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Stress Factor Contagion Among EU Countries

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Work project carried out under the supervision of:

Professor Miguel Lebre de Freitas

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Abstract

In this paper we study contagion effect among the EU yields (Austria, Belgium, Greece, Germany, Finland, France, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Slovakia, Spain and UK), over the period 1999:03-2014:12. We investigate if the fact of one country entering in a period of stress will that affect the other countries' probability of also entering in stress period. We find that, on top of the variation of the global risk and liquidity, changes in the other countries' stress indicator will also explain their stress.

Keywords: Contagion, Stress Factor, Euro Area.

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I. Introduction

In the 2008-2009 international financial crisis, and the aftermath of the Lehman Brothers bankruptcy in autumn 2008, fiscal imbalances increased in most European economies and the euro area in particular. These developments have been followed by a sovereign debt crisis, which started from Greece in autumn 2009 and gradually engulfed the whole of the European Economic and Monetary Union (EMU), particularly the so-called periphery EMU economies. And then in 2010-11 Greece, Ireland and Portugal were all forced to resort to financial rescue schemes. In the second half of 2011 others government bonds came under significant market pressure.

There is a literature¹ studying why does the crisis spread so violent across countries and economic sectors. Contagion is a co-movement above and beyond what can be explained by the fundamentals taking into account their natural evolution over time. Therefore, authors² also was interested on studying the contagion within the countries. There is a studying literature³ that consider the possibility of the “Globalization Hypothesis”, which implies that contagion during the crises hits hardest those economies that are highly integrated globally, specially through trades and financial linkages. The alternative hypothesis states that a crisis initially restricted to one country provides new information that may prompt investor to reassess the vulnerability of other country, which spreads the crisis across markets and borders⁴. And then the last hypothesis is that contagion occurs without discrimination at all, driven by herding behavior or investors’ risk appetite beyond the effect of fundamentals. The hypothesis “Globalization Hypothesis”

¹ See Bekaert et al (2005) for instance.

² See Bayoumi et al (2003) for instance.

³ See Geert Bekaert et al (2011) for instance.

⁴ See Masson, (1999); Goldstein, Kaminsky and Reinhart, (2000)

was rejected contagion by Geert Bekaert et al (2011) since the differences in external exposure instruments, such as trade openness, or financial depth do not explain. So, we will focus on the alternative hypothesis, since the last one is not measurable.

Despite the fact that literature has increasingly focused on the effect of uncertainty on macroeconomic outcomes, (Gourio et al., 2013; Fogli and Perri, 2015) literature about contagion is still limited. In particular, while the VIX—a measure of global uncertainty or global risk aversion—has proved to be an important push factor of international capital flows (Forbes et al., 2012; Fratzscher, 2012; Ahmed and Zlate, 2014; Bruno and Shin, 2014; Passari and Rey, 2015).

Identifying the contagion effect is challenging since it's hard to identify the shock was caused by factor directly or, was it caused by contagion. For example, in the second half of 2011 Spanish and Italian government bonds came under significant market pressure, was it caused by the Lehman Brothers bankruptcy in autumn 2008, or by sovereign debt crisis, which started from Greece in autumn 2009. We overcome this challenge by creating a stress factor for each country that reflects their stress period, and also including the VIX (as a Global risk measure), with that we expect to measure as much as possible all the factors but the contagion.

In this paper we employ the 16 of the Europe countries (Austria, Belgium, Greece, Germany, Finland, France, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Slovakia, Slovenia, Spain and UK) then we assess the role of an extended set of potential spreads' determinants namely international risk (VIX) and liquidity conditions. This paper will contribute to this literature by providing the possibility of contagion within EU countries.

The remaining paper is organized as follow. In Section II proposes an interpretation for the phenomenal at model what may the contagion to happen. Sector III describes the yields rates together with data on global risk and liquidity and explains the econometric methodology used in this paper to identify the contagion within the countries. Section IV presents the data used. Sector V presents the main results and sector VI concludes.

