Three Banks, one country

Econometrics Assignment

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Abstract

In this assignment I study impacts of the financial sector of a small country (Portugal) h on the sovereign yields of that same country. At the core of the idea is how do Bank capital needs and valuation impact the sovereign debt of a country. A financial crisis might lead to a programme of public assistance (particularly if there is a "too big too fail" financial sector), and therefore increase the likelihood of a sovereign default as the government might face liquidity constraints. This is particularly relevant as banks simultaneously receive public funding and invest in Sovereign debt thus creating an additional feedback effect. In this paper I used data for the period 2001-2014 to construct different econometric models that confirm the existence of a negative effect created by the financial sector.

Contents

1 Introduction

The macroeconomic developments of the last 15 years in Europe and US have highlighted the strong linkage between the financial sector and the overall direction of the economy. In the US a fast growing financial sector created more aggressive practices of secularization, risk sharing and financial innovation that eventually lead to the subprime crisis and a global economic slowdown now know as the great recession. In Europe the creation of the eurozone also lead to the expansion of the financial sector in some peripheral economies, aided by the availability of cheap credit. This problem, associated with the perception of increasingly frequency of financial crisis created a trend on assessing if there is something as an optimal size of the financial sector. Jean-Louis Arcand et al. (2015) shows that there is indeed such thing as "too much finance".

My research idea deals with the home-country bias. Banking activity, even in the context of a monetary union, is characterized by the existence of several systemically important banks at the regional (national in the case of the eurozone) level. This banks operate in a regional economy(national), and are highly dependant of the outcome of that same economy. If this is the case, and that dependence can have some feedback effects (as a crisis in the banking system can lead to an economic crisis that in turn accentuates the banking crisis), maybe the capital requirements of investments in bonds of the national economy should have different capital requirements. Given that this idea is inspired in the recent developments of the European economy it might sound a very regional-specific problem, but it generalizes in several different ways.

2 What's the role of home country bias in a sovereign debt crisis?

The disproportionate size of the financial system in some European countries lead to an additional level of instability in the past decade. Several European banks though are not *too big to fail* for the eurozone are definitely to their local economy. Bank nationalizations, or massive programs of public assistance have been pretty common during the last decade and have included giants like RBS, Lloyds, Anglo-Irish Bank and arguably Citigroup. Given the sheer significance of the involved amounts this has created threats to the solvability of some sovereign nations. Consider for instance Ireland where the nationalisation of Anglo Irish Bank and Irish Nationwide Bank cost amounted to 34.7 billion euros more than 20% of the country GDP. To some extent this proves that the activity of the financial sector has a high degree of political setting that is not fully explained by a profit maximization behaviour. Fernández-Villaverde et al. (2013) provides an extensive and interesting narrative for the case of political credit cycles in Europe.

There is early evidence on the role of home country bias. Just recently a study by the IMF, Asonuma et al. (2015),conducted an analysis of advanced and emerging markets and showed that home country bias is used as a cost saving mechanism, but that indeed creates some fragility as in the presence of worsening market situations decreases the effectiveness of fiscal policy.

This research line seems to be gaining some attention Cornand et al. (2014) is a recent working paper that models the impact of home country bias and, in my opinion, finds a particularly striking finding that home country bias is not destabilizing. I believe that the source of this result is some deficient modelling of the financial sector in their theoretical approach. Their view is that the government chooses to pay/default based on their observation of the level of debt owned by home

households - it fails to introduce the mechanism that the cost of that debt might be externally affected by the amount of bias.

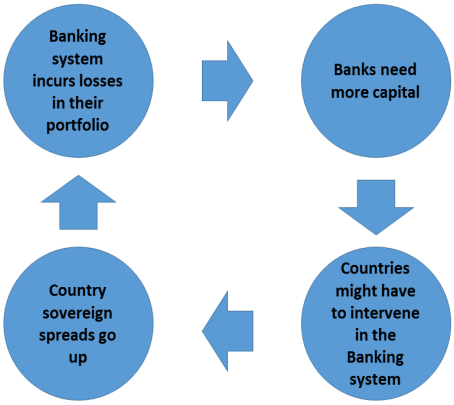

Figure 1: Sovereign feedback effects in a Banking Crisis

The role of the financial system in the realization of a sovereign debt crisis has been mostly ignored in academic research where often subjects are studied separately (banking crisis on one side, sovereign debt crisis in a different one). The IMF in IMF (2014) however shed some light on this dynamics and specifically highlights that most governments do not discuss the fiscal risks associated with supporting the banking sector as a major problem[1].

