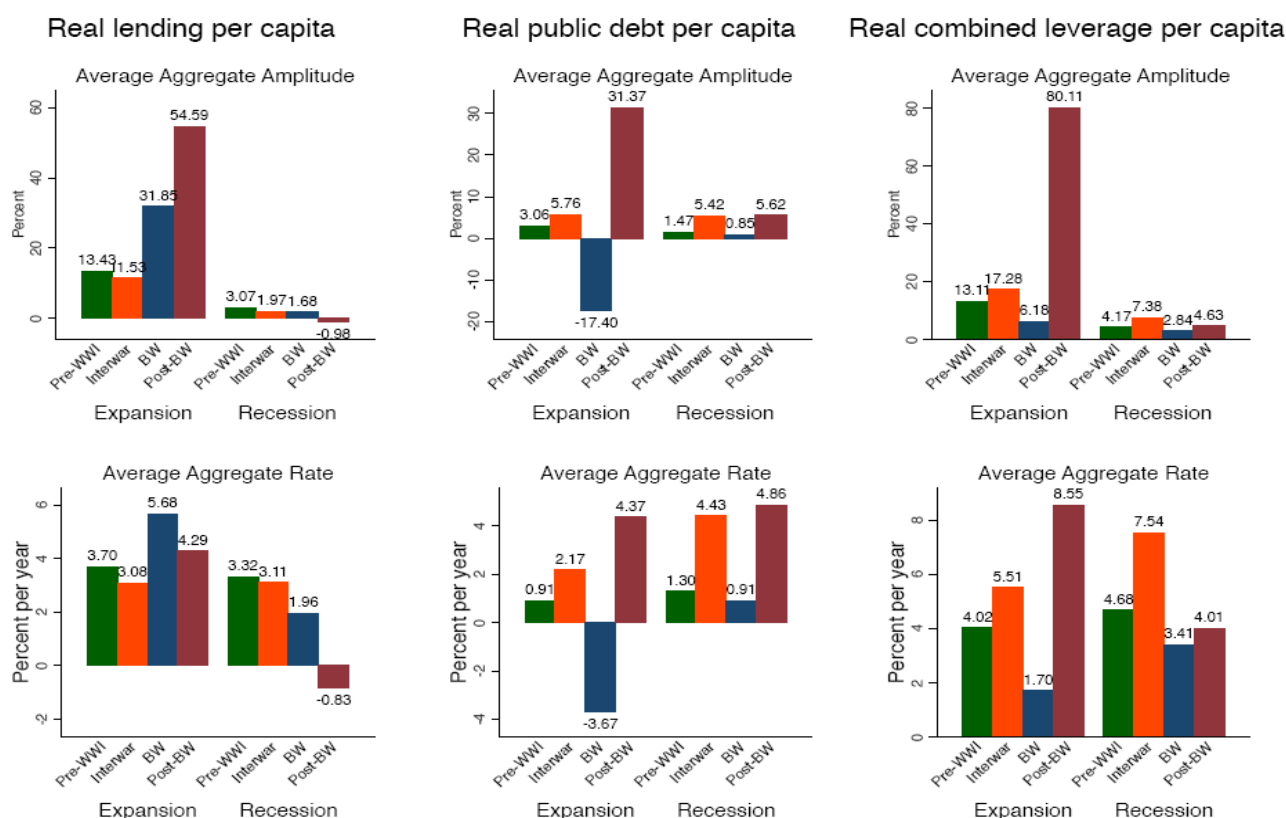
The real GDP rate of growth per year in the expansion has diminished as from 3.5% before the WWI it reached a maximum of 5.2% between the two wars and then it started to decline. During the Bretton Woods agreement, it accounted for 4.3% per annum and in the last era it was 2.7%. Thus, the prolonged expansion periods are not really valuable because they are not accompanied by high growth rate.

Private credit is procyclical because it tends to grow more rapidly during the expansion of the economy whereas it shrinks in recessions. On the other hand, public debt follows a counter cyclical process because it is more accumulated during recessions. It is interesting to remark that during the Bretton Woods era public debt was reduced in both sides of the business cycle because countries enforced restoration programs and strict banking regulation.

Lastly, the total debt (private and public) has increased during the last financial period. During this period the public debt has been slightly elevated while the private credit reached a high growth rate. Thus, total debt was increasing at a rate of 8.5%

during the expansion period of the business cycle and 4% during the recessions. So, business cycles are marked by the presence of more and more credit.

Figure B.17. Private and Public Debt Over the Business Cycle: Amplitude and Rate



Source: Jorda et al. (2014)

Jorda et al. (2014) examined if there are dissimilarities between business cycles related to financial crisis recessions and normal recessions. According to them, a recession is defined as financial if it is bonded with a financial crisis which has begun 2 years before or after the recession. They used a sample of 269 recessions, 63 of which are financial. The financial recessions were more frequent before WWII than after WWII. This is because before WWII, 1 out of 3 recessions was a financial crisis, whereas after WWII this frequency fell to 1 out of 5.

An interesting result is that private credit growth is much higher before financial recessions than before normal recessions, no matter if the examined era is before WWII or after WWII. The financial crises are introduced by expanded private credit which may be twice as much as the one of normal recessions.

As far as public debt is concerned, the relative ratio decreases before financial and non-financial recessions. This reduction was 0.3% annually in the case of financial crises before WWII and 1% in the case of normal recessions at the same period. During the post WWII era, this difference has become wider. In particular, during the last decades, public debt has been reduced in percentage, matching cases of normal crises, but has reached 0.4% prior to financial crises. Thus, in general, there are no great differences in public debt when examining the financial periods or the type of crises, which implies that financial instability typically derives from private debt and not from the public debt.

Jorda, Schularick, and Taylor examined how the recovery pathway of the economy is affected by the amount of credit. They broke down their survey in three parts. In the first part they focused on the recovery pathway of an economy entering a crisis with high private debt. In the second they examined the pathway with high public debt and finally with both private and public debt.

Recession with expanded private debt

First, they examined the effect of excessive private credit in the recession and the recovery of an economy. In all of the following graphs the blue line presents the pathway of the economy in normal crisis and the red one depicts the financial crisis. The shaded area presents a 95% confidence interval. The analysis is divided into two periods where the first one covers the whole period from 1870 to 2011 while the second one focuses only on the post WWII era.

Figure B.18. Normal Recessions and Financial Crisis Recessions, 1870-2011

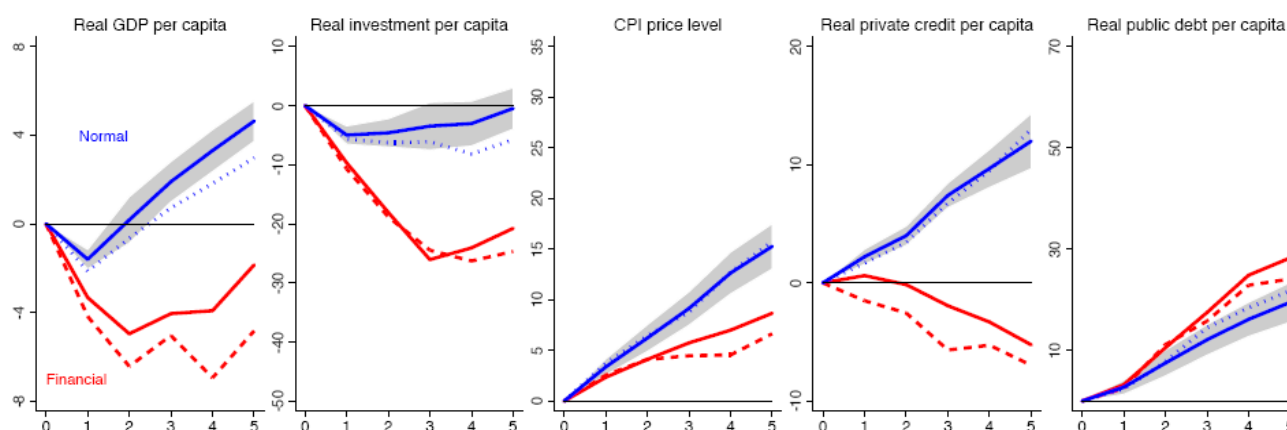
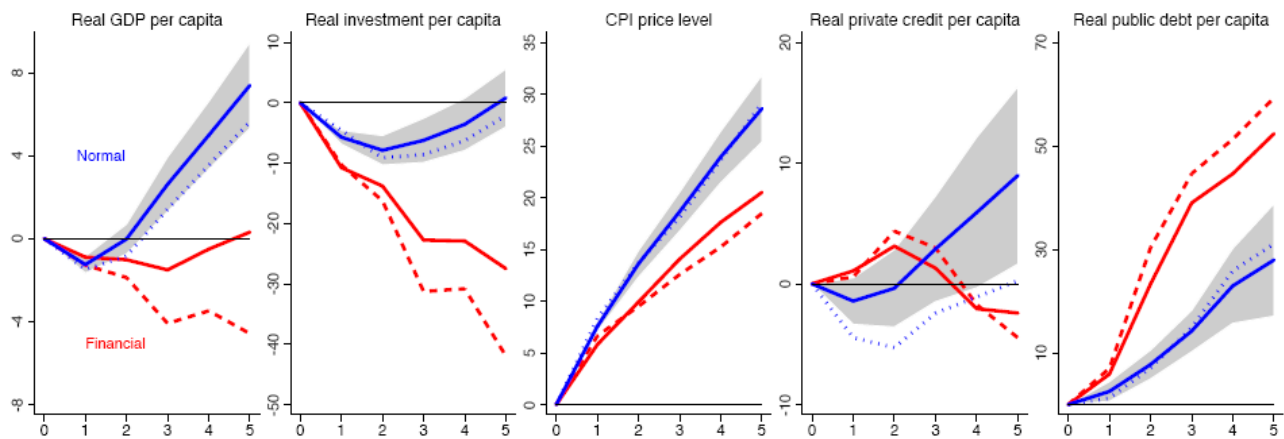


Figure B.19. Normal Recessions and Financial Crisis Recessions, 1946-2011



Source: Jorda et al. (2014)

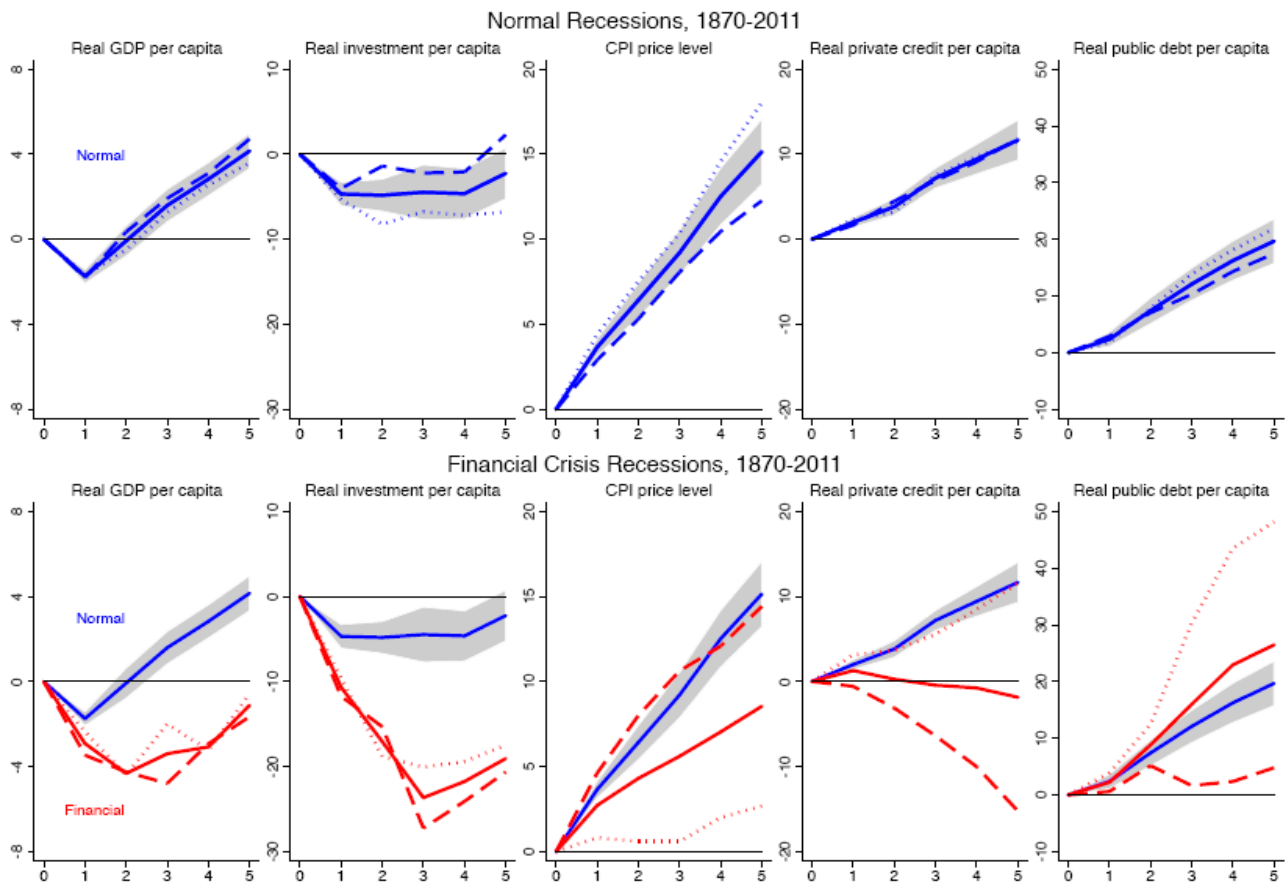
According to the graphs, when an economy faces a crisis with elevated private debt the type of recession, whether financial or non-financial, constitutes a significant difference. The latter case is marked by a GDP drop up to 2%, it then reaches the previous peak the next year and then it continues to higher levels. On the other hand, output loss in financial recessions lasts for two years and its drop may reach 5%. Typically a time span of five years is necessary in order for the GDP to surpass the erstwhile peak. The recovery pathway worsens if the financial crises are accompanied with credit overhang. The recession is followed by a great drop in real investments, reaching almost 30%, and the inflation rate is constrained. Another great difference between recession pathways is credit. Credit volume is not influenced by non-financial recessions but it crunches in the case of financial crisis. Public debt increases at a higher rate in financial recessions than in non-financial ones. Thus, the financial recessions are harsher and recovery needs more time.

