Transmission of the Financial and Sovereign Debt Crises to the EMU: Stock Prices, CDS Spreads and Exchange Rates*

Theoharry Grammatikos[a] and Robert Vermeulen[b]

16 December 2010

Abstract

This paper tests for the transmission of the 2007-2010 financial and sovereign debt crises to fifteen EMU countries. We use daily data from 2003 to 2010 on country financial and non-financial stock market indexes. First, we find strong evidence of crisis transmission to European non-financials from US non-financials, whereas the increase in dependence of European financials on US financials is rather limited. Second, in order to test how the sovereign debt crisis affected stock market developments we split the crisis in pre- and post-Lehman sub periods. Results show that financials become significantly more dependent on changes in Greek CDS spreads after Lehman's collapse, compared to the pre-Lehman sub period. However, this increase is not present for non-financials. Third, before the crisis euro appreciations are associated with European stock market decreases, whereas during the crisis this is reversed. Finally, the reversal in the relationship between the euro-dollar exchange rate and stock prices seems to have been triggered by Lehman's collapse.

Keywords: financial crisis, euro exchange rate, EMU, equity markets, sovereign debt

J.E.L. codes: F31, G01, G15

[a] Luxembourg School of Finance, University of Luxembourg, 4 Rue Albert Bourschette, L-1246 Luxembourg. E-mail: theoharry.grammatikos@uni.lu

[b] Corresponding author. De Nederlandsche Bank, Economics and Research Division, P.O. Box 98, 100 AB Amsterdam. E-mail: r.j.g.vermeulen@dnb.nl.

* We would like to thank Ian Cooper and seminar participants at DNB for useful comments and constructive discussions. This paper presents the authors' personal views and opinions. They do not necessarily coincide with those of de Nederlandsche Bank. All errors are our own.

1. Introduction

The global financial and economic crisis of 2007-2010, which had its origin in the United States (US) subprime mortgage market, triggered a chain reaction in the US and global financial systems. These problems reached their zenith with the collapse of Lehman Brothers, when it became clear that there would be a deep global recession. European financial markets were not isolated from developments in the US. To stem the evolving crisis European national governments massively injected capital in financial institutions (e.g. Royal Bank of Scotland, Fortis, Anglo-Irish, etc.) and undertook fiscal stimulus measures. The single currency, however, proved vulnerable to the crisis because, as it has been argued, it was created without a single government above it to control tax, spending and transfers between the euro zone's richer and poorer economies. Consequently, financial markets distrusted some of the European governments resulting in a sovereign debt crisis. The country worst hit by this sovereign debt crisis is Greece, which was not able to borrow anymore on international capital markets and had to be bailed out by a joint EMU-IMF rescue package.[1]

This paper investigates the sensitivity of financials and non-financials in 15 EMU countries to the crisis developments in the US, to sovereign debt problems in EMU and to exchange rate movements before and during the financial crisis. By comparing a tranquil pre-crisis period (1-1-2003 until 26-2-2007) with a crisis period (27-2-2007 until 31-8-2010) we test explicitly for the transmission of the financial crisis. In addition, we distinguish between two sub periods within the financial crisis, where the bankruptcy of Lehman Brothers on 15 September 2008 is the breakpoint.

For each EMU country we estimate an individual GARCH model for both its financials and non-financials index. The GARCH model is well known for its ability to deal with the time varying nature of stock market volatility, a necessity when analyzing the turbulent markets during the financial crisis. In the empirical model, both the contemporaneous and lagged US return are included to capture the dependence on developments in the US and deal with non-synchronous trading hours. In addition, by including the euro-dollar exchange rate we control explicitly for exchange rate movements. Finally, when considering only the crisis period Greek CDS spreads are included to investigate the effects of the European sovereign debt crisis on stock returns. In order to test for the crisis transmission we include an indicator variable to allow the coefficients to change during the pre-crisis vs. crisis periods and pre-Lehman vs. post-Lehman sub periods. A significant change in the coefficient signals transmission of the crisis.

The results show four key findings. First we find evidence of crisis transmission to European non-financials from US non-financials, whereas the increase in dependence of European financials on US financials is rather limited. Second, financials become significantly more sensitive to

[1] Ireland also received support from other EMU countries and the IMF to refinance its government debt during a later stage of the sovereign debt crisis.

developments in Greek CDS spreads after the collapse of Lehman Brothers. However, we do not find this increase for non-financials. Third, before the financial crisis euro appreciations are associated with stock market decreases for both European financials and non-financials. However, during the crisis the relationship changes and stock prices increase when the euro appreciates for both financials and non-financials. Finally, the reversal in the relationship between the euro and stock prices seems to have been triggered by Lehman's collapse and the concomitant radical change in default expectations among market participants.

The paper is organized as follows. Section 2 discusses the key dates of the crisis. Section 3 covers the data and empirical methodology. Section 4 presents the empirical findings and Section 5 concludes.

2. The key dates of the financial crisis

In order to determine the starting point of the financial crisis we follow the Federal Reserve Bank of St. Louis' crisis timeline.[2] This timeline is very detailed and lists all key events. The crisis period examined in this study extends from 27 February 2007 to 31 August 2010. We choose 27 February 2007 as the starting point of the financial crisis, because on this date the first signs of problems in the subprime mortgage market appeared when Freddie Mac announced that it will no longer buy the most risky subprime mortgages and mortgage-related securities. In order to compare the results with a "normal" situation we also examine a non-crisis period which starts on 1 January 2003 when the stock markets started to recover from the crash of the IT bubble and ends on 26 February 2007.

A key milestone event during the financial crisis is the bankruptcy of Lehman Brothers on 15 September 2008. Using the words of Jean-Claude Trichet: *"[I}t is clear that since September 2008 we have been facing the most difficult situation since the Second World War -- perhaps even since the First World War. We have experienced -- and are experiencing -- truly dramatic times"* (Spiegel Online, 2010). From then onwards credit markets froze and the US subprime mortgage crisis turned into a global financial and economic crisis. Consequently, for the later part of the study we split the crisis period into a pre-Lehman (27 February 2007 – 14 September 2008) and a post-Lehman sub period (15 September 2008 – 31 August 2010).

The time series, presented in Figures 1-4, illustrate the changes before and during the crisis and support the choice of the periods and sub periods examined in this study.

[Figure 1 about here]

[2] The Federal Reserve Bank of St. Louis' crisis timeline can be accessed via http://timeline.stlouisfed.org/.

Figure 1 displays the development of the financials stock index of four selected countries: Finland, Germany, Ireland and the United States. The data overall show a drastic decline in values starting shortly after the start of the crisis (27 February 2007). After the Lehman collapse, markets continue their downward trend and decrease further until early 2009, when the situation seems to have stabilized. When assessing how financials stand on 31 August 2010, we observe a large variety in how the crisis affected financials across countries. The performance of the rest of the economy (not shown), i.e. the country market indexes excluding financials, exhibit the same trends albeit the picture is more homogeneous across countries.

The importance of the key event dates is confirmed by the development of stock market volatility during 2003-2010 which shows even clearer how the crisis evolved. Figure 2 plots the volatility of the German and American financials indexes.[3] Finland and Ireland have been omitted because the general picture is similar across all countries.

[Figure 2 about here]

In the period 2003 to early 2007 volatility in the financial markets is very low, both in Germany and the United States. In early 2007, after the eruption of the crisis, Figure 2 shows gradual volatility increases in both Germany and United States. Even though German volatility was decreasing before Lehman, after Lehman's collapse volatility in both markets skyrockets. This is strong evidence of the existence of a break point in the data series around the key dates chosen for the study. During 2009 US volatility remains at high levels, while German volatility decreases in early 2009. As of late 2009 German and US volatilities are at similar levels.

When analyzing the volatility of the non-financials market index (not shown) there is a different development. Basically, from 2003 up to the collapse of Lehman Brothers in September 2008, volatility is quite constant. It seems that only following Lehman's failure the spillovers of the financial sector to the real economy became apparent resulting in sharp volatility increases in non-financial sectors.

[Figure 3 about here]

The euro-dollar exchange rate shows large fluctuations during 2003-2010, illustrated by Figure 3. At the start of 2003 the exchange rate was around parity and appreciated slowly to around

[3] Volatility is calculated as the standard deviation of the residuals of a univariate GARCH(1,1) model for the specific time series. The estimation incorporates a lagged return term.