Arellano and Bai (2012) showed that sovereign default events are interlinked, as a default of one nation increases the probability of other nation's default. In their multi-country model nations are linked to one another by borrowing from and renegotiating with common lenders. However this propagation mechanism is not completely realistic I would argue, as it relies on a strong assumption about common lenders that does not particularly hold. And when it holds, those lenders tend to be international Institutions like the IMF or ESM that have a core concern on avoiding the contagion of default events. In my theoretical approach the contagion mechanism is made through the fragility of the national financial system. As presented in the diagram above banks limited profitability and failure risk increase the chance of a bailout, that in turn puts pressure on the yields of sovereign debt and has banks are heavily exposed to sovereign debt the circle starts all over again.

2.1 Theoretical framework

The recent research on sovereign debt and the linkages with the current political debate is discussed at length in Aguiar and Amador (2015). They show the specific dynamics of the sovereign debt markets, defined by the limited commitment; political economy frictions; the possibility of unobserved or unverifiable shocks in limiting risk sharing; the vulnerability to self-fulfilling debt crises; the difficulties in renegotiating debt in a timely and efficient manner. My research idea

[1] Also interesting to note that the IMF has a long standing tradition in understanding the role of a correct sovereign debt design in preventing economic crisis - see for instance Borensztein et al. (2005). Even latest model generations of sovereign default and debt restructuring fail to incorporate the feedback effects of a strong bank exposure (see for instance Yue (2010)

clearly fits into this agenda. First of all I would like to consider the hypothesis that the degree of home country bias can have an effect on the final outcome/equilibria. ***Conceptually, I argue that a country where the banking system has a higher exposure to the nation sovereign debt is more likely to have sovereign default mostly justified by the feedback loop discussed in the previous point.***

De Marco (2013) using data for European banks during the sovereign debt crisis in southern Europe shows that for a 1% increase in the sovereign losses over total assets, on average, the growth rate in loans declines by 5.3%. This is particularly worrying as in the limit the financial system can be seen as an inefficient leveraged bet on sovereign debt. European banks benefited from cheap liquidity assistance, and in some cases public capital and used that to passively invest in sovereign debt. It adds to the inefficiency that countries like Ireland, Portugal, Spain and Greece injected capital in their banking system at a cost lower cost than their cost in the international market. This situation represents to some extent a capture of the political system, that is trapped in a situation where effectively is subsidizing the financial system to buy sovereign debt. Using data from European Banks Battistini et al. (2013) finds supporting evidence to this view, they concluded that in the periphery, banks respond to increases in country risk by increasing their domestic exposure, while in core countries they do not. By their risk taking actions, banks in the periphery increased the likelihood of a sovereign default as they added to the fragility of the banking system.

2.2 Empirical strategy

In this essay I will focus on the specific case of Portugal. The Portuguese financial system is characterized by a small number of banks, the largest portuguese Bank is Caixa Geral de Depositos and is fully owned by the state. The private sector portuguese Banks (Banco Espirito Santo[2], Banco Portugues de Investimento and Banco Comercial Portugues) are public listed and engage in retail and investment banking both locally and internationally. As part of their activity, and taking advantage of lax capital requirements all these banks were heavily invested in Portuguese sovereign bonds. Given that Portuguese bonds were affected by the aftermaths of the Greek crisis, and led to an international programme of financial assistance by the IMF and ECB the banks portfolios in public debt suffered significant losses.

2.3 Policy implications

The most straightforward implication is that an optimal level of capital requirements should be influenced by the degree of home country bias. If a bank is basically using the public guarantees to buy sovereign debt it is effectively receiving a subsidy from the government. Research like Clerc et al. (2014) and Mendicino (2014) already shows that optimum levels of capital might be significantly higher than the ones proposed in Basel, it is likely that this optimal level might be higher in the presence of bias, or lower in the case of a country where the Banking system is well diversified.

[2]disclosure: I started my professional career in Banco Espirito Santo but I don't see this as a conflict of interest. Banco Espirito Santo was declared Bankrupt in 2014 mostly due to some account sheningans that started while I was working in Banco Espirito Santo. Fortunately enough, my role had nothing to do with those creative accounting exercises so my experience did not provide me any particular insight in the matter. I left Banco Espirito Santo in 2009.