Recessions with expanded public debt

Jorda et al. (2014) also examined if the level of public debt influences recessions and recoveries. Their results are depicted in the following graphs. Again the blue solid line represents the pathway of the economy under normal recessions while the red one represents financial crises. The shaded area depicts the 95% confidence interval; the dotted line shows the debt with a standard deviation below the mean and the dashed

line the standard deviation above the mean. They first depict the scenario of normal recessions and then they depict both normal and financial recessions.

Figure B.20. Recessions with expanded public debt



Source: Jorda et al. (2014)

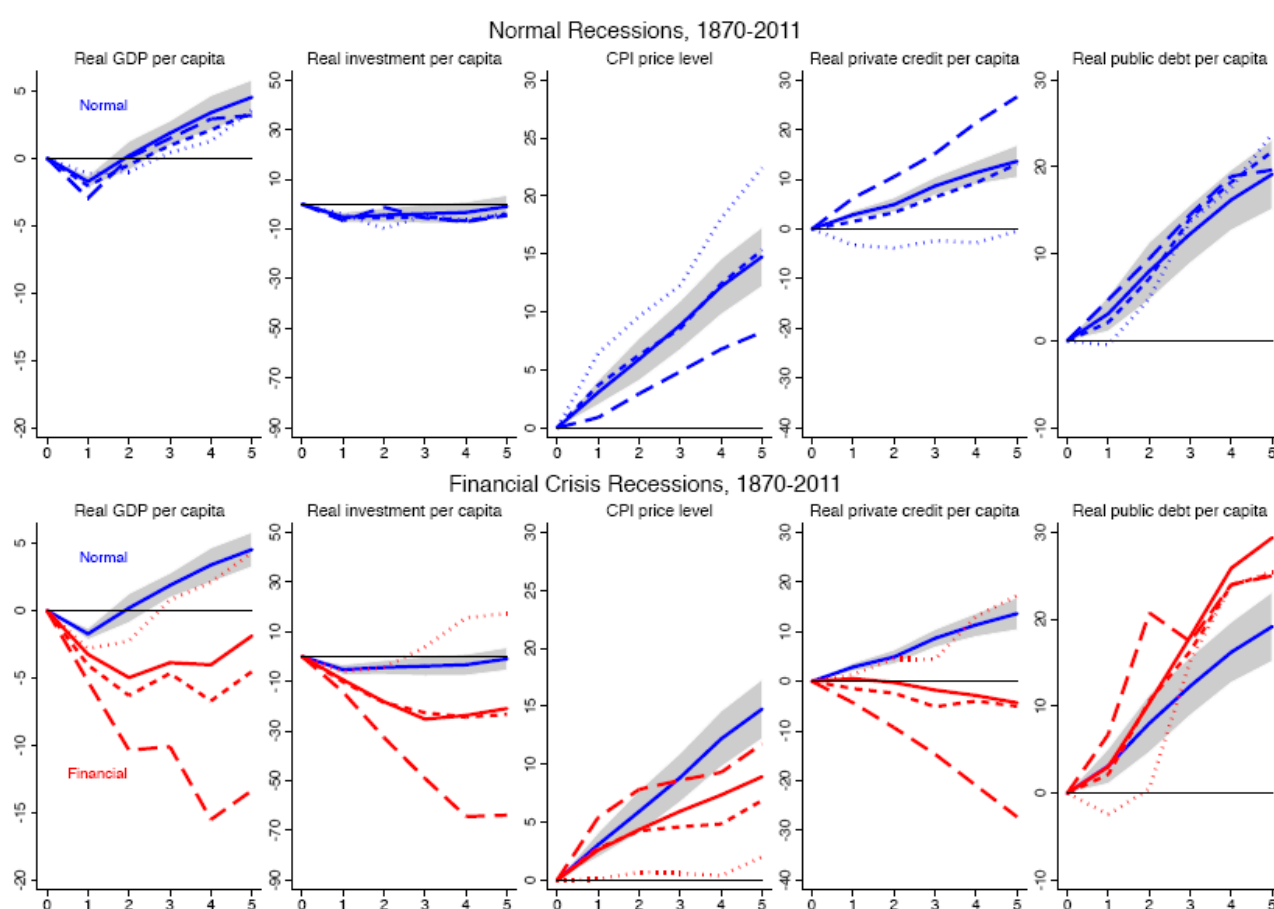
As far as the output pathway is concerned, the amount of public credit does not affect the economy in non-financial crises. The GDP path will follow almost the same trajectory regardless if the public debt is high or low. This also holds for the real GDP per capita in financial crises. However, the rest macroeconomic variables are significantly influenced. In case that the economy faces a financial recession with high debt, the inflation rate rises and bank lending decreases. The rate of accumulation of debt is the same for the first years of the recession no matter the initial level of the public debt.

The height of public debt slightly influences the economy's pathway except in the case of recession. However, it influences lending greatly. Moreover, when debt is relatively low, fiscal policies are used in order for financial crises to be mitigated, which is in stark contrast with the cases of high public debt where fiscal policies cannot be enforced.

Recessions with expanded private and public debt

Finally, a lot of attention was given on the coexistence of high private debt and high public debt. Again they examined the recovery pathway in the case of normal recessions and financial recessions under the assumption that the economy faces both high public and private debt. The blue solid line presents the pathway under normal recessions and the red one under financial recessions. The shaded area presents the 95% confidence interval.

Figure B.21. Recessions with expanded private debt and public debt



Source: Jorda et al. (2014)

Focusing on the results stemming from normal recessions, we understand that there are no great differences between this case and the previous one. The pathway for the majority of parameters is almost the same whereas dissimilarities can be found in lending and inflation rate. In the case of financial crises, the coexistence of escalated private debt and public debt may be a real burden for an economy. The recovery pathway is impeded and more years are needed in order to reach the previous peak. A time period of five years does not seem to be enough to reach the erstwhile peak. Moreover, investments collapse and bank lending is scant which both deteriorate the situation. Furthermore, high public debt constitutes an obstacle for the policy makers to enforce fiscal policy in order to avoid the current problems.

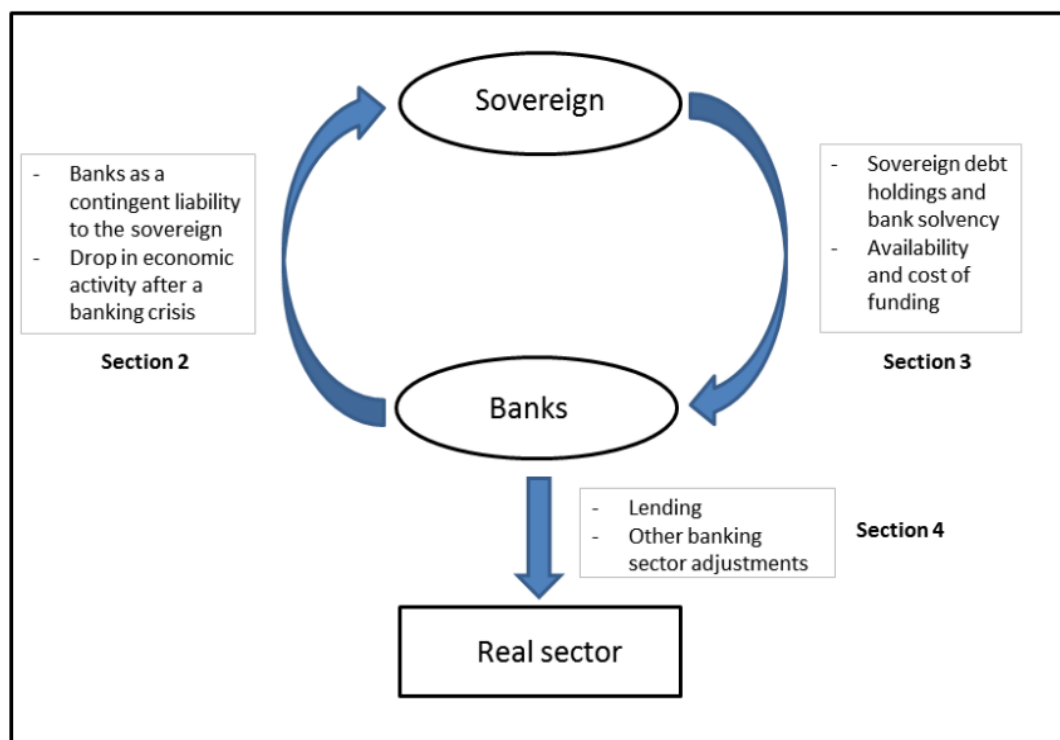
Based on a recent research of Laeven and Valencia (2012), 66 cases of sovereign debt crisis from 1970 to 2011 have been recorded, while 3 of them occurred between 2008 and 2011. Sovereign debt crises cause or are caused by financial crises either in the form of banking crises or in the form of currency crises. Typically banking crises precede sovereign debt crises and currency crises. This deduction comes from the fact that 16% of the banking crises started within three years of a currency crisis in the same country, whereas the opposite exists in 21% of the cases. As far as sovereign debt crises are concerned, 5% of banking crises were followed by sovereign debt crises and the opposite row accounts for only 1% of the banking crises. The linkage between the crises above was examined for a three year time span as a quite fair period for two crises to influence each other.

According to Reinhart and Rogoff (2011), not only banking crises typically precede sovereign debt crises but they can also be used for their prediction. The external debt, either private or public, increases before banking crises while public debt expands before sovereign crises. Moreover, before the outburst of sovereign debt and banking crises, debt is characterized by a short-term maturity.

The interaction between sovereign debt crises and banking crises

The twin crises may happen either due to the fact that the financial sector causes problems to the public sector or the other way around. This process is described by the following figure from Correa and Sapriza (2014) and it will be proven really helpful in order to understand the following analysis.

Figure B.22. Links between the sovereign, banks, and the real sector



Source: Correa and Sapriza (2014)

It is understood that banks influence the sovereign stability and sovereign debt harms banks. As a consequence, the real economy suffers because of the fact that banking system does not operate appropriately.

The first case which will be presented is the one when the banking sector produces sovereign debt crises. Next follows the opposite case where sovereign debt crises affect financial stability. Finally their dynamic interaction will be outlined.

Why do banking crises cause sovereign debt crises?

The role of the financial system is very important for the overall production of a country. A possible collapse of the banking system will produce significant output drop and thus the ratio of public debt to GDP will increase. This is a serious threat for the debt servicing procedure and it may give rise to a sovereign debt crisis. Apart from this, the sovereign debt crises are produced due to banking crises through an alternative way. Governments are not willing to let financial institutions to collapse. This is because a bank's default can cause a generalized banking crisis. This in turn will cause the depositors to worry, as well as lead to bank runs and decreased credit. Thus, governments offer financial support to financial institutions which face problems. However, this assistance deteriorates the fiscal situation and sovereign problems of the country. This happened in the Eurozone during the last financial crisis, when the banking crises caused higher public debts.

Following strictly the classification of Correa and Saprizza (2014), the transmission from banking crises to the sovereign debt crises happens in two ways.

The first one is based on the insurance that governments offer to financial institutions while the second one is related to the macroeconomic situation of the country. Governments provide guarantee to financial institutions through the following ways.

- Firstly, governments usually guarantee the operation of the banking system which makes governments carry high public debt. For instance, the support of the government of Ireland to its banking system during the last crisis made it prone to sovereign debt crisis because the spread premium increased immediately (Acharya et al. 2013).
- The next way is the bailout. Bailout deteriorates fiscal economics because the potential losses of the banking system weigh down society. The problematic financial institutions cannot be easily decomposed and thus government support is unavoidable. The most known measures in this case are governmental takeover of financial institutions and liquidity support.
- The third way is related to the balance sheet of the financial institutions and it can be found in Bolton and Jeanne (2011). According to the authors, the majority of public debt of emerging countries is carried by financial

institutions, mainly due to the fact that the financial sector in those countries is not advanced (Kumhof and Tanner 2005). In developed countries banks hold government bonds because this permits them to absorb liquidity using them as collateral in the repo market. When government interferes to support a financial institution the fiscal situation of this specific country deteriorates. Then government bond prices fall and thus the financial situation of the other banks worsens. This fact causes a sovereign crisis which may lead to default.

The other transmission path focuses on the macroeconomic situation behind the interaction of banking crises and financial crises. This can be further analyzed in subcategories.

- The first case links the banking crises and the sovereign debt crises with currency crises, a combination known as the triplet crises. When financial institutions are exposed to foreign exchange rate risk, a potential devaluation of the domestic currency may lead to excessive burden of government debt, making the bailout really dangerous for the sovereign debt.
- The second case is related to the output of the economy. As the banking crisis increases, financial institutions are more unwilling to lend funds and they ask more collateral. The problems of adverse selection and moral hazard increase and credit is limited. This means reduced output and decreased tax revenues. This problem is enhanced when the government budget is marked by automatic stabilizers. The automatic stabilizers are related to countercyclical policies where government budget is negative in recessions and positive in booms. Therefore, the borrowing needs of the government increase and produce sovereign debt crises.

The next table is taken from Balteanu and Erce (2014) and it presents the recent twin crises episodes which started in the banking sector.

Table B.4. Twin crises: Bank-to-Debt

Country	Bank crisis	Debt crisis	Source
Algeria	1990	1991	S&P and L&V
Argentina	1980	1982	S&P and L&V
Chile	1981	1983	S&P and L&V
Dominican Republic	2003	2005	S&P and L&V
Ecuador	1982	1982	S&P and L&V
Ecuador	1998	1999	S&P and L&V
Guinea	1985	1986	S&P and L&V
Indonesia	1997	1998	S&P and L&V
Kenya*	1992	1994	S&P and L&V
Mexico	1981	1982	S&P and L&V
Morocco	1980	1983	S&P and L&V
Philippines	1983	1983	S&P and L&V
Nigeria	1991	1992	S&P and L&V
Senegal	1988	1990	S&P and L&V
Uruguay	1981	1983	S&P and L&V
Uruguay	2002	2003	S&P and L&V
Venezuela, R.B.	1994	1995	S&P and L&V

Source: Balteanu and Erce (2014)

Why do sovereign debt crises cause banking crises?

Having described the transmission from the banking sector to the sovereign sector, it is necessary to describe the other way of interaction between them. Correa and Saprizza (2014) divide those causes in two categories. The first case contains the likelihood that public debt is held in the financial institutions' portfolio. The second one covers the likelihood when banks face higher funding costs due to sovereign crises.

- Financial institutions usually hold government bonds in their balance sheet. Government bonds are low-risk investments which provide profitability and liquidity. The sovereign debt crises reduce the value of the government bonds of a particular country and thus a potential liquidation of those assets will not bring the expected revenues. This problem becomes harsher in the case of

sovereign default. This happened in Greece when the debt restructure program made local banks to write off the government bonds from their balance sheet.