II. Herd Behavior

It's also important to know why the contagion may be happening and here is a theory that has a really interesting way to explain how and why the contagion may happen. Our decision making is often influenced by the decisions that were made by the other people around us, and this model will exactly explain the reasons behind that (Banerjee, 1992).

This theory will set as what everyone else is doing is rationale, and their decisions may reflect information that they have, and we do not. Then it turns out that a likely consequence of people trying to use this information, and we call this herd behavior which is known as when you choose to do something that everyone is doing, even that your private information suggests something different.

In this situation we may even say that one country may enter in stress, because people see that there is a country that just entered in stress, so they act differently even though that there is no private information saying that the own country will enter in stress. But due to those people acting differently, that may actually cause the own country entering in stress.

So, in other words we are able to say, due to a stress that is happening in a country may cause a stress in other country, and vis-versa. However, as

“Barnerjee, 1992” as concluded, it’s difficult to distinguish the effects of macroeconomic and the other fundamental determinants from those caused by herd behavior.

III. Empirical Framework

To study the contagion within EU countries, we need to measure the default risk. The default risk represents the returns they are demanding to buy instead for a safer bond.

$$DR_{it} = Yields_{it} - Eurepo_t$$

EUREPO index is the benchmark for secured money market transactions in the euro area. So, we consider the EUREPO index will represent the returns for the safer loan. For that we subtracted the Eurepo index from the 10 years government bonds of each country.

DR_{it} is the default risk from the country i on time t . Then the $Yields_{it}$ represents the 10 years government bonds of the same country on time t . And finally, the $Eurepo_t$ is the Eurepo index on time t .

We compute the moving average and the standard deviation. Then we find the period where that fulfill the both criteria: the countries’ yields after we subtracted the benchmark lies at two standard deviation above the moving average; then the episode of stress starts when it lies at one standard deviation above the moving average, and only end when it reverts back to the mean.

Since the yields on sovereign bonds within the EMU are extremely correlated among them, there would lead to a conflicting result. To overcome these problems our model is based on the construction of an indicator that will reflect the stress in sovereign debt markets. Following Calvo et al. (2004) a

dummy factor which will represent, if the country is in a stress period were computed.

IV. Data

For the risk aversion factor, we used the Chicago board of exchange index (VIX), as an explanatory variable, to measure the global risk. And for the liquidity, since we were working on the Eurozone countries, we decided to use the Eurepo index. So, here we have the push factors for each country. And there will have no pull factors since we will run the regression of each country separately.

As our main source we used the “Reuters” to extract the 10 years daily government bonds for each country in study (Austria, Belgium, Greece, Germany, Finland, France, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Slovakia, Spain and UK), over the period 1999:03-2014:12. These rates will provide information about the respective countries’ financial. 10 years yield is used as a proxy for mortgage rates. It’s also seen as a sign of investor sentiment about the economy.

Also, that VIX is the Chicago board of exchange volatility index were extracted from the boomerang, over the period 1999:03-2014:12, which will represent as a measure of global risk. VIX is a real-time index that represents the market’s expectations for the relative strength or near-term changes of the S&P 500 index. And finally, “Eurepo” were extracted from EMMI, over the period 2002:03-2014:12 that we are using as benchmark liquidity.

The stress period must contain at least one observation (in our case one day, since we are using daily data) where the countries’ yields lies at least two

standard deviations above the moving average.⁵ But the episode starts when it lies at one standard deviation above the moving average. The episode will only end when it reverts back to 1 standard deviation from the mean.

$$Moving\ average_t = \frac{\sum_{i=1}^N (Yields_{i-180})}{N}, N = 360$$

$$Standard\ Deviation_t = \sqrt{\frac{\sum_{i=1}^N (Yield_{i-180} - Moving\ average_t)^2}{N}}$$

With this we create a dummy variable that takes value one if the country is in a stress period and zero otherwise.

