Sovereign credit risk and the real economy: A risk-return framework

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Abstract

We propose a framework to analyze the relation of risk and return at the country level. Our framework follows a top-down approach that combines information from financial markets and the real economy at three levels of aggregation. At the top level we consider sovereign CDS spreads and GDP growth, at the intermediate level the corporate sector's contribution to sovereign CDS spreads and to GDP growth, and at the bottom level the contribution of the non-financial and financial sector to the sovereign CDS spread and GDP growth. We apply these measures to 19 developed countries during the period 2004-2010. We find substantial cross-country differences in the importance of the real economy, lead-lag relationships between the return-risk measures and macroeconomic variables, and that risk has become more volatile than return. We also demonstrate how our framework can be used to identify contagion effects, analyze international investments, and to build CDS trading strategies.

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1. Introduction

Governments are the largest borrowers in the world and sovereign debt levels have risen to unprecedented levels as a consequence of the global financial crisis of 2007-2009 and the current sovereign debt crisis in the Euro area. Sovereign credit risk, as reflected by the increasing number of sovereign credit rating downgrades and countries that are at the brink of default, has become the epicenter of the recent public debate but there is relatively scarce research in finance and economics on the relation of risk and return at the country level, especially for developed countries. For a long time, the literature has focused on fundamental macroeconomic questions related to growth of the real economy, allocative efficiency, and social welfare, but neglected the issue of sovereign credit risk of developed countries (an important exception is research on emerging economies and the Asian, Russian and Latin American sovereign debt crisis; e.g., Panizza, Sturzenegger and Zettelmeyer, 2010). Interest rates (yields) of government securities and/or central banks of the largest developed countries have been considered by researchers, market participants and policy makers as "risk-free rates". This view stands in stark contrast with recent evidence from financial markets. An obvious implication is that we know a lot about economic value creation at the country level (return) but we know relatively little about country risk, and almost nothing about the relation of risk and return at the country level. This is surprising because there is abundant research on the relation of risk and return of firms, starting with the theoretical and empirical work on modern portfolio theory (e.g., Markowitz 1952; Sharpe, 1964; Lintner, 1965). This literature, which initially focused on corporate stocks, has become a paradigm in financial economics and later been extended to other financial instruments such as corporate bonds, derivatives and mutual funds.

This paper proposes a framework to analyze the risk and return at the country level. We focus on sovereign *credit* risk (instead of other risk concepts) because sovereigns cannot issue equity

and thus largely rely on debt as external source of finance, and credit risk, i.e. the probability of default, is the most relevant risk associated with debt finance. We note that the probability of default of a sovereign depends, among other factors, on the volatility of its return distribution and the default threshold. Our framework has two main characteristics. First, we combine information about country credit risk from financial markets and information on country return from the real economy. Specifically, we use sovereign and corporate credit default swap (CDS) spreads from one country to measure the risk component and aggregate and sector-specific economic growth rates from the same country to measure the return component. Second, we propose a top-down approach. We argue that risk and return of country measured at the macroeconomic level can be interpreted as the aggregate outcome of microeconomic activity of the private sector (corporate sector and households) plus government activity. We implement the top-down approach at three levels of aggregation. At the top level we consider sovereign CDS spreads and GDP growth, at the intermediate level the contribution of the corporate sector to the sovereign CDS spread and GDP growth, and at the bottom level the contribution of the non-financial and financial sector to the sovereign CDS spread and GDP growth. We note that our approach also helps understanding the sources of return and risk of countries. One government might prefer to strongly intervene in the country's economy, while another government prefers a minimum level of intervention. The first case is similar to a "pay-through structure" (managed cash flows), while the second case is similar to a "pass-through structure" (all cash flows are passed through without any modification). In other words, country return and risk depend on how (strongly) the government influences the economic activity of the country, and on the importance of the financial and non-financial component of the country's corporate sector.

We apply these measures to 19 developed countries (United States, Japan, Korea, Australia and 15 European countries) during the period 2004-2010, which account for more than 60% of

the world GDP and include seven of the top ten world GDP contributors. We identify three groups of countries with similar return (GDP growth) and risk (sovereign CDS spread) profiles, using information at the highest level of aggregation. Moreover, we study the intermediate return-risk level with country-by-country daily time series regressions and find that the average CDS spread level (change) of the corporate sector from a country can explain 74% (15%) of the variation in its sovereign CDS spread level (change). At the lowest level of aggregation, we break down the contribution of the corporate sector into return and risk contributions of the non-financial and financial sector of a country. The resulting return-risk contribution measure (based on the non-financial part of the corporate sector) makes it possible for us to assign the countries to return-risk clusters. In a next step, we report the correlations between our return-risk measures (contemporaneous and lagged by four quarters) and macroeconomic variables (GDP, trade balance, government expenses, debt/GDP, government expenses/GDP) as well as the sovereign credit rating from Standard & Poor's, the Corruption Perception Index from Transparency International, and the average corporate CDS spread from the same country. The signs of the correlations are as expected but their magnitude becomes stronger when we take the risk-return measure from four quarters ago and the other variables from the current quarter. In a dynamic analysis based on quarterly rolling windows we compare the return-risk measures (return-risk contribution measures) of the United States and Germany as well as those of Ireland and Greece.

This analysis indicates substantial cross-country differences in the importance of the real economy, lead-lag relationships between the return-risk measures and macroeconomic variables, and that risk has become more volatile than return. Finally, we demonstrate how our framework can be used to identify cross-country and cross-sector contagion effects, analyze foreign investments, and to build profitable CDS trading strategies.

Our paper contributes to the literature in several ways. First, we extend and complement earlier studies on sovereign credit risk that are based on government bond market data. Some of these studies analyze the determinants and behavior of credit spreads of governments bonds (e.g., Gande and Parsley, 2005; Hielscher and Nosbusch, 2010; Ejsing and Lemke, 2011), while others examine the determinants of sovereign credit ratings (e.g., Alsakka and Gwilym, 2010; Hill, Brooks and Faff, 2010).

Second, we build on the empirical literature on corporate and sovereign CDS markets. Credit derivatives, especially CDS, have been considered as the most significant financial innovation from the last 20 years (Stulz, 2010). The corporate CDS market was relatively resilient during the recent the global financial crisis and CDS spreads have become the benchmark for market-based measures of corporate default risk. Empirical research on the informational efficiency of the CDS market shows that CDS spreads lead credit spreads of corporate bonds, and benefit from a higher market liquidity (e.g., Blanco, Brennan and Marsh, 2005; Longstaff, Mithal and Neis, 2005; Norden and Weber, 2009; Bongaerts, de Jong and Driessen, 2011). Corporate CDS spreads start changing considerable time before credit rating announcements (e.g., Hull, Predescu and White, 2004; Norden and Weber, 2004), and CDS spreads reflect intra-industry contagion (competitive) effects around Chapter 11 (7) bankruptcies better than stock returns (Jorion and Zhang, 2007). There is also evidence that CDS spreads reflect private information of banks that simultaneously act as CDS traders and lenders to large companies (e.g., Acharya and Johnson, 2007; Norden, 2011). Next to research on the corporate CDS market, there is a growing literature about the sovereign CDS market, which initially focused on emerging markets (e.g., Zhang, 2003; Andritzky, 2005; Longstaff, Pan, Pedersen and Singleton, 2010; Ismailescu and Kazemi, 2010). A number of recent studies investigate the private-public risk transfer in developed countries arising from bank bailouts by governments during the global financial crisis (e.g., Acharya,

Drechsler and Schnabl, 2011; Ang and Longstaff, 2011; Alter and Schüler, 2011; Bolton and Jeanne, 2011; Dieckmann and Plank, 2011; Fontana and Scheicher, 2010; Huizinga and Horváth, 2011).

The rest of the paper is structured as follows. In Section 2 we describe our data. In Section 3 we present the top-down approach of risk and return at the country level. In Section 4 we analyze the dynamics of country risk and return. In Section 5 we demonstrate various applications for our framework. Section 6 concludes.