1.3 US dollars per euro up to the crisis. During the first part of the crisis, when the problems seemed to be contained to the US subprime mortgage market, the euro appreciated by a further 25% to 1.6 US dollars per euro. However, during the summer of 2008 it became apparent that the financial crisis spilled over to the rest of the world and would affect the real global economy. This implies that Europe did not decouple from the US. Even worse, some European economies contracted even faster than the US. This resulted in a sharp depreciation of the euro and an increased volatility of the exchange rate. In 2009 the exchange rate strengthened, but depreciated during the European sovereign debt crisis. The exchange rate is around 1.3 US dollars per euro on 31 August 2010, when the sample period ends.

[Figure 4 about here]

Finally, to illustrate the effects of the European sovereign debt crisis we focus on two polar cases: German government debt vs. Greek government debt. Credit Default Swaps (CDS) are a financial instrument to insure against the risk of a government default. The price of this insurance, i.e. the CDS spread, is low for all EMU countries at the outset of the subprime mortgage crisis. Even when this crisis erupts spreads are low and only start to increase slightly for Greece during 2007. Apparently the markets initially assigned a very low probability of bankruptcy of an EMU country, i.e. default is seen as an extremely unlikely event. However, this perception is drastically revised following the collapse of Lehman Brothers (Figure 4). German CDS spreads climb to around 100 basis points in early 2009, while Greek CDS spreads are already about 250 basis points around that time. The situation is aggravated further when investors start expressing doubts about the Greek government's solvency in late 2009.[4] From that point onwards the German CDS spread remains low until August 2010, but the Greek one skyrockets.

In sum, the figures in this section illustrate the outbreak of the financial and economic crisis and clearly identify the key dates during the financial crisis. Basically, we can split the crisis period in two sub periods, before Lehman and after Lehman.[5] Hence, the study will contrast and compare the market co-movements: 1) pre-crisis vs. crisis and 2) within the crisis, pre-Lehman vs. post-Lehman.

[4] The announcement by Dubai World regarding its debt problems on 25 November 2009 has also been linked to a reassessment of sovereign debts worldwide. Unreported results using this break date show smaller differences in the estimated coefficients indicating that Lehman's bankruptcy had a more dramatic impact on market expectations for sovereign debt at least in the EMU.

[5] Dooley and Hutchison (2009) consider three sub periods of the financial crisis by splitting the pre-Lehman crisis in two sub periods. Since they study developing countries the focus is slightly different.

3. Data and methodology

3.1 Data

The database consists of Datastream stock market indexes for the United States and Eurozone countries available at the daily frequency. We consider both a financial sector index and a non-financials market index (i.e. total market index excluding financials). These data are available for all EMU countries (Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovenia and Spain) in euros and for the United States in US dollars. The data exhibit the familiar properties of financial time series, in particular non-normality and time varying volatility. The 5 year Greek government bond CDS spread is also included in the later part of the study and its properties become apparent from Figure 4. Non-normality and time varying volatility are even more prevalent compared to stock markets. Finally, the euro-dollar exchange rate is retrieved from Datastream and measured in US dollars per euro. Therefore, an appreciation of the euro is captured by an increase in the exchange rate. Table 1 summarizes the mean and volatility of both financials and non-financials indexes during the two periods: 1) Pre-crisis (1/1/2003 – 26/2/2007) and 2) Crisis (27/2/2007 – 31/8/2010), and the two sub periods within the financial crisis 2a) Pre-Lehman (27/2/2007 – 14/9/2008) and 2b) Post-Lehman (15/9/2008 – 31/8/2010).

[Table 1 about here]

The average daily mean return exhibits a boom-bust pattern during the sample period 2003-2010 (see also the graphical representation in Figure 1). It is positive for all markets during the pre-crisis period and negative for virtually all markets during the crisis period. When distinguishing between the pre-Lehman and post-Lehman crisis period, we do not find a general pattern across countries.

The striking differences in volatility between the pre-crisis period and the different crisis sub periods are illustrative of the increased uncertainty during the financial crisis. The pre-crisis period is characterized by tranquil markets and displays a very low volatility. During the pre-Lehman crisis period volatility doubles or triples for most time series. The increase in volatility is generally stronger for financials, compared to non-financials. Tension in stock markets increases further after the collapse of Lehman Brothers, i.e. volatility skyrockets for financials. This is especially the case in Greece, Ireland and the United States. The volatility of the EMU-15 financials and non-financials in

the pre-crisis period is remarkably similar to the corresponding figures in the US. However, during the crisis, volatility in the US is higher, in particular after the collapse of Lehman and especially for US financials.

The reported differences in mean returns and volatility among countries, as well as the time-varying volatilities need to be taken into account when deciding on the empirical methodology.

3.2 Empirical methodology

There exist several theoretical definitions and empirical methodologies to test for the spreading or transmission of financial shocks. In this paper we follow a definition employed in the contagion literature according to which: *"(Shift-) contagion occurs when the transmission channel intensifies or, more generally, changes after a shock in one market."* (Pericoli and Sbracia, 2003).[6] This implies that we model the transmission channel during tranquil times, i.e. during the non-crisis period, and test if shocks are transmitted more strongly during the 2007-2010 crises.

Scholars use several methodologies when dealing with daily data, e.g. GARCH models (Hamao et al, 1990; Engle et al, 1990), correlations (Forbes and Rigobon, 2002), logit models (Bae et al, 2003) and factor models (Dungey and Martin, 2007).[7] The large swings in stock market volatility before and during the crisis, but also within the crisis sub periods, warrant an empirical strategy able to accommodate the time varying nature of volatility (see Figure 2). Since GARCH models are able to capture these changes successfully we follow the empirical strategy in the spirit of GARCH and factor models.

During tranquil times we postulate the following model:

$$y_{i,t} = \alpha_i + \lambda_i y_{i,t-1} + \beta_i y_{us,t} + \gamma_i y_{us,t-1} + \delta_i E_t + \varepsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ represents the current equity return of country i (either financials or non-financials), $y_{i,t-1}$ the one day lagged return of country i, $y_{us,t}$ the current equity return in the US (either financials or non-financials), $y_{us,t-1}$ the one day lagged return in the US and E_t the euro-dollar exchange rate. Equation (1) allows for a lagged effect of return to capture the persistence in stock markets. In contrast to latent factor models, we assume that the factors are observed and exogenous for European countries' stock market indexes. In addition, due to the non-synchronous trading hours we allow for a lagged effect from the US market.

[6] This definition has also been used among others by Forbes and Rigobon (2002).
[7] For an elaborate overview we refer to Pericoli and Sbracia (2003) and Dungey and Martin (2007).

The residual captures the specific news relevant for market i and is allowed to be of the GARCH(1,1) type to capture the time varying volatility of equity market returns:

$$\sigma_{i,t}^2 = \omega + \alpha_i^V \varepsilon_{i,t}^2 + \beta_i^V \sigma_{i,t-1}^2 .$$

where α^V and β^V are the coefficients of the volatility dynamics.

During tranquil times the model in Equation (1) is used to capture the movements in country i's stock market returns. However, during the financial crisis we allow the transmission channel to intensify. Therefore, we introduce an indicator variable that is equal to zero in tranquil times (I(c=0) = 0) and equal to one during the crisis period (I(c=1) = 1).

Put differently, we allow the coefficient on the factors to differ during the crisis period. Equation (2) specifies this model:

$$y_{i,t} = \alpha_i + \lambda_i y_{i,t-1} + \beta_i y_{us,t} + \beta_i^c I(c=1) y_{us,t} + \gamma_i y_{us,t-1} + \gamma_i^c I(c=1) y_{us,t-1} + \delta_i E_t + \delta_i^c I(c=1) E_t + \varepsilon_{i,t} \quad (2)$$

where, I(c=1) is the indicator variable and β^c, γ^c and δ^c are the crisis coefficients. Crisis transmission is present whenever these coefficients are significantly different from zero.