Table 1.1 represents the average of the number of times that each country was in stress period. We can see that there are a few countries that has a much higher percentage of stress factor such Malta, Slovakia and Slovenia, but their values maybe biased, since they have a much lower number of observations, that was caused for not having all their 10 years government bonds yields information. As we can see they has a different sample period, for instance Malta we only have available data starting from 02:2008. Then, if we do not count with the countries that has a really low number of observations, we notice that the countries represent with the highest average number of stress factor were Austria, Greece, Ireland, Italy and Spain. France, Germany and Netherlands are outstanding for having the lowest average of number of stress factor, and it coincides that they normally are considered as the core economies in Europe.

⁵ The moving average and the standard deviation were computed with a one-year period yields.

Average of Stress Factor for each country using Eurepo as benchmark			
Table 1.2	Obs.	Sample Period	(360)
Austria	3137	03:2002/12:2014	13%
Belgium	3283	03:2002/12:2014	9%
Finland	3251	03:2002/12:2014	8%
France	3282	03:2002/12:2014	7%
Germany	3269	03:2002/12:2014	7%
Greece	3238	03:2002/12:2014	14%
Ireland	2909	03:2002/12:2014	17%
Italy	3262	03:2002/12:2014	12%
Lithuania	2961	01:2003/12:2014	9%
Malta	1100	02:2008/12:2014	29%
Netherlands	3290	03:2002/12:2014	6%
Portugal	3278	03:2002/12:2014	9%
Slovakia	1264	05:2007/12:2014	36%
Slovenia	1737	04:2007/12:2014	33%
Spain	3276	03:2002/12:2014	10%
UK	3251	03:2002/12:2014	8%

Source: Own calculations.

Notes: the table displays the percentage of time that the country was in Stress Period for each country. Stress Factor were computed by using the countries' yields moving average and standard deviation.

After the stress factor had been computed we looked at their correlation so that we can make sure that there is any type of linear relationship (positive or negative) between them. The table 2 shows the correlation between the countries' stress factor. And as take a deeper look on the values there no evidence of a linear relationship between the countries' stress factor.

(Table 2)

Only then, we looked for the countries that we want to study and try to look for the countries that they were affected by. Our dependent variable it's

a dummy variable so we will use a probit model. For each country we will run the following regression, where the country's stress factor in study will be regressed using three other countries' stress factor, using combination 3 by, until all the combination possible are regressed. VIX was also included in the model to measure the uncertainty caused by the global risk.

$$P(SF_{it} = 1 | VIX_t, SF_{jt-1}, SF_{kt-1}, SF_{lt-1}) = \Phi(\beta_1 VIX_t + \beta_2 SF_{jt-1} + \beta_3 SF_{kt-1} + \beta_4 SF_{lt-1})$$

Where $i \neq j \neq k \neq l$ (which identify all the countries in study)

Our dependent variable is the Stress factor that I have already referred above SF_{it} and i denominates for country in study at time t . $SF_{k,t-1}$ is the other countries' stress factor, at time $t - 1$. Then by looking at their significance we will study if is there any contagion between them. So, we will know if the fact of country j, k, l entering in stress period is that significant at explaining our dependent variable. For that we run all the possible combinations (3 by 3) and made the OLS regression and looked at each of them and their significance. And that's 455 regressions for each country.

V. Results

Table 3.1 shows the percentage of the country's stress factor that was significant at explaining the dependent countries' stress factor, as we run the regression above. As we can see there are two groups that highlights. Which normally called as the periphery group and the core countries group.

Portugal, Ireland, Italy and Spain these groups most of them are known as periphery countries within the Europe. We can see that there is contagion within them, what happens in one country is highly explanatory for other countries status. And these countries are exactly the countries that were worst hit during the Eurozone crisis.

Taking Portugal to a deeper study we can see that Ireland, Italy and Spain, their stress factor (at time $t-1$) are always significant at explaining the Portugal stress (at time t). And notice that this table indicate significance at 1%. And also, really important is that there are no core countries, such as Germany and UK, being significant at explaining the Portugal stress factor, as we can see that Germany was only 3% significant at explaining the Portugal. With this there is a possibility that when the crisis hit the core countries it will ends there.

Same for the other countries from the periphery group. Their stress was also explained by themselves. And none of the core countries represented to be significant at explaining the periphery's countries' stress factor.