The next issue generated by sovereign debt crises is the higher financing rate that the financial institutions face when the sovereign debt is considerable. This can be broken down into three different subcategories.

- The first one concerns the collaterals. Banks provide credit typically accompanied by collateral, which constitutes a guarantee in case when borrowers cannot meet their obligations. In the majority of cases, government bonds constitute the less risky assets and thus banks deeply rely on those to provide credit. The problems arise when the sovereign crises reduce the market value of government bonds and thus collateral value drops. Then credit expansion is hampered.
- The other way is related to rating companies. Rating agencies provide credit grades to both countries and financial institutions. The downgrade of an economy is followed by the downgrade of banks which operate in it or they are exposed to its currency. This in turn, reduces the bank's equity and its ability to receive funding. The same holds for the case when sovereign debt crises increase the sovereign yields. This higher risk premium makes the funding cost of financial institutions higher. Then banks cannot face the refinancing risk which produces decreased profitability and potential banks default. This is the case of Northern Rock and Lehman Brothers which both defaulted at the beginning of the current crisis.
- The last issue in this category is government support. The financial institutions that enjoy government support have a benefit in comparison to the ones that do not. The former are able to draw funding with lower interest rates than the latter. This phenomenon is strengthened as the size of financial institutions increase and the "too-big-to-fail" banks have a comparative advantage in this domain. As a sovereign debt crisis deepens, the ability of government to provide support is reduced and thus the financing advantages vanish.

The first one from the following two tables presents the recent twin crises episodes which begun as sovereign debt crises and they affected the banking sector. The second one briefly presents the history of single and twin crises.

Table B.5. Twin crises: Debt-to-Bank

Country	Debt crisis	Bank crisis	Source
Albania	1991	1994	S&P and L&V
Argentina	1989	1989	S&P and L&V
Argentina	2001	2001	S&P and L&V
Bolivia	1986	1986	S&P and L&V
Brazil	1990	1990	S&P and L&V
Costa Rica	1981	1987	S&P and L&V
Cameroon	1985	1987	S&P and L&V
Ghana	1979	1982	S&P and L&V
Guinea*	1991	1993	S&P and L&V
Jordan	1989	1989	S&P and L&V
Macedonia	1992	1993	S&P and L&V
Niger*	1983	1983	S&P and L&V
Panama	1987	1988	S&P and L&V
Peru	1976	1983	S&P and L&V
Tanzania*	1984	1987	S&P and L&V
Turkey	1982	1982	S&P and L&V
Togo*	1988	1993	S&P and L&V
Russian Federation	1998	1998	S&P and L&V
Ukraine	1998	1998	S&P and L&V

Source: Balteanu and Erce (2014)

Table B.6. Crisis episodes 1975-2007, by type (number)

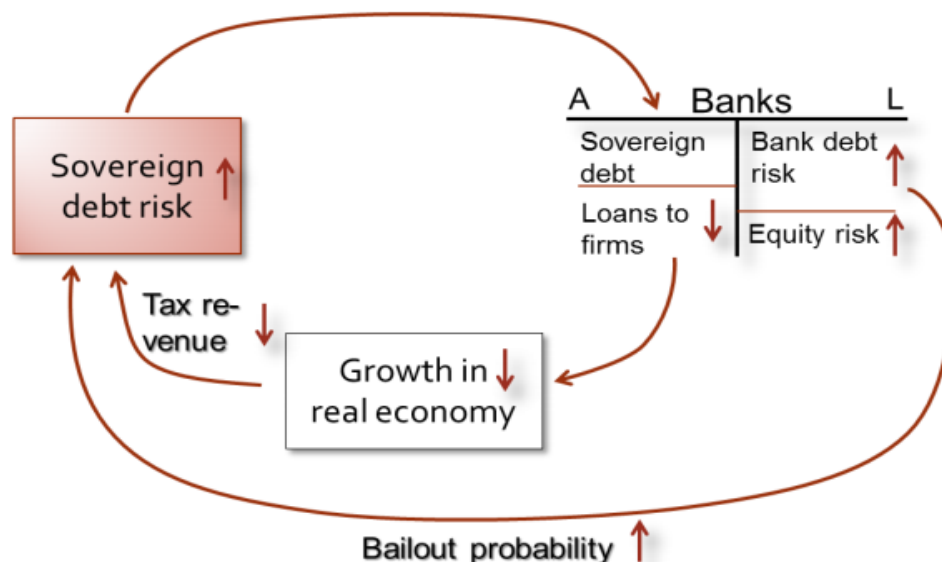
	1970s	1980s	1990s	2000s	Total
"Single" bank crises	3	17	55	2	77
"Single" debt crises	11	43	17	14	85
"Twin" crises	2	19	12	3	36
Twin bank-debt	0	9	6	2	17
Twin debt-bank	2	10	6	1	19
TOTAL	16	79	84	19	198
Total: bank crises	5	36	67	5	113
Total: debt crises	13	62	29	17	121

Source: Balteanu and Erce (2014)

The interaction between the two crises

The problem described above, either starting from the public sector or from the banking sector, constitutes a dynamic interaction because one problem leads to the other. The stability of the system is further decreased; a domino effect between two sides. This situation can be described as a “feedback loop” and it gradually produces further problems for the economy. Any loop deteriorates banking system and the real economy suffers from the paucity of funds. The following figure from Garicano (2013) describes the “diabolic loop” between the sovereign debt crises and the banking crises.

Figure B.23. Contagion due to diabolic loop - "twin crisis"



Source: Brunnermeier et al. (2011)

As the sovereign debt risk increases, the market value of government bonds decreases and this reduces the ability of banks to provide credit. This leads to smaller output, less tax revenues and further deterioration of the sovereign debt. As a consequence, banks will provide even less credit, increasing the sovereign risk more and more. Moreover, the increased equity risk and bank debt risk make a potential bailout more probable and sovereign risk rises. This in turn causes limited credit expansion and the circular phenomena of the feedback loop.

C. Empirical Part

The main attempt of the dissertation is to show that there was relation between the sovereign debt crises and banking crises in the Eurozone during the last financial crisis. In order to do that, I will try to compare a fact that reveals banking crisis with another which reveals sovereign debt crisis. The former is expressed by the non-performing loans (NPLs) of the financial institutions while the later will be the spread over the long-term government bond. Moreover, it will be shown that banking crises, and the NPLs in particular, can be an indicator for a forthcoming sovereign debt crisis.

C. 1. Non-Performing Loans

As it was mentioned in the first part of the dissertation, banking crises are characterized by different phenomena such as strong mergers and acquisitions of financial institutions, government support and takeover, liquidity needs of financial institutions and others. The majority of those cannot be treated numerically and the decision about whether there is a banking crisis or not is left to qualitative analysis.

However, NPLs constitute a measure which can reveal whether a bank faces problems or not. This is because, as problems with loans increase, the operation of the financial institution is in danger. The bank lacks the necessary funds to cover the depositors and its profitability is reduced. Financial institutions typically ask government support in order to cover the liquidity ratios and the capital required by the Basel committee and the depositors are also worried about the solvency of the financial institution. This fact leads to bank runs and to generalized banking crises as explained in the first section. Therefore, NPLs constitute a valuable measure in order for a researcher to examine how healthy the banking system is.

The non-performing loans constitute an extensive category in Banking Economics and a deeper examination is necessary. For some researchers NPLs are all the loans that are not served as they were expected to. This could be a strict definition which includes any type of delayed loans, even if they concerned a one-month installment. On the other hand, other researchers argue that restructured loans do not belong to the

category of NPLs. Thus, many researchers adopt a less strict approach to this issue. Those believe that this category must include the loans that are not served at all or at least they are not served for a prolonged period. In our analysis we will accept the definition provided by the Reuters Database below.

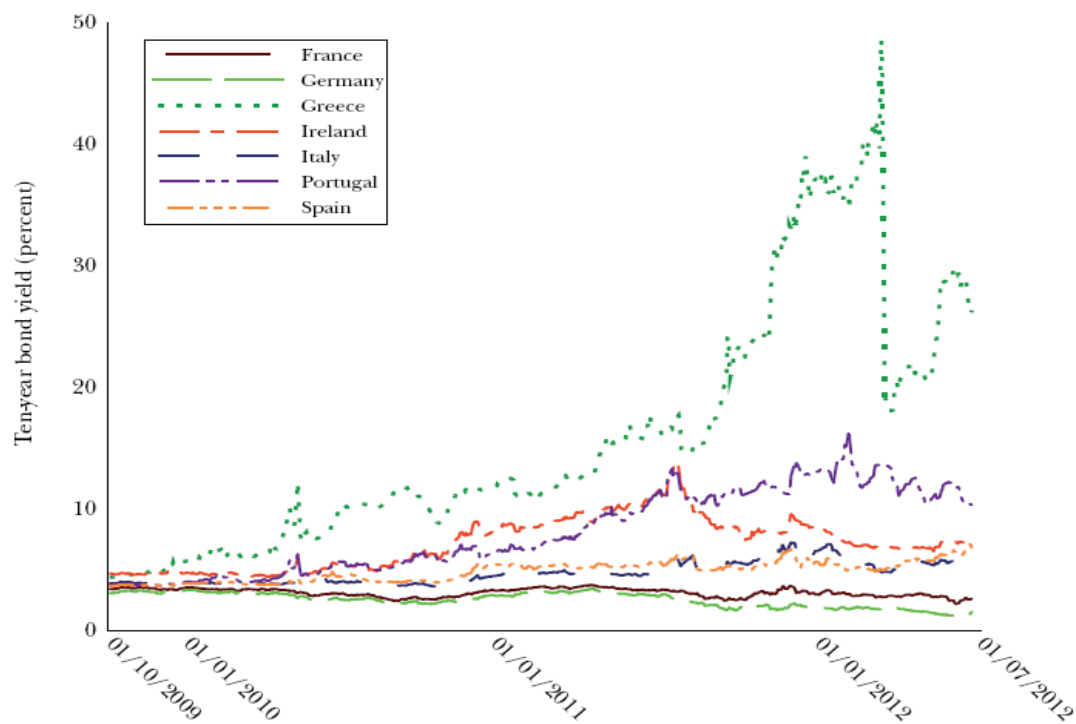
According to the database, data consisting of “bank nonperforming loans to total gross loans are the value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions). The loan amount recorded as nonperforming should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue”.

C. 2. The long-term government bonds

As it was previously analyzed, sovereign debt crises are crises related to public debt. They include problems of paying off the accumulated debt or problems in receiving new funds from the international markets in order to pay back the previous creditors and to finance current activities. As it was mentioned in the first part of the dissertation, difficulties in drawing funds leads to sudden stops which in turn cause severe output drop and increased unemployment.

The long-term government bonds constitute a good indicator which reveals the capability of an economy to absorb foreign capital. The higher interest rates contain a sense of unwillingness of foreign investors to lend the economy. The same also holds for private borrowers. The interest rates reflect the cost of lending and more dangerous borrowers are financed with a higher cost of capital. This is a trade-off between danger of the creditor and their expected return. As it is obvious, the creditors who are less trustworthy are financed with higher interest rates than the ones who can meet their obligations more easily.

Figure C.1. Yields on Ten-Year Sovereign Bonds (percent)



Source: Lane (2012)

The long term government bonds can show the untrustworthiness in financial markets clearer than the short-term government bonds. This is because the probability of a credit event is higher as borrowing is becoming more long-term. The investors understand that they are exposed to greater risk and they require higher rates. So, the analysis will be based on the long-term government bonds.

A more accurate indicator is the spread between the interest rates of a country and the risk-free rate. Risk-free rate is the interest rate that contains no risk and it reveals solely the investors preferences to lend their funds. It is impossible to link an asset with the risk free rate because all the assets are subject to some risk. The more usual approximations of the risk-free rate are those of the USA government bonds and recently the German government bonds. The difference between the interest rate of a borrower and the risk-free rate is the credit spread. Credit spread is defined by the following equation:

$$cs_i = r_i - r_f$$

where cs_i denotes the credit spread for country i , the second term denotes the interest rate of this country, and the last term is the risk-free interest rate.

C.3. Presentation of the approach and the model

The goal of the empirical part is to reveal that there was a close interaction between the sovereign debt crises and the banking crises during the recent European crisis. Thus it is necessary to compare variables which are sensitive to the public debt of the economy and variables which express the banking system. As it was extensively discussed above, non-performing loans (NPLs) constitute a variable which encompasses the operation of the financial system and their increase constitutes a signal for the stability of the banking system. On the other hand, the 10 year government bond reveals how easily a country may receive funding. Specifically, we will use the sovereign credit spread for the 10 year government bond of each country. This is constructed easily as it derives from the difference between the market interest rate per country and the risk-free interest rate which exists in each time period. For our case, the risk-free asset is the 10 year government bond of Germany. This is a realistic hypothesis because Germany is generally thought as the safest economy in the Eurozone and one of the safest worldwide.

During the last financial crisis, the government bonds of Germany were preferred in contrast to the other Eurozone countries, a phenomenon known as “flight to quality”. This situation is characterized by the investors’ tendency to avoid risky securities with high expected return, and preference towards safer assets such as gold, the USA Treasury Bills, and other government bonds issued by countries which are thought as more solvent. The “flight to quality” in Eurozone was marked by the fall of sovereign yields in some countries and the rising of sovereign debt spreads in the economically weak countries. More precisely, capital migrated from the southern countries of the Euro area and moved to Germany and countries of similar economic situation. The following graphs are taken from Garicano (2013) and they reveal the “flight to safety” phenomenon.

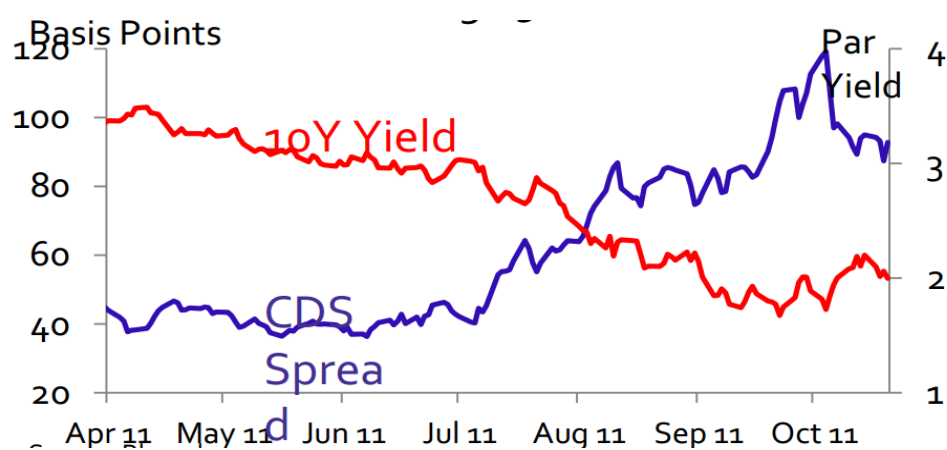
Figure C.2. Flight to Safety



Source: Garicano (2013)

The yield of the German 10 year government bond decreased from 3.3% per annum in April 2011 to 2% in October 2011. This means that the funding cost of Germany was reduced almost by half within less than one year.