Finally, we capture the sovereign debt problems by the Greek CDS spread which provides a market price of Greek default risk. The Greek CDS spread is of prime concern since most attention has been directed to Greece during the sovereign debt crisis. In Equation (3) we distinguish between the pre-Lehman and post-Lehman crisis sub periods.[8]

$$\begin{aligned} y_{i,t} = {} & \alpha_i + \lambda_i y_{i,t-1} + \beta_i y_{us,t} + \beta_i^{aLeh} I(aLeh=1) y_{us,t} + \gamma_i y_{us,t-1} + \gamma_i^{aLeh} I(aLeh=1) y_{us,t-1} \\ & + \delta_i E_t + \delta_i^{aLeh} I(aLeh=1) E_t + \eta_i CDS_{GR,t} + \eta_i^{aLeh} I(aLeh=1) CDS_{GR,t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

The coefficient η captures the coefficient on Greek CDS spreads during the crisis and η^{aLeh} the additional effect during the post Lehman sub period. The indicator variable is zero before the collapse of Lehman (I(aLeh)=0) = 0) and one after the collapse of Lehman Brothers (I(aLeh=1) = 1). The pre-Lehman sub period is from 27-2-2007 until 14-9-2008, while the post-Lehman sub period runs from 15-9-2008 until 31-8-2010. Note that in this set-up the pre-Lehman sub period is treated as "baseline" and sovereign debt crisis transmission is present when the post-Lehman coefficient of the

[8] Didier et al (2010) present a similar model set-up, but use both a pre- and post-Lehman dummy. Quantitatively this is identical to our approach, but requires an F-test to test for coefficient differences. By using a dummy only for post-Lehman, we can directly infer coefficient differences.

respective variable is significantly different from zero. The exchange rate is included in the models above because the European returns are measured in euros and the US returns in dollars (see section 4.2).

One important assumption in the above equations is the exogeneity of US returns. In order for this to be valid we need to establish that US returns cause European returns, but that this relationship does not go in the other direction. Several arguments justify this choice. The US stock market is by far the largest stock market measured in terms of capitalization. It accounts for about 40% of world stock market capitalization. Individual EMU stock markets are quite a bit smaller than the US market. For example, the largest EMU market is the French one and corresponds to only 5% of global market capitalization. Empirical findings reported by Ehrmann et al (2010) indeed show that European returns only have a marginal impact on US returns, whereas US returns have a strong impact on European results. Similar findings are also obtained by Masih and Masih (2001). Finally, linear causality tests presented by Beine et al (2008) confirm the leading impact of the United States in global stock markets.[9]

4. Empirical findings

4.1 The transmission of the financial crisis

This section studies the dependence of EMU financial and non-financial stock indexes on developments in the US before and during the 2007-2010 financial crisis, while Section 4.2 discusses the Greek sovereign debt crisis. The analysis of the role of the euro during both crises is presented in Section 4.3..

[Table 2 about here]

Table 2 presents the results when estimating Equation (2) for the financial stock indexes in EMU countries on the US financials index and the euro-dollar exchange rate. The coefficient on the lagged return shows that there is negative persistence in returns for most countries and positive for a few. A negative sign indicates that a good day is followed by a poorer one and vice versa. When assessing the contemporaneous (day t) impact of US financials on European financials we find a large and significant coefficient for most markets. The smallest countries (Luxembourg, Malta and Slovenia) seem to be relatively isolated from US events during tranquil times. This is in line with the results of Didier et al (2010) who find that a low degree of comovement with the US can be explained

[9] A simple Granger causality test provides further supporting evidence.

by illiquidity in the stock market. The French, German, Dutch and Spanish markets seem to have the closest contemporaneous ties to the US, where a 1% increase in the US results in a 0.5% increase in the domestic market. During the crisis, links intensify for Austria, Greece, Ireland, Luxembourg and Portugal, but decrease for Germany. The stronger dependence of Greece, Ireland and Portugal has much to do with these countries being among the hardest hit ones by the crisis.

The one day lagged US returns show a similar picture. Dependence is significant and large for all EMU countries, except for the small countries mentioned before. During the crisis we observe an increase for Austria, Cyprus and Luxembourg, but again a decrease for Germany. It is striking that the German financial sector´s dependence on the US has decreased. A strong increase is only visible for Austria and can be explained by losses on large investments of Austrian banks in Central and East European countries.

[Table 3 about here]

Table 3 presents the dependence patterns for non-financials before and during the crisis in the same fashion. The coefficients on the lagged return are very similar to those in Table 2. Perhaps surprising, the contemporaneous dependence of European non-financials on US non-financials is equal to or even larger than the dependence of European financials on US financials. In contrast to financials, the dependence of non-financials increases significantly in most countries during the crisis. For non-financials there is indeed strong evidence in favour of crisis transmission. The lagged dependence on the US is also positive and highly significant for most European countries. However, we only observe an increase for a few countries during the crisis when using this variable. Overall, total dependence of EMU non-financials on US developments has increased sharply.[10]

4.2 The transmission of the sovereign debt crisis

The economic and financial crisis did not only affect the European financial sector, but had far reaching consequences for fiscal policy. First, governments injected large amounts of equity in banks and other financial institutions to stabilize the financial sector, resulting in rising debt levels. Second, government deficits increased as well due to the countercyclical fiscal policy measures induced by the global economic recession. Table 4 provides key figures on the fiscal stance of EMU governments.

[Table 4 about here]

[10] Adding additional control variables such as t-bill rate changes or oil price changes does not alter these results. These robustness checks are available upon request.

Gross debt to GDP ratios increased across all EMU countries during 2007-2011, but with different magnitudes. The increases in Ireland (62.3%), Greece (38.2%) and Spain (36.3%) are the largest, resulting in several debt rating downgrades and, in the case of Greece, even an inability to borrow on the financial markets.[11] When considering debt sustainability, we need to distinguish between the different factors increasing the debt. First, the debt can increase due to the primary balance, which is fully controlled by the government. The second factor is due to interest and growth contributions. This is not directly controlled by the government since it depends on previous governments' expenses and current economic conditions. Finally, we consider stock-flow adjustments, which are not direct expenses, but can be viewed more as investments since they increase government assets. These stock-flow adjustments are very important during the current crisis due to the bank bailouts.[12] The countries with the largest increase in debt due to the primary balance and interest & growth contribution are Portugal, Ireland, Greece and Spain[13]. We now investigate how sensitive European equity markets are to the debt financing problems and default risk in these countries.

Table 5 presents the results when estimating Equation (3) for the financials index in all 15 EMU countries. The coefficients regarding the contemporaneous and lagged dependence on US financials are large and similar to those reported in Table 2. It is also worth noting that the contemporaneous dependence is the same during the entire crisis (before and after the collapse of Lehman). For several countries the lagged dependence decreases after the collapse of Lehman.

[Table 5 about here]

Before Lehman, just a few countries' financials are affected by changes in the Greek CDS spread (Austria, Cyprus, Greece and Luxembourg). Figure 4 shows that the actual movements were quite limited and a closer inspection of the data reveals that Greek and German CDS spreads move closely in the pre-Lehman sub period. The correlation between the two variables is 0.87 during this sub period. Hence, in the pre-Lehman sub period the Greek CDS spread seems to capture a European

[11] Ferreira and Gama (2007) provide evidence on the transmission of sovereign debt rating downgrades to international stock market.

[12] Consider Luxembourg which has the smallest debt to GDP ratio at the start of the crisis. The main reason for its debt increase is stock-flow adjustments, associated with the support to Fortis and Dexia. Ireland also started with a low debt level in 2007 and its stock-flow adjustments are similar in size to those of Luxembourg due to the bail out of Anglo Irish and other financial institutions. However, contrary to Luxembourg the Irish economy contracted strongly and primary deficits increased fast. Hence, the part of Irish debt which is spending instead of investment is much larger than in Luxembourg. Therefore, this debt will have a permanent nature and has to be refinanced when governments do not run primary surpluses.

[13] In the popular press this group of countries is coined the PIGS.

level default premium. However, during the post-Lehman sub period the correlation drops to 0.31 and the Greek CDS spread captures more strongly the pure Greek debt problems. We should expect that an increase in Greek CDS spreads has a negative effect on stock prices, since rising CDS spreads signal economic hardship. Therefore, the coefficients on η and η^{aLeh} are expected to have a negative sign.