2. Data

We conduct our analysis on data from developed countries that are frequently traded underlyings in the market of sovereign credit default swaps and for which quarterly macroeconomic data is publicly available. After applying these data requirements, we obtain a final sample of 19 countries which account for more than 60% of the World GDP and include seven out of the top ten World GDP contributors. We also collect sovereign credit ratings from Standard & Poor's, Moody's Investors Service, and the Corruption Perception Index from Transparency International for these countries. Table 1 presents summary statistics.[3]

(Insert Table 1 about here)

[3] China is excluded due to GDP decomposition availability and, as for Brazil, its classification as an emerging country by per-capita GDP. Russia does not have a liquid sovereign CDS market. All estimates are based on average GDP numbers over the sample period in USD.

The CDS data come from Markit and CMA. We consider the five-year sovereign CDS spread because it is the most liquidly traded CDS contract. We do not use the full CDS term structure as often off-the-run maturities are derived from the on-the run level rather than observed.

Based on semi-annual information on the constituents of the iTraxx/CDX CDS index family we select for each country a sample of corporate CDS spreads. These indices contain the most liquidly traded firms as constituents and are re-issued every six months. Overall, our corporate sample consists of 865 companies, which we map to the countries based on their country of domicile. In 9 of 10 cases the country of domicile is identical with the company's ultimate parent's country of domicile. In the remaining cases, which account for 3.4% of the market capitalization represented by our dataset, we assign a country according to the company's most likely contribution of risk.[4]

3. A top-down approach of risk and return at the country level

3.1 Return-risk measures

We construct time-varying country-specific return-risk measures based on daily information from the sovereign and corporate CDS markets and quarterly macroeconomic data. The return of a country is measured by the change in the value of all goods and services produced in the country in a given time period. This number is given by the gross-value added (GVA) or the gross domestic product (GDP) when considering taxes as part of a service provided by the government. We do not use return of government bonds as they measure the return of a specific investment *in* a country rather than the return *of* a country.

[4] E.g. Rio Tinto PLC, an Australian mining company, is owned by its parent Rio Tinto LTD which is listed in the UK, the CDS on the Australian entity is referenced to the British mother, thus we assign Rio Tinto PLC to UK risk.

We measure the credit risk of a country with its sovereign CDS spreads. Using financial market information in assessing the risk of a country is novel, partly due to the late raise of the CDS market as whole. Recent empirical studies on corporate CDS markets find a significant information advantage over corporate bond markets in pricing risk (e.g., Blanco, Brennan and Marsh, 2005; Norden and Weber, 2009). The credit risk reflected by the sovereign CDS spread is the market's expectation of a country's probability of default. It is not the risk of a direct investment in this country nor does it measure the uncertainty of future returns.[5]

The use of the sovereign CDS spread as measure of country credit risk has several advantages. First, it is the most liquidly traded financial instrument on sovereigns. Government bonds, which are compared to corporate bonds highly liquid, depend on the term structure and the current availability of certain bonds. The sovereign CDS has, in the absence of short selling restrictions, virtually unlimited availability. Second, for government bonds the expected inflation plays a role as well as the current and future exchange rates. The sovereign CDS in contrast are all traded in US dollar, expect the one on the United States which is traded in Euro. In general sovereign CDS spreads and credit spreads of government bonds are positively correlated but there are reasons and periods why/when they decouple. For example, such basis between CDS and bond spreads can emerge because of delivery options or a "flight-to-quality" (as during the Russian Crisis in 1998), which leads to increasing bond prices at constant risk levels (= constant CDS spreads) because of excess demand. Using bond prices as default indicators would be misleading during those times. Third, sovereign credit ratings, unlike the permanently updated expectations reflected by the sovereign CDS spread, provide a stable and long-term credit risk assessment of government debt securities. Related research shows that sovereign credit ratings do

[5] The former would be measured in the government bond market, the latter by the expected volatility of GDP growth.

neither provide a timely risk assessment nor do they solely focus on the economic risk of the investment in a country (e.g., Hill, Brooks and Faff, 2010; Alsakka and Gwilym, 2010).

Similar to modern portfolio theory in finance, we conduct a return-risk-analysis by plotting for every country its mean credit risk over the sample period on the horizontal axis and its mean GDP growth over the sample period on the vertical axis. Figure 1 displays the results.

(Insert Figure 1 about here)

First, there is substantial variation across countries. Second, the variation is higher in the risk dimension than in the return dimension. With exception of Japan all countries display positive growth on average with Norway being the top growth country of our sample. On the risk axis the United States, Germany and Sweden exhibit the lowest risk, while Korea, Ireland and Greece exhibit the highest risk.

There are several clusters visible in this figure. The United States form one group with Germany, Sweden and France. A second cluster consists of the Netherlands, Belgium, UK, Denmark, Austria and Australia. The third group consists of countries which during the ongoing European sovereign crisis market participants abbreviate into the acronym P(ortugal) I(taly) I(reland) G(reece) S(pain) (dubbed "PIIGS" in the popular press). For these countries the volatility of the return measure is significantly higher than in the two other clusters. The exceptional high risk of Ireland and Greece in this sample is a result of their recent debt troubles. Interestingly, Korea is also in this cluster. While the recovery of Korea after the Asian crisis and the global financial crisis has led to the second highest growth on average in our sample, the CDS market reflects a relatively high country credit risk. Potential reasons are the aging population and an expected increase in government spending, as in several other developed countries. In

addition, the government debt of Korea has increased twice as fast as the GDP since 2000 which has gradually increased the risk of default, which is reflected by the sovereign CDS spreads.

While Panel A of Figure 1 shows the return and risk of our country sample over the whole observation period from 2004-2010, the second panel B focuses on the situation after the beginning of the global financial crisis of 2007-2009, which gradually shifted to the ongoing sovereign debt crisis in Europe and the United States. When adverse shocks hit the real economy, the countries shift to the south (i.e., growth decreases), and as risk increases they shift to the east. Such shift is most pronounced for Greece and Ireland with an increase in the risk component between 50 and 100 per cent.

3.2 Return-risk contribution measures

In a next step, we add the corporate sector to our analysis, which makes it possible for us to investigate its contribution to risk and return at the country level. A prerequisite of such analysis is that there is a close relationship between both measures. To examine this issue, we conduct country-specific time-series regression with weekly data, taking the sovereign CDS spread as dependent variable and the mean corporate CDS spread as explanatory variable.[6]

$$\text{Sovereign CDS}_{i,t} = \alpha + \beta\text{Mean Corporate CDS}_{i,t} + \varepsilon_{i,t} \quad (1)$$

Panel A of Table 2 reports the corresponding results from time-series regressions and from a panel data regression with country fixed effects. We also test for unit-roots of the CDS spread levels and cannot reject presence of a unit root in any of the countries. We thus estimate the

[6] Other ways of aggregation (e.g., median split, quintile split, or value-weighting) lead to similar results. Detailed results are available from the authors on request.

model in weekly first differences (and weekly percentage changes) of CDS spreads, as shown in Panel B of Table 2.

(Insert Table 2 about here)

For the level and changes specification we find a close relationship between the sovereign CDS spread and corporate CDS spread, both for all individual countries and overall. The average R^2 is at 77% for the levels and between 15% and 25% for the changes. Only two countries, Austria and Denmark, are not significant in all three specifications. The model with country fixed effects shows also a close relation between the two variables.

The loading on the mean corporate CDS, β in equation (1), estimates the sensitivity of the risk in a country's corporate sector on the sovereign risk. These sensitivities are qualitatively similar across the three specifications, but vary between countries. A high loading implies a high influence of the risk due to the corporate sector on the sovereign, while a low loading implies factors other than the corporate CDS market drive the sovereign's credit risk.

The interpretation of equation (1) assumes risk to mitigate from the corporate sector to the sovereign. Theoretically one could argue that a change in sovereign risk transfers, e.g. by changing tax environment or access to financing, to corporate risk. We thus test the Granger causality for both directions using a one period lag and the average over four periods (one month) pooling over all countries. The hypothesis that the corporate risk Granger causes the sovereign risk cannot be rejected for any specification (average p-value: 0.0395), while the opposite direction of the sovereign risk causing the corporate risk is rejected (average p-value: 0.151).

