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Comparing systemic risk in European government bonds and national indices

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Abstract

It has been shown, that the systemic risk contained in financial markets can be indicated by the change of cross-correlation between different indices and stocks. This change is tracked by using principle component analysis (PCA). We use this technique to investigate the systemic risk contained in European economy by comparing government long term bonds and indices.

1 Introduction

The inability to refinance their sovereign debts of some European states and the outbreak of the financial crisis in 2008 led in 2010 to the still ongoing European sovereign debt crisis. To stabilize the markets and give incentives to invest in Europe, the European Union implemented the European Financial Stability Facility (EFSF) and later the European Stability Mechanism (ESM). Heavily indebted European nations can use these tools to refinance their government debt.[1] The utilization of this bailout support has to be accompanied by fiscal consolidation, reforms and privatization of public goods.[8]

Recent studies have shown, that principle component analysis (PCA) is a viable tool to monitor the systemic risk[14, 2, 6, 11, 12]. Zheng et al. have used the first eigenvalues of the cross-correlations of returns of different stock indices and stocks to reveal the rise in systemic risk, that lead to the financial crisis in 2007. In financial correlation matrices the first eigenvalue dominates. This shows that most of the information is contained in the largest eigenvalue and its eigenvector. Smaller eigenvalues are typically in the random regime and therefore carry less information of the system, but are not pure noise.[1][13, 7]

Furthermore we compare government bonds with national stocks indices and see, that government bonds react show an earlier but not so distinct rise in systemic risk than stocks indices.

2 Results

We analyzed the principle components λ^i of the correlations between European government bonds in moving time windows with 12 and 24 months. In figure 1 it can be observed, that the rise in the first principle component strongly depends on the chosen time window, as was already reported by [14]. Graph a) and b) have its steepest rise in λ^1 in July 2010 and indicate the beginning of the European debt crisis. It can also be seen, that the first eigenvalue increases in May 2007. This corresponds to the financial crisis, that started in December 2007 in the USA and took some time to spread to Europe.

[1] see Figure 1, Figure 2

The lower figures of 1 show the time derivation of λ^1 and it's CARS. For the 12 months time window we can see, that the CARS (see 5.2) did not decrease to low values after 2013. In the lower right figure the 24 months time window both the CARS and the derivation show an alarming rise at the end of the year 2014, which is also the end of our available data at the moment. Note that the arrows labeling the finance crisis 2008 and 2011 refer to the dates of a strong rise in λ^1 in the analysis for the national stocks indices as seen in figure 2.

Figure 1: Upper figures: Principle component analysis of the monthly returns of European government bonds in a 12 months (left) and a 24 months(right) moving time window. Note that λ^2 to λ^4 actually represent the sum of the all previous components and themselves. Lower figures: Derivation of λ^1 and its conditional average rolling sum for a 12 months (left) and a 24 months (right) moving time window.

Figure 2 depicts the same analysis for European national stocks indices. The change of the eigenvalues is much more distinct than for the government bonds. But for the 12 months time window (a) the rise for the finance crisis in 2008 happens a little bit later than for the government bonds in the previous figure. It can also be observed, that λ^1 of the stocks indices decreases for both time windows, when the bonds had their maximum increase (denoted by the arrow with dept crisis). But the highest rise in λ^1 corresponds to the financial crisis that followed the dept crisis. The conditional averaged rolling sum CARS of the stocks indices shows, like the CARS of the

bonds, a strong rise at the end of 2014. Note that the end of data is in the beginning of 2015, not in the end of 2014, like in data for the bonds.