After the collapse of Lehman virtually all countries have a significantly negative loading on changes in Greek CDS spreads. Ireland and Greece have the highest absolute coefficients, but Spain and Portugal also face a large impact. These results can be explained by the higher perceived default risk for these countries following Lehman's collapse. However, strong results are also evident for Germany, France and the Netherlands. The reason in these cases probably is not linked to the default perceptions but rather to their exposure to Greek debt. Indeed, over 75% of Greek government debt is held by foreign investors and the EMU countries most exposed are Belgium, Cyprus, France, Germany, Greece, Portugal and the Netherlands (Blundell-Wignall and Slovik, 2010).[14] It is no surprise then that financials in these countries are also strongly affected by developments in Greece. In sum, even though the sovereign debt crisis affects the group of EMU countries most exposed to a default risk, financials across other EMU countries are also affected due to the many financial interlinkages.

[Table 6 about here]

Next we estimate Equation (3) for the non-financials in the same spirit as Table 3. These results are reported in Table 6. Again, as for the financials, we observe a large degree of contemporaneous and lagged dependence on US developments. Before the collapse of Lehman we document that about half of the non-financial indexes have a significantly negative loading on changes in the Greek CDS spread, even though the magnitude is relatively small. This can be explained by the high correlation of Greek CDS spreads and German CDS spreads before the collapse of Lehman. It is most likely that we capture the non-financials' sensitivity to aggregate EMU sovereign debt developments. In contrast to the financials we do not observe many increases in dependence on Greek CDS spreads post-Lehman. Only for Finland, Greece, Portugal and Spain there are significant increases in the impact of Greek CDS spreads.

Summarizing the results, we find that the transmission of the financial crisis that originated in the US to the EMU financial sector was largely contained possibly due to (expectations of) decisive European actions to protect the vulnerable institutions and to the inherent insulation of other institutions to the mortgage crisis. Expectations of a strong EMU action were apparently shattered

14 Exposures to Greece are measured by the exposure in % of tier 1 capital.

after the collapse of Lehman resulting in a serious transmission of the Greek sovereign debt crisis to the financials of most EMU countries. Less attention or ability to protecting the non-financial sector following the mortgage crisis, on the other hand, can probably explain why that crisis was transmitted rather strongly to this sector in EMU. On the positive side the non-financial sector seems to have been largely unaffected by the sovereign debt crisis.

4.3 The effects of the euro-dollar exchange rate during the crises

The theoretical literature does not agree on the sign of the relationship between stock prices and exchange rates. One part of the literature argues that exchange rates are determined by developments in the current account (See e.g. Dornbusch and Fisher (1980)). According to the "harmful to exports" hypothesis exchange rate movements have an effect on firm competitiveness, which affects future profitability and consequently stock prices. A more expensive currency makes European products more expensive, results in decreasing exports and, consequently, profitability.[15] So, a negative relationship is predicted between stock prices and exchange rates (i.e., exchange rate appreciations should be correlated with negative stock market returns).

The second strand starts from portfolio balance models (Branson (1983) and Frankel (1983)). These models view exchange rate determination as a variable equating the supply and demand of financial assets. Hence, portfolio balance models predict a positive relationship between stock prices and exchange rates (exchange rate appreciations are correlated with positive stock market returns). A stock price increase increases the value of the equity market, which is associated with an exchange rate appreciation. This view can be termed the "signal of economic strength" hypothesis.

During tranquil times the effect of the euro-dollar exchange rate for financials is in line with the predictions from the "harmful to exports" hypothesis, as shown by the significantly negative coefficient for virtually all countries (see Table 2). These results are in line with the findings of Dunne et al (2010), who find a negative coefficient on exchange rates for the French stock market index during 1999-2006. The only exception is Slovenia. Note that the financial sector is very small in Slovenia and may consist mainly of locally active banks. The effects are strongest for large exporting countries such as Belgium, France, Germany, Italy and the Netherlands. For example, a 1% appreciation of the euro is associated with a 0.2% decrease in German stock prices.

During the crisis, however, this relationship is fundamentally different. All countries have a positive coefficient on the crisis exchange rate and for most countries this coefficient is large enough to turn the overall effect of the exchange rate from negative to positive. For example, when we consider Germany again, a 1% appreciation of the euro-dollar exchange rate results in an increase of

[15] This also holds for multinationals. A subsidiary of a European firm operating in the US generates its profits in US dollars, but then converted in euros; the profitability of the European multinational is smaller.

0.2% in stock prices during the crisis. In sum, the role of a strong euro during the crisis period appears to have changed from "harmful to exports" to a "signal of economic strength".

For non-financials the effect of the euro-dollar exchange rate between tranquil times and the crisis is as striking as it is for the financials (see Table 3). Virtually all countries have significantly negative coefficients on the exchange rate before the crisis, whereas the coefficient during the crisis period is positive and significant for virtually all countries. Again, in many cases the sign is reversed during the crisis, implying that euro appreciations lift European non-financial equity prices. This shows that the relationship between exchange rates and stock prices is time varying and depends on what the markets perceive as normal or crisis periods.

Table 5 shows that for financials the reversal of the exchange rate effect described above takes place during the crisis period. First, the coefficient on exchange rates is insignificant in the sub period from the start of the crisis up to the collapse of Lehman (exceptions are Malta and Slovenia). However, the big turn takes place after the collapse of Lehman, where the signs of most countries turn significantly positive. When considering the euro-dollar exchange rate in the case of the non-financials, we document the same reversal as for the financials, i.e., no relationship before the collapse of Lehman for most countries, but a strong increase for the majority of countries after the collapse of Lehman (see Table 6). Hence, the trigger point for the reversal of the exchange rate effect can be identified with Lehman's collapse. This single event underlies the dramatic impacts when a "too big to fail" financial institution was allowed to fail. It might be expected that Lehman's collapse would radically change market's default expectations. Perhaps it shouldn't be surprising then that in such more pessimistic expectations a "signal of economic strength" from a strong euro would override any concerns that it might be "harmful to exports".

Summarizing the results, we find that the relationship between the exchange rate and stock prices has changed from negative before the crisis, neutral during the first part of the crisis and positive after the collapse of Lehman. As the depth of the financial crisis and subsequent recession became clear, an appreciation of the euro becomes more and more a sign of confidence in the economic prospects of the euro area.

5. Conclusion

This study uses daily data on stock market indexes for the United States and 15 Eurozone countries to test for the presence of transmission of the 2007-2010 financial and sovereign debt crises. We consider both a financial sector index and a non-financials market index (i.e. total market index excluding financials). For each EMU country's (financials or non-financials) indexes we explain the stock market movements using a GARCH model. The GARCH model is well known for its ability to deal with the time varying nature of stock market volatility. Both the contemporaneous and lagged

US return are included to capture the dependence of EMU markets on developments in the US. Indicator variables are introduced to allow the coefficients to change during the pre-crisis vs. crisis periods and pre-Lehman vs. post-Lehman sub periods.

There is strong evidence of crisis transmission from US non-financials to European non-financials, whereas the increase in dependence of European financials on US financials is rather limited. Following the collapse of Lehman Brothers financials become much more dependent on changes in Greek CDS spreads compared to the pre-Lehman sub period. However, this increase is not present for non-financials. The relationship between the euro-dollar exchange rate and stock prices has changed from negative before the crisis, neutral during the first part of the crisis and positive after the collapse of Lehman. .

The findings have important implications for the on-going debate about how to reform the financial system so as to mitigate systemic risk in the future. First, the importance of the non-financial crisis transmission channels needs to be taken into account and to be investigated further. Second, exchange rates and stock market returns are correlated but this relationship seems to depend crucially on the overall market sentiment. The time varying nature of this relationship is a possible fruitful area for further research. Finally, the study shows the serious impact on market risk perceptions from a single but dramatic default event. Hence, policies to reduce the failure possibility of institutions deemed “too big to fail” become increasingly important.

References

Bae, K.-H. and Karolyi, G. A. and Stulz, R. M. (2003). A new approach to measuring financial contagion. The Review of Financial Studies, 16(3), 717-763.

Beine, M., Capelle-Blancard, G. and Raymond, H. (2008). International nonlinear causality between stock markets. The European Journal of Finance, 14(8) , 663 – 686.