Based on the analysis above, we split the countries into three groups. The first group contains the United States, Germany, Norway, Denmark, France and Japan. All these countries have a loading of less than 0.20, with the US at the smallest value of 0.038 meaning that less than 4% of the average corporate risk is transferred to the sovereign risk. The second group has a loading between 0.2 and 0.5 and includes Great Britain, Switzerland, the Benelux and Australia. These country's corporate sectors have a medium impact on the sovereign, while the corporate sector of the third group has a large impact (loading above 0.5) and includes countries like Spain, Ireland, Portugal and Greece. Greece is the only country in our sample with a loading larger than one, i.e., an increase in the riskiness of the corporate sector heavily increases Greece's sovereign credit risk. Note that these groups in general mimic the clusters identified graphically in Figure 1.

A single measure capturing the return-risk profile of a country at a given date can be easily constructed in analogy of the Sharpe ratio (Sharpe, 1964). We propose to divide the return contribution of the corporate sector by its risk contribution, as given by β in Equation (1) and call this the return-risk measure RR. This measure relates a country's *overall* return (as measured by the GDP growth) with the risk contribution of the corporate sector because it includes the private and government sector in the estimate of the return. Thus, the measure overstates the true return contribution of the corporate sector. Using the gross value added (GVA) instead of the GDP and adjusting for private consumption and government spending, however, does not alter our findings qualitatively. Furthermore, the corporate sector risk is likely to affect the private sector with a time lag and government expenses will typically lead their effects in the corporate and private sector. Hence, the major driver is the current economic activity in the corporate sector.

Having established the link between the corporate sector and its sovereign, we now decompose the corporate sector and estimate risk contributions of financial and non-financial

firms. Specifically, we estimate the following country-specific time-series regression with weekly data:

$$\text{Sovereign CDS}_{i,t} = \alpha + \beta_1 \text{Mean(Non-Financial CDS)}_{i,t} + \beta_2 \text{ Mean(Financial CDS)}_{i,t} + \varepsilon_{i,t} \quad (2)$$

To circumvent the potential endogeneity problem, we combine a two-stage least squares estimation with the seemingly unrelated regression (SUR) into a three-stage least squares estimation as proposed by Zellner and Theil (1962). This approach allows us to simultaneously estimate β_1 and β_2 from equation (2). We estimate both coefficients for each country over the whole sample period, using a non-overlapping window of 12 weeks. We obtain the risk contribution of the non-financial sector as:[7]

$$\text{Risk contribution}^{\text{NONFIN}} = |\beta_1|/(|\beta_1|+|\beta_2|) \quad (3)$$

Accordingly, the risk contribution of the financial sector equals one minus the contribution of the non-financial sector. To obtain the return-risk contribution measure, we divide the return component of the sector by its risk component. The return contribution of the non-financial sector is measured by its contribution to the overall GDP growth, as shown in equation (4).

$$\text{Return contribution}^{\text{NONFIN}} = \Delta\text{GDP(Non-Financial)}_{it}/\Delta\text{GDP}_{it} \quad (4)$$

[7] We also applied two other empirical methods to derive risk contributions. It turned out that the other two approaches lead to values that are highly correlated with the ratio of the SUR-based coefficients.

The share of the non-financial contribution to the GDP has steadily been declining in some countries. For the United States, Philippon (2008) estimates an increase of the financial's GDP contribution from 2.61% in 1960 to 5.57% in 2007. The question whether the non-financial sector declines in growth contribution led to a decreasing risk contribution as well is answered by the ratio of equation (4) and (3), which we call the return-risk-contribution of a country's non-financial sector: RRC^{NONFIN}.

Table 3 reports the return and risk contribution measures (column 1-2) and the return-risk contribution measure of the non-financial sector RRC^{NONFIN} (column 3).

(Insert Table 3 about here)

The return contribution is very similar in most countries ranging from 0.67 non-financial sector contribution to GDP growth in France to 0.99 in Sweden. The average is at 0.78 and the standard deviation at a mere 7.8% across countries. The risk contribution, on the other hand, exhibits a large cross-country variance of 0.21 with an average risk contribution of 0.38. The measure ranges from 0.13 risk contribution of the non-financial sector to the sovereign risk for Sweden up to 0.75 for Greece. The Spearman correlation between the risk contribution and the ranking of the corporate CDS loading is at -0.596 (p-value: 0.007), thus lower sensitivity due to risk transfer of the corporate sector transfers to a higher return/risk contribution of the non-financial sector.

The grouping of the countries in terciles according to the return-risk measure largely mimics the pattern shown in Figure 1. The first group RR^{low} consists of the PIIGS country plus Austria and Belgium, but without Spain, which is in the second group RR^{med} together with the northern European countries Denmark and Norway plus Korea, Australia and Switzerland. The third (best)

group RR^{high} consists of the United States, United Kingdom, Sweden, Netherlands, Japan, France and Germany and relates closely to the top contributors of the international monetary fund (IMF). In fact, the Spearman rank correlation between the IMF's contribution and our return-risk measure is 0.585 (p-value: 0.0086) and the third group sums up to 42.45% of the total IMF's contribution.[8]

3.3 The relation of the return-risk measures and other country measures

Before we continue with the dynamic analysis of the return-risk and return-risk contribution measures proposed above, we briefly examine how they relate to other measures of country return and risk. Table 4 shows the correlation of various other measures and our return-risk measures (Panel A) and return and risk contribution measures (Panel B). We report the contemporaneous correlations and the lead-lag correlations (i.e., other measures from time t and the risk and return from quarter t-4).

(Insert Table 4 about here)

The return-risk measure (Panel A of Table 4) is significantly correlated with key macroeconomic variables such as the GDP, trade balance and government expenses. The correlation persists even for lags of four quarters. This finding indicates a potential forecasting ability of this measure. The same finding holds for the sovereign credit ratings of

[8] See http://www.imf.org/external/np/fin/tad/extsdr1.aspx

S&P.[9] The rating symbols are converted to numerical values increasing with lower credit quality (e.g., AAA = 1, …). The negative correlation implies a higher return-risk measure for lower (better) rating classes. From the strength of the correlation, we infer that S&P's sovereign ratings are more closely tracked by credit markets than Moody's sovereign ratings. We also calculate the correlation with the Corruption Perception Index rank from Transparency International. The index indicates the transparency of a country and is closely related to its competitiveness (e.g., Mauro, 1995 or Faccio, 2010). Our return-risk measure does, however, neither correlate with the corruption rank nor with Debt to GDP. This changes when looking at the three groups of countries. For the group with the lowest return-risk the corruption rank correlates negatively at -0.248. Thus, a higher corruption level indicates a lower return-risk profile in this group. For the medium group the correlation is however positive which could indicate a benefit from some corruption developing to a higher return-risk profile.

For the return-risk contribution measure shown in Panel B of Table 4, we find that the risk adjusted return contribution of the non-financial sector exhibits a negative correlation with the corruption rank, i.e., higher contribution of the non-financial sector indicates a lower corruption rank (= higher transparency). We also consider the average corporate CDS spread which is used as an input for our return-risk measures. The relatively low correlation, however, implies that both measures add value compared to considering only CDS spreads. Together with the strong correlation with key macroeconomic variables, both contemporaneous and with a lag of up to four quarters, we conclude that our measures mimic an important economic relationship which we shall explore more closely in a dynamic analysis.

[9] We do not report the findings for the Moody's sovereign credit ratings as they are qualitatively similar and S&P is considered by investors as the dominant rating agency for sovereign debt.

4. Dynamic analysis

Based on the top-down framework outlined above, we are now ready to investigate the dynamics of country return-risk profiles over time and at different levels of aggregation. We believe that, because of their dramatic impact on financial stability and the real economy in many countries, the global financial crisis of 2007-2009 and the subsequent European sovereign debt crisis are a particularly interesting testing ground for our return-risk measures.

To conduct a time-series analysis, we estimate the RR measure and the RRC^{NONFIN} measure in non-overlapping rolling windows. The return component in both cases is estimated using quarterly reported GDP data which we interpolate linearly to obtain monthly data. We use a rolling window length of 12 weeks. Note that using average daily CDS spreads within a quarter or the end-of-quarter spreads does not alter the results and the rank correlation between these two is 0.99.