3 Data

The data used covers the equity prices of the public listed Portuguese Banks and the sovereign yield spread of a portuguese 10 year bond. The data for the portuguese banks refers to the daily share price of Banco Espirito Santo (BES.lS), Banco Comercial Portugues (BCP.LS), Banco Portugues de Investimento (BPI.LS) . This data was obtained from Yahoo Finance. The data for the portuguese 10 year bond is obtained from the respective Bloomberg Index (GSPT10YR:IND). Data for the German 10 year Bond was also obtained from Bloomberg. The germand bond was used as a proxy for the risk-free interest rate.

The data refers to the period from the beginning of 2001 to mid 2014. During those 13 years, the situation has moved for an euphoria moment where Portuguese bond yields were basically on par with the ones from Germany to the heights of the euro crisis where a default looked almost unavoidable to finally a period of recovery after the commitment to do "whatever it takes" by the ECB governor Mario Draghi. From the next figure we see that the Portuguese spread was as low as 0% in 2006 and as high as 16% in 2012. The equity prices of the different banks are now significantly lower than in the early 2000's but have shown different patterns and cycles that do not necessarily match the evolution of the sovereign yield.

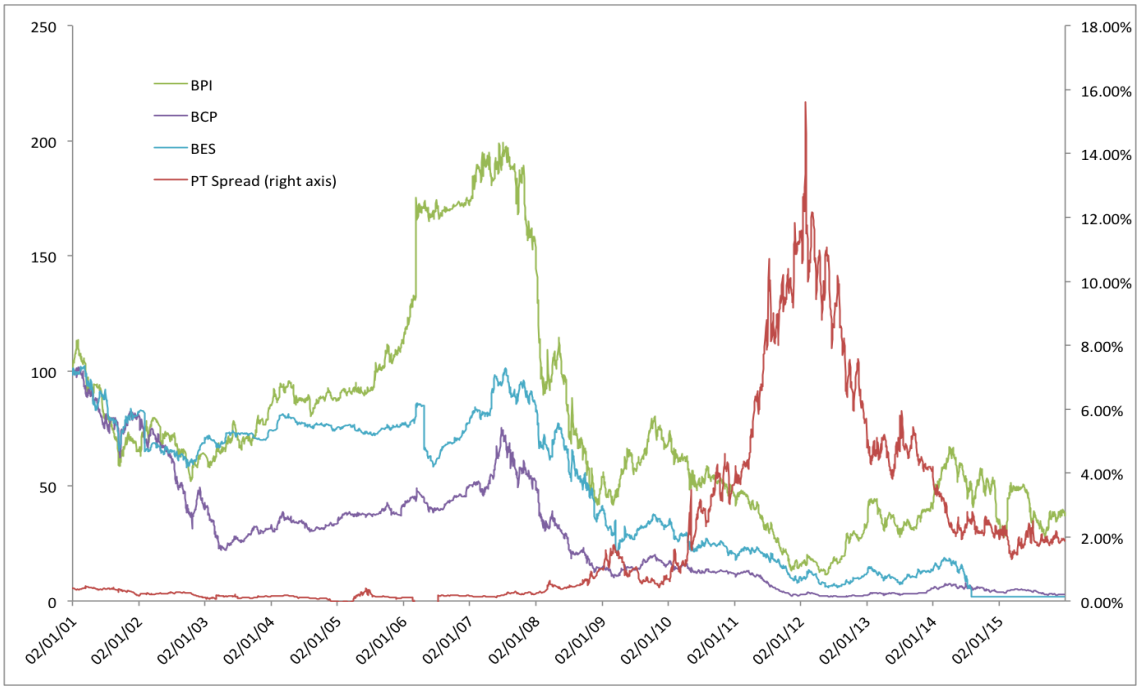

Figure 2: Evolution of Equity prices (Jan2001 = 100) and Portuguese sovereign bond yield spread (%)

Traditionally the overall level of the bond yield is not very informative as one of the main components is the risk-free interest rate. Following the usual convention in financial markets and economic theory, I used the bond yield of the German equivalent bond as a proxy for the risk-free interest rate. Therefore the Portuguese spread (lets call it PTSpread) is just the difference between those two values. Because we are interested in assessing the results on the changes of the spread we can additionally define:

$$PTVar_t = PTSpread_t - PTSpread_{t-1} \tag{1}$$

For the equity data, we are not interested in the overall price level of each of the individual banks (BES, BPI, BCP) but their daily changed defined as:

$$VARBank_t = (BankPrice_t / BankPrice_{t-1}) - 1 \tag{2}$$

4 Modelling

In this section I will build several econometric models that will incrementally add some more depth to the analysis and will work in turn as sensitive tests. The data set, covering approximately 15 years should provide space to different approaches while covering different economic moments (expansions, recessions, international events and local events).