Figure C.3. German 10 year Yield and 5 year CDS



Source: Garicano (2013)

The countries included in the empirical part are almost all the countries of the Eurozone, provided that they offer significant amount of data to conduct the experiment. Those countries are: Austria, Belgium, Finland, France, Greece, Ireland, Italy, Portugal, and Spain. The dissertation focuses on countries from the Eurozone instead of including additional economies because it will enable us to compare countries which belong to the same currency area. Based on this we are able to focus exclusively on the sovereign debt crisis and the banking crisis instead on paying attention to exchange rate issues. As it was mentioned in the first part, those crises sometimes take place at the same time, forming triplet crises. As we zoom in on the twin crises, it would be useful to hold the same currency for all the countries. This will reveal that the NPLs may constitute an indicator for a forthcoming sovereign debt crisis, without the impact of the exchange rate.

The Netherlands and Luxembourg have been excluded because their data do not cover the full range of the last years. Moreover, countries which recently became members of the union are also excluded because they adopted the common currency after the onset of the financial crisis and for this reason it would not be consistent to compare the NPLs under two different currencies. The countries which take part in the empirical part of the dissertation are those countries of the Eurozone which provide information about the NPLs from 2004 to 2012 without discontinuities and they belong to the currency area before 2004.

As it was stated above, the interest rate of government bonds does not suffice for our analysis. The estimation of country risk is based on the credit spread as Arora and Cerisola (2001) did. However, in this case the risk-free asset will be the German government bond instead of the USA bond. This calculation will give us the spread over the German government bond that will be used for the sovereign debt crisis.

The long-term government bond will be expressed by the 10 year government bond. This is a benchmark for the capital cost of a country and it covers the needs of long-term cost as mentioned in the previous section. This bond is available for almost any country, so it covers our needs for the research.

Annual observations of the 10 year government bonds have been collected and the estimation method will be the simple linear regression. The depended variable will be the spread over the government bond of Germany and the independed variable will be

the NPLs. Based on the literature, banking crises typically provoke sovereign debt crises whereas the opposite is extremely rare. However, we cannot argue that the opposite would be incorrect. For this reason, the correlation between the two variables will be also reported in order to have a more spherical approach.

Data sources:

Data about the non-performing loans and the 10 year government bond were taken by Reuters Datastream.

The estimation of the econometric model occurred through E-views. The diagrams and the correlation between the variables took place through Excel.

Econometric model

The formula of the linear regression model is the following:

$$Spread_t = c_0 + c_1 NPLs_t + e_t$$

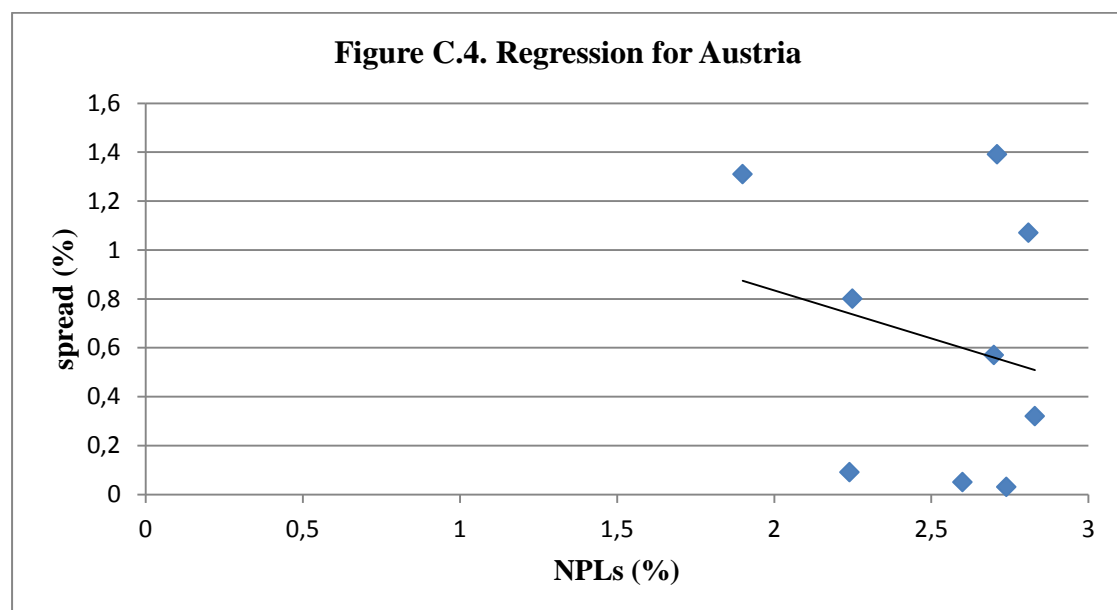
It is probable that the strict exogeneity does not hold in this model. Heteroskedasticity and Autocorrelation will not affect unbiasedness but the estimated standard errors will not be the real and t-statistics will not be valid. In order to be sure that the results will not be influenced by the potential correlation between errors, I will report the Newey-West HAC standard errors and t-statistics.

C.4. Results and Discussion

The NPLs will be compared with the government spread over the 10 year government bond of Germany in each country because we focus on the co-existence of those variables. Each country below is followed by one scatter plot and one line graph. The scatter plot is the appropriate graph in order to understand the regression method whereas the line graph will enable us to observe the historical movement of those variables. The standard errors are computed based on the Newey-West method to correct possible Heteroskedasticity and Autocorrelation of the standard errors.

Results by country

Austria: The scatter plot enables us to understand the relation between the spread and the NPLs.



Source: Author's calculations

The estimated slope is negative which causes worry concerning the interaction of the NPLs and the spread. However, both the estimated coefficients are not statistically significant, so we cannot reject the likelihood that the real value of the slope is zero. The R squared is extremely low which means that NPLs in Austria cannot explain the

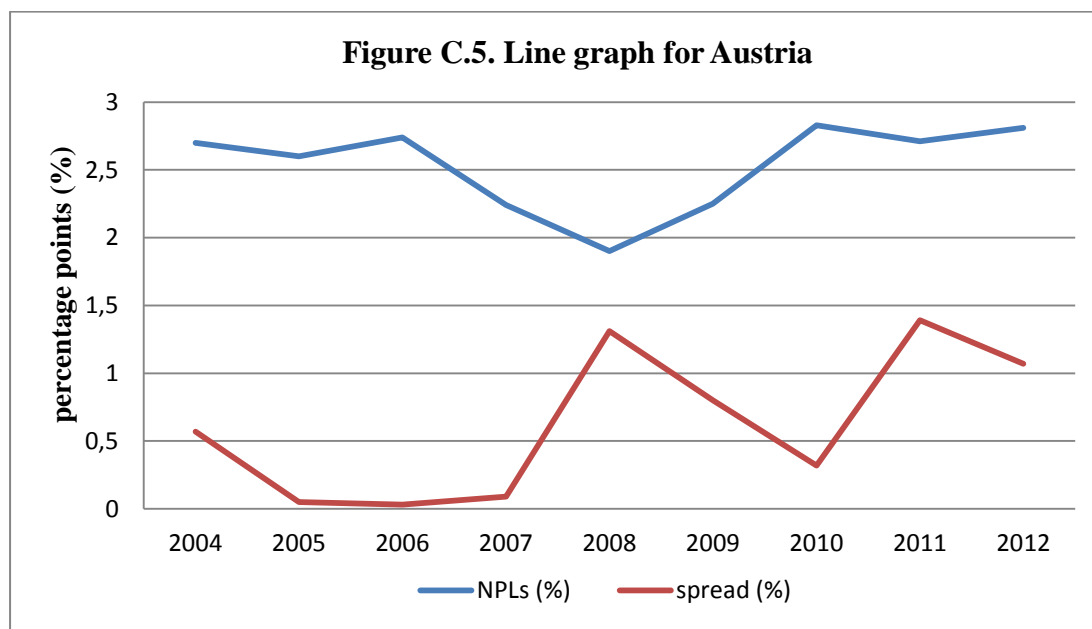
higher funding cost in the country. In this case, NPLs do not suffice to explain the cost of funding and other omitted variables may better explain the spread.

Table C.1. Results for Austria

Austria	Estimated value	P-value
Intercept	1.619638	0.1887
Slope	-0.392745	0.4402
R squared	0.055010	
Correlation	-0.234540	

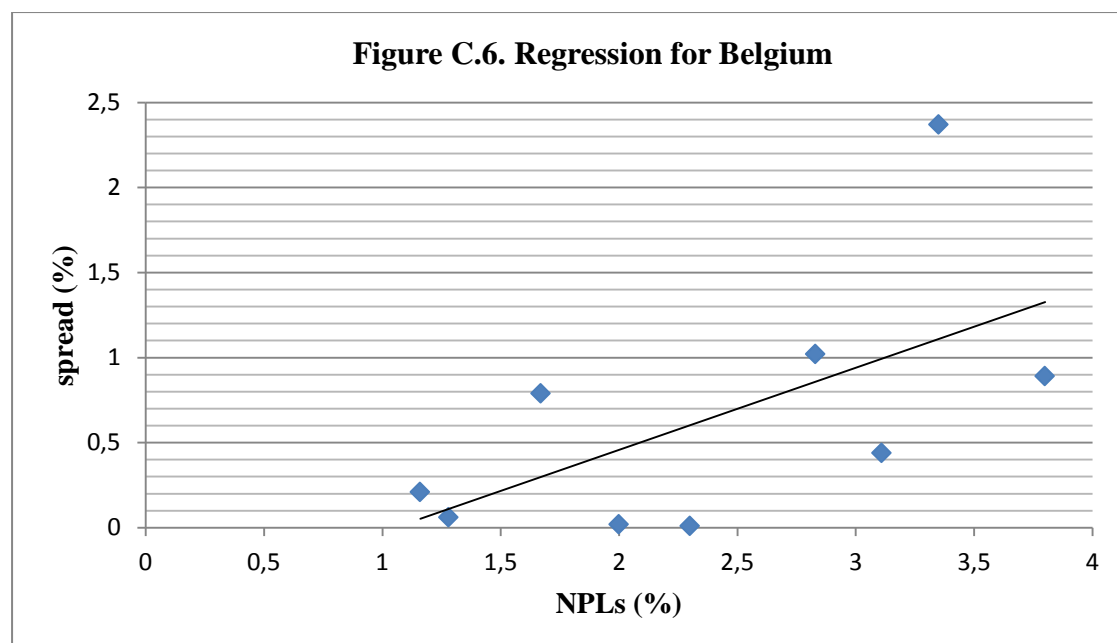
Source: Author's calculations

The line graph shows that there is no close relationship between the NPLs and the government bond spread. Before the financial crisis of 2007 the percentage of the NPLs decreased while the spread increased. After 2008, the NPLs increased whereas the spread was characterized by fluctuations. In the case of Austria, the diabolic loop explained in the first part of the dissertation did not exist.



Source: Author's calculations

Belgium: The scatter plot reveals that there is positive interaction between the explanatory and the explained variable.



Source: Author's calculations

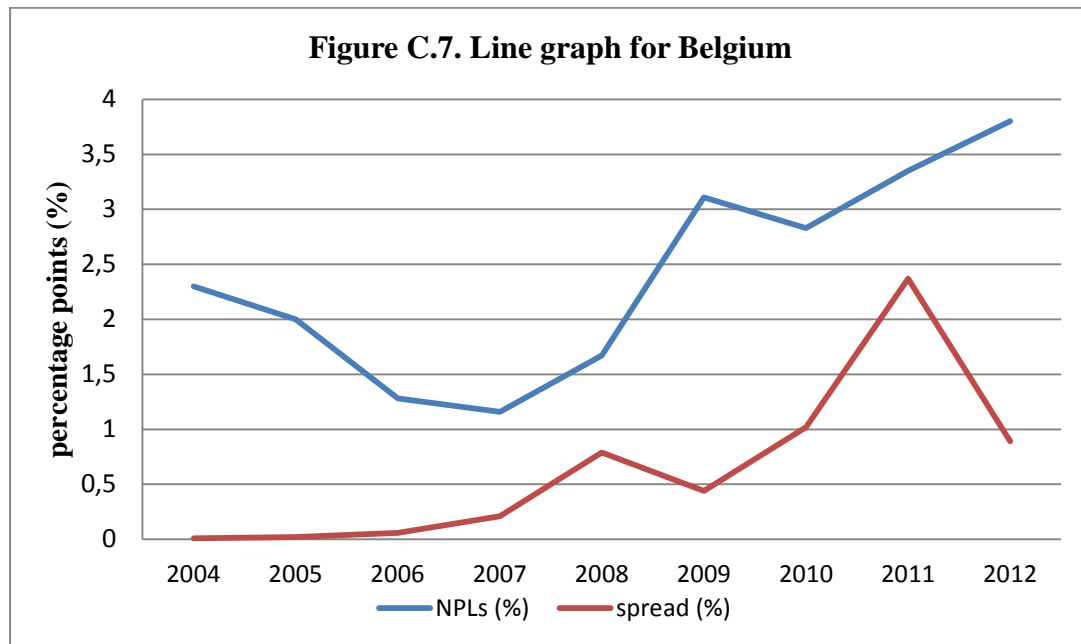
The estimated intercept is statistically insignificant but the estimated slope is statistically significant at 5%. The R squared is low, slightly over 35%. Thus, the gradual increase of the government spreads can be explained up to a point by the NPLs. The correlation is high, almost 60%, which means that the two variables present the same movement up to a point.