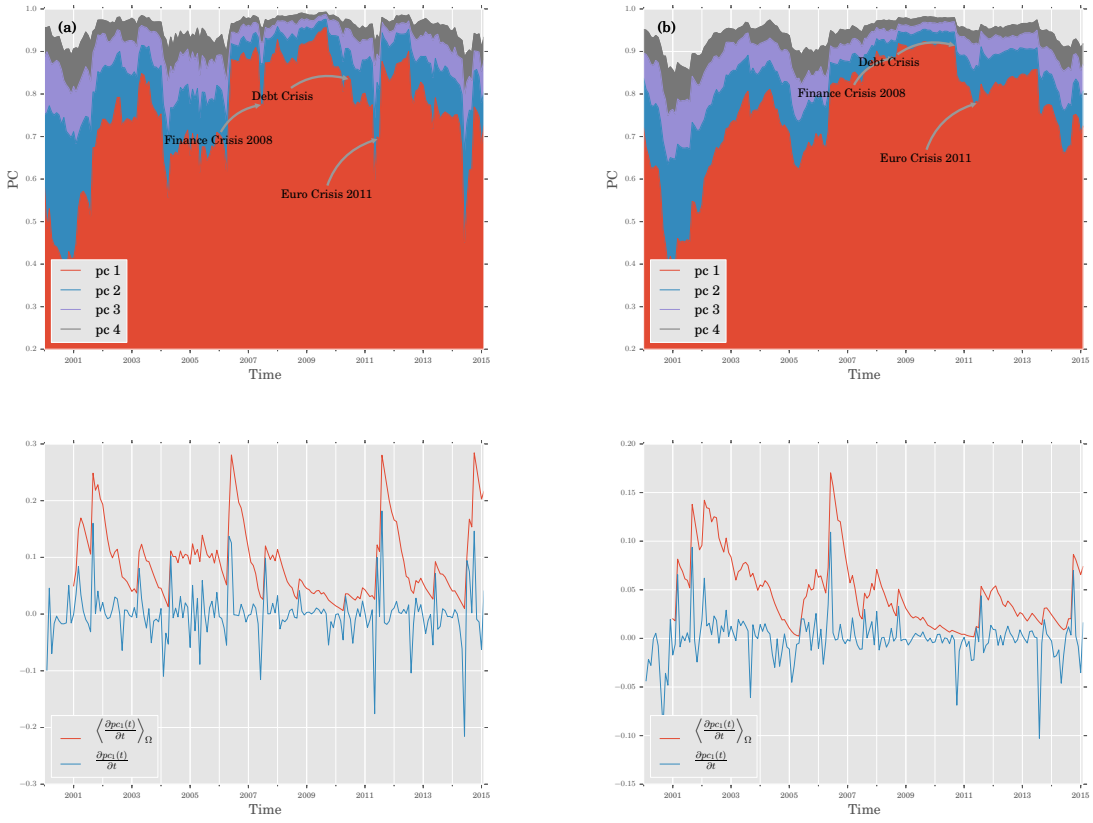

Figure 2: Upper figures: Principle component analysis of the monthly returns of European national indices in a 12 months (left) and a 24 months (right) moving time window. Note that λ^2 to λ^4 actually represent the sum of the all previous components and themselves. Lower figures: Derivation of λ^1 and its conditional average rolling sum for a 12 months (left) and a 24 months (right) moving time window.

Comparing the normalized CARS of European bonds and indices in figure 3, we illustrate the fact that the increase in bond risks takes place as a first sign of an upcoming crisis. The surge in CARS of the bonds manifests in December 2010. The financial markets react up on the crisis nine months later in September 2011 for the time window of one year.

The same behavior is visible in the two year time window. After aftermath of the financial crisis, the CARS of bonds drops almost to zero, showing no apparent risk within. But in December 2010 a sudden increase is observed, which can be connected to the beginning of the European debt crisis.

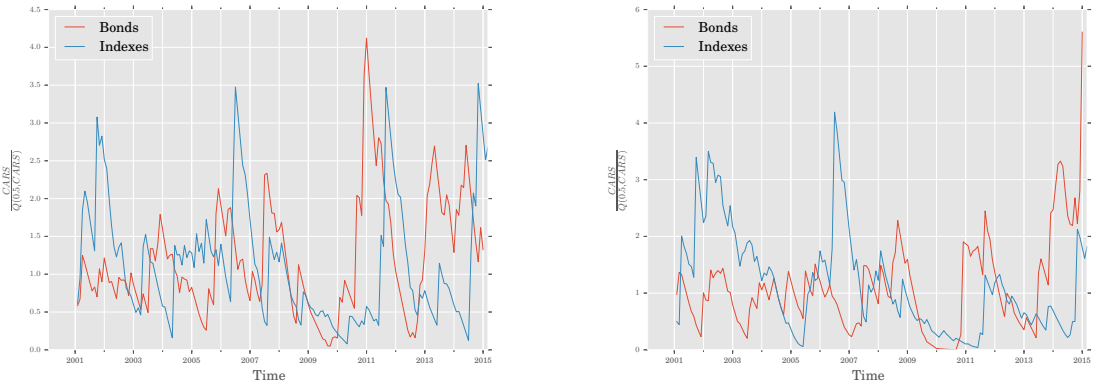

Figure 3: This figure shows the CARS of bonds and indices for 12 and 14 months time windows (left and right) . Note that the CARS was normed to the respective median.