4.1 A Naive Baseline Model

The first model is a naive formulation that will work as a preliminary exploration and as a baseline result. If my theoretical approach is correct, I should be able to find in a regression context the negative correlation mentioned between the Banks equity prices and the Portuguese Sovereign bond yield. As I'm not interested in the levels of any of the variables, I will use the daily appreciation/depreciation of the individual prices of the three main banks and it's effects on the sovereign yields - the changes in the total yield.

Table 1: Portuguese Sovereign bond yield spread and the changes in the Portuguese Bank's equity prices

	Dependent variable:	
	PT_var	
	default	robust
	(1)	(2)
Var_BCP	-0.513***	-0.513***
	(0.102)	(0.159)
Var_BES	-0.749***	-0.749***
	(0.097)	(0.149)
Var_BPI	-0.749***	-0.749***
	(0.118)	(0.162)
Constant	-0.0002	-0.0002
	(0.002)	(0.002)
Observations	3,535	3,535
R^2	0.094	0.094
Adjusted R^2	0.093	0.093
Residual Std. Error (df = 3531)	0.121	0.121
F Statistic (df = 3; 3531)	121.705***	121.705***
Note:	*p<0.1; **p<0.05; ***p<0.01	

The results from the first model are in line with what would be expected given my theoretical approach. For all the three banks Positive (negative) impacts in equity prices cause decreases (increases) in the sovereign yield. The results suggest that a 1% decrease in the equity prices of banks causes an increase of 5.1 to 7.4 basis points in the Portuguese bond yield spread [3] All this results are significant to the 1% level. Finally, but also relevant, the constant is statistically insignificant which is to be expected as the changes of yields are not expected to have a drift element.

4.2 A model of bad and good news

The moral hazard element introduced by the "too big too fail" phenomena, where the government might be required to intervine in the banks is marked by an assymetric payoff strucutre. Bad news for the financial institutions are bad news for the sovereign yields as it might indicate the necessisty of intervention, while good news for the financial institutions are just neutral to the sovereign yields

[3]Please note that there's an inverse relationship between bond yields, and bond prices. Thus if a bond yield goes up the corresponding price goes down, leading to a higher cost of funding for the sovereign.

(as the government does not receive any sort of payout for banks not going into bankruptcy). With this in mind the model of this section decomposes the changes in equity prices into Positive and negative. Where positive changes are:

$$VARPositive_t = VARBank_t \text{ ,if VARBank greater or equal than 0} \tag{3}$$

and

$$VARPositive_t = 0 \text{ ,elsewhere} \tag{4}$$

Conversely negative changes are defined for each bank as:

$$VARNegative_t = VARBank_t \text{ ,if VARBank less than 0} \tag{5}$$

and

$$VARNegative_t = 0 \text{ ,elsewhere} \tag{6}$$

For interpretation of the regression results please note that VARPositive will be either zero or a positive figure, whilst VARNegative will always be negative or zero.

The regression coefficients have all negative signs, consistent with the hypothesis presented in this paper. A negative impact in the equity prices will have a positive impact in the overall yield spread, whilst a positive impact leads to a decrease in the yield spread. There seems to be some evidence of heterokedasticity in these regression, so looking at the roubust specification we see that for Banco Espirito Santo both negative and positive shocks are statistically significant, and the coefficient for negative shocks is larger. This is particularly interesting as Banco Espirito Santo eventually was declared bankrupt and had to be nationalised effectively costing several billion euros to the taxpayers. For BPI and BCP only positive impacts seem to affect the sovereig yield spread. This seems to indicate a channel of transmission that positive impacts lead to a reduced probability of intervention by public authorities thus reducing the likelihood of a public cost. Once again the constant was found to be statistically insignificant which once again supports the idea that there is no fixed component in the changes of the bond yields spread.

