Contagion in CDS, Bank and Equity Markets

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Outline of the Presentation

1. Motivation
2. Objectives
3. Contribution
4. Data
5. Methodology
6. Empirical results
7. Conclusions

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Motivation

- Recent financial crises had their effects spread to most of the world
  - The *Global Financial Crisis*
    - From the collapse of the subprime market in the USA to a world-wide crisis
  - The *European Sovereign Debt Crisis*
    - From the fiscal problems of the Greek government to most of the world

- The study of contagion and the volatility of worldwide financial markets are important for regulatory authorities because of their impact on Financial Stability

- Most of the contagion testing frameworks rely on crisis dates, but such dates are usually defined exogenously from the test models.

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Objectives

•Propose a procedure for contagion testing, which does not rely on an exogenous or arbitrary crisis dating.

•Using this procedure, show that it can identify the periods in recent crises when contagion was strongest.

•Apply this procedure in testing for contagion to both recent crises and verify their results to Brazil.

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Contribution

Main contributions:

1.Development of a procedure for endogenous contagion testing – defining the timing of the crisis;

2.Show an application of the procedure to a wide range of countries and markets;

3.Analysis of the impact of the recent crises to the Brazilian economy.

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Data

- We tested for contagion across three channels:
  - o The banking system:
    Data Stream Bank Sector index
  - o Country equity market:
    MSCI standard country index
  - o CDS spreads:
    Thomson Reuters Sovereign CDS (Snr 5y)

- The period analyzed is from January 2006 to October 2011.
  GFC crisis period: January 2008 to December 2009;
  European sovereign debt crisis period: December 2009 to October 2011.

- Exogenous variables:
  - Daily *US Federal Funds Rate*
  - Commodities - *CRB Total Return index*.

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Testing for contagion

- Three tests for contagion
  - Correlation-Based
    - *FR statistic*
  - *Coskewness-based*
    - *CS1* and *CS2* statistics

- Correlation contagion:
  - If the prices of market *i* falls, the prices of market *j* also fall in a way that is more correlated to j than expected.

- Coskewness contagion:
  - Risk-averse agents prefer positive skewness (Kraus and Litzeberger, 76)
  - In a crisis coskewness of *i* and *j* will increase more than expected as risk averse agents trade-off lower returns for positive skewness

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Methodology – Correlation *FR* test

- The correlation-based testing for contagion used follows the proposal by Forbes and Rigobon (2002) as modified by Fry et al. (2008).

$$FR(i \rightarrow j) = \left(\frac{\upsilon_c - \rho_{pre}}{\sqrt{Var(\upsilon_c - \rho_{pre})}} \right)^2 \qquad \upsilon_c = \frac{\rho_c}{\sqrt{1 + \delta(1 - \rho_c^2)}} \qquad \delta = \frac{s_{c,i}^2 - s_{pre,i}^2}{s_{pre,i}^2}$$

- Where:

υ_c = The correlation of the crisis period adjusted for the greater volatility of the crisis period;

ρ_c and ρ_{pre} = The correlations between i and j in the crisis and pre-crisis periods;

$s_{c,i}^2$ and s_{pre}^i = The variances of i in the crisis and pre-crisis periods respectively;

T_c and T_{pre} = The number of observations in the crisis period and the number of observation in the pre-crisis period.

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Methodology –Coskewness - *CS1* and *CS2* tests

- The coskewness tests for contagion proposed by Fry et al. (2008).
  - This test identifies contagion from the value of *i* to the volatility of *j* (CS1 test) and from the volatility of *i* to the value of *j* (CS2 test).
- The tests are described as:

$$CS_1\left(i \to j; i^1, j^2\right) = \left(\frac{\psi_c\left(i^1, j^2\right) - \psi_{pre}\left(i^1, j^2\right)}{\sqrt{\frac{4\upsilon_c + 2}{T_c} + \frac{4\rho_{pre}^2 + 2}{T_{pre}}}} \right)^2$$

$$CS_2\left(i \to j; i^2, j^1\right) = \left(\frac{\psi_c\left(i^2, j^1\right) - \psi_{pre}\left(i^2, j^1\right)}{\sqrt{\frac{4\upsilon_c + 2}{T_c} + \frac{4\rho_{pre}^2 + 2}{T_{pre}}}} \right)^2$$

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Methodology – Coskewness

- Where:

$$\psi_c\left(i^m, j^n\right) = \frac{1}{T_c}\sum_{t=1}^{T_c}\left(\frac{i_t - \hat{\mu}_{c,i}}{\hat{\sigma}_{c,i}}\right)^m\left(\frac{j_t - \hat{\mu}_{c,j}}{\hat{\sigma}_{c,j}}\right)^n;$$

$$\psi_{pre}\left(i^m, j^n\right) = \frac{1}{T_{pre}}\sum_{t=1}^{T_{pre}}\left(\frac{i_t - \hat{\mu}_{pre,i}}{\hat{\sigma}_{pre,i}}\right)^m\left(\frac{j_t - \hat{\mu}_{pre,j}}{\hat{\sigma}_{pre,j}}\right)^n;$$

$\mu_{T,k}$ = The mean of k in period T;

$\sigma_{T,k}$ = The standard deviation of k in T, where T can be either T_c ou T_{pre} and k can be either i or j.