Table C.2. Results for Belgium

Belgium	Estimated value	P-value
Intercept	-0.507220	0.2639
Slope	0.482557	0.0305
R squared	0.359411	
Correlation	0.599509	

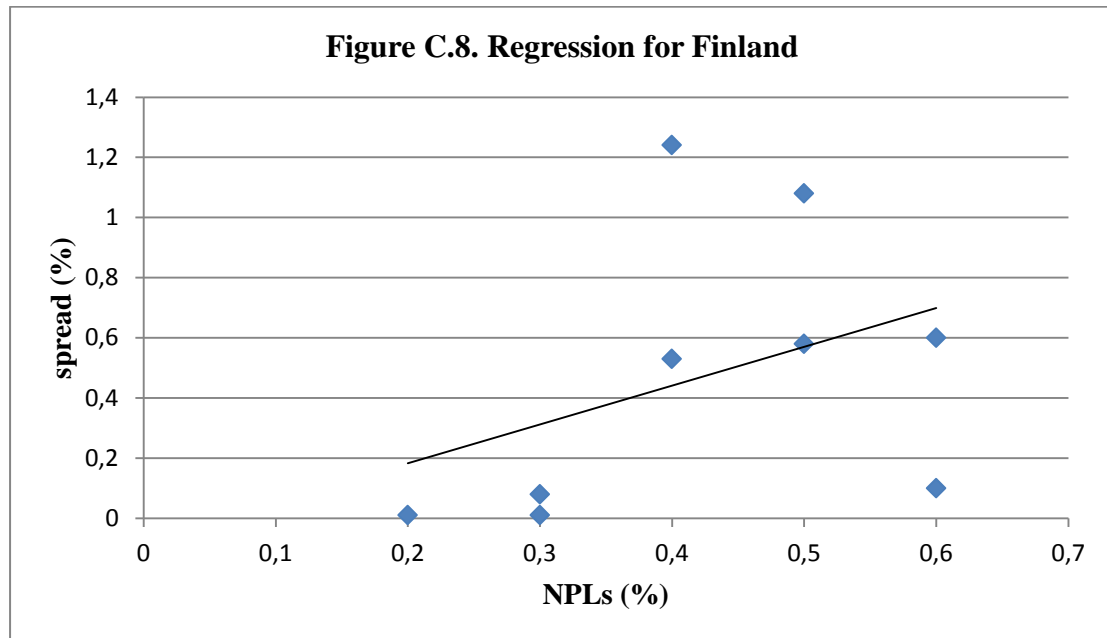
Source: Author's calculations

The line graph below shows that there is significant interaction between the two sectors. After 2006 NPLs were marked by a positive trend during the examined time period while the spread was also increasing. However, their connection is not very strong because the spread dropped in 2012 while NPLs continued to expand. The feedback loop was present to a certain extend in Belgium.



Source: Author's calculations

Finland: The scatter plot shows that there is positive weak relation between the NPLs and the spread.



Source: Author's calculations

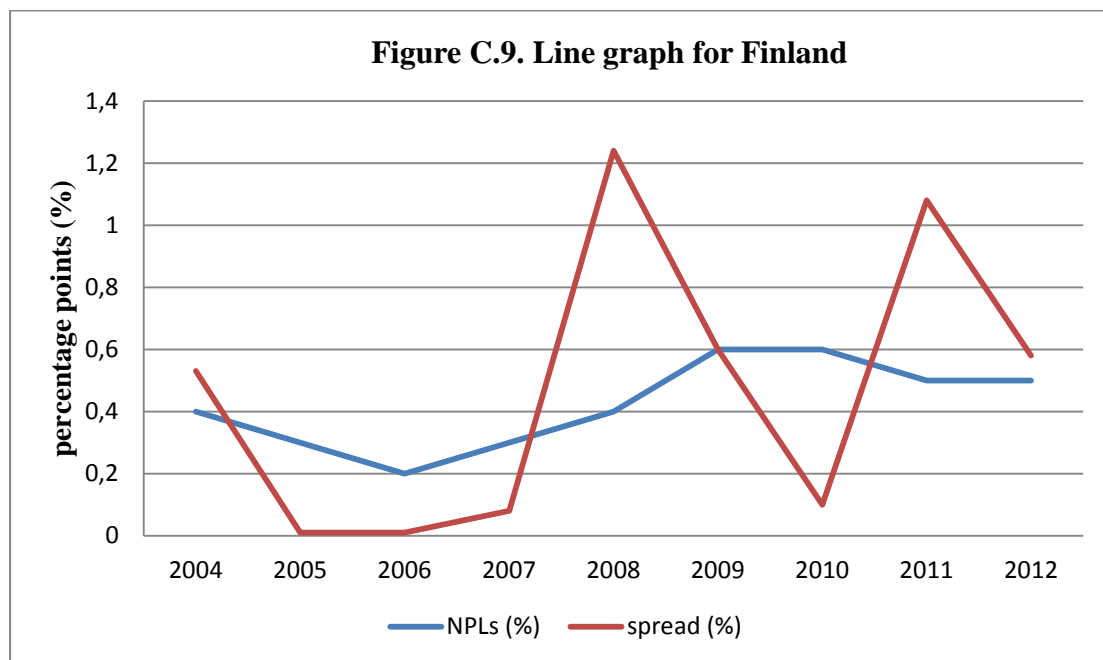
Even if the estimated slope of the model is positive, its P-value is very high so that we could say that NPLs do not significantly affect the government bonds. The R squared is very low which means that the econometric model cannot sufficiently explain the economy of Finland.

Table C.3. Results for Finland

Finland	Estimated value	P-value
Intercept	-0.075571	0.8680
Slope	1.292143	0.2249
R squared	0.151901	
Correlation	0.389745	

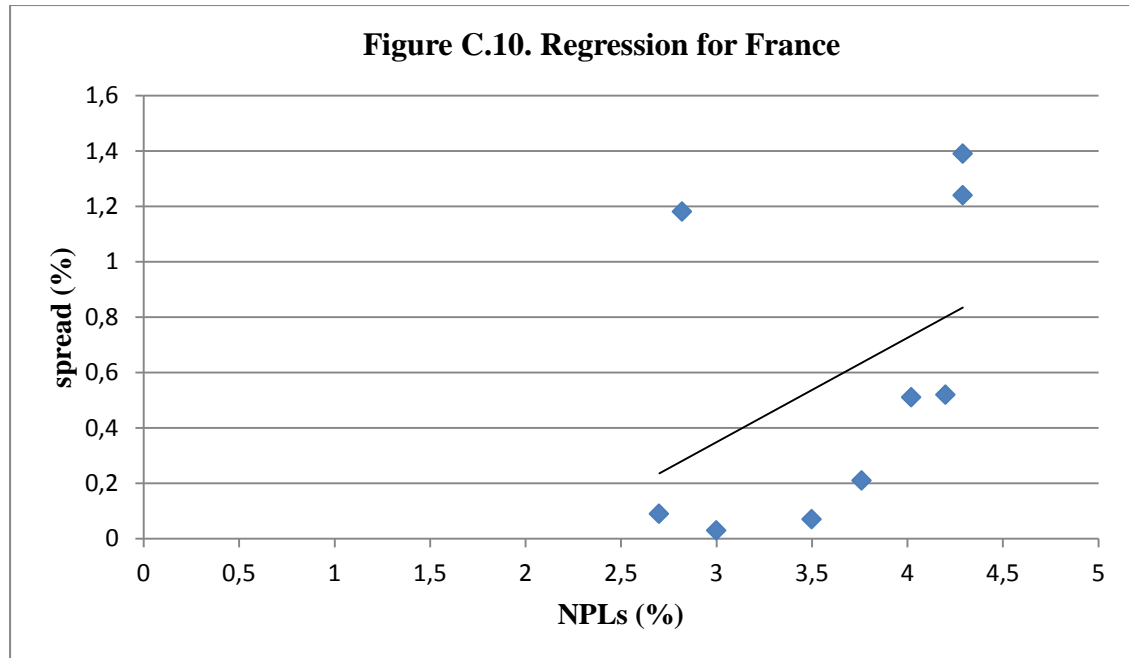
Source: Author's calculations

The line graph reveals the reason due to which the NPLs cannot explain the spread. The spread fluctuated a lot during this 8 year period while the NPLs remained almost constant. Thus, there are other reasons, apart from loans, which explain this movement.



Source: Author's calculations

France: The scatter plot in France shows that there is no close connection between the sovereign bond spread and the NPLs of the financial institutions.



Source: Author's calculations

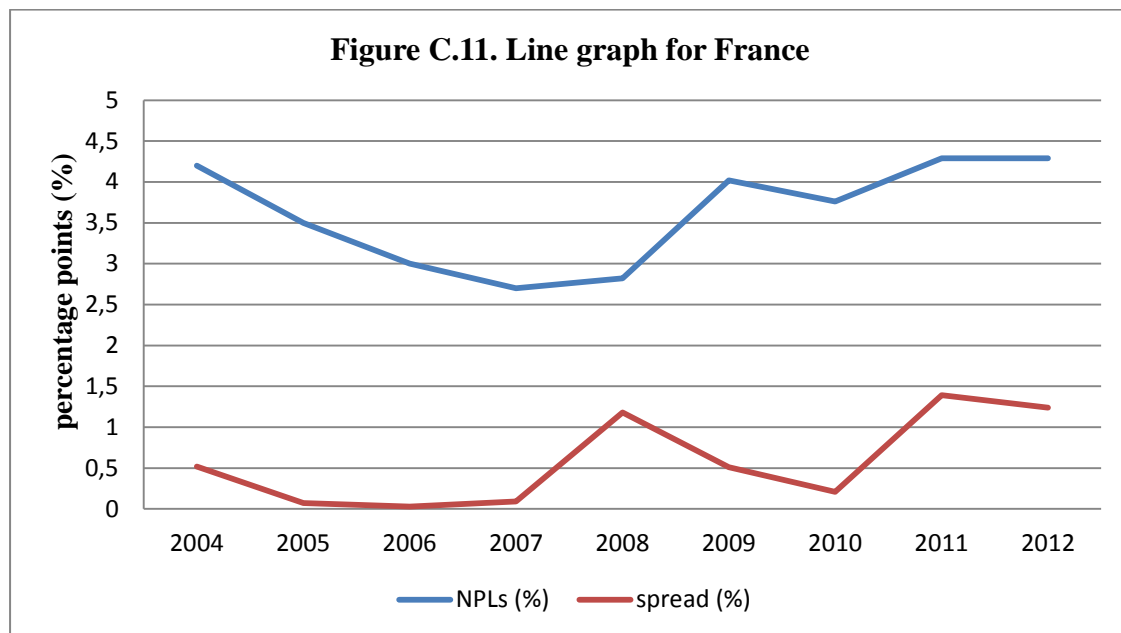
The case of France is similar to the previous one because both the estimated intercept and the estimated slope are statistically insignificant. Even if the estimated value of the slope is positive, we cannot reject the possibility that its real value can be zero. The R squared is almost 20% which means that the NPLs cannot sufficiently explain the government spread. The same holds for the correlation which is low.

Table C.4. Results for France

France	Estimated value	P-value
Intercept	-0.782054	0.5127
slope	0.376872	0.2630
R squared	0.195255	
Correlation	0.441877	

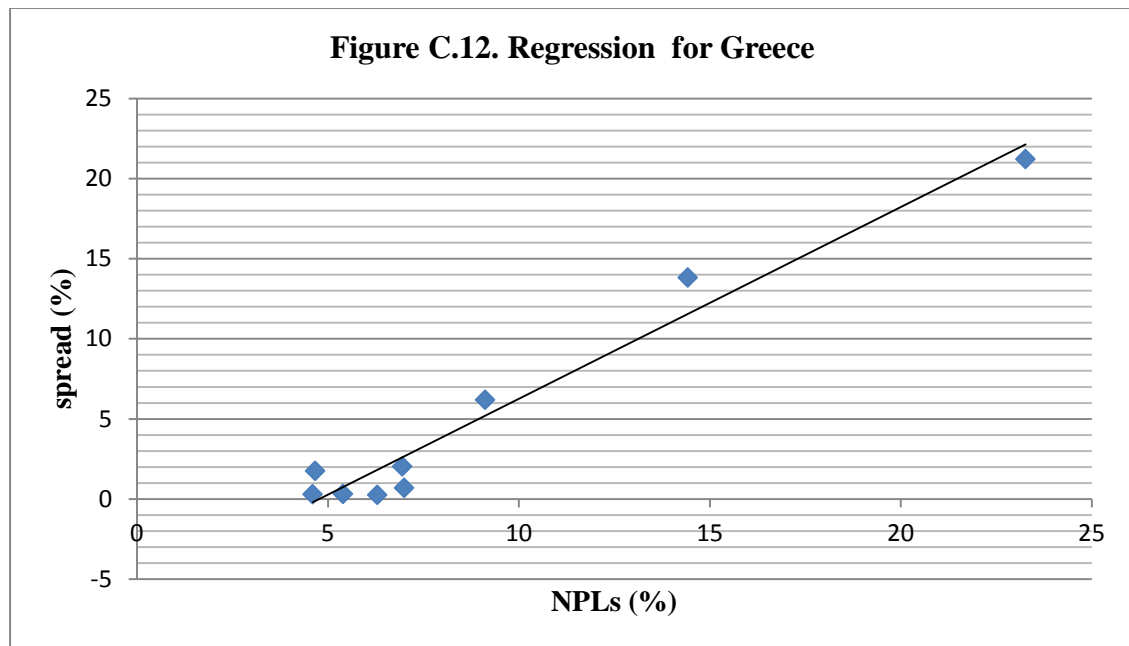
Source: Author's calculations

The line plot presents the historical evolution between the two variables. We can observe that the two variables do not have the same evolution during the last years. The spread was almost zero before 2007 whereas the ratio of NPLs was declining throughout that period. The financial crisis of 2007 produced an upturn of the government's funding cost and at the same year the ratio of NPLs also increased. The period from 2004 to 2008 implies interaction between the two sides, but, after that year, the ratio of NPLs was stabilized while the spread was volatile. The case of France does not completely support the approach of the interaction between banking crises and sovereign debt crises.



Source: Author's calculations

Greece: The results reveal that there was great interaction between the two sectors.