Table 2: A model of sovereign yield spread with negative and positive impacts

	Dependent variable:	
	PT_var	
	default	robust
	(1)	(2)
BCP_Negative	-0.316**	-0.316
	(0.156)	(0.276)
BCP_Positive	-0.615***	-0.615**
	(0.176)	(0.240)
BPI_Negative	-0.222	-0.222
	(0.179)	(0.220)
BPI_Positive	-1.264***	-1.264***
	(0.208)	(0.302)
BES_Negative	-1.381***	-1.381***
	(0.177)	(0.282)
BES_Positive	-0.397***	-0.397***
	(0.126)	(0.131)
Constant	-0.003	-0.003
	(0.003)	(0.004)
Observations	3,535	3,535
R^2	0.100	0.100
Adjusted R^2	0.098	0.098
Residual Std. Error (df = 3528)	0.121	0.121
F Statistic (df = 6; 3528)	65.310***	65.310***
Note:	*p<0.1; **p<0.05; ***p<0.01	

4.3 VAR Model

Using the package "vars" in R I have computed the several information criterion to estimate the optimal lag structure. Given that the data is related to daily financial prices that are expected to have low memory and persistence is not surprising that the number of lags is relatively low. For the estimation of the model I have decided to use n = 4. Please check the tables below for the summary statistics.

Table 3: Optimal lag lenght for the several information criterion

AIC(n)	HQ(n)	SC(n)	FPE(n)
7	4	1	7

Table 4: Summary statistics for the several Information Criterion

1	2	3	4	5	6	7	8
-27.397	-27.396	-27.400	-27.435	-27.436	-27.443	-27.443	-27.438
-27.382	-27.371	-27.365	-27.390	-27.381	-27.378	-27.369	-27.354
-27.354	-27.326	-27.302	-27.309	-27.282	-27.261	-27.233	-27.200
0	0	0	0	0	0	0	0

The specific output of the VAR regressions is not particularly relevant for the content of this paper, but it may be checked in the online appendix of the article. Of Particular relevance is the impact that a shock in each of the Portuguese banks (BES, BPI and BCP) has on the bond yield spread. The figures below show the impact that a orthogonal shock in the price of each of the Individual Banks has on the overall yield spread. For all three cases the effect seems to last only up to two weeks (10 trading days).For two of the studied banks (BES and BPI) there seems to exist an effect consistent with this paper hypothesis as a positive shock leads to a lower sovereign yield spread. The case of BCP indicates a effect on the opposite direction. However, for all three cases the impacts confidence intervals are wide enough that make all this results inconclusive.