To demonstrate the dynamics of our measures we conduct a case study with four of the most prominent countries during the recent crises (United States, Germany, Greece and Ireland). There are two countries on the blink of default: Greece and Ireland. Ireland growth from the 1980s to early 2000s was among the highest of industrialized countries coining the term “celtic tiger” and was considered the best place to live in 2005, according to the Economist. At the end of 2008 Ireland was in a deep recession with double digit unemployment and a sharply increasing public debt due to the bailout of the financial sector. In April 2010 the IMF and the EU started to intervene with a first rescue package. Days later Greece requested an IMF/EU bailout too, subsequently followed by the announcement of several austerity measures and further bailout funding. Figure 2 shows the four countries in two charts. Panel A shows the evolution of the

Return-Risk measure for the USA and Germany, while the Panel B shows those of Ireland and Greece.

(Insert Figure 2 about here)

Panel A of Figure 2 shows that the return of the United States (left axis) starts much higher than the one of Germany (right axis), has a downward trend over time, and exhibits a larger volatility. After the beginning of the financial crisis both measures converge, while Germany recovers slightly faster. The Spearman correlation between these two countries is negative at -0.486 (p-value: 0.07) during the first period 2004-2007 and positive at 0.673 (p-value: 0.033) hereafter. The corresponding results for Ireland and Greece are displayed in Panel B of Figure 2. It looks very different compared to Panel A. The scaling for Greece (right axis) is roughly one-tenth of the one for Ireland (left axis). Ireland has a pronounced upward trend from 2004 to 2007, which is then followed by a clear and fast downward trend afterwards the first quarter of 2007. Both countries spike in 2007 with a return-risk measure of 3.3 for Ireland and 0.31 for Greece. While there is no significant correlation between these two countries there are significant positive correlations between the pairs US/Germany and Ireland/Greece.

To examine the importance of the real economy we plot the relative contribution of return and risk of the non-financial sector RRC^{NONFIN} for the four countries in Figure 3.

(Insert Figure 3 about here)

The findings for the return-risk contribution measures are plotted in Figure 3. For the United States and Germany the figures look quite similar (see Panel A of Figure 3). The non-financial

sector contributes more to the return-risk profile of the United States compared to Germany. Both countries increase their levels during the first years of the sample. While Germany's measure stays relatively stable after the financial crisis, even increases temporarily, the corresponding measure of the United States shows a steady decline. This pattern reflects the importance of the financial sector after the crisis. For the troubled countries Ireland and Greece the graphs are shown in Panel B of Figure 3. Again, Greece's scaling is very small but increases until 2007 and declines afterwards. In contrast, Ireland spikes in 2005, which could be due to the end of tax reductions for the manufacturing industry[10], and stabilizes on a slightly increasing level. The financial crisis does not seem to affect the Irish non-financial sector's contribution by the same extent.

We note that these effects are robust to the introduction of lags. However, the quarterly frequency of macroeconomic variables limits a more detailed time-series analysis. To study cross-country spillover effects we take advantage of our daily data of sovereign CDS spreads and corporate CDS spreads. Our return-risk framework shows that the variation in the risk component is larger than the variation in the return part. To study the effect during the global financial crisis and the European sovereign debt crisis the CDS spreads, which reflect continuously updated market expectations, are likely to react in more timely way than macroeconomic measures.

5. Applications

The top-down framework of risk and return at the country level can be applied for various purposes. In remainder, we make suggestions for three potential applications. First, we study the effects of cross-country and cross-sector contagion. The contagion study shows the informational

[10] The corporate taxation was generally seen as one advantage for headquartering in Ireland (e.g. O'Carroll, L. in Guardian, 24 March 2011).

content of the return-risk measures and can be used by central banks, supra-national banks and policy makers to facilitate country monitoring and decision making. Second, we document how the return-risk measures relate to foreign direct investments (FDI). The net amount and change of FDIs is expected to relate to the return-risk profile of the target country. This application offers insights that are useful for real investments of the corporate sector, governments, and any other type of international investor. Third, we demonstrate that our framework can be used to develop profitable CDS trading strategies.

5.1 Cross-country and cross-sector contagion effects

To study cross-country contagion effects we use daily percentage changes of the sovereign and corporate CDS spreads in a vector-autoregressive (VAR) model. We estimate a country's response in its sovereign and/or corporate CDS spread to an impulse from another country's sovereign and/or corporate CDS spread. Following Lütkepohl (2005) we estimate the optimal lag length included in the VAR model according to the HQIC information criterion which in contrast to the Akaike (1973) AIC does not lead to an overestimation of the true lag order. The stability condition for each of our estimated VAR is fulfilled.

To estimate the impulse-response function (IRF) for the three groups of countries according to the return-risk measure we create an index based on each group's individual country CDS spread. We follow the market standard of weighting each index component by its risky PV01, where the risky PV01 (Present Value of 01 basis point) is calculated by discounting the expected fee payments with the risk-free rate. The expected fee payments are given as one (basis point)

times the probability of surviving until the scheduled payment date. We denote today by t_0, each coupon date by t, and maturity by T, and then the risky PV01 is defined as:[11]

$$RiskyPV01 = \sum_{t=t_0}^{T} \frac{1 - PD(t_0, t)}{(1 + r_t)^{t-t_0}} \tag{5}$$

Following the convention in the CDS market, we use the ISDA swap rates to estimate the formula. To keep our analysis of contagion effects manageable, we consider the four countries we already used in the previous section (US, Germany, Ireland and Greece). Furthermore we investigate reactions of three country indices built upon the return-risk measure (shown in the rightmost column of Table 3). Figure 4 shows the countries in a diagram with the average sovereign CDS spread level on the y-axis and the return-risk measure on the x-axis.

(Insert Figure 4 about here)

We distinguish between different types of contagion effects. In a first step, we analyze the contagion of sovereign credit risk between countries for our three return-risk groups. Figure 5 shows the impulses of country groups in each row and the responses of other country groups. The coefficients indicate the cumulative response where the stars indicate the significance of a Granger causality test for each of the impulse-response pairs.

(Insert Figure 5 about here)

[11] See Löffler and Posch (2011).

The reaction to an impulse from better countries is higher in worse countries than vice versa. For example an impulse from the worst return-risk group RR^{Low} has a cumulative response of 0.117 from the best return-risk group RR^{High}. The opposite impulse yields a response of 0.337, three times higher. An impulse from the middle group RR^{Med} is unanswered by RR^{High}, while the opposite direction has a final effect of 0.545.

When a group of solvent countries increasingly gets into economic problems the less solvent ones react very strongly. These findings are even more pronounced when we use alternative rules to create the indices (e.g. equally weighting). For the PIIGS countries, which are only disjunctive for the highest and have a large overlap the lowest return-risk group, the effect is almost identical for all groups.[12] During the sovereign debt crisis all reactions increase in magnitude, especially the reaction of the PIIGS to increases in sovereign CDS spreads of the highest return-risk group is 60% higher than for the whole sample. The pace of contagion increases during the second half of our sample period with solvent countries being more and more affected. The return-risk framework provides a stable classification of country groups.

In a next step, we continue the analysis by studying contagion effects between sectors and countries. Figure 6 displays the effects of financial responses to sovereign risk in Panel A as well as the non-financial sector's reactions in Panel B. These figures include responses from the same country group as the initial shock is from giving the sector-contagion within a country group.

(Insert Figure 6 about here)

[12] Detailed results are available from the authors on request.

We find that the responses of the financial and non-financial sectors to sovereign shocks are qualitatively and often quantitatively similar. The financial sector's response to a sovereign shock is more pronounced from high return-risk countries to low return-risk countries than vice versa. For example a low return-risk sovereign does not affect the financial sector within the group (the coefficient of 0.18 is not significant), nor financials from higher return-risk groups. Conversely a sovereign shock from a high return-risk sovereign has large impact on the financial sector within this group as well as for the financial sectors of weaker countries.[13]

In summary, we find that the informational content of the return-risk framework is useful to identify cross-country and cross-sector contagion effects. The impulse-response analysis together with the classification of the return-risk measure provides financial economists and policy makers with a flexible toolbox to assess the relation between sovereign credit risk and the real economy.