Blundell-Wignall, A. and Slovik, P. (2010), The EU Stress Test and Sovereign Debt Exposures, OECD Working Papers on Finance, Insurance and Private Pensions, No. 4.

Branson, W. H. (1983). Macroeconomic determinants of real exchange rate risk, in Managing Foreign Exchange Risk, edited by R. J. Herring. Cambridge: Cambridge University Press.

Dooley, M. and Hutchison, M. (2009). Transmission of the U.S. subprime crisis to emerging markets: Evidence on the decoupling–recoupling hypothesis. Journal of International Money and Finance, 28(8), 1331-1349.

Didier, T., Love, I. and Martinez Peria, M. S. (2010). What explains stock markets' vulnerability to the 2007-2008 crisis? World Bank Policy Research Working Paper 5224.

Dornbusch, R. and Fisher, S. (1980). Exchange rates and the current account. American Economic Review, 70, 960-971.

Dungey, M. and Martin, V.L. (2007). Unraveling financial market linkages during crises. Journal of Applied Econometrics, 22, 89-119.

Dunne, P., Hau, H. and Moore, M. (2010). International order flows: Explaining equity and exchange rate returns. Journal of International Money and Finance, 29, 358-386.

Ehrmann, M. Fratzscher, M. and Rigobon, R. (2010). Stocks, bonds, money markets and exchange rates: Measuring international financial transmission. Journal of Applied Econometrics, forthcoming.

Engle, R.F., Ito, T. and Lin, W. (1990) Meteor showers or heat waves? Heteroskedastic intra-daily volatility in the foreign exchange market. Econometrica, 58, 525–542.

Ferreira, M. A. and Gama, P. M. (2007). Does sovereign debt ratings news spill over to international stock markets? Journal of Banking & Finance, 31, 3162–3182

Frankel, J. (1983). Monetary and portfolio balance models of exchange rate determination, in Economic Interdependence and Flexible Exchange Rates, edited by Bhandari, J. and Putnam, B., p. 84-114. Cambridge, MA: MIT Press

Hamao, Y., Masulis, R. W. and Ng, V. (1990) Correlations in price changes and volatility across international stock markets. Review of Financial Studies, 3, 281–307.

Forbes, K. J. and Rigobon, R. (2002). No Contagion, Only Interdependence: Measuring Stock Market Comovements. The Journal of Finance, 57(5), 2223-2261.

Masih, R. and Masih, A. M. M. (2001). Long and short term dynamic causal transmission amongst international stock markets. Journal of International Money and Finance, 20(4), 563-587.

Pericoli, M. and Sbracia, M., A primer on financial contagion. Journal of Economic Surveys, 2003, 17(4), 571–608.

Spiegel Online (2010). European Central Bank President Jean-Claude Trichet: A 'Quantum Leap' in Governance of the Euro Zone Is Needed. Spiegel Online, 15 May 2010.

Table 1: Descriptive statistics of daily stock returns

	mean				variance			
period	pre-crisis	crisis	crisis	crisis	pre-crisis	crisis	crisis	crisis
sub period			pre-Lehman	post-Lehman			pre-Lehman	post-Lehman
Financials								
Austria	0.124	-0.091	-0.137	-0.055	0.008	0.057	0.025	0.082
Belgium	0.086	-0.145	-0.159	-0.134	0.012	0.056	0.032	0.076
Cyprus	0.132	-0.144	-0.131	-0.154	0.021	0.074	0.037	0.104
Finland	0.105	-0.026	-0.078	0.015	0.015	0.045	0.028	0.059
France	0.090	-0.092	-0.132	-0.060	0.011	0.061	0.033	0.083
Germany	0.075	-0.070	-0.103	-0.044	0.011	0.036	0.018	0.050
Greece	0.123	-0.172	-0.127	-0.208	0.018	0.080	0.031	0.119
Ireland	0.076	-0.338	-0.302	-0.367	0.010	0.314	0.079	0.502
Italy	0.078	-0.115	-0.130	-0.103	0.008	0.046	0.018	0.068
Luxembourg	0.059	-0.006	-0.052	0.030	0.003	0.010	0.004	0.015
Malta	0.113	-0.051	-0.083	-0.026	0.009	0.014	0.007	0.020
Netherlands	0.058	-0.122	-0.119	-0.124	0.017	0.056	0.024	0.081
Portugal	0.069	-0.141	-0.183	-0.108	0.006	0.041	0.029	0.050
Slovenia	0.054	-0.069	0.040	-0.156	0.026	0.027	0.023	0.030
Spain	0.091	-0.082	-0.132	-0.041	0.010	0.052	0.021	0.076
EMU-15	0.083	-0.095	-0.127	-0.070	0.008	0.042	0.020	0.059
US	0.053	-0.094	-0.119	-0.075	0.006	0.091	0.041	0.130
Non-financials								
Austria	0.117	-0.059	-0.057	-0.060	0.008	0.031	0.016	0.043
Belgium	0.079	0.000	-0.058	0.047	0.005	0.020	0.013	0.026
Cyprus	0.031	-0.098	-0.025	-0.156	0.007	0.012	0.010	0.014
Finland	0.052	-0.062	-0.077	-0.050	0.018	0.039	0.027	0.048
France	0.065	-0.042	-0.062	-0.026	0.009	0.026	0.013	0.035
Germany	0.077	-0.031	-0.032	-0.031	0.009	0.027	0.012	0.038
Greece	0.074	-0.089	-0.079	-0.097	0.009	0.022	0.013	0.029
Ireland	0.097	-0.078	-0.145	-0.025	0.010	0.034	0.026	0.040
Italy	0.055	-0.065	-0.093	-0.043	0.006	0.027	0.013	0.039
Luxembourg	0.090	0.004	-0.029	0.031	0.011	0.028	0.016	0.037
Malta	0.033	-0.037	-0.021	-0.050	0.014	0.007	0.002	0.010
Netherlands	0.053	-0.029	-0.030	-0.028	0.009	0.029	0.015	0.041
Portugal	0.079	-0.034	-0.070	-0.005	0.004	0.024	0.014	0.033
Slovenia	0.088	-0.077	-0.019	-0.123	0.004	0.023	0.020	0.025
Spain	0.093	-0.051	-0.063	-0.041	0.006	0.023	0.015	0.030
EMU-15	0.070	-0.039	-0.056	-0.026	0.007	0.022	0.012	0.029
US	0.052	-0.020	-0.013	-0.025	0.006	0.027	0.011	0.040

Note: This table shows descriptive statistics for the financials and non-financials index of each country, based on daily data retrieved from Thomson Datastream. The EMU-15 return series is calculated as a weighted average of all EMU countries and the volatility is directly calculated from this generated return series.

Table 2: Dependence of European financials on US financials before and during the crisis