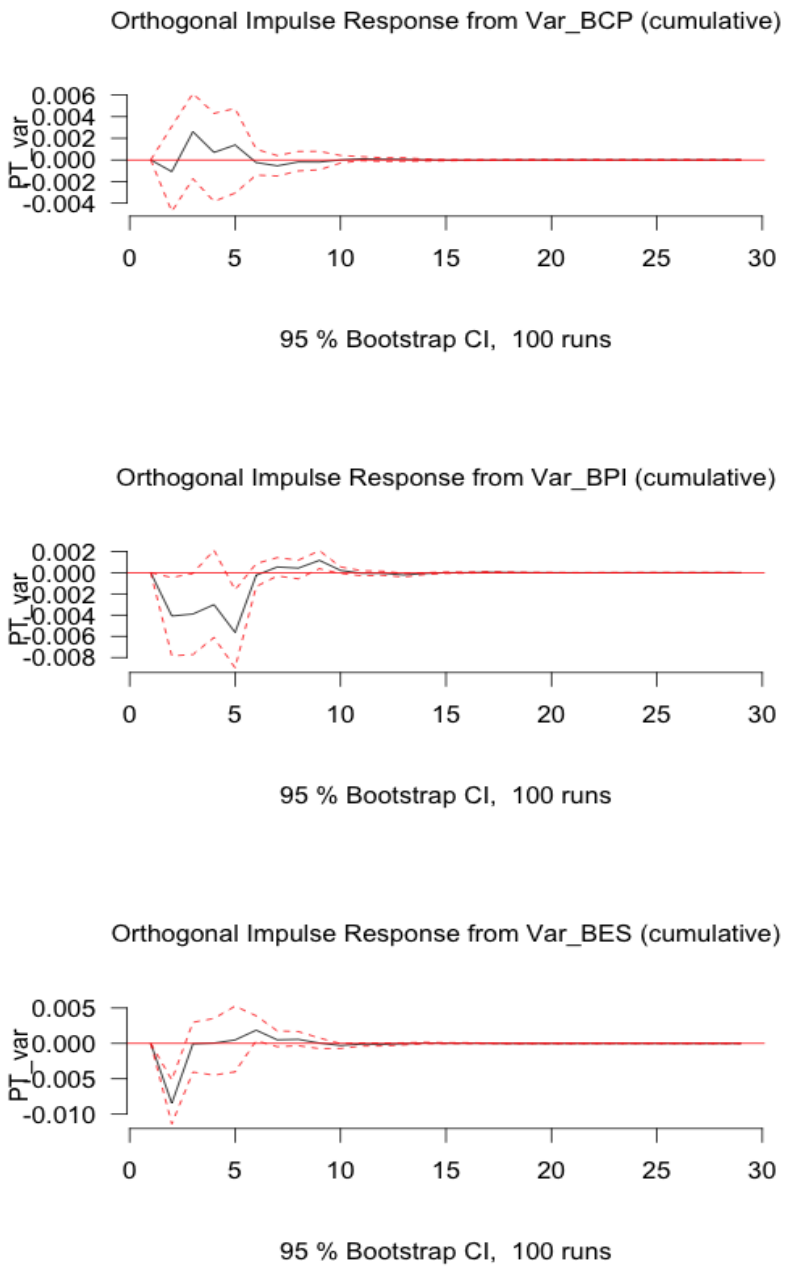

Figure 3: Impulse response functions

4.4 A time series model

The model of section 4.2 by looking only at the contemporaneous effect of the bank equity prices on the Portuguese sovereign yield spread. In this section I develop that model by adding a time-series component. After several iterations to find the optimal lag length I developed a model with only two lags. The results, in the table below, show that the impact of the identified banks are

negative as in the previous models. The only noticeable difference is that the effects from BCP are not statistically significant. But the results from BES and BPI are in the direction expected by my hypothesis and add to the evidence that a negative impact in the financial sector creates a cost to the sovereign yield spread.

Table 5:

	Dependent variable:	
	PT_var	
	default	robust
	(1)	(2)
Lag1_BCP	-0.144	-0.144
	(0.107)	(0.127)
Lag2_BCP	0.125	0.125
	(0.107)	(0.120)
Lag1_BES	-0.340***	-0.340**
	(0.106)	(0.132)
Lag2_BES	0.079	0.079
	(0.113)	(0.135)
Lag1_BPI	-0.260**	-0.260*
	(0.124)	(0.147)
Lag2_BPI	-0.299**	-0.299**
	(0.125)	(0.150)
Constant	0.0004	0.0004
	(0.002)	(0.002)
Observations	3,532	3,532
R^2	0.014	0.014
Adjusted R^2	0.013	0.013
Residual Std. Error (df = 3525)	0.127	0.127
F Statistic (df = 6; 3525)	8.602***	8.602***
Note:	*p<0.1; **p<0.05; ***p<0.01	

4.5 Forecast and a Profitable trading model

The following trading algorithm was implemented after the first 50 observations.

1. With the information available at period t, estimate the model of the previous section by simple OLS.
2. Compute the t+1 forecast
3. If the forecast is of an increase in Yield short the Bond, if it is of a decrease go long the Bond
4. Check the actual realization of the yield at t+1. Add/Subtract the corresponding basis point changes to the strategy profit
5. If t+1 still inside the data set range go back to 1.
6. Finish

   This means that the trading decision are made with an out-of-sample forecast, and this loop estimated over 3,500 regressions (one for each day in the dataset). The idea of this section is not to provide a profitable trading strategy, but using a trading environment as a testing ground of the idea presented in this paper. This exercise does not consider trading costs, liquidity concerns and other situations relevant for a actual trading strategy.

   To provide some context and comparison term I first introduce a naive strategy of always going short the portuguese sovereign yield bond. Not surprisingly this charts mimics the evolution of Figure 1. It generated a profit while the Portuguese bonds were under pressure after 2009, but it generated a loss as the bond yield returned to lower levels.