Source: Author's calculations

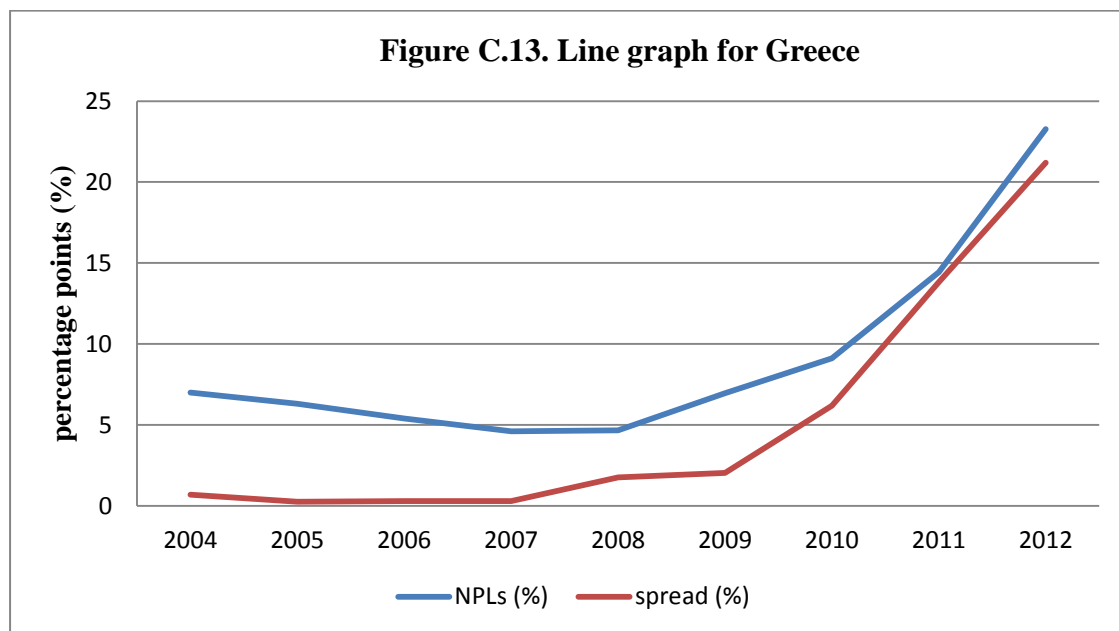
Both estimated values are statistically significant because their P-value is almost equal to zero. The estimated slope is different from zero even for significance level of 1% and the R squared is over 95%. This means that NPLs in Greece produce increased government bonds spread. However, it is accepted that in Greece the sovereign debt crisis preceded the banking crisis. This is an exception, because according to Reinhart and Rogoff (2011) banking crises arise first. In any case, there is strong interaction between the two terms and this is verified by the extremely high correlation between the two variables.

Table C.5. Results for Greece

Greece	Estimated value	P-value
Intercept	-5.695492	0.0005
Slope	1.195980	0.0000
R squared	0.960400	
Correlation	0.980000	

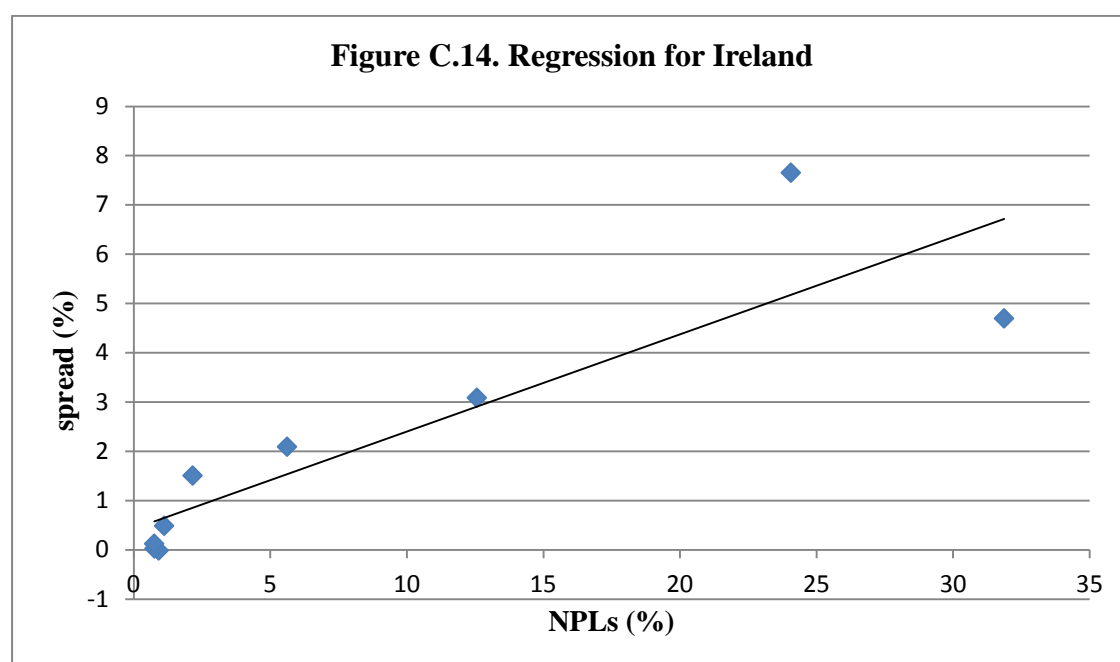
Source: Author's calculations

The line graph reveals the pathway of the two variables and it is impressive how closely related the two variables are. They both started at a low level and they were both gradually increased. The most significant increase for both measures is recorded from the period 2009 to 2010 where the country was influenced by the financial crisis and it finally adopted the memorandum. So, Greece constitutes a typical case of the diabolic loop.



Source: Author's calculations

Ireland: The results show that there was great interaction between the two sectors.



Source: Author's calculations

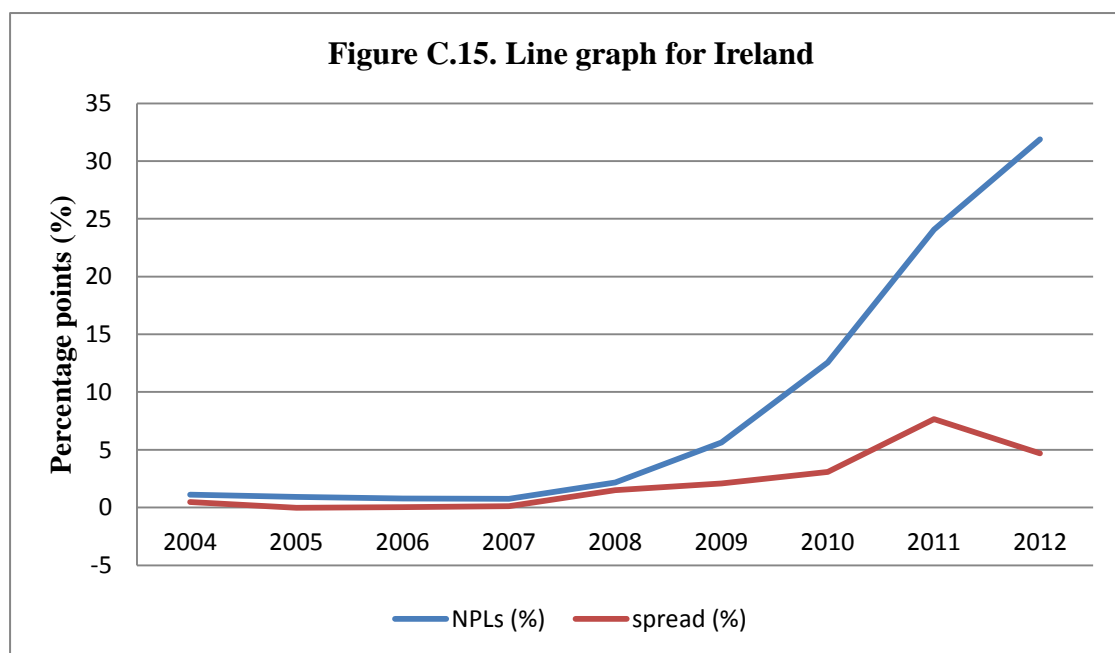
In Ireland, the estimated intercept is statistically insignificant, but the estimated slope is statistically significant at 1% level. The R squared is almost equal to 78%, and so the sovereign debt crisis in Ireland can be significantly explained by the increased NPLs. The correlation is very high, a fact which discloses that the banking crisis coexisted with the sovereign debt crisis.

Table C.6. Results for Ireland

Ireland	Estimated value	P-value
Intercept	0.426688	0.2573
Slope	0.197394	0.0013
R squared	0.779858	
Correlation	0.883096	

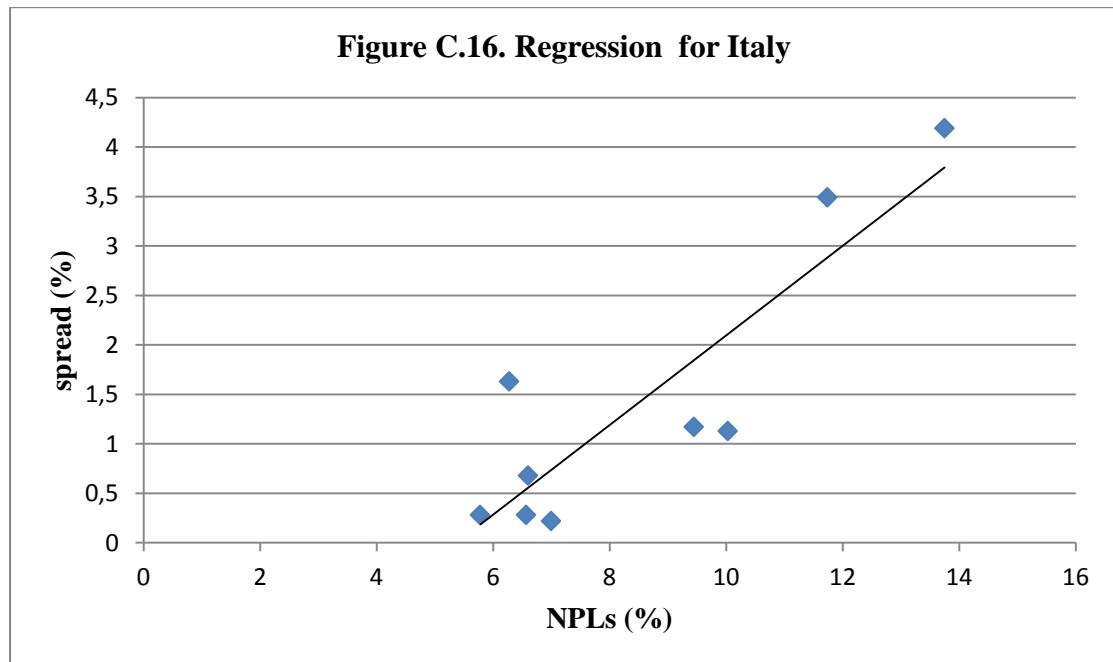
Source: Author's calculations

The next line graph is impressive because it reveals what exactly happened in Ireland. This country faced the financial crisis because of its expanded financial sector. It constitutes one of the typical examples of countries where the diabolic loop was caused by the banking sector. Until the year of 2007, both variables were at the minimum value, just above zero. From 2007, NPLs started to increase and thus the two lines began to be distinguished from each other. The extreme increase of the NPLs after the collapse of real estate market produced a burden in the public sector because the government's ability to borrow was reduced. The spread of the government bond increased until it reached 5% in 2011. Then Ireland was unable to receive funding from the international markets and it received a loan from the International Monetary Fund (IMF).



Source: Author's calculations

Italy: The following scatter plot shows the same picture as the case of Ireland.



Source: Author's calculations

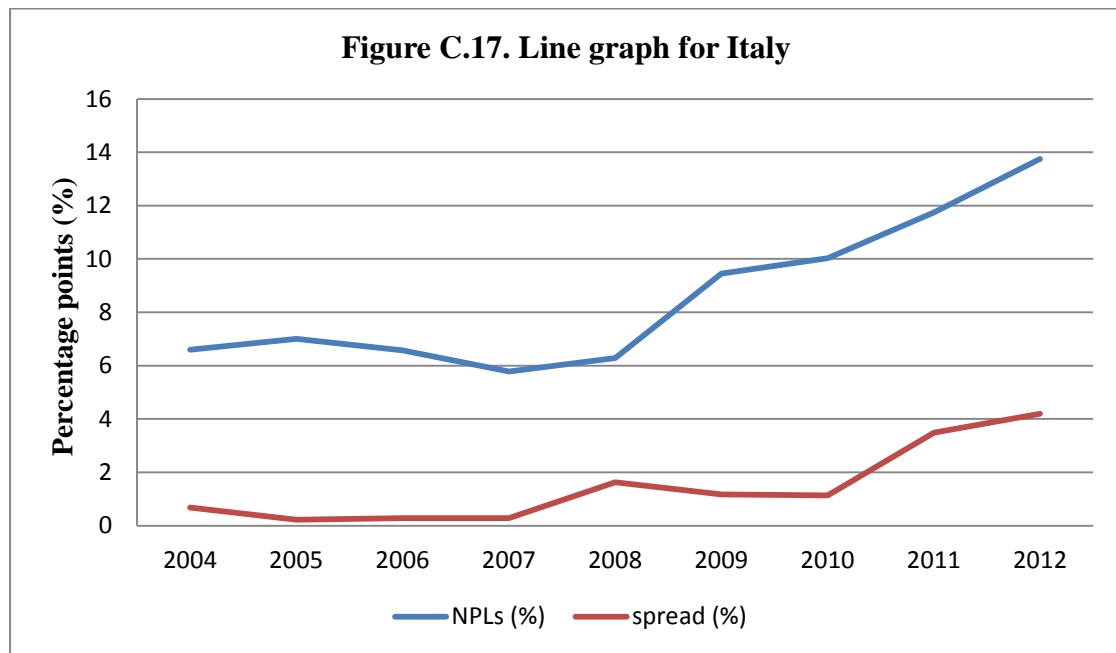
The estimated intercept is statistically significant at 5% and the estimated slope is statistically significant at 1%. The R squared is high at 77% and the correlation is approximately 88%. So, in Italy NPLs can explain a great part of the increased government bond spread.