5.2 Foreign direct investment

Another application for our risk-return framework is foreign direct investment (FDIs). FDI measures the amount foreign entities invest in a country and thus indicates the investment sentiment of foreigners concerning the real economy of a country. We obtain quarterly FDI data for both the inflow and the outflow of direct investments relative to the GDP and run pooled regressions of both components on the lagged return-risk measure. Table 5 reports the results by country.

(Insert Table 5 about here)

[13] The case of Austrian banks investing worth roughly 70% of Austria's GDP in eastern European countries, such as Hungary, can be seen as anecdotal evidence for this finding, cf. S&P Press Release on the Austria Downgrade, January 15, 2012.

The average net effect, obtains as difference between the FDI inflows' and the FDI outflow's coefficients is at 1.102. Thus, an increase of the return-risk measure by one percentage point increases the net-FDIs by 1.102 percentage points relative to the GDP. Germany and Spain are the only two countries with a negative net-FDI coefficient, indicating that higher return-risk lead to less net foreign investments. Note that due to the one quarter lag of the return-risk measure this is an out-of-time prediction. This relationship can be useful for the planning, decision making and monitoring of international real investments.

5.3 CDS trading strategy

Our risk-return framework can be used to develop a CDS trading strategy. Specifically, changes in the return-risk measures might indicate trading signals for taking long and short positions in the sovereign CDS market. The question is whether the informational content of the measure is sufficient to build a profitable trading strategy.

We propose the following strategy. For different cutoffs c, we generate trading signals depending on the current rank of the sovereign's return-risk measure. We then take a long position in the credit risk of the highest ranked c sovereigns (by selling protection with CDS) and take a short position in the credit risk of the lowest ranked c sovereigns (by buying protection with CDS). Trading signals are updated every quarter and the carry is accounted for.[14] Table 6 reports the results for different cutoff values where Panel A is based on the rank of the RR measure whereas Panel B is based on the RRC^{NONFIN} measure. The hit-ratio is defined as the

[14] As a simplification, we approximate the carry earned or the premium paid by dividing the yearly CDS premium into four quarterly payments (and thus abstract from day count conventions and accrued payments).

number of true predictions, i.e. predicted short risk position followed by a CDS price increase or predicted long risk position followed by a CDS price decline, over the total number of trades.[15]

(Insert Table 6 about here)

Starting with the strategy that goes long in the credit risk of the two countries with the highest return-risk measure against going short in the credit risk of the two lowest return-risk measure countries, we already achieve a significant hit ratio of 59.4%. The cumulative return of this strategy is at 310 basis points and increases to 12.03% for the highest cutoff strategy. Here, however, the results are largely driven by the short position in credit risk during the sovereign debt crisis. The hit ratios are higher in Panel B. Using the return-risk contribution of the non-financial sector as trading signal thus gives a more precise strategy which, however, yields a lower cumulative return of between 30 and 711 basis points.

The risk-return framework introduced here can be useful to develop profitable relative value trading strategy with sovereign CDS. The previously shown lead-lag relationship between macroeconomic conditions in quarter t and the return-risk measure from quarter t-4 is one explanation why the trading strategy is profitable (see Table 4). More complex extensions of this simple strategy can be used by asset managers of sovereign portfolios, such as insurance companies, mutual funds, and pension funds.

6. Conclusion

[15] Given that there are 19 countries in our sample, cutoffs that are larger than 9 result in going both long and short in each country at each point in time.

This paper proposes a framework to analyze the relation of risk and return at the country level. While there is abundant theoretical and empirical research on the risk-return relation of securities issued by companies (e.g., stocks, corporate bonds, derivatives), there is little knowledge about the actual or optimal relation of risk and return of sovereigns. We focus on credit risk since governments heavily rely on debt as main source of external finance. Our framework has two main characteristics. First, we combine information about country credit risk from sovereign and corporate CDS markets with information about country return from macroeconomic statistics. Second, we propose a top-down approach, considering the macro economy as the aggregate outcome of microeconomic activity in the private sector plus government economic activity, that can be applied to study country credit risk and return at three levels of aggregation.

We apply these measures to 19 developed countries (United States, Japan, Korea, Australia and 15 European countries) during the period 2004-2010. We find substantial cross-country differences in the importance of the real economy, lead-lag relationships between the return-risk measures and macroeconomic variables, and provide evidence that country risk has become more volatile than return. We also show that our framework can be used to identify contagion effects, analyze international investments, and to build CDS trading strategies.

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Table 1: Summary statistics

This table reports means of daily credit default swap spreads of sovereigns (SOVCDS) and corporate (CORPCDS) and means of quarterly macroeconomic variables by country. DEBT_GDP refers to the ratio of total central government debt over GDP, TAX_GDP refers to Tax revenues over GDP, GOV_GDP refers to cash payments for operating activities of the government in providing goods and services, the GDP in current USD (trillion $), and the Corruption Perception Index rank comes from Transparency International. The sample period covers the period from January 2004 to October 2010.

		SOVCDS	CORPCDS	DEBT_GDP	TAX_GDP	GOV_GDP	GDP	ΔGDP	Corruption Perception Index
Country	Iso code	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Australia	AU	32.56	98.36	17.02	11.82	17.49	0.81	0.72	9.08
Austria	AT	31.37	118.29	63.65	10.75	18.59	0.34	0.85	12.96
Belgium	BE	27.93	119.02	93.15	12.65	23.45	0.42	0.82	19.35
Denmark	DK	28.38	232.24	35.98	20.32	25.25	0.29	0.74	2.46
France	FR	18.57	141.73	67.90	14.87	8.26	2.43	0.69	20.92
Germany	DE	14.61	171.86	67.12	12.28	18.87	3.12	0.44	15.19
Greece	GR	122.60	126.02	100.34	11.91	16.65	0.28	0.97	56.31
Ireland	IE	80.66	174.90	35.36	12.76	15.71	0.22	0.43	16.77
Italy	IT	49.45	162.65	107.51	14.63	20.40	1.98	0.42	47.92
Japan	JP	24.00	120.31	170.68	NA	17.82	4.64	-0.14	19.00
Korea	KR	84.95	133.36	22.81	11.43	14.24	0.88	1.46	39.00
Netherlands	NL	23.34	115.67	53.68	12.69	24.32	0.72	0.79	8.23
Norway	NO	21.57	235.15	49.28	8.45	20.14	0.35	1.67	9.62
Portugal	PT	54.99	80.90	65.48	15.08	20.40	0.21	0.67	28.96
Spain	ES	47.44	93.04	46.04	10.80	113.08	1.32	1.15	25.58
Sweden	SE	18.80	144.21	45.68	17.69	26.69	0.41	0.67	4.38
Switzerland	CH	62.93	102.18	48.56	3.27	11.09	0.42	0.79	6.46
United Kingdom	GB	27.50	164.32	48.13	11.50	21.82	2.43	0.85	13.19
United States	US	15.56	504.56	57.98	6.77	18.97	13.40	0.80	18.62
Average		41.78	159.99	62.97	12.20	23.85	7.26	0.78	19.86

Table 2: The relation between sovereign and corporate CDS spreads by country

This table reports results from regressions of daily sovereign CDS spreads on the daily cross-sectional mean of all corporate CDS spreads from the same country i at time t. We report results for the regression of CDS spread levels and percentage CDS spread changes. In the two bottom rows we display the average outcome of the country-specific time-series regressions and the results from a panel data regression with country fixed effects. T-statistics are based on robust Huber-White standard errors. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. The data come from 19 countries and from the period from January 2004 to October 2010.