However, there is also another group that were found, that's Germany, Austria, Finland, France, Netherlands and UK, which basically is consisted by the EU core countries, here they also have a strong relation between them. In other words, it means that one of these countries entering in stress will increase the chance of another country in this group to also enter in stress period. So, it is suggesting that there is contagion within them.

Here we will use Germany to look deeper relations. Countries that were always significant here were Austria, Finland, France, Netherlands and UK. With this we can say that there is not only contagion within the periphery countries but also within the core countries.

And just one another fact is that the periphery countries had almost nothing to do with the core countries entering in stress time, at least not directly. As the data shows us periphery countries had almost no significance at explaining the stress factor of these core countries.

(Table 3.1)

Now we will take a look at table 3.2 since 1% critical value may actually omit some important facts too. Here we changed to 5% critical value so that we could see if there were other countries that may be excluded from the groups since we were using a too strong restriction. There was no evidence of any existing country that were excluded from the groups, only a stronger evidence of these group being interconnected. For example, that at 1% Greece were only 84% significant at explaining the Spain's stress factor but if we use 5% as critical value it increases to 91%. There was also no evidence of an existing 3rd group.

(Table 3.2)

Table 5, that shows us how many times the coefficient was negatively significant at 1%. In other words the other countries' stress factor coefficient is negative, which means that the fact of that country entering in stress that will actually decrease the chance of the country entering in stress and there is one country that highlights and that's Greece. Greece Stress factor had a 100% rate at explaining the Germany's stress factor and a really notable high rate at explaining the UK's stress factor. When all the rest remained at a really low rate. This may be explained by the fact when people

see one country entering in stress, they will choose a safer asset to invest such as Germany government bonds or UK, since both seems to be really safe investment, also known as the “portfolio rebalancing effect”

(Table 4)

VI. Conclusion

This paper will contribute to this literature by testing the possibility of contagion among sovereign bonds of EU countries. Unlike the most of studies that focused on the effect of uncertainty on macroeconomic outcomes (in particular VIX), we assume that VIX is the uncertainty caused by the global risk, since its already proved to be an important push factor of international capital.

The results suggest that is contagion in the two groups of countries. One of the periphery countries that enter in stress will affect the countries within the group. But we can't say that it will spread around to the core countries, at least not directly. And is also true when the core countries enter in stress that will make all the other core countries more vulnerable to the stress, so in other words we can say that the core countries its harder to enter in stress, but as soon as it enters is really likely that all the other core countries will also enter in stress.

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Table 2.1

Correlation Table

	Austria	Belgium	Greece	Germany	Finland	France	Ireland	Italy	Lithuania	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain	UK
Austria	1															
Belgium	0.64	1														
Greece	-0.08	0.00	1													
Germany	0.75	0.74	-0.06	1												
Finland	0.81	0.71	-0.08	0.73	1											
France	0.59	0.73	0.00	0.66	0.69	1										
Ireland	0.32	0.45	0.30	0.30	0.34	0.41	1									
Italy	0.34	0.57	0.16	0.39	0.45	0.58	0.54	1								
Lithuania	0.09	0.16	-0.05	0.06	0.16	0.18	0.24	0.20	1							
Malta	0.42	0.46	0.01	0.38	0.41	0.48	0.36	0.51	0.25	1						
Netherlands	0.74	0.83	-0.07	0.75	0.76	0.75	0.42	0.56	0.15	0.47	1					
Portugal	0.23	0.41	0.17	0.23	0.25	0.44	0.53	0.63	0.29	0.43	0.38	1				
Slovakia	0.40	0.52	0.09	0.40	0.42	0.47	0.45	0.49	0.27	0.50	0.54	0.39	1			
Slovenia	0.27	0.27	0.18	0.21	0.24	0.32	0.39	0.41	0.27	0.39	0.30	0.35	0.36	1		
Spain	0.40	0.53	0.21	0.37	0.40	0.48	0.53	0.63	0.21	0.42	0.51	0.49	0.39	0.46	1	
UK	0.50	0.45	-0.13	0.47	0.46	0.47	0.15	0.37	0.03	0.39	0.52	0.32	0.38	0.16	0.20	1

Source: Own Calculations

Notes: The table displays the results of a correlation between the stress factor of each country

Table 3.1: The percentage of times that each country's stress factor was significant (1%) at explaining the country's stress factor in study.