Table C.7. Results for Italy

Italy	Estimated value	P-value
Intercept	-2.430051	0.0160
Slope	0.452597	0.0013
R squared	0.773633	
Correlation	0.879507	

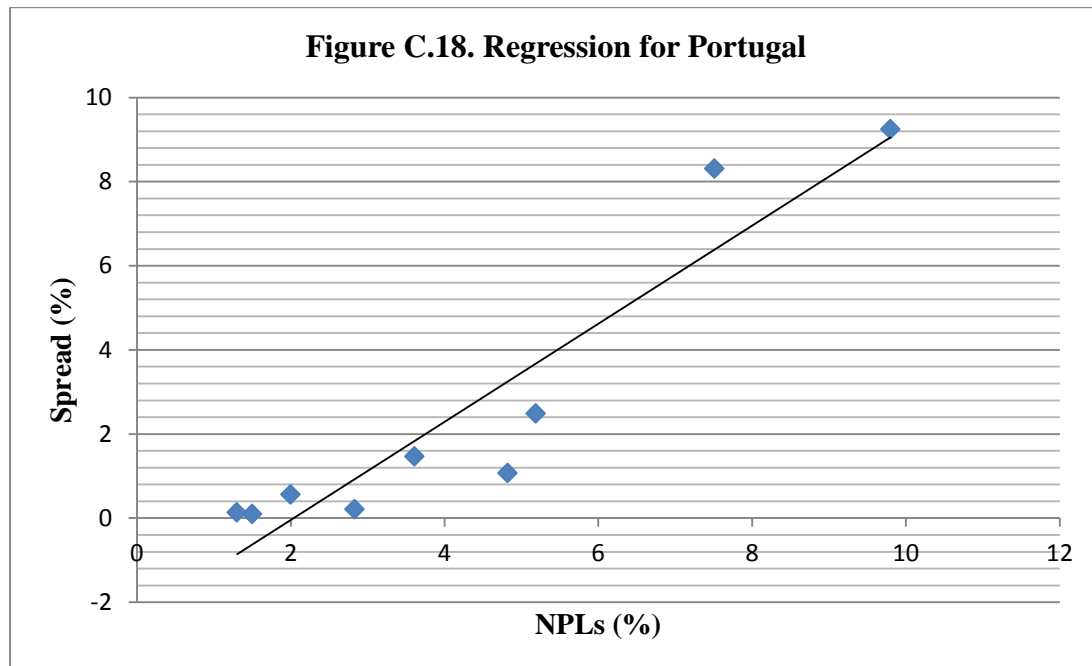
Source: Author's calculations

Before the financial crisis the two variables used to be stable. However, there is an upturn in both NPLs and spread from 2007 to 2012. Their common course reveals that in the case of Italy one crisis produced the other. Again the diabolic loop exists but at a lower level.



Source: Author's calculations

Portugal: The scatter plot reveals the close connection between the banking sector and the sovereign debt crisis in this country.



Source: Author's calculations

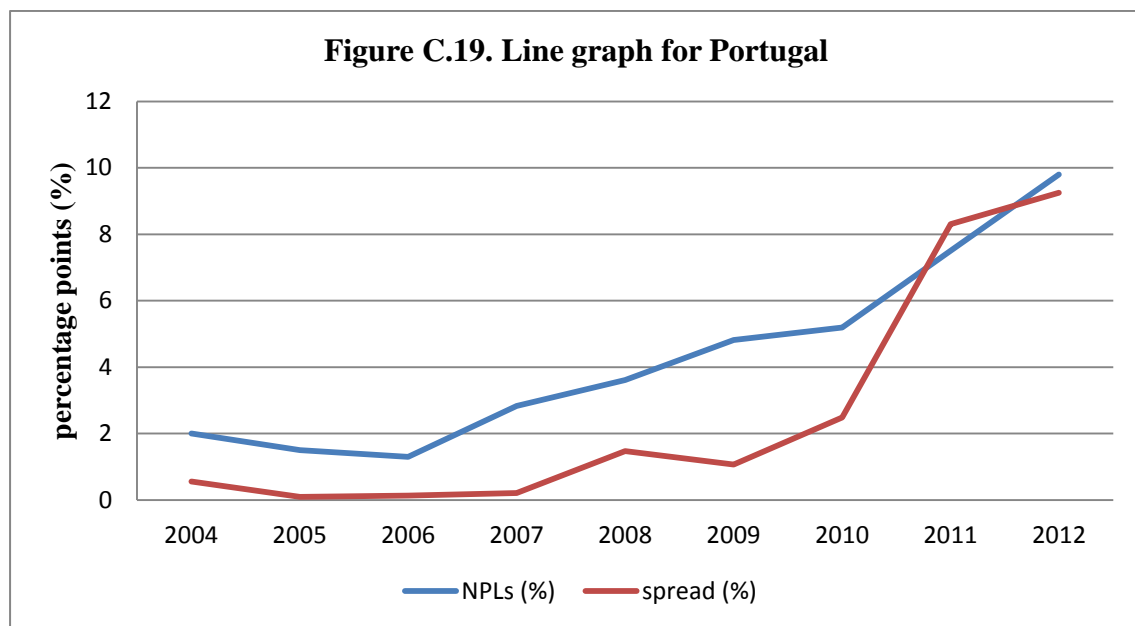
The estimated intercept is statistically significant at 5% and the estimated slope is statistically significant at 1%. The slope of model shows that the NPLs have a great influence on the government bond spread, much higher than in the previous countries. In the case of Portugal a small increase in the NPLs is adequate for an increased sovereign bond spread. This is why Portugal could not receive funding from the international markets even if this country's NPLs were not as high as in the rest countries. The R squared is 88% and the correlation is almost 94%.

Table C.8. Results for Portugal

Portugal	Estimated value	P-value
Intercept	-2.372018	0.0152
Slope	1.165668	0.0001
R squared	0.878888	
Correlation	0.937490	

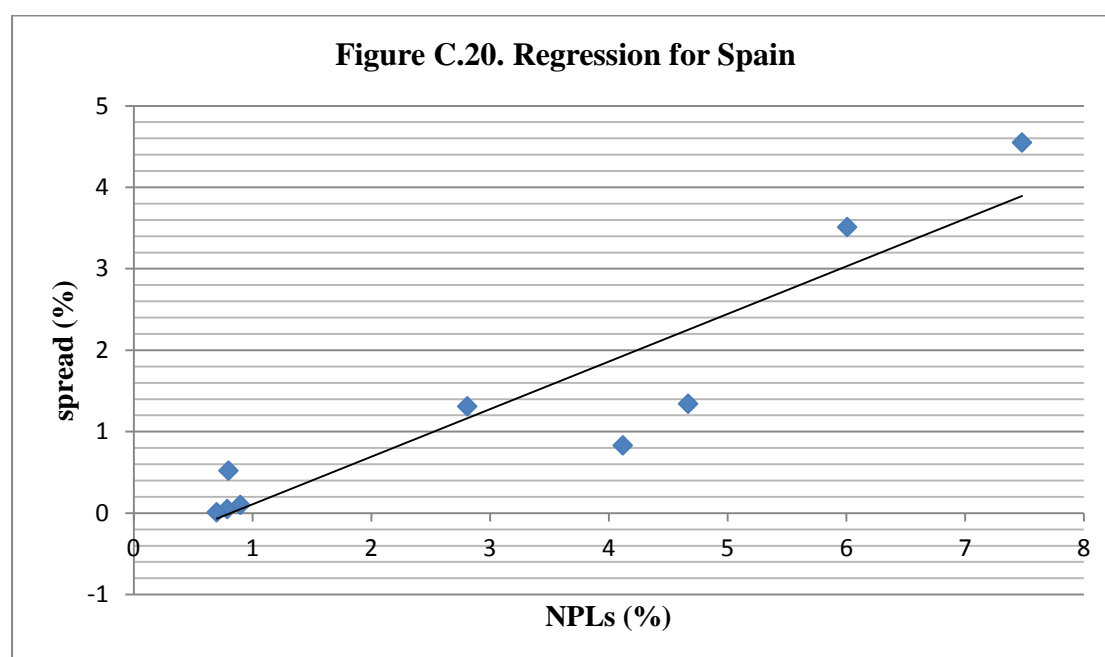
Source: Author's calculations

The line graph presents the interaction between the examined variables and the pathway of the variables is similar to Ireland's. The non-performing loans used to be less than 1% and government bond spread was less than 2% before the financial crisis. From the beginning of the crisis, both of them started to increase and in particular the NPLs. The problematic banking system caused the spread to increase until Portugal could not refinance its public debt.



Source: Author's calculations

Spain: The scatter plot shows the close connection between the two variables.



Source: Author's calculations

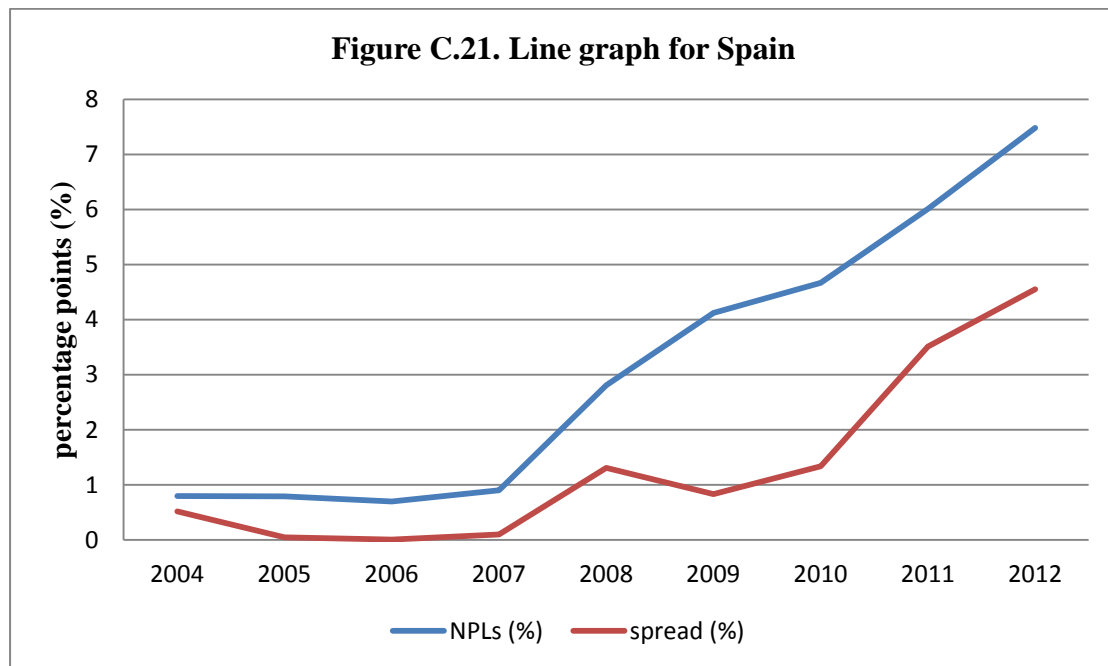
The estimated intercept is statistically significant at 10% level and the estimated slope is statistically significant at 1%. The R squared is over 85%, so in Spain NPLs can explain a very significant part of the sovereign debt crisis. The correlation between the two variables is approximately 92% which verifies their interaction.

Table C.9. Results for Spain

Spain	Estimated value	P-value
Intercept	-0.477891	0.0882
Slope	0.584195	0.0003
R squared	0.855926	
Correlation	0.925163	

Source: Author's calculations

The line graph shows the pathway of the two variables. Again there are significant similarities between the two variables, as in the case of Portugal. The two variables used to move in parallel to each other and they both were under 1%, as happened in Ireland. The NPLs and spread increased after the recent financial crisis with the NPLs reaching 3% in just one year. From that period onwards the NPLs follow a non-decreasing pathway while the sovereign spread slightly decreased in 2009. Then government funding became costlier and the two variables continued to increase in parallel. This situation is characteristic of the feedback loop described above and it justifies the researchers' results that the financial crisis in Spain emerged through the housing bubble.



Source: Author's calculations

Comparison between the countries:

The information presented above by country is summarized into the following table.

Table C.10. Summarized results

	Correlation	Intercept	Slope	R squared
Austria	-0.234540	1.619638	-0.392745	0.055010
Belgium	0.599509	-0.507220	0.482557**	0.359411
Finland	0.389745	-0.075571	1.292143	0.151901
France	0.441877	-0.782054	0.376872	0.195255
Greece	0.980000	-5.695492***	1.195980***	0.960400
Ireland	0.883096	0.426688	0.197394***	0.779858
Italy	0.879507	-2.430051**	0.452597***	0.773633
Portugal	0.937490	-2.372018**	1.165668***	0.878888
Spain	0.925163	-0.477891*	0.584195 ***	0.855926

Significance levels denoted by *** p<1%, ** p<5%, * p<10%.

Source: Author's calculations

It is clear that in general there is close relation between the NPLs and government bond spreads. In any examined country, except Austria, their relation was positive and their correlation was high for the majority of the cases. The R squared was also high in many countries. Austria, Belgium, Finland, and France, are characterized by small R squared, but the rest of the countries have really high R squared. The statistical significance of the slope varies depending on the country. There are three countries where this value is not statistically significant, one country where the slope is statistically significant at 5%, and in the rest cases the slope is statistically significant at 1%. Thus, the model largely explains the sovereign debt crises in Eurozone.

Austria, Finland, and France are the countries where the model does not produce significant results because the relation between the two variables is weak. This can be explained by the fact that those countries did not experience increased government spread and for this reason they did not face problems with refinancing their debt. In the rest of the countries the elevated government bond spreads were more profound

and long-lasting, and for this reason the model proved that there was a significant interaction. Thus, the test is mainly valuable for cases where countries face a serious sovereign debt crisis and not only slightly temporal increased government bond spread.

In conclusion, the NPLs retain an explanatory value of the sovereign debt crises at least for cases where banking crises precede sovereign debt crises. Furthermore, the NPLs can be an indicator of a forthcoming sovereign debt crisis even if the opposite is also likely.

Measures against the diabolic loop

The interaction above is strengthened by the bailout process and the overprotection of the banking sector. According to Correa and Saprizza (2014), the strong relation between public debt and financial institutions can be mitigated by the enforcement of the appropriate measures.

Even if the complete immunization of macroeconomic problems due to sovereign crises is impossible, they provide three solutions in order for this problem to become less severe. The first one is through a clear process of bank resolution. Its aim must be the taxpayers' relief from the burden of bailout. The establishment of a resolution system will make investors to pay attention to the financial risks of the banking system and the government will not have to provide financial support. The second one is the appropriate level of deposit insurance. The deposit insurance makes financial institution executives more prone to excessive risk. According to Acharya et al. (2010), the deposit insurance must be analogous to the risk taken by each financial institution and its share of systemic risk. The last one concerns the regulation of the banking system and the capital adequacy. The more capital is held by financial institutions the easier it is for them to overcome potential problems, such as the expanded NPLs. The increased capital is costly but it does not produce severe banking crisis when a financial institution defaults. Moreover, capital adequacy must be related to the amount of government bonds that each institution holds to its balance sheet. This stems from the fact that as the proportion of government bonds increases the potential interaction between the two sides becomes more probable.

According to many economists and policymakers, the current financial crisis in the Eurozone will overcome with the introduction of Euro Bonds because this common asset will break the diabolic loop between sovereign debt crisis and banking crisis. The Euro Bonds will stop the “flight to quality” phenomenon and it will contribute to global financial stability. However, a lot of steps must be taken in order for its realization. This is because Euro Bonds are related to fiscal coordination. For this reason, Brunnermeier et al. (2011) propose a strong alternative method.