Panel A: The relation between weekly CDS spread levels

Country	Coeff.		Robust t-stat.	R^2
Australia	0.426	***	20.51	0.73
Austria	0.474	***	13.21	0.81
Belgium	0.371	***	13.52	0.89
Denmark	0.157	***	12.49	0.66
France	0.184	***	22.68	0.65
Germany	0.121	***	21.57	0.69
Greece	2.094	***	8.84	0.66
Ireland	0.813	***	16.68	0.65
Italy	0.430	***	26.87	0.81
Japan	0.197	***	33.26	0.88
Korea	0.659	***	40.09	0.96
Netherlands	0.370	***	9.26	0.38
Norway	0.125	***	9.49	0.67
Portugal	0.915	***	36.57	0.94
Spain	0.784	***	19.02	0.76
Sweden	0.276	***	18.06	0.73
Switzerland	0.276	***	14.17	0.69
United Kingdom	0.283	***	35.01	0.76
United States	0.038	***	26.12	0.82
Average	0.473	***	20.91	0.74
Country fixed effects model	0.185	**	1.89	0.25

Table 2 (continued)

Panel B: The relation between weekly CDS spread changes

	First differences				Percentage Changes			
Country	Coeff.		Robust t-stat.	R^2	Coeff.		Robust t-stat.	R^2
Australia	0.313	***	4.83	0.16	0.800	***	5.96	0.22
Austria	0.426	***	2.61	0.29	1.373		1.43	0.07
Belgium	0.334	***	5.67	0.47	0.712	***	3.99	0.37
Denmark	0.085	***	3.18	0.09	0.081		0.89	0.00
France	0.149	***	6.70	0.24	0.630	***	5.11	0.05
Germany	0.094	***	5.85	0.22	0.217	***	2.36	0.02
Greece	1.255	***	2.62	0.22	1.240	***	4.15	0.44
Ireland	0.680	***	4.45	0.28	0.378	***	2.24	0.13
Italy	0.321	***	6.67	0.27	0.490	***	6.23	0.15
Japan	0.105	***	3.32	0.15	0.641	***	5.74	0.20
Korea	1.009	***	8.65	0.80	0.855	***	3.99	0.44
Netherlands	0.168	***	4.91	0.13	0.866	***	2.16	0.07
Norway	0.032	***	3.29	0.11	0.615	***	2.53	0.08
Portugal	0.828	***	5.35	0.61	0.499	***	6.02	0.23
Spain	0.529	***	5.95	0.33	0.522	***	6.89	0.17
Sweden	0.068	***	2.35	0.03	0.177	***	2.47	0.02
Switzerland	0.080	***	2.84	0.05	0.244	***	1.97	0.03
United Kingdom	0.136	***	3.25	0.13	0.699	***	4.38	0.13
United States	0.033	***	4.39	0.12	0.292	***	2.51	0.02
Average	0.350	***	4.57	0.25	0.596	***	3.74	0.15
Country fixed effects model	0.304	***	2.09	0.16	0.600	***	5.45	0.08

Table 3: Risk and return contributions by country

This table reports the risk and return contributions of the non-financial corporate sector by country. The return contribution of the non-financial sector is calculated from each country's national accounts as follows: RETURN=[ΔGDP_{it} - $\Delta GDP(FIN)_{it}$]/[$\Delta GDP(NONFIN)_{it}$ - $\Delta GDP(FIN)_{it}$]. The risk contribution is calculated from country-specific regressions with CDS market data. We estimate a three-stage least square regression with SOV_{it} as endogenous and FIN_{it} and $NONFIN_{it}$ as endogenous variables to obtain the risk contribution of the non-financial sector as follows: RISK = |(β(NONFIN))|/[|β(NONFIN)| + |β(FIN)|]. The data come from 19 countries and from the period from January 2004 to October 2010.

Country	(1) RETURN Return contribution^{NONFIN} (National accounts)	(2) RISK Risk contribution^{NONFIN} (CDS markets)	(3) RETURN/RISK RRC^{NONFIN}	(4) RETURN/RISK RRC^{NONFIN} group
Australia	0.87	0.47	1.84	Med
Austria	0.76	0.63	1.22	Low
Belgium	0.71	0.73	0.97	Low
Denmark	0.75	0.41	1.82	Med
France	0.67	0.11	5.83	High
Germany	0.7	0.20	3.43	High
Greece	0.81	0.75	1.08	Low
Ireland	0.73	0.50	1.47	Low
Italy	0.73	0.52	1.42	Low
Japan	0.81	0.23	3.52	High
Korea	0.85	0.42	2.02	Med
Netherlands	0.72	0.16	4.45	High
Norway	0.82	0.33	2.46	Med
Portugal	0.78	0.67	1.17	Low
Spain	0.78	0.25	3.12	Med
Sweden	1.00	0.13	7.78	High
United Kingdom	0.68	0.15	4.39	High
United States	0.87	0.12	7.30	High
Switzerland	0.77	0.37	2.06	Med
Average	0.78	0.38	3.05	

Table 4: Correlation of return-risk measures and other variables

This table reports the average Spearman rank correlation of the return-risk measure and other variables. The data come from 19 countries and from the period from January 2004 to October 2010. *** denotes 1% significance of the correlation, ** 5% and * 10%.

	Panel A: RR		Panel B: RRC^{NONFIN}	
Variable	Contemporaneous	Lag 4Q	Cotemporaneous	Lag 4Q
GDP level	-0.121 **	-0.106 **	0.232 ***	0.225 ***
RR^{Low}	-0.012	0.094	-0.093	-0.071
RR^{Med}	-0.164 *	-0.223 **	-0.348 ***	-0.489 ***
RR^{High}	-0.142 *	-0.075	0.149 *	0.131
Trade Balance	0.116 **	0.142 ***	-0.003	-0.011
RR^{Low}	-0.146 *	-0.260 ***	-0.240 ***	-0.276 ***
RR^{Med}	0.192 **	0.385 ***	0.402 ***	0.182 *
RR^{High}	0.208 ***	0.243 ***	0.095	0.131
Government Expenses	-0.144 ***	-0.156 ***	0.159 ***	0.146 ***
RR^{Low}	-0.087	-0.056	-0.134	-0.111
RR^{Med}	-0.211 **	-0.293 ***	-0.326 ***	-0.429 ***
RR^{High}	-0.180 **	-0.146 *	0.077	0.070
Debt/GDP	-0.046	-0.119 **	-0.179 ***	-0.183 ***
RR^{Low}	-0.145 *	-0.324 ***	-0.241 ***	-0.268 ***
RR^{Med}	-0.049	-0.087	0.509 ***	0.622 ***
RR^{High}	-0.168 **	-0.280 ***	-0.536 ***	-0.568 ***
Gov/GDP	0.017	0.026	0.154 ***	0.148 ***
RR^{Low}	-0.060	-0.110	-0.248 ***	-0.223 **
RR^{Med}	0.139	0.234 **	0.575 ***	0.546 ***
RR^{High}	-0.050	-0.052	0.178 **	0.173 **
Corruption Rank	-0.033	-0.045	-0.312 ***	-0.317 ***
RR^{Low}	-0.248 ***	-0.331 ***	-0.118	-0.206 **
RR^{Med}	0.187 *	0.239 **	0.518 ***	0.531 ***
RR^{High}	-0.068	-0.035	-0.079	0.011
S&P Rating	-0.177 ***	-0.266 ***	-0.514 ***	-0.518 ***
RR^{Low}	-0.228 ***	-0.340 ***	-0.153 *	-0.209 **
RR^{Med}	-0.225 **	-0.324 ***	-0.173 *	-0.100
RR^{High}	-0.189 **	-0.248 ***	-0.546 ***	-0.537 ***
Corp CDS Avg.	-0.534 ***	-0.420 ***	0.251 ***	0.138 ***
RR^{Low}	-0.696 ***	-0.539 ***	0.009	-0.085
RR^{Med}	-0.646 ***	-0.390 ***	0.212 **	0.132
RR^{High}	-0.399 ***	-0.347 ***	0.213 ***	0.166 **

Table 5: Return-risk measure and foreign direct investment

This table reports results from a pooled regression with country effects of the foreign direct investment (FDI) inflow and outflow on the return-risk measure lagged by one quarter. T-statistics are based on robust Huber-White standard errors. *, **, and *** denote significance at the 10, 5, and 1 percent level, respectively. The data comes from 19 countries and from the period from January 2004 to October 2010.