	AUT	BEL	CYP	FIN	FRA	DEU	GRC	IRL	ITA	LUX	MAL	NLD	PRT	SJO	ESP
R(i, t-1)	-0.0490*	-0.0712***	0.0874***	-0.102***	-0.129***	-0.0510**	0.0521**	-0.00984	-0.0527**	-0.0818***	0.197***	-0.0358	0.0317	-0.149***	-0.0832***
	(0.0280)	(0.0270)	(0.0240)	(0.0256)	(0.0242)	(0.0236)	(0.0230)	(0.0270)	(0.0257)	(0.0302)	(0.0410)	(0.0258)	(0.0277)	(0.0370)	(0.0265)
R(US,t)	0.189***	0.366***	0.109**	0.301***	0.497***	0.548***	0.183***	0.257***	0.373***	-0.0155	-0.0112	0.467***	0.165***	0.0735	0.451***
	(0.0305)	(0.0369)	(0.0476)	(0.0485)	(0.0407)	(0.0363)	(0.0489)	(0.0362)	(0.0339)	(0.0180)	(0.0234)	(0.0401)	(0.0382)	(0.0584)	(0.0380)
R^c(US,t)	0.214***	0.0821	0.0353	0.0645	0.0155	-0.128***	0.109*	0.424***	0.0448	0.0509**	0.00339	-0.0588	0.109**	-0.0903	-0.0373
	(0.0514)	(0.0501)	(0.0629)	(0.0572)	(0.0515)	(0.0422)	(0.0621)	(0.0935)	(0.0455)	(0.0229)	(0.0273)	(0.0512)	(0.0498)	(0.0890)	(0.0482)
R(US,t-1)	0.185***	0.279***	0.129***	0.308***	0.397***	0.257***	0.352***	0.295***	0.185***	0.0404**	0.0631**	0.379***	0.147***	0.0700	0.276***
	(0.0299)	(0.0322)	(0.0477)	(0.0471)	(0.0340)	(0.0339)	(0.0516)	(0.0339)	(0.0300)	(0.0186)	(0.0257)	(0.0356)	(0.0401)	(0.0616)	(0.0374)
R^c (US,t-1)	0.134***	0.0629	0.233***	-0.0237	-0.0159	-0.0611*	-0.0932	0.146	0.0624	0.0417*	-0.0455	-0.0262	0.0474	0.0564	-0.0222
	(0.0485)	(0.0442)	(0.0614)	(0.0569)	(0.0446)	(0.0364)	(0.0660)	(0.0895)	(0.0413)	(0.0243)	(0.0312)	(0.0452)	(0.0465)	(0.0744)	(0.0469)
E(t)	-0.0575	-0.229***	-0.0135	-0.0750	-0.248***	-0.199***	-0.134**	-0.0764*	-0.219***	-0.0725***	-0.137***	-0.307***	-0.0887***	0.167**	-0.167***
	(0.0392)	(0.0324)	(0.0485)	(0.115)	(0.0350)	(0.0319)	(0.0531)	(0.0400)	(0.0309)	(0.0191)	(0.0330)	(0.0351)	(0.0299)	(0.0786)	(0.0346)
E^c(t)	0.360***	0.509***	0.450***	0.298**	0.554***	0.393***	0.521***	0.232	0.520***	0.0179	0.0893	0.553***	0.387***	0.123	0.484***
	(0.0859)	(0.0793)	(0.105)	(0.144)	(0.0780)	(0.0548)	(0.114)	(0.175)	(0.0921)	(0.0470)	(0.0750)	(0.0741)	(0.0803)	(0.206)	(0.0816)

Note: Equation (2) is estimated using a GARCH (1,1) model on stock market financial indexes for the full pre-crisis and crisis periods (1/1/2003 – 31/8/2010).
*, ** and *** denote significance at the 10%, 5% and 1%, respectively.

Table 3: Dependence of European non-financials on US non-financials before and during the crisis

	AUT	BEL	CYP	FIN	FRA	DEU	GRC	IRL	ITA	LUX	MAL	NLD	PRT	SJO	ESP
R(i, t-1)	-0.0405	-0.0738***	0.0376	-0.118***	-0.217***	-0.141***	0.00101	-0.0995**	-0.174***	-0.163***	0.0283	-0.186***	-0.00961	0.128***	-0.150***
	(0.0252)	(0.0237)	(0.0291)	(0.0266)	(0.0223)	(0.0238)	(0.0227)	(0.0455)	(0.0247)	(0.0236)	(0.0323)	(0.0225)	(0.0263)	(0.0285)	(0.0241)
R(US,t)	0.216***	0.216***	0.0238	0.588***	0.524***	0.630***	0.190***	0.315***	0.459***	0.119***	-0.0488	0.494***	0.156***	0.0210	0.443***
	(0.0318)	(0.0272)	(0.0310)	(0.0531)	(0.0340)	(0.0331)	(0.0358)	(0.0889)	(0.0317)	(0.0422)	(0.0476)	(0.0317)	(0.0282)	(0.0246)	(0.0315)
R^c(US,t)	0.326***	0.266***	0.107**	0.0690	0.141***	0.115**	0.161***	0.273**	0.172***	0.0861	0.0660	0.191***	0.261***	0.0798	0.142***
	(0.0539)	(0.0504)	(0.0459)	(0.0690)	(0.0462)	(0.0500)	(0.0520)	(0.107)	(0.0475)	(0.0581)	(0.0505)	(0.0473)	(0.0483)	(0.0631)	(0.0466)
R(US,t-1)	0.227***	0.213***	0.128***	0.600***	0.417***	0.276***	0.285***	0.427***	0.263***	0.321***	-0.0146	0.401***	0.165***	0.0602**	0.271***
	(0.0312)	(0.0278)	(0.0305)	(0.0483)	(0.0318)	(0.0316)	(0.0356)	(0.0485)	(0.0294)	(0.0444)	(0.0472)	(0.0318)	(0.0245)	(0.0247)	(0.0326)
R^c (US,t-1)	0.159***	0.0657	0.0925*	-0.197***	-0.0107	-0.0309	-0.0522	-0.0444	0.0991**	-0.0780	0.0247	0.0190	0.0722	0.140***	0.0242
	(0.0512)	(0.0529)	(0.0508)	(0.0655)	(0.0454)	(0.0392)	(0.0501)	(0.0671)	(0.0468)	(0.0593)	(0.0509)	(0.0456)	(0.0481)	(0.0538)	(0.0446)
E(t)	-0.0663*	-0.0785***	-0.0295	-0.226***	-0.224***	-0.196***	-0.150***	-0.165***	-0.131***	-0.139***	-0.108*	-0.280***	-0.0755***	-0.0627**	-0.173***
	(0.0358)	(0.0252)	(0.0305)	(0.0566)	(0.0308)	(0.0304)	(0.0375)	(0.0401)	(0.0300)	(0.0410)	(0.0609)	(0.0306)	(0.0237)	(0.0262)	(0.0287)
E^c(t)	0.278***	0.145**	0.144**	0.440***	0.335***	0.276***	0.313***	0.223***	0.316***	0.0728	0.0639	0.413***	0.261***	0.143**	0.305***
	(0.0632)	(0.0575)	(0.0634)	(0.0835)	(0.0497)	(0.0472)	(0.0669)	(0.0754)	(0.0544)	(0.0741)	(0.0725)	(0.0565)	(0.0537)	(0.0700)	(0.0507)

Note: Equation (2) is estimated using a GARCH (1,1) model on stock market non-financial indexes for the full pre-crisis and crisis periods (1/1/2003 – 31/8/2010).

*, ** and *** denote significance at the 10%, 5% and 1%, respectively.

.

Table 4: Composition of changes in the government debt ratio in EMU member states (% of GDP)

	Gross debt ratio		Change in debt ratio	Source of change in debt ratio 2007-2011:		
Country	2007	2011	2007-2011	Primary balance	Interest & growth contribution	Stock-flow adjustment
Austria	59.5	72.9	13.4	2.2	6.2	5
Belgium	84.2	100.9	16.7	2.2	8.5	6
Cyprus	58.3	67.6	9.3	9.1	4	-3.8
Finland	35.2	54.9	19.7	-0.3	3.4	16.5
France	63.8	88.6	24.8	15.6	5.9	3.4
Germany	65	81.6	16.5	2.2	8.4	5.9
Greece	95.7	133.9	38.2	19.7	15	3.5
Ireland	25	87.3	62.3	35.5	14.6	12.2
Italy	103.5	118.9	15.5	-1	14.8	1.7
Luxembourg	6.7	23.6	16.9	3.4	0.5	13.1
Malta	61.9	72.5	10.6	3.2	5.7	1.7
Netherlands	45.5	69.6	24.1	7	5.9	11.2
Portugal	63.6	91.1	27.5	16.4	8.9	2.2
Slovenia	23.4	45.4	22	12.2	4.3	5.5
Spain	36.2	72.5	36.3	25.7	7.2	3.4
EMU-15	66.0	88.5	22.5	9.0	8.7	4.9

Source: European Commission Spring 2010 Economic Forecast.