The Euro-Safe-Bonds (ESBies) can produce financial stabilization, they are not influenced by political obstacles and they do not require great fiscal integration. Specifically, they combine numerous benefits. Firstly, ESBies may provide a high level of guarantee because they will be issued by a European Debt Agency (EDA) composed by the European states. As any government bond, this type of security is in general safer than the private debt. The next benefit is that ESBies will not suffer from inflation because they are issued in Euro and the European Central Bank (ECB) has as main target price stability. More precisely, the inflation target is the yearly inflation rate increase which does not to exceed 2%. The last benefit is that ESBies will be traded in high levels of liquidity. This is because the ESBies will be traded in large amounts and combined with their low risk they could constitute a safe security for portfolio diversification.

Apart from the ESBies, the operation of the EDA is based on the junior tranche. In contrast to the ESBies, the junior tranche consists of the sum of risky securities that banks hold. For example, junior tranche must include sovereign bonds whose value has been reduced. The losses of the risky government bonds will reduce the junior tranche while the EDA will be unaffected by this devaluation.

The scheme that will break the feedback loop will be based on the European Debt Agency (EDA) which will purchase the government bonds and it will hold them in the assets' side of its balance sheet. Those government bonds will be treated as collateral for the following two securities. The first one is the ESBies which will be the senior debt. The second one will be the junior tranche and it will be decreased as the government bonds lose their value. The decrease in government bonds value will burden the junior tranche and their holders instead of the EDA.

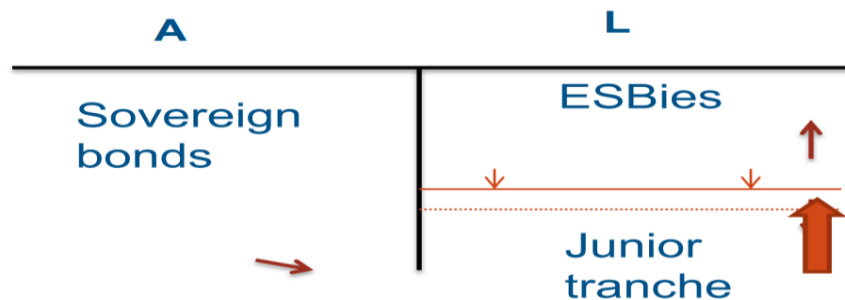
Figure C.22. The ESBies and the junior tranche



Source: Garicano (2013)

The breaking of “fly to quality” is described by the following graph, taken by Garicano (2013). It takes place with the transmission of funds from the junior tranche to the ESBies, instead of fund migration from one country to another. This will decrease the sudden stops of capital inflows of the weak economies because the flight to quality will take place between tranches and not countries.

Figure C.23. ESBies break the diabolic loop



Source: Garicano (2013)

D. Conclusions

The banking crises cannot be isolated from the rest forms of financial crises and in particular sovereign debt crises. This is because there is interaction between the deterioration of the financial system and the sustainability of the public debt, known as “feedback loop” or “diabolic loop”. This interaction may start either from the public debt or the banking sector and several pathways have been recorded through which crises move from the one sector to the other.

In the case of the Eurozone, the banking sector affected the sovereign stability. The goal of this dissertation was the examination of this phenomenon in the Eurozone. For this reason, I compared the evolution of the NPLs of 9 country-members of the Eurozone with their cost of lending. In particular, the German government bond was assumed to be the risk-free asset and I created the spread over the German government bond. In the majority of the examined countries the dependence between the two variables was high and this relation was greater for the countries which faced the stronger crisis. As a result, the NPLs may constitute an indicator for potential sovereign debt crises.

A solution for this problem has not yet been provided but researchers have expressed some views towards its mitigation. The introduction of a specific type of Euro Bonds, the European Stability Bonds, seem a valuable tool which can stop the “fly to safety” phenomenon and to maintain stability in the monetary union.

Appendix

The OLS estimation occurred through the Eviews. The analytical results are given by country:

Austria:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.619638	1.112169	1.456288	0.1887
NPLS	-0.392745	0.479981	-0.818251	0.4402
R-squared	0.055010	Mean dependent var		0.625556
Adjusted R-squared	-0.079989	S.D. dependent var		0.541990
S.E. of regression	0.563249	Akaike info criterion		1.882941
Sum squared resid	2.220748	Schwarz criterion		1.926769
Log likelihood	-6.473234	F-statistic		0.407484
Durbin-Watson stat	1.279066	Prob(F-statistic)		0.543560

Belgium:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.507220	0.417577	-1.214674	0.2639
NPLS	0.482557	0.178516	2.703158	0.0305
R-squared	0.359411	Mean dependent var		0.645556
Adjusted R-squared	0.267899	S.D. dependent var		0.755366
S.E. of regression	0.646313	Akaike info criterion		2.158065
Sum squared resid	2.924045	Schwarz criterion		2.201893
Log likelihood	-7.711292	F-statistic		3.927449
Durbin-Watson stat	2.058867	Prob(F-statistic)		0.087951

Finland:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.075571	0.438377	-0.172389	0.8680
NPLS	1.292143	0.970695	1.331152	0.2249
R-squared	0.151901	Mean dependent var		0.470000
Adjusted R-squared	0.030744	S.D. dependent var		0.462304
S.E. of regression	0.455142	Akaike info criterion		1.456715
Sum squared resid	1.450079	Schwarz criterion		1.500543
Log likelihood	-4.555218	F-statistic		1.253756
Durbin-Watson stat	2.601903	Prob(F-statistic)		0.299780

France:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.782054	1.134195	-0.689523	0.5127
NPLS	0.376872	0.309633	1.217155	0.2630
R-squared	0.195255	Mean dependent var		0.582222
Adjusted R-squared	0.080292	S.D. dependent var		0.547695
S.E. of regression	0.525247	Akaike info criterion		1.743234
Sum squared resid	1.931191	Schwarz criterion		1.787061
Log likelihood	-5.844552	F-statistic		1.698409
Durbin-Watson stat	1.792602	Prob(F-statistic)		0.233723

Greece:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.695492	0.947701	-6.009797	0.0005
NPLS	1.195980	0.060858	19.65204	0.0000
R-squared	0.960400	Mean dependent var	5.166667	
Adjusted R-squared	0.954743	S.D. dependent var	7.468745	
S.E. of regression	1.588883	Akaike info criterion	3.957070	
Sum squared resid	17.67185	Schwarz criterion	4.000897	
Log likelihood	-15.80681	F-statistic	169.7671	
Durbin-Watson stat	1.385452	Prob(F-statistic)	0.000004	

Ireland:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.426688	0.346020	1.233131	0.2573
NPLS	0.197394	0.038388	5.142086	0.0013
R-squared	0.779858	Mean dependent var	2.178889	
Adjusted R-squared	0.748409	S.D. dependent var	2.601458	
S.E. of regression	1.304861	Akaike info criterion	3.563200	
Sum squared resid	11.91864	Schwarz criterion	3.607028	
Log likelihood	-14.03440	F-statistic	24.79766	
Durbin-Watson stat	2.276519	Prob(F-statistic)	0.001601	

Italy:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.430051	0.769577	-3.157646	0.0160
NPLS	0.452597	0.088044	5.140595	0.0013
R-squared	0.773533	Mean dependent var	1.452222	
Adjusted R-squared	0.741181	S.D. dependent var	1.445941	
S.E. of regression	0.735612	Akaike info criterion	2.416902	
Sum squared resid	3.787873	Schwarz criterion	2.460729	
Log likelihood	-8.876057	F-statistic	23.90962	
Durbin-Watson stat	2.140355	Prob(F-statistic)	0.001774	

Portugal:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.372018	0.742831	-3.193213	0.0152
NPLS	1.165668	0.134365	8.675368	0.0001
R-squared	0.878888	Mean dependent var	2.622222	
Adjusted R-squared	0.861586	S.D. dependent var	3.581678	
S.E. of regression	1.332530	Akaike info criterion	3.605166	
Sum squared resid	12.42945	Schwarz criterion	3.648994	
Log likelihood	-14.22325	F-statistic	50.79751	
Durbin-Watson stat	1.617291	Prob(F-statistic)	0.000189	

Spain:

Dependent Variable: SPREAD

Method: Least Squares

Sample: 2004 2012

Included observations: 9

Newey-West HAC Standard Errors & Covariance (lag truncation=2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.477891	0.241392	-1.979728	0.0882
NPLS	0.584195	0.087756	6.657005	0.0003
R-squared	0.855926	Mean dependent var	1.357778	
Adjusted R-squared	0.835344	S.D. dependent var	1.616870	
S.E. of regression	0.656090	Akaike info criterion	2.188094	
Sum squared resid	3.013183	Schwarz criterion	2.231922	
Log likelihood	-7.846423	F-statistic	41.58619	
Durbin-Watson stat	1.250727	Prob(F-statistic)	0.000351	

Bibliography:

Acharya, V. V., Santos, A. C., J., Yorulmazer, T., (2010) “Systemic Risk and Deposit Insurance Premiums” FRBNY Economic Policy Review

Aguiar, M., Amador, M., (2013) “Sovereign Debt: A review” NBER Working Paper 19388

Akerlof, G., (1970) “The Market for “Lemons”: Quality Uncertainty and the Market Mechanism” Quarterly Journal of Economics

Allen, F., Gale, D., (1998) “Optimal Financial Crises” Journal of Finance

Allen, F., Gale, D., (2007) “An Introduction to Financial Crises”

Arora, V., Cerisola, M., (2001) “How Does U.S. Monetary Policy Influence Sovereign Spreads in Emerging Markets?” IMF Working Paper

Balteanu, I., Erce, A., (2014) “Bank Crises and Sovereign Defaults in Emerging Markets: Exploring the Links”, Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper No. 184

Bolton, P., Jeanne, O., (2011) “Sovereign Default Risk And Bank Fragility In Financially Integrated Economies” NBER WORKING PAPER SERIES

Broner, A. F., Lorenzoni, G., Schmukler, L. S., (2011) “Why Do Emerging Economies Borrow Short Term?” Journal of the European Economics Association

Brunnermeier, K. M., Garicano, L., Lane, R. P., Pagano, M., Reis, R., Santos, T., Thesmar, D., Van Nieuwerburgh, S., Vayanos, D., (2011) “The Euro-nomics group” <http://www.columbia.edu/~rr2572/papers/11-ESBies.pdf>

Bryant, J., (1980) “A Model of Reservers, Bank Runs, and Deposit Insurance” Journal of Banking and Finance

Calomiris W. C., (1990) “Is Deposit Insurance Necessary? A Historical Perspective” Journal of Economic History

Calvo, A. G., (1998) “Capital Flows and Capital-Market Crises: The Simple Economics of Sudden Stops” Journal of Applied Economics

- Canuto, O., Santos, P. F. P. dos, Sa Porto, P. C. de, (2004) “Macroeconomics and Sovereign Risk Ratings” *Journal of International Commerce, Economics and Policy*
- Claessens, S., Kose, M. A., (2013) “Financial Crises: Explanations, Types, and Implications” IMF Working Paper
- Correa, R., Sapriz, H., (2014) “Sovereign Debt Crises” Board of Governors of the Federal Reserve System, International Finance Discussion Papers, Number 1104
- Cuadra, G., Sapriz, H., (2008) “Sovereign default, interest rates and political uncertainty in emerging markets” *Journal of International Economics*
- Diamond, D., Dybvig, P., (1983) “Bank Runs, Deposit Insurance, and Liquidity” *Journal of Political Economy*
- Frankel, A. J., Rose, K. A., (1996) “Currency crashes in emerging markets: An empirical treatment” *Journal of International Economics*
- Garicano, L., (2013) “What next for the Eurozone?” http://www.lse.ac.uk/publicEvents/pdf/2013_LT/20130123%20Luis%20Garicano.pdf
- Goldstein, I., Razin, A., (2013) “Review of Theories of Financial Crises” NBER Working Paper 18670
- Hatchondo, J.C., Martinez L., Sapriz H. (2009) “Heterogeneous Borrowers in Quantitative Models of Sovereign Default.” *International Economic Review*
- Hull, C. J., (2012) “Risk Management and Financial Institutions” Wiley & Sons
- Jorda, O., Schularick, M., Taylor, M. A., (2014) “Sovereigns versus Banks: Credit, Crises, and Consequences” Federal Reserve Bank of San Francisco Working Paper Series
- Kaminsky, L. G., Reinhart, M. C., (1999) “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems” *American Economic Review*
- Kannan, P., Scott, A., Terrones, E. M., (2009) “From Recession to Recover: How Soon and How Strong” *World Economic Outlook*

- Kumhof, M., Tanner, E., (2005) "Government Debt: A Key Role in Financial Intermediation" IMF Working Paper
- Laeven, L., Valencia, F., (2012) "Systemic Banking Crises Database: An Update" IMF Working Paper
- Lane, R. P., (2012) "The European Sovereign Debt Crisis" Journal of Economic Perspectives
- Lo, W. A., (2012) "Reading About the Financial Crisis: A 21-Book Review" Journal of Economic Literature
- Nagy, P. J., (1984) "Country Risk: How to Assess, Quantify, and Monitor it" Euromoney Publications, London
- Reinhart, C., Calvo, G., (2000) "When Capital Inflows Come to a Sudden Stop: Consequences and Policy Options" MPRA Paper No. 6982
- Reinhart, C., Rogoff, K., Savastano, M., (2003) "Debt intolerance" MPRA Paper No. 13932
- Reinhart, M. C., Reinhart, R. V., and Rogoff, S. K., (2012) "Public Debt Overhangs: Advanced-Economy Episodes Since 1800" Journal of Economic Perspectives
- Reinhart, M. C., Rogoff, S. K., (2009) "This Time is Different: Eight Centuries of Financial Folly" Princeton Press
- Reinhart, M. C., Rogoff, S. K., (2011) "From Financial Crash to Debt Crisis" NBER Working Paper 15795
- Sapountzoglou, G., Pentotis, Ch., (2009) "Banking Economics" G. Benou (in Greek)
- Schularick, M., Taylor, M. A., (2009) "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles and Financial Crises, 1870-2008" NBER WORKING PAPER SERIES Working Paper 15512
- Sturzenegger, F., Zettelmeyer, J., (2006) "Debt Defaults and Lessons From a Decade of Crises" MIT Press

Sturzenegger, F., Zettelmeyer, J., (2008) “Haircuts: Estimating Investor Losses in Sovereign Debt Restructurings, 1998-2005” *Journal of International Money and Finance*

Tomz, M., Wright, L. J. M., (2007) “Do Countries Default in “Bad Times”?” Federal Reserve Bank of San Francisco WORKING PAPER SERIES

Uribe, M., Yue, Z. V., (2006) “Country spreads and emerging countries: Who drives whom?” NBER Working Paper 10018