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Methodology – Endogenous tests

- For each pair of markets *i* and *j*, in each channel (banking system, equity, CDS):
  - We define test windows of fixed length over the entire period
  - Each window consists of a pre-crisis period and a crisis period.
  - In our model the pre-crisis periods are 24 months in length
  - We did the contagion tests with crisis periods of 4, 6 and 8 months in length, for additional robustness

- We estimate a *VAR* of the source and destination market in each period (crisis and pre-crisis);
  - We control it for the pre-defined exogenous variables (US Federal Funds rate and Commodities index);
  - Each *VAR* was calculated with a fixed lag of 5 observations in order to eliminate residual autocorrelation.

- The residuals of the crisis period *VAR* is then tested against the residuals of the pre-crisis period *VAR* using the three statistics: *FR, CS1* and *CS2*.

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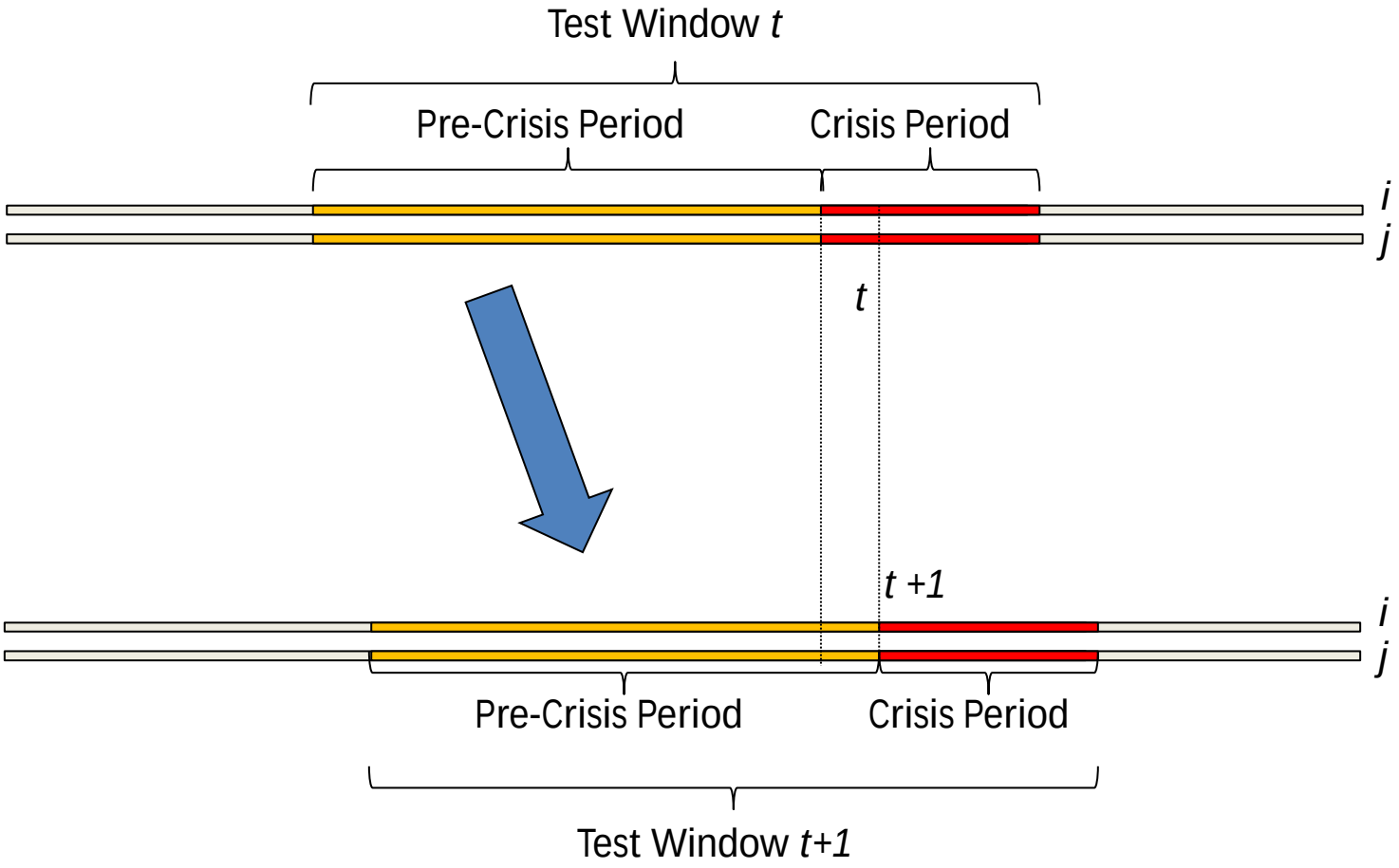
Methodology – Endogenous tests