Table 5: Dependence of European financials on US financials and Greek CDS spreads before and after Lehman's collapse

	AUT	BEL	CYP	FIN	FRA	DEU	GRC	IRL	ITA	LUX	MAL	NLD	PRT	SJO	ESP
R(i, t-1)	-0.0588*	-0.0630*	0.0579*	-0.0942***	-0.123***	-0.0790**	-0.0249	0.00703	-0.0561	-0.0883**	0.126**	0.00305	0.0345	-0.117**	-0.0821**
	(0.0328)	(0.0361)	(0.0336)	(0.0324)	(0.0334)	(0.0326)	(0.0333)	(0.0428)	(0.0344)	(0.0436)	(0.0599)	(0.0353)	(0.0358)	(0.0511)	(0.0355)
R(US,t)	0.270***	0.438***	0.0711	0.290***	0.471***	0.400***	0.191***	0.600***	0.343***	0.0246*	-0.0418	0.339***	0.270***	-0.167*	0.329***
	(0.0453)	(0.0471)	(0.0506)	(0.0570)	(0.0499)	(0.0370)	(0.0419)	(0.0852)	(0.0435)	(0.0141)	(0.0266)	(0.0441)	(0.0493)	(0.0924)	(0.0352)
R^{aLeh}(US,t)	0.113	-0.0413	0.0211	0.0538	0.00538	-0.00948	0.0423	0.0914	0.0731	0.00964	0.0330	0.0685	-0.0640	0.187**	0.0756
	(0.0717)	(0.0613)	(0.0706)	(0.0674)	(0.0633)	(0.0442)	(0.0668)	(0.162)	(0.0586)	(0.0222)	(0.0295)	(0.0594)	(0.0609)	(0.0900)	(0.0509)
R(US,t-1)	0.324***	0.337***	0.454***	0.396***	0.415***	0.199***	0.336***	0.408***	0.226***	0.0936***	0.0528	0.322***	0.239***	0.175**	0.238***
	(0.0400)	(0.0421)	(0.0414)	(0.0540)	(0.0478)	(0.0314)	(0.0444)	(0.0809)	(0.0362)	(0.0155)	(0.0362)	(0.0395)	(0.0422)	(0.0873)	(0.0347)
R^{aLeh}(US,t-1)	-0.0378	-0.0339	-0.191***	-0.181***	-0.0751	-0.00629	-0.207***	0.0508	-0.000829	-0.0286	-0.0520	0.00991	-0.108**	-0.0647	-0.0161
	(0.0633)	(0.0553)	(0.0636)	(0.0614)	(0.0575)	(0.0371)	(0.0703)	(0.136)	(0.0530)	(0.0235)	(0.0381)	(0.0527)	(0.0508)	(0.110)	(0.0491)
E(t)	-0.123	-0.0148	0.133	0.0520	-0.0469	0.0299	0.0517	-0.114	0.00748	-0.0392	-0.150*	-0.0397	0.0148	0.372***	-0.0375
	(0.0963)	(0.0981)	(0.131)	(0.128)	(0.102)	(0.0779)	(0.110)	(0.146)	(0.0956)	(0.0364)	(0.0795)	(0.108)	(0.112)	(0.132)	(0.0807)
E^{aLeh}(t)	0.558***	0.355***	0.343**	0.177	0.428***	0.187**	0.512***	0.483	0.353***	-0.0446	0.167	0.341**	0.300**	-0.241	0.461***
	(0.132)	(0.124)	(0.173)	(0.146)	(0.125)	(0.0894)	(0.181)	(0.326)	(0.122)	(0.0649)	(0.107)	(0.134)	(0.132)	(0.149)	(0.123)
CDS GRC(t)	-0.0244**	-0.00456	-0.0434***	0.00233	-0.00838	-0.00463	-0.0316***	0.0223	-0.00412	-0.0190**	-0.00439	-0.00351	-0.0211	-0.00550	-0.0144
	(0.0110)	(0.0101)	(0.0150)	(0.0172)	(0.0108)	(0.00856)	(0.0117)	(0.0188)	(0.0105)	(0.00775)	(0.00842)	(0.00807)	(0.0146)	(0.0106)	(0.0109)
CDS GRC^{aLeh}(t)	-0.0619**	-0.0710***	-0.123***	-0.0810***	-0.0659***	-0.0431***	-0.224***	-0.190***	-0.0921***	-0.00662	0.0111	-0.0689***	-0.100***	-0.00386	-0.103***
	(0.0242)	(0.0250)	(0.0273)	(0.0244)	(0.0223)	(0.0130)	(0.0340)	(0.0492)	(0.0250)	(0.0190)	(0.0118)	(0.0203)	(0.0255)	(0.0151)	(0.0319)

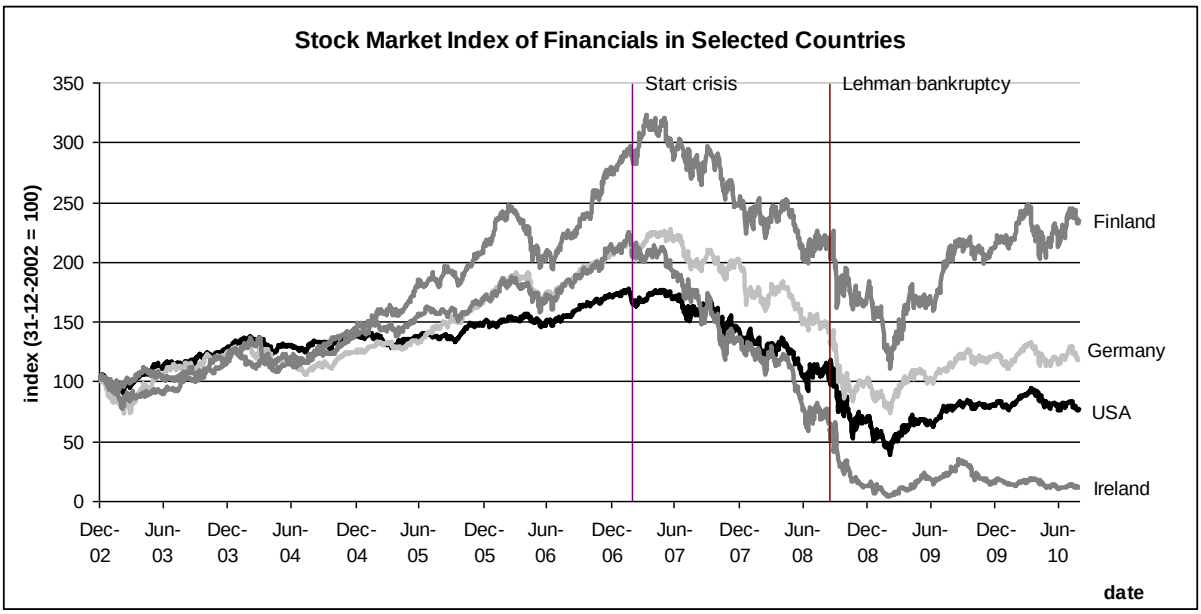
Note: Equation (3) is estimated using a GARCH (1,1) model on stock market financial indexes for the pre- and post-Lehman crisis sub periods (27/2/2007 – 31/8/2010).
*, ** and *** denote significance at the 10%, 5% and 1%, respectively.

Table 6: Dependence of European non-financials on US non-financials and Greek CDS spreads before and after Lehman's collapse