3 Discussion

A rise in the largest eigenvalue corresponds to a rise in the systemic risk, because the eigenvalue explains most of the variation in data [14]. There is a distinct rise in λ^1 in 2008 for both the European government bonds and the European national stocks indices. This shows the connection in Europe between the financial crisis and the dept crisis. Kaminsky et al. already observed that a banking crisis can lead to currency crisis.[5] An interesting fact is, that the bonds react earlier than the stocks indices. Only the bonds show the higher systemic risk, that originates from the fear of sovereign debt defaults surfaced in late 2009 [3], which eventually lead to a consecutive financial crisis in 2011. We see that the CARS of the government bonds has risen in 2013 and holds high values since then. We hypothesize, that sovereign bailout tools like the European Stability Mechanism, which was ratified in the last quarter of 2012[4], coupled the fiscal budget of the European states more tightly and this is reflected in the CARS. Furthermore a alarming increase in the CARS of the indices and the bonds (in the 24 months time window) can be observed in December 2014. We assume that this surge can be associated with recent political uncertainties.

4 Conclusion

We showed that the method used in [14] to indicate the rise in systemic risk, leading to the financial crisis of 2008, can also be used to indicate the European debt crisis. The start of the Euro crisis can be seen by applying principle component analysis to European government bonds, while its impact on the financial markets can be tracked using national stock indices instead of bonds. We introduced the conditional average rolling sum (CARS), which gives distinct spikes indicating a strong rise in correlation. The CARS shows alarming values since 2013 and a very steep surge in the end of 2014. This leads us to the conclusion, that the European debt crisis, despite its unusual duration in terms of a financial crisis[10], it is not subsiding but an ongoing process with an uncertain outcome.

5 Appendix

5.1 Data

We used the website https://research.stlouisfed.org/fred2/, which offers data for economic research. In table 5.1 the symbols for the long-term government bonds are listed.

Country	FredSymbol
Greece	IRLTLT01GRM156N
Germany	IRLTLT01DEM156N
Switzerland	IRLTLT01CHM156N
Spain	IRLTLT01ESM156N
Great Britain	IRLTLT01GBM156N
Italy	IRLTLT01ITM156N
Euro Area	IRLTLT01EZM156N
France	IRLTLT01FRM156N
Dennmark	IRLTLT01DKM156N
Norway	IRLTLT01NOM156N
Poland	IRLTLT01PLM156N
Luxenbourg	IRLTLT01LUM156N
Portugal	IRLTLT01PTM156N
Sweden	IRLTLT01SEM156N
Czech Republic	IRLTLT01CZM156N
Austria	IRLTLT01ATM156N
Irland	IRLTLT01IEM156N
Netherlands	IRLTLT01NLM156N
Slovak Republic	IRLTLT01SKM156N
Slowenia	IRLTLT01SIM156N
Belgium	IRLTLT01BEM156N
Finnland	IRLTLT01FIM156N
Iceland	IRLTLT01ISM156N

Table 1: Fred symbols for European long term bonds[9]

country	Yahoo Symbol
Greece	GD.AT
Dennmark	OMXC20.CO
Austria	^ATX
Belgium	^BFX
France	^FCHI
Great Britain	^FTSE
Germany	^GDAXI
Euro Zone	^STOXX50E
Switzerland	^SSMI

Table 2: Yahoo symbols for the major European Indexes

Table 5.1 shows the yahoo ticker symbols of the major European indexes.

5.2 Method

The conditional averaged rolling sum $CARS$ is defined by

$$\left\langle \dot{\lambda^1} \right\rangle_{\Omega}^{\dot{\lambda}(t)>0} = \frac{1}{|\Omega|} \sum_{\omega \in \Omega} \sum_{\substack{t \in \omega \\ \dot{\lambda}(t)>0}} \dot{\lambda}(t) \tag{1}$$

where λ^1 is the first principal component of the correlation matrix $C(t)$ at time t for the time frame $\omega = \{t' | t - \Delta \leq t' \leq t\}$. In our case, we choose a set of ω with different time lags $\Delta = 1, 2, ..., 12 month$. In general the CARS $\langle \cdot \rangle_{\Omega}^{\texttt{cond.}}$ can be used to identify time-dependent events of importance and reveal their memory effects. The advantage of CARS is that past events are not forgotten and bubbles, which are usually building up over a period of time, can be detected.

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