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Methodology – Endogenous tests

- The result is a set of statistics for that particular test instance $T_{i,j,D,W,L}$:
  - Where i is the source market, j the destination market, D the channel being tested, W the period window, and L the crisis window length.
- A test instance is said to be an instance of contagion if the following conditions are met:
  - The volatility of the crisis period residuals must be greater than that of the pre-crisis period;
  - The correlation or coskewness of the crisis period residuals must be greater than that of the pre-crisis period;
  - The tests results (*FR*, *CS1* and *CS2*) must be greater than a critical value.

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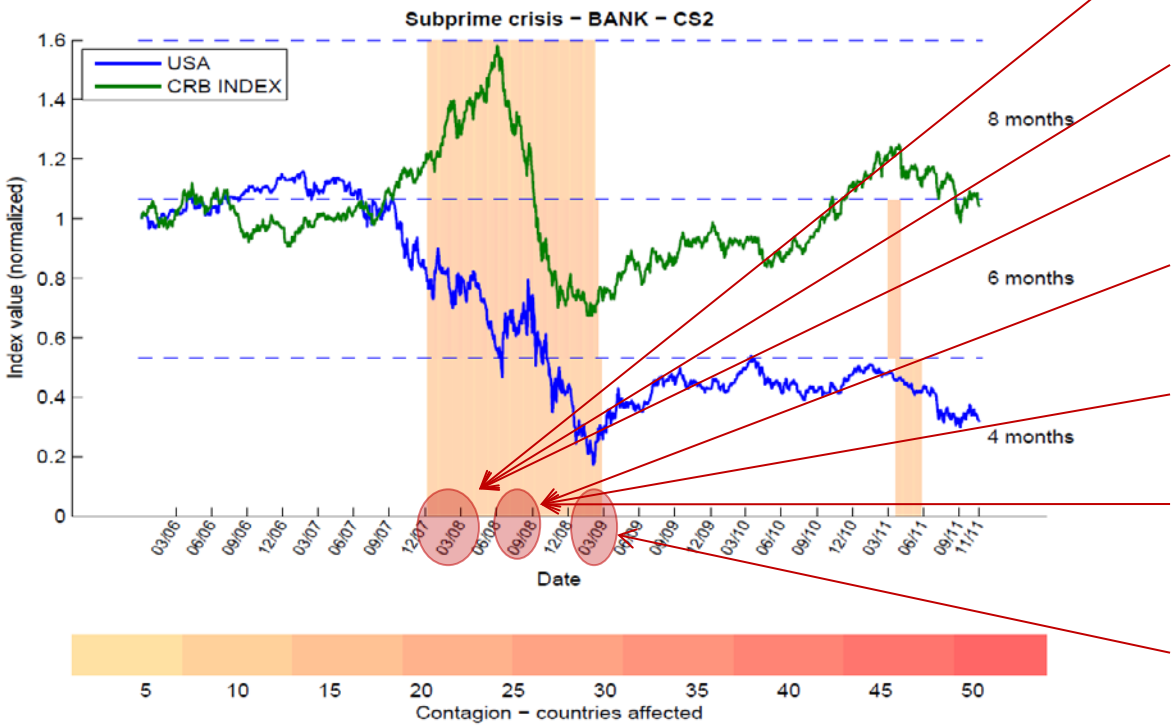
Empirical results – Global Financial Crisis – Banking Sector

- Contagion to the Banking sector was pervasive in the subprime crisis
  - Stronger in te beggining of 2008 and then after September 2008
  - Almost every country in the sample was affected by contagion



Feb 10, 2008: G7 announces that losses due to subprime market collapse count reach $400 billions

Mar 7, 2008: The US Federal Reserve inject $200bn

Mar 16, 2008: JP Morgan acquires Bear Sterns

Sep 15, 2008: Lehman Brothers files for bankrupcy

Oct 2, 2008: US Congress approves $700bn TARP (bailout)

Oct 8, 2008: Fed, the BoE and the ECB all cut half a point off their key interest rates

Mar 3, 2009: The U.S. Treasury Department and the Federal Reserve Board announce the launch of the Term Asset-Backed Securities Loan Facility (TALF).