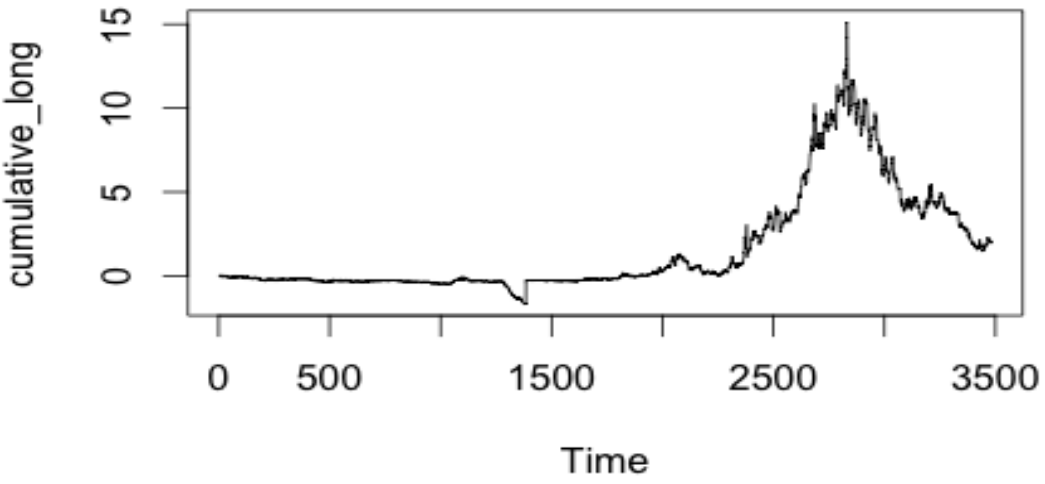

Figure 4: Sum of basis points gained (in % points) by going only short the Bond

A different naive strategy would be to the opposite, to go long the bond every single day. This figure is just the inverse from the previous one and shows that tough it was profitable in the later

periods (as bond prices recovered) it incurred in significant losses during the height of the sovereign bond crisis.

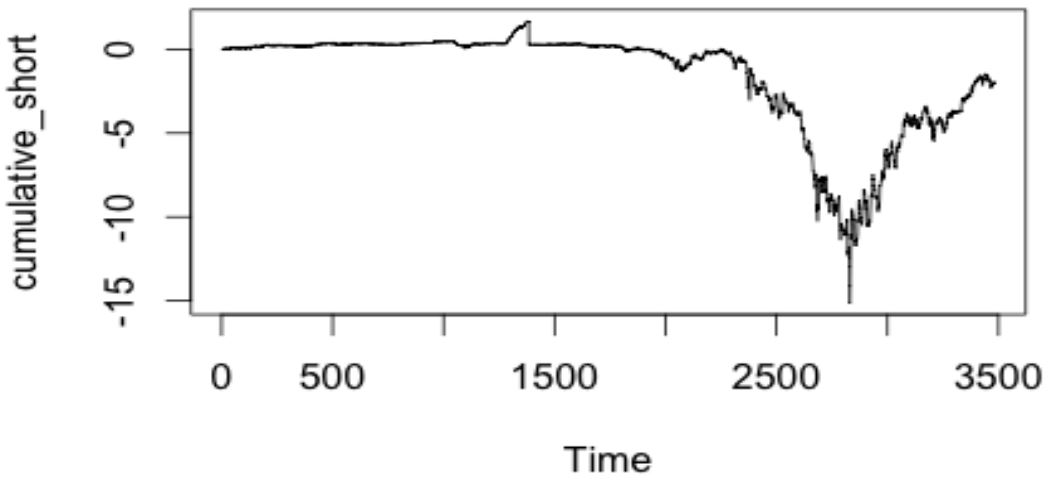

Figure 5: Sum of basis points gained (in % points) by going only Long the Bond

Which lead us to the results of the trading algorithm devised in this section. The basic model, computed iteratively, is the yield spread on the two lags of the individual banks (as seen in the previous section). The model based on the evolution of the equity prices will forecast an increase or decrease of the yield for the following day. A trading decision is then made using that information. The forecasting model seems to pass with distinction the market test. It generates excess returns that are not dependent of the overall trend of the yield spread. It generates profits in the phase of ascending yields, but also once the yields returned to lower levels. Of particular interest is the fact for the first 2,000 days in the sample the trading strategy produces null returns. The profitability of the strategy only starts to be shown from 2009, exactly the moment where the attention of international markets focused on the sovereign yield spread. This result is a strong piece of evidence that the performance of the sovereign yield spread is closely linked (and even determined) by the overall situation of the financial sector.