	AUT	BEL	CYP	FIN	FRA	DEU	GRC	IRL	ITA	LUX	MAL	NLD	PRT	SJO	ESP
R(i, t-1)	-0.0901***	-0.111***	-0.0102	-0.196***	-0.237***	-0.160***	-0.0333	-0.113***	-0.207***	-0.265***	-0.0595	-0.215***	-0.0516	0.0817**	-0.143***
	(0.0308)	(0.0342)	(0.0429)	(0.0382)	(0.0325)	(0.0350)	(0.0345)	(0.0334)	(0.0334)	(0.0331)	(0.0665)	(0.0331)	(0.0355)	(0.0412)	(0.0356)
R(US,t)	0.440***	0.515***	0.180***	0.669***	0.585***	0.668***	0.313***	0.656***	0.549***	0.155***	-0.0313*	0.632***	0.320***	0.0436	0.577***
	(0.0582)	(0.0497)	(0.0388)	(0.0823)	(0.0432)	(0.0530)	(0.0582)	(0.0639)	(0.0444)	(0.0578)	(0.0184)	(0.0482)	(0.0652)	(0.0935)	(0.0553)
R^{aLeh}(US,t)	0.0717	-0.108	-0.106**	-0.0851	0.0859	0.0623	-0.0410	-0.142*	0.0847	0.0633	0.0878***	0.0376	0.0967	0.0611	-0.0483
	(0.0732)	(0.0700)	(0.0536)	(0.0993)	(0.0594)	(0.0648)	(0.0730)	(0.0857)	(0.0634)	(0.0778)	(0.0294)	(0.0655)	(0.0786)	(0.102)	(0.0650)
R(US,t-1)	0.475***	0.424***	0.379***	0.636***	0.470***	0.304***	0.305***	0.508***	0.412***	0.210***	-0.0119	0.487***	0.362***	0.190*	0.328***
	(0.0611)	(0.0673)	(0.0440)	(0.0840)	(0.0524)	(0.0516)	(0.0563)	(0.0710)	(0.0488)	(0.0573)	(0.0206)	(0.0557)	(0.0607)	(0.103)	(0.0567)
R^{aLeh}(US,t-1)	-0.109	-0.223***	-0.244***	-0.300***	-0.0913	-0.0765	-0.131*	-0.179**	-0.0654	0.0477	0.0492	-0.0969	-0.185**	0.0231	-0.0795
	(0.0750)	(0.0807)	(0.0562)	(0.1000)	(0.0672)	(0.0570)	(0.0696)	(0.0811)	(0.0674)	(0.0723)	(0.0387)	(0.0660)	(0.0761)	(0.107)	(0.0628)
E(t)	-0.0761	-0.0763	0.0403	0.124	-0.103	-0.0649	-0.0272	-0.200**	0.0558	-0.149*	0.0295	-0.00739	-0.0341	-0.00246	-0.0545
	(0.0832)	(0.0730)	(0.0624)	(0.118)	(0.0645)	(0.0608)	(0.0762)	(0.0836)	(0.0623)	(0.0772)	(0.0248)	(0.0708)	(0.0721)	(0.0999)	(0.0759)
E^{aLeh}(t)	0.371***	0.186**	0.0480	0.0121	0.238***	0.177**	0.226**	0.384***	0.131	0.109	-0.172*	0.158*	0.247***	0.116	0.214**
	(0.101)	(0.0939)	(0.0799)	(0.131)	(0.0786)	(0.0722)	(0.101)	(0.109)	(0.0825)	(0.118)	(0.103)	(0.0885)	(0.0877)	(0.116)	(0.0888)
CDS GRC(t)	-0.0260***	-0.0132	-0.0358***	-0.0159	-0.0182**	-0.0147	-0.00490	-0.0117	-0.0253***	-0.0230*	0.00646	-0.0217**	-0.00810	-0.00381	-0.0213*
	(0.0101)	(0.00959)	(0.00918)	(0.0132)	(0.00864)	(0.00901)	(0.0112)	(0.0141)	(0.00792)	(0.0120)	(0.00591)	(0.00878)	(0.00784)	(0.0176)	(0.0124)
CDS GRC^{aLeh}(t)	-0.00761	-0.0134	0.00246	-0.0442**	-0.0133	-0.00595	-0.0875***	-0.0182	-0.0116	0.0227	-0.00639	-0.0102	-0.0428***	-0.00455	-0.0281*
	(0.0144)	(0.0155)	(0.0125)	(0.0212)	(0.0128)	(0.0121)	(0.0169)	(0.0195)	(0.0133)	(0.0201)	(0.00989)	(0.0131)	(0.0141)	(0.0190)	(0.0164)

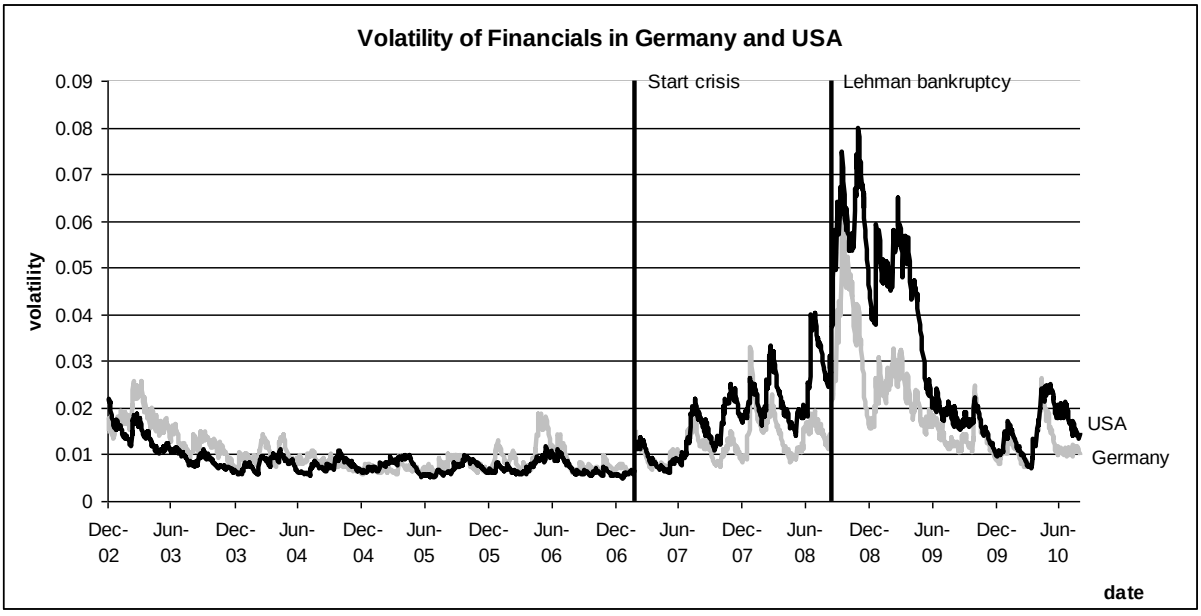
Note: Equation (3) is estimated using a GARCH (1,1) model on stock market non-financial indexes for the pre- and post-Lehman crisis sub periods (27/2/2007 – 31/8/2010).
*, ** and *** denote significance at the 10%, 5% and 1%, respectively.

Figure 1:



Source: Thomson Datastream.

Figure 2:

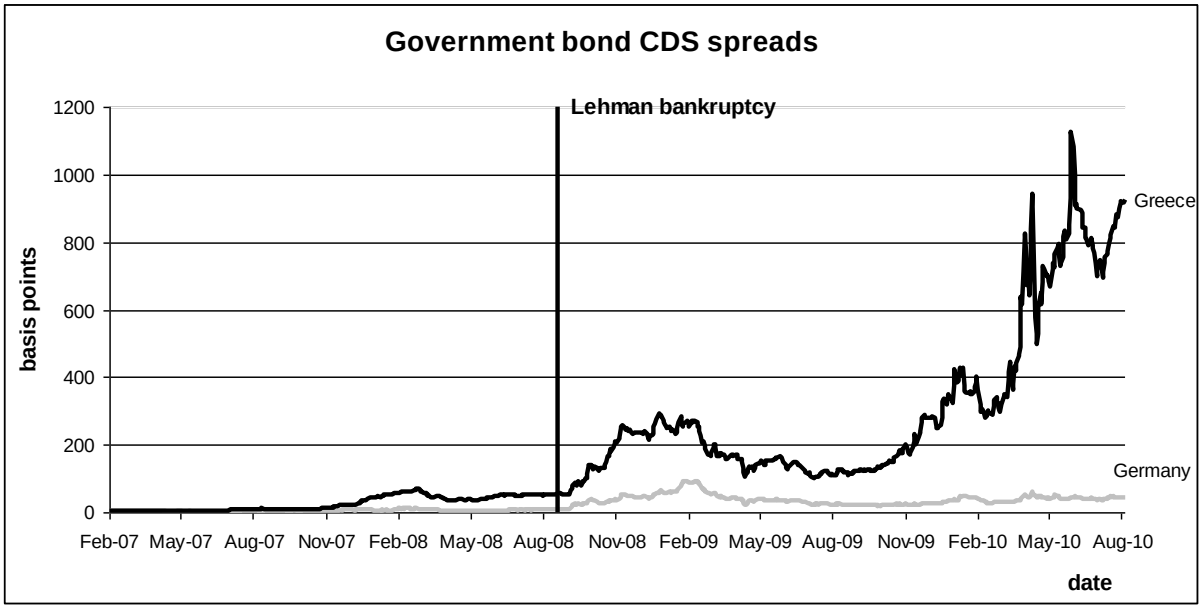


Source: Thomson Datastream.

Figure 3:

Source: Thomson Datastream.

Figure 4:



Source: Thomson Datastream.