	FDI Inflow			FDI Outflow			FDI Net: Inflow - Outflow	
	Coeff.		Robust t-stat	Coeff.		Robust t-stat	Coeff.	
Australia	-5.351	***	-2.48	-6.584	***	-2.76	1.233	***
Austria	-7.636	***	-2.43	-9.513	***	-2.71	1.876	***
Belgium	7.800	***	2.80	18.549	***	6.21	-10.749	***
Denmark	-9.327	***	-1.98	-11.466	***	-2.11	2.139	***
France	-7.809	***	-2.59	-9.567	***	-2.88	1.758	***
Germany	-20.984	***	-2.61	-25.778	***	-2.91	4.795	***
Greece	-31.665	***	-2.70	-38.791	***	-3.04	7.126	***
Ireland	-31.908	***	-2.46	-39.096	***	-2.71	7.188	***
Italy	-59.080	***	-2.62	-72.490	***	-2.93	13.409	***
Japan	-15.059	***	-2.13	-18.531	***	-2.29	3.471	***
Korea	12.187	***	4.56	31.005	***	7.11	-18.818	***
Netherlands	-4.419	***	-2.37	-5.409	***	-2.58	0.990	***
Norway	-1.541	***	-2.29	-1.799	***	-2.40	0.258	***
Portugal	-7.831	***	-1.97	-9.607	***	-2.09	1.776	***
Spain	-0.101		-0.44	-0.124		-0.44	0.023	
Sweden	-0.324		-0.31	-0.886		-0.67	0.561	
Switzerland	-8.834	***	-2.58	-10.872	***	-2.88	2.038	***
United Kingdom	-3.077		-2.64	-3.835		-3.03	0.758	
United States	-4.704		-2.54	-5.812		-2.85	1.109	
Average	-10.509	***	-1.57	-11.611	***	-1.47	1.102	***
Obs.	405			405				
R^2	0.237			0.576				

Table 6: CDS trading strategy

This table shows the results of using the return/risk measures as trading signals. For different cutoffs c we generate trading signals depending on the current rank of the sovereign. We enter a long risk position in the best c sovereigns by selling CDS protection and enter a short risk position in the worst c sovereigns. Trading signals are re-estimated each quarter. Hit-ratios are estimated for the combined long/short strategy and t-statistics test against the null hypothesis of a 0.5 hit-ratio. The rightmost column gives the cumulative return of the strategy in basis points. Panel A uses the rank of the RR-basic measure whereas panel B uses the return/risk contribution by the non-financial sector.

Panel A: Ranked by the return/risk RR measure

Cutoff	Hit-Ratio	t-Statistic	Cumulative return [bps]
1	0.583	1.17	210
2	0.594*	1.87	310
3	0.569*	1.68	303
4	0.573***	2.04	385
5	0.563**	1.95	598
6	0.576***	2.62	1123
7	0.568***	2.53	1065
8	0.565***	2.57	1043
9	0.581***	3.41	1203

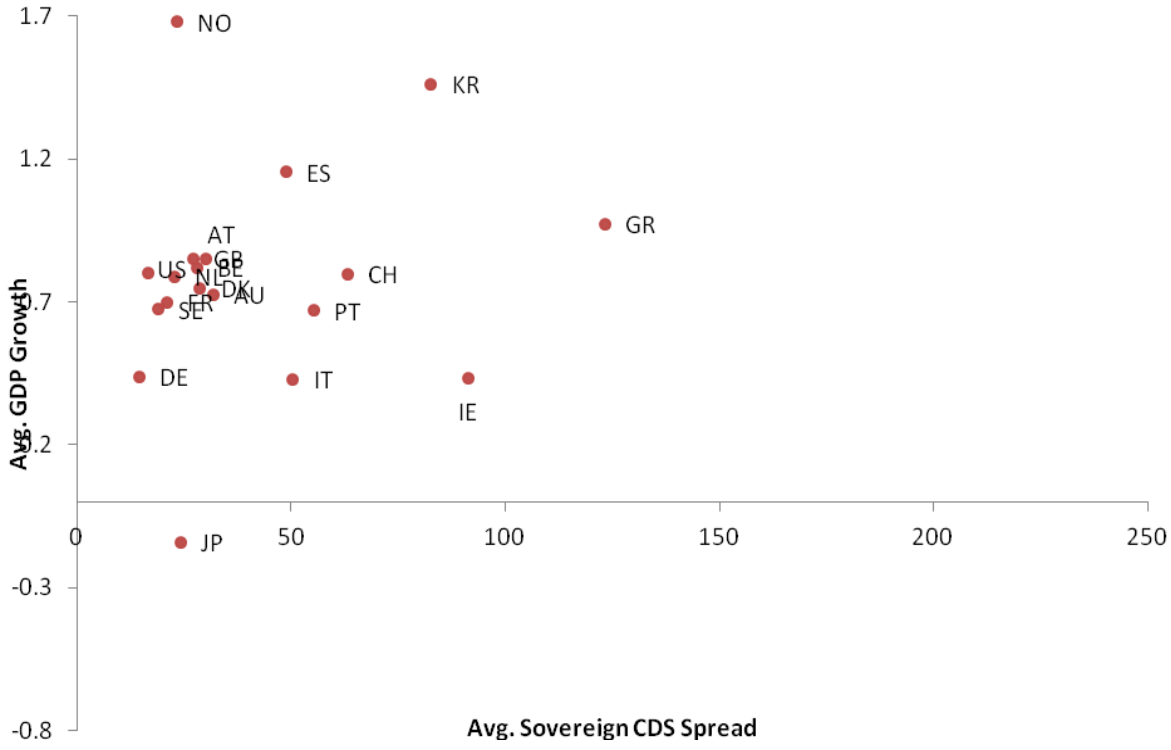
Panel B: Ranked by the return-risk contribution RRC non-financial measure

Cutoff	Hit-Ratio	t-Statistic	Cumulative return [bps]
1	0.688***	2.80	30
2	0.656***	3.22	100
3	0.604***	2.56	385
4	0.583***	2.34	478
5	0.588***	2.75	554
6	0.608***	3.74	621
7	0.601***	3.79	560
8	0.591***	3.63	453
9	0.588***	3.71	711

Figure 1: Average risk and return by country

The figure displays the mean GDP growth rate (return) and the mean sovereign CDS spread (risk) of 19 countries. The data covers the period from January 2004 to October 2010.

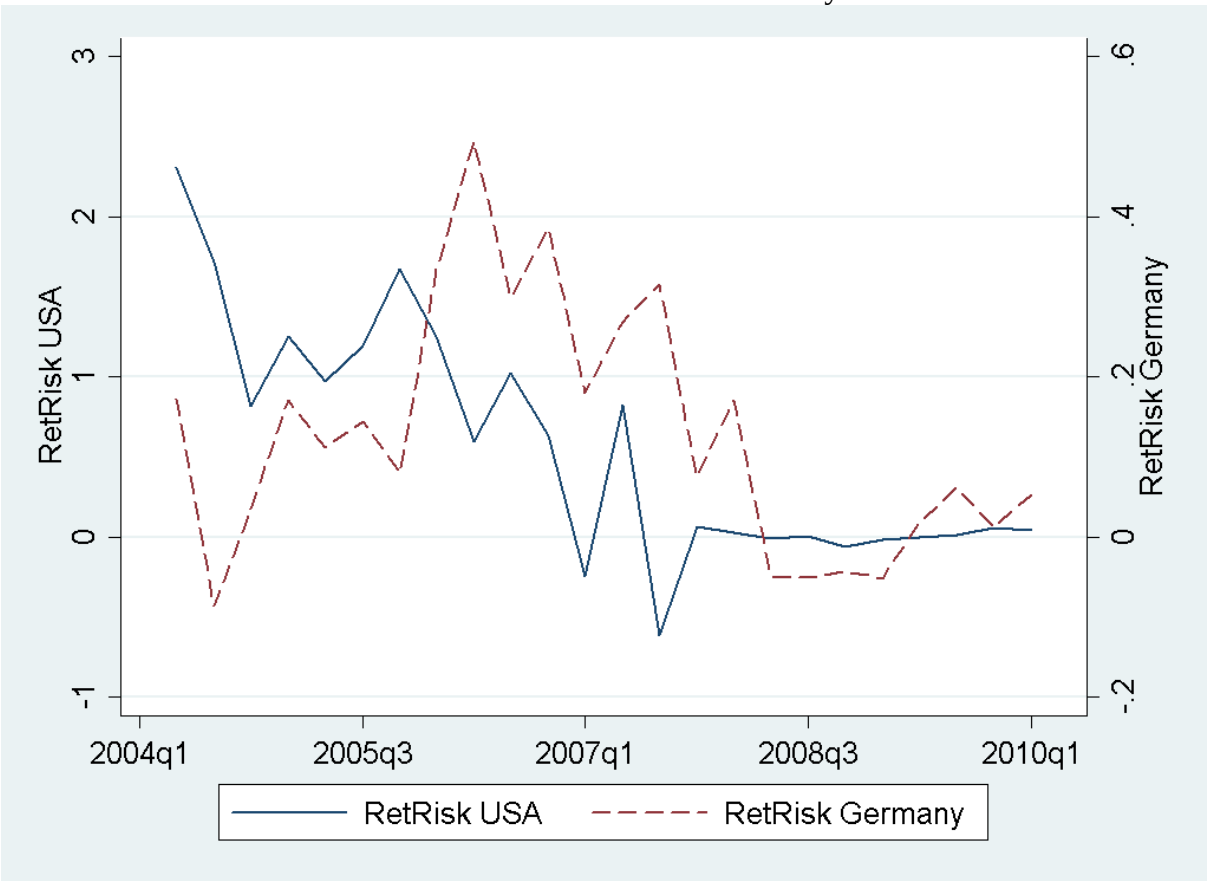
Panel A: Full sample period (Jan 2004 to Oct 2010)