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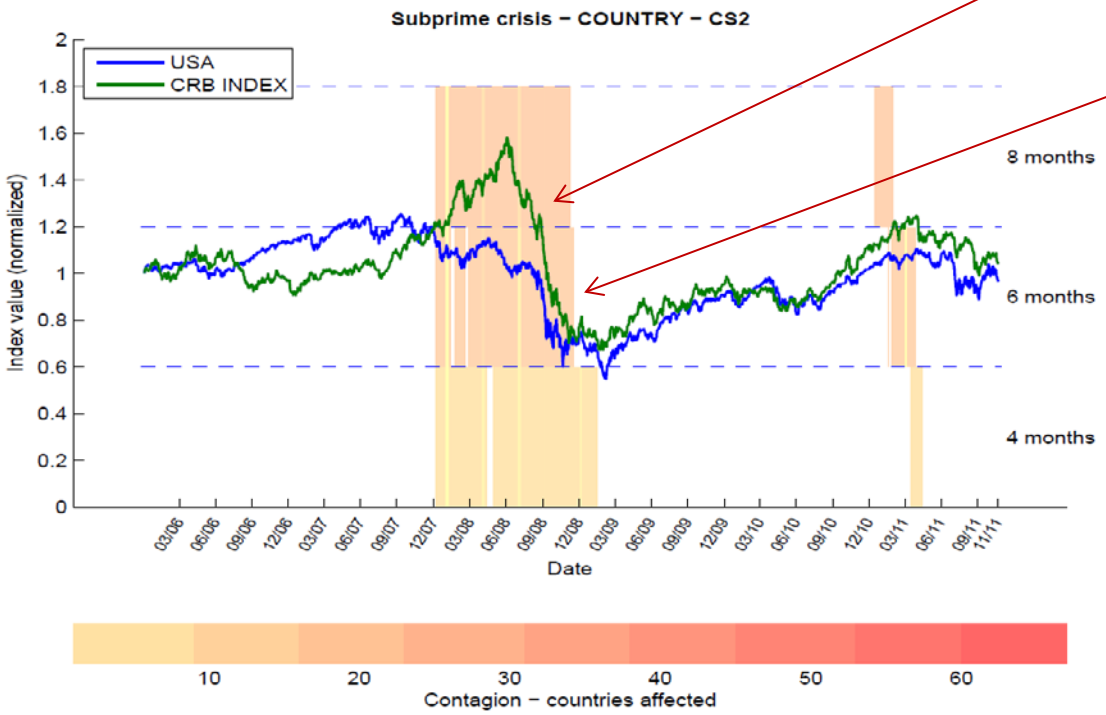
Empirical results – Global Financial Crisis – Equity Market

- Contagion to the Equity Market was also pervasive in the subprime crisis



Contagion in the equity market was stronger after September , 2008 (Lehman Brothers bankruptcy)

Contagion in the equity market stopped at an earlier date than in the banking sector

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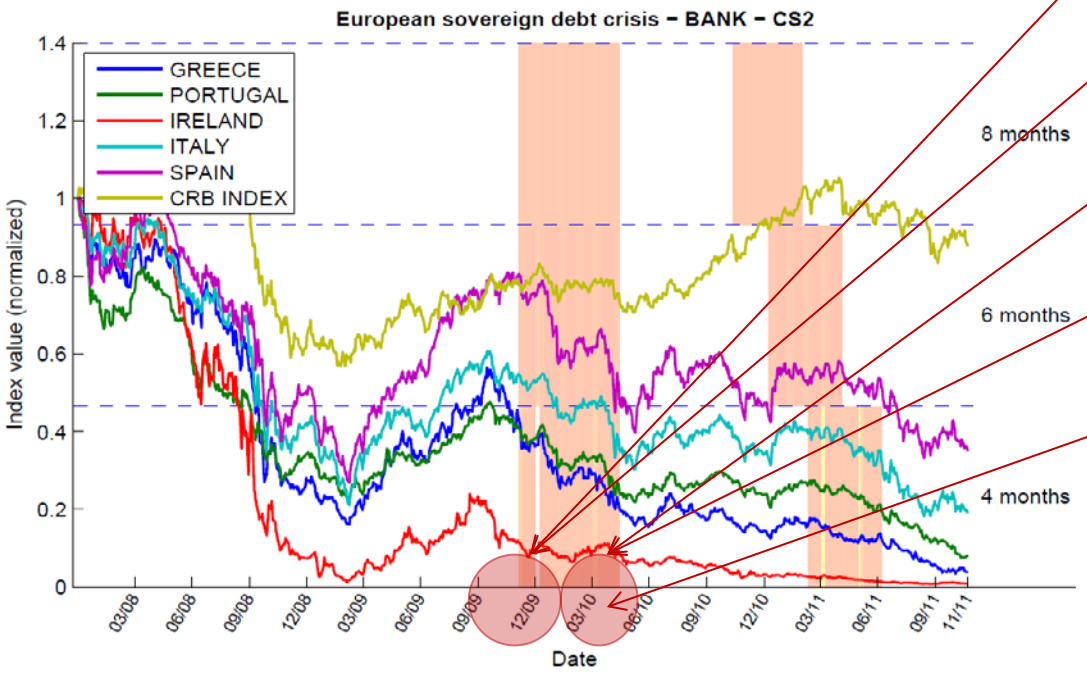
Empirical results – European Sovereign Debt Crisis – Banking Sector