	1% Significant (Positive)															
	Austria_t-1	Belgium_t-1	Greece_t-1	Germany_t-1	Finland_t-1	France_t-1	Ireland_t-1	Italy_t-1	Lithuania_t-1	Malta_t-1	Netherlands_t-1	Portugal_t-1	Slovakia_t-1	Slovenia_t-1	Spain_t-1	UK_t-1
Austria		100%	0%	100%	100%	99%	65%	56%	3%	91%	99%	42%	51%	27%	97%	100%
Belgium	100%		0%	98%	100%	100%	87%	100%	7%	85%	100%	78%	100%	4%	78%	98%
Greece	0%	0%		0%	0%	18%	100%	97%	0%	4%	11%	99%	1%	98%	91%	0%
Germany	100%	96%	0%		100%	100%	2%	31%	1%	88%	100%	7%	99%	0%	53%	100%
Finland	100%	99%	0%	100%		100%	8%	29%	1%	56%	100%	5%	60%	3%	63%	99%
France	100%	100%	20%	100%	100%		70%	86%	1%	100%	100%	67%	89%	48%	100%	100%
Ireland	68%	93%	100%	5%	9%	78%		100%	68%	32%	20%	99%	82%	98%	100%	1%
Italy	57%	100%	98%	30%	26%	87%	100%		63%	100%	81%	100%	99%	100%	100%	9%
Lithuania	0%	42%	0%	1%	1%	1%	67%	65%		0%	10%	10%	87%	86%	1%	1%
Malta	91%	85%	0%	85%	49%	100%	7%	100%	0%		81%	82%	100%	100%	96%	100%
Netherlands	100%	100%	8%	100%	100%	100%	14%	87%	5%	77%		37%	95%	21%	98%	99%
Portugal	46%	64%	100%	3%	3%	60%	100%	100%	12%	77%	43%		96%	51%	100%	12%
Slovakia	45%	100%	0%	98%	60%	82%	69%	92%	100%	100%	97%	91%		8%	7%	97%
Slovenia	29%	15%	100%	0%	1%	31%	96%	100%	86%	100%	19%	51%	23%		97%	2%
Spain	84%	80%	84%	52%	57%	99%	100%	100%	7%	95%	95%	99%	19%	97%		16%
UK	100%	92%	0%	100%	98%	100%	1%	15%	1%	100%	99%	7%	95%	2%	14%	

Source: Own calculation

Note: Table display the percentage of times that the stress factor of one country was significant at explaining the other country's stress factor in study. And the red color means that it was above 95% significant and green one means there was not even once significant at explaining it.

Table 4: The percentage of times that each country's stress factor was significant (1%) with a negative sign at explaining the country's stress factor in study.