Panel B: Crisis period (Q3:2007 - Oct 2010)

Figure 2: The return-risk measure RR over time

Panel A: United States and Germany



Panel B: Ireland and Greece

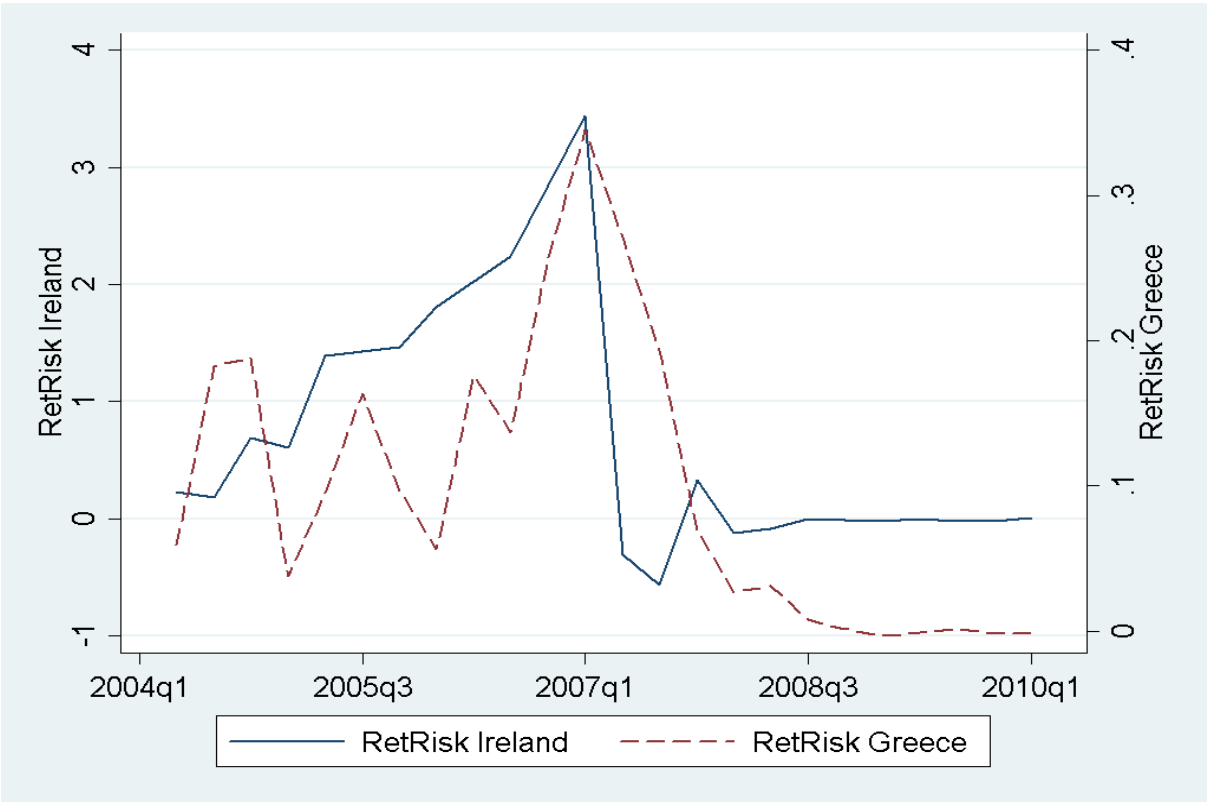
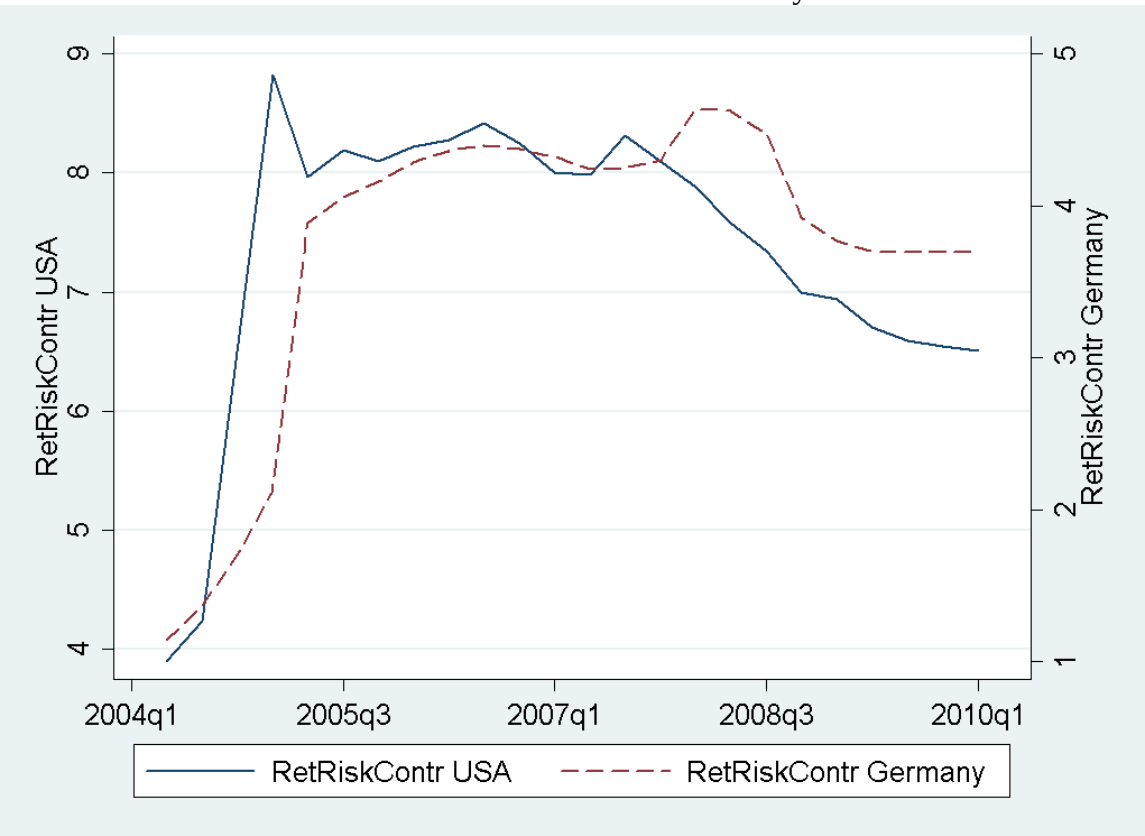


Figure 3: Return-risk contribution of the non-financial sector RRC^{NONFIN} over time

Panel A: United States and Germany



Panel B: Ireland and Greece