- Contagion to the banking sector was also pervasive in the european crisis
  - Two distinct periods of contagion: early 2010 and mid to late 2011
  - Almost every country in the sample was affected by contagion



Dec 8, 2009: Greek Debt Downgraded Greece's debt €300bn, 113% of GDP

Jan 2010: rising concern over EU more heavily indebted countries (Portugal, Ireland, Italy, Greece, Spain)

Mar 2010: EU and IMF agree on a fund of €22bn for Greece, but no loans just yet

Apr 2010: EU and IMF agree on loaning up to €30bn to Greece. Portugal and Spain had their debt ratings downgraded

May, 2010: Eu and IMF approve €110bn in loans to Greece

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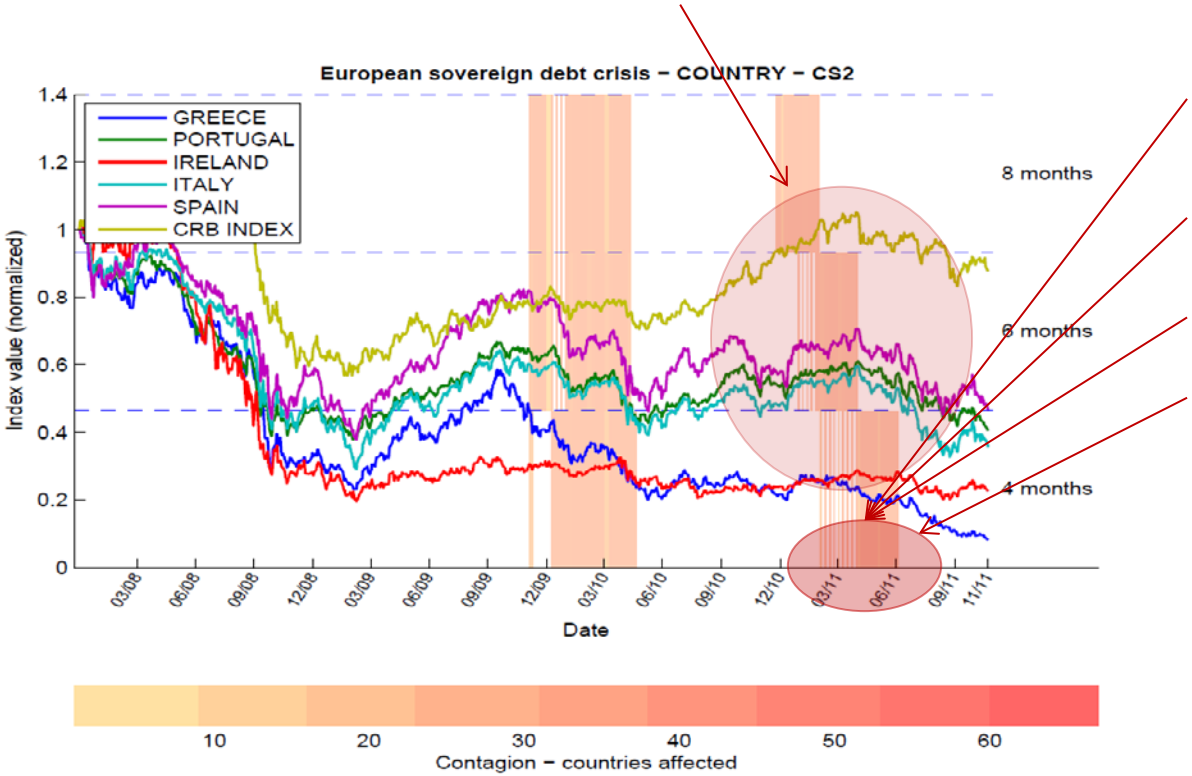
Empirical results – European Sovereign Debt Crisis – Equity Market

- Similar to the contagion to the banking sector

The second wave of contagion indicates that the actual contagion is nearer the end of each window, mostly in the period starting in June, 2011



Mar/Apr 2011: Portuguese and greek debts are further downgraded

Apr 2011: Portugal requests financial aid from the EU

May 2011: EU approves € 78bn to Portugal

Jul 2011: EU agreed on further €109bn for Greece

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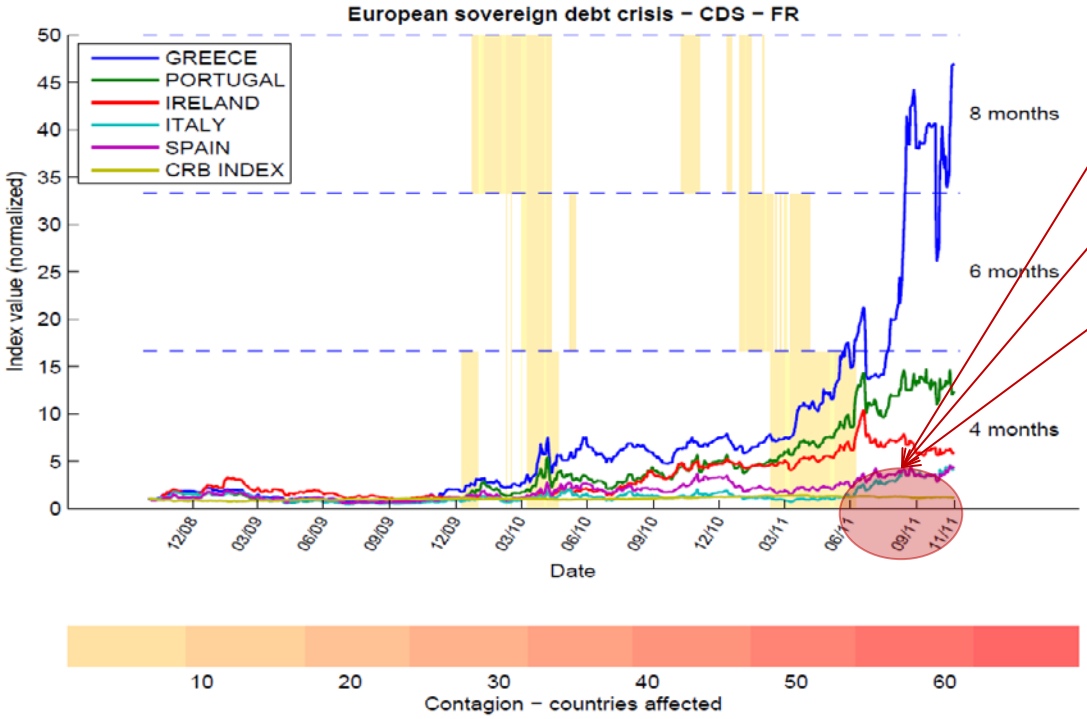
Empirical results – European Sovereign Debt Crisis – CDS spreads

- There was contagion to the CDS spreads
  - Our tests found correlation contagion in the CDS spreads (*FR* statistic)
  - There is a spike in CDS spreads in May 2010, and in April 2011 spreads start to rise sharply, specially Greece's.Italy's and Spain's rise in the second half of 2011 to almost 5 times their December 2008 spreads.



Aug 2011: Yields in Italian and Spanish bonds rise sharply, CDS spreads also rise

Sep 2011: Italian debt is downgrades

Oct 2011: 5y CDS spreads are about their highest since December/2011 (except for Ireland)

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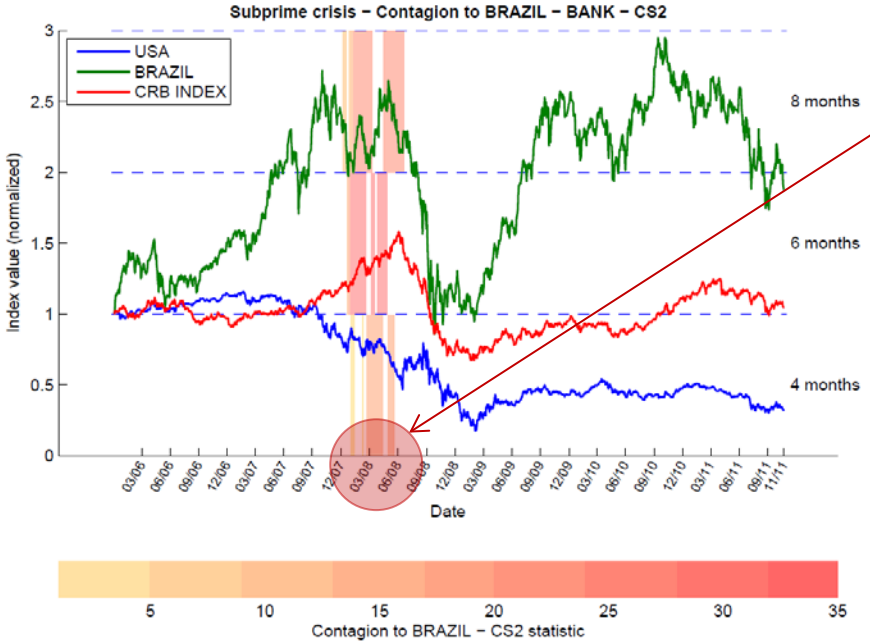
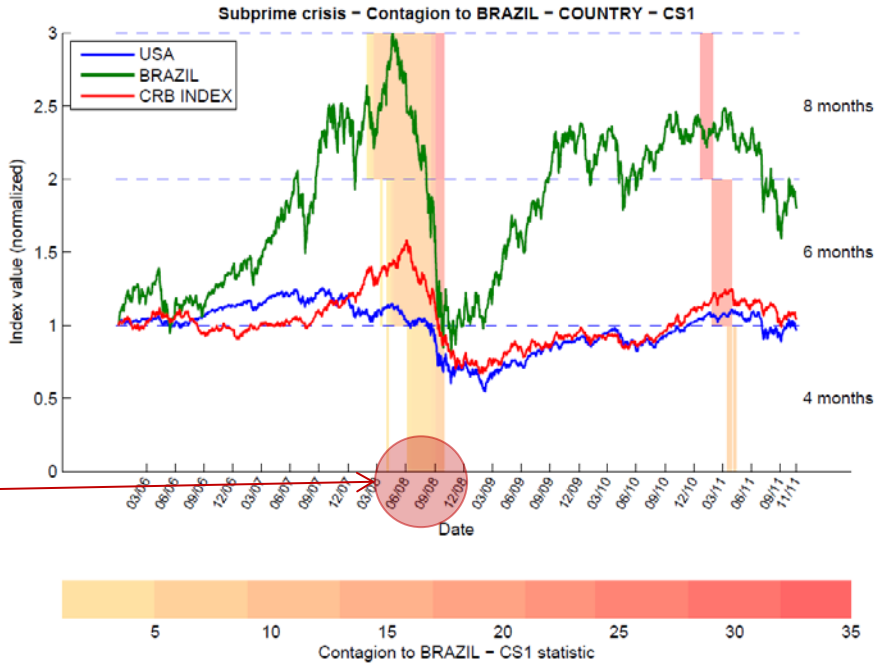
Empirical results – Contagion to Brazil – Global Financial Crisis

- There was contagion to Brazil in the Bank Sector and Equity Market



Contagion to Brazil in the banking sector was detected only in the *CS2* statistic, and was stronger from February and March 2008



Contagion to Brazil in the equity market was detected only in the *CS1* and *CS2* statistics, and was stronger after September, 2008, following the bankruptcy of the Lehman Brothers.

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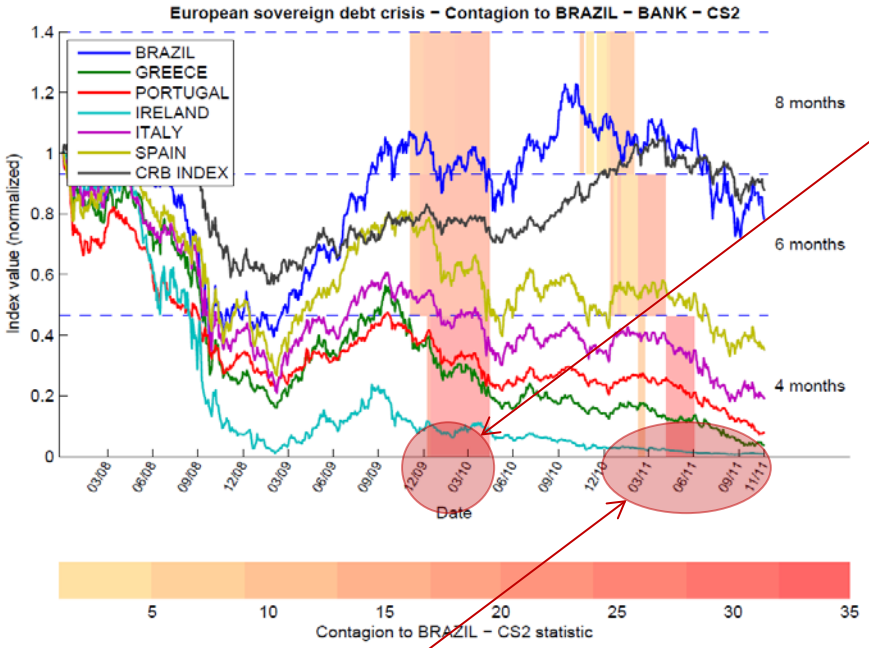
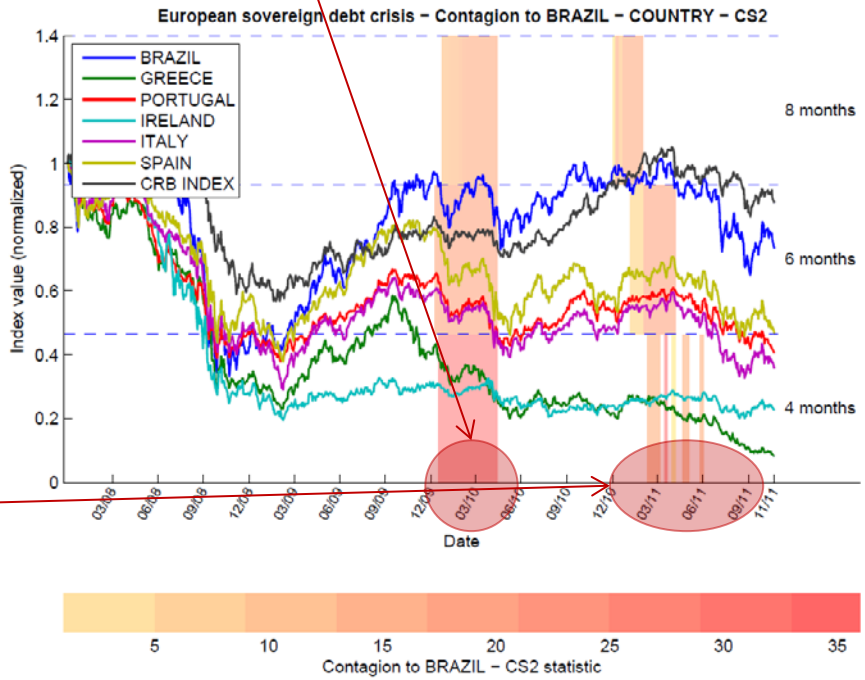
Empirical results – Contagion to Brazil – European Sovereign Debt Crisis

- There was contagion to Brazil in the Bank Sector and Equity Market...



Contagion to Brazilian banking sector and equity market was mostly from Portugal and Spain in the first period of the European Debt Crisis



In addition to Portugal and Spain our tests also detected contagion to Brazil from Italy in the Second Period.

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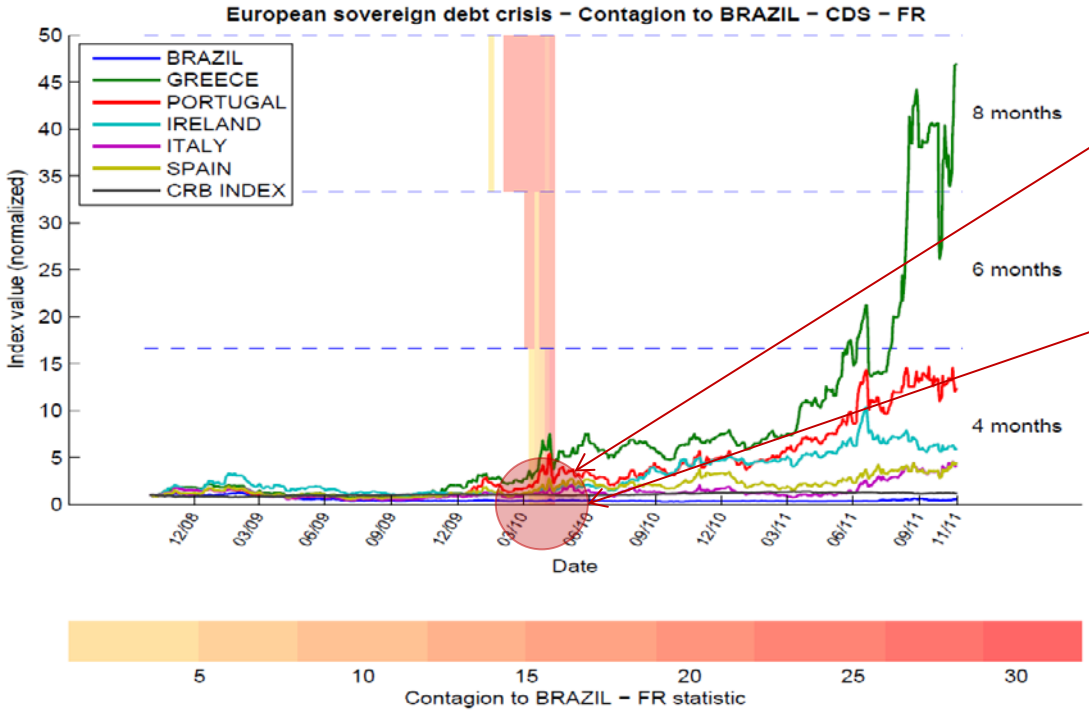
Empirical results – Contagion to Brazil – European Sovereign Debt Crisis

... And also in the CDS spreads...



Contagion to Brazilian CDS spreads was detected in the first and second quarter of 2010, the strongest around early May

In the case of CDS spreads, the contagion to Brazil was from Greek and Italian CDS spreads, following the spike in early May

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Conclusions

•We developed an approach to define the timing of the contagion in a financial crisis through endogenous testing.

•Our results show that contagion has been pervasive in the *Global Financial Crisis* and in *European Sovereign Debt Crisis*, and the timing that we obtained is consistent with general consensus over each crisis's dating.

The tests proposed are an additional tool for regulators and policy makers to assess the effectiveness of their policies and the communication of their actions.

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Thank you

Comments and suggestions are welcome