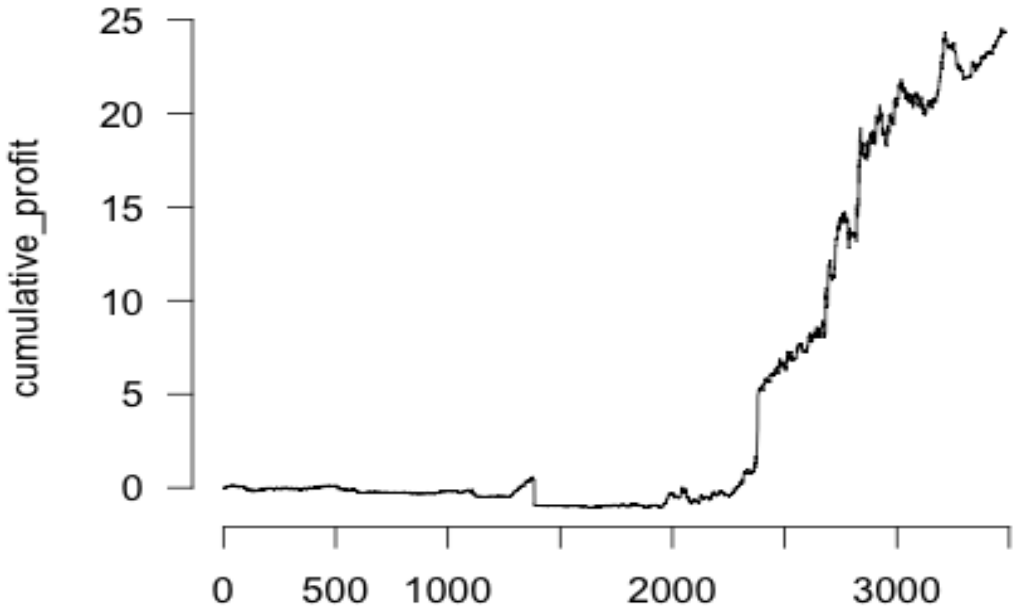

Figure 6: Sum of basis points gained (in % points) by timing the trading direction according to the estimated model

5 Conclusion

This paper presented several empirical models to assess the impact of the financial sector perceived situation on the sovereign yield spread of a country. The analysis focused on Portugal during a period over a decade covering times of tranquility in the financial sector, but also two financial crisis.

The first model simply described the evolution of the sovereign yield spread as the function of the bank equity prices on that same day. This showed that the three main Portuguese banks negatively impacted the yield spread of the Portuguese government. The estimated range showed that a 1% increase/decrease in equity prices of an individual bank would lead to a decrease/increase of 5 to 7 basis points in the sovereign yield spread.

In a second model I addressed the possibility that the nature of the effects might not be symmetric. Meaning, that an increase in the bank's equity prices might have a greater or smaller effect than a decrease. The model decomposed the changes of equity prices into positive and negative effects. The results supported this idea, has for the three banks the effects are different depending on the direction of the movement. But still the main result that bad news in the equity prices are bad news for the yield spread was maintained.

For the third model I decided to add the time series dimension of the dataset. I constructed a VAR model as I acknowledge that sovereign yields are affected by the banks, but also that banks are affected by the sovereign yields. The results from the VAR model suggested that impacts in the prices of banks might impact the sovereign yield spread up to 10 days after the initial shock. The final results show some evidence of negative impacts of bank prices in the overall yield spread,

however given the wide confidence intervals the results are not as conclusive as in the other models.

A fourth model also explored the time-series dynamic of the dataset, specifically for the purpose of forecasting. I developed a model where the change in the sovereign yield spread is a function of 2 lags in the changes in the banks equity prices. Instead in assessing the forecasts with traditional statistical metrics I did something more ambitious. I assessed if the forecasts were capable of generating positive returns in trading the sovereign yield spread. The results were quite conclusive, by running an equation for each trading day I was able to generate a 1 step ahead out-of-sample forecast. Those forecasts generated an astonishing return (excluding transaction costs). The returns are mostly concentrated in the post 2009 period, a period of high volatility in the sovereign yield. This suggests that in the post 2009 period in broader terms the faith of the Portuguese financial sector determined the cost of funding of the Portuguese government.

Overall I presented 4 different approaches to assess the impact of the Portuguese financial sector in the sovereign yield spread. All the models to some extent have showed a non-trivial negative effect. A main result is that a 1% decrease in a single bank might lead to a 5-8 basis point increases in the sovereign yield spread. Also as a financial asset the financial sector shares seem to have worked as a leveraged bet on the Portuguese sovereign yield as it was possible to forecast the return of the Portuguese bonds just looking at the two day returns of the financial sector.

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