	1% Significant (Negative)															
	Austria_t-1	Belgium_t-1	Greece_t-1	Germany_t-1	Finland_t-1	France_t-1	Ireland_t-1	Italy_t-1	Lithuania_t-1	Malta_t-1	Netherlands_t-1	Portugal_t-1	Slovakia_t-1	Slovenia_t-1	Spain_t-1	UK_t-1
Austria	0%	0%	70%	0%	0%	0%	2%	8%	62%	0%	0%	2%	0%	4%	0%	0%
Belgium	0%	0%	46%	0%	0%	0%	0%	0%	10%	0%	0%	0%	0%	0%	0%	0%
Greece	68%	47%	0%	97%	65%	15%	0%	0%	0%	7%	31%	0%	5%	0%	0%	97%
Germany	0%	0%	100%	0%	0%	0%	56%	10%	68%	0%	0%	36%	1%	37%	4%	0%
Finland	0%	0%	77%	0%	0%	0%	35%	4%	0%	0%	0%	10%	0%	10%	0%	0%
France	0%	0%	14%	0%	0%	0%	0%	1%	23%	0%	0%	0%	0%	0%	0%	0%
Ireland	1%	0%	0%	44%	29%	0%	0%	0%	0%	8%	23%	1%	0%	0%	0%	68%
Italy	7%	0%	0%	12%	11%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	34%
Lithuania	46%	7%	0%	76%	1%	32%	0%	0%	0%	10%	7%	0%	0%	0%	32%	95%
Malta	0%	0%	9%	2%	1%	0%	13%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Netherlands	0%	0%	30%	0%	0%	0%	21%	0%	10%	0%	0%	2%	1%	1%	0%	0%
Portugal	0%	0%	0%	30%	14%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	2%
Slovakia	1%	0%	8%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	4%	0%
Slovenia	8%	0%	0%	26%	18%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	9%
Spain	0%	0%	0%	3%	0%	0%	0%	0%	30%	0%	0%	0%	0%	0%	0%	30%
UK	0%	0%	96%	0%	0%	0%	81%	21%	93%	0%	0%	16%	0%	10%	32%	0%

Source: Own calculation

Note: Table display the percentage of times that the stress factor in one country was significant with a negative sign at explaining the other country's stress factor in study. And the red color means that it was above 95% significant. Green one means there was not even once significant at explaining it.

Table 3.2 The percentage of times that each country's stress factor was significant (1%) at explaining the country's stress factor in study.

	5% Significant (Positive)															
	Austria_t-1	Belgium_t-1	Greece_t-1	Germany_t-1	Finland_t-1	France_t-1	Ireland_t-1	Italy_t-1	Lithuania_t-1	Malta_t-1	Netherlands_t-1	Portugal_t-1	Slovakia_t-1	Slovenia_t-1	Spain_t-1	UK_t-1
Austria		100%	0%	100%	100%	100%	69%	66%	3%	96%	99%	53%	59%	40%	97%	100%
Belgium	100%		0%	99%	100%	100%	91%	100%	20%	86%	100%	84%	100%	16%	81%	98%
Greece	1%	0%		0%	0%	26%	100%	99%	0%	15%	14%	99%	7%	98%	96%	0%
Germany	100%	98%	0%		100%	100%	3%	40%	1%	91%	100%	8%	99%	0%	56%	100%
Finland	100%	100%	0%	100%		100%	8%	36%	4%	70%	100%	8%	79%	7%	76%	100%
France	100%	100%	30%	100%	100%		79%	91%	2%	100%	100%	79%	93%	66%	100%	100%
Ireland	75%	97%	100%	7%	11%	81%		100%	93%	44%	23%	99%	91%	99%	100%	2%
Italy	63%	100%	99%	34%	32%	90%	100%		75%	100%	87%	100%	99%	100%	100%	13%
Lithuania	0%	55%	0%	1%	5%	1%	88%	84%		1%	18%	14%	100%	90%	5%	1%
Malta	95%	87%	5%	89%	54%	100%	21%	100%	3%		95%	97%	100%	100%	98%	100%
Netherlands	100%	100%	14%	100%	100%	100%	19%	91%	12%	88%		41%	96%	32%	98%	100%
Portugal	56%	77%	100%	7%	3%	71%	100%	100%	13%	86%	54%		97%	62%	100%	18%
Slovakia	52%	100%	2%	100%	77%	87%	84%	97%	100%	100%	98%	95%		25%	21%	99%
Slovenia	40%	26%	100%	1%	8%	47%	98%	100%	86%	100%	30%	60%	56%		99%	4%
Spain	89%	82%	91%	57%	59%	99%	100%	100%	13%	97%	97%	99%	31%	99%		21%
UK	100%	92%	0%	100%	100%	100%	1%	19%	1%	100%	100%	9%	97%	4%	19%	

Source: Own calculation

Note: Table display the percentage of times that the stress factor of one country was significant at explaining the other country's stress factor in study, with 5% significant. And the red color means that it was above 95% significant and green one means there was not even once significant at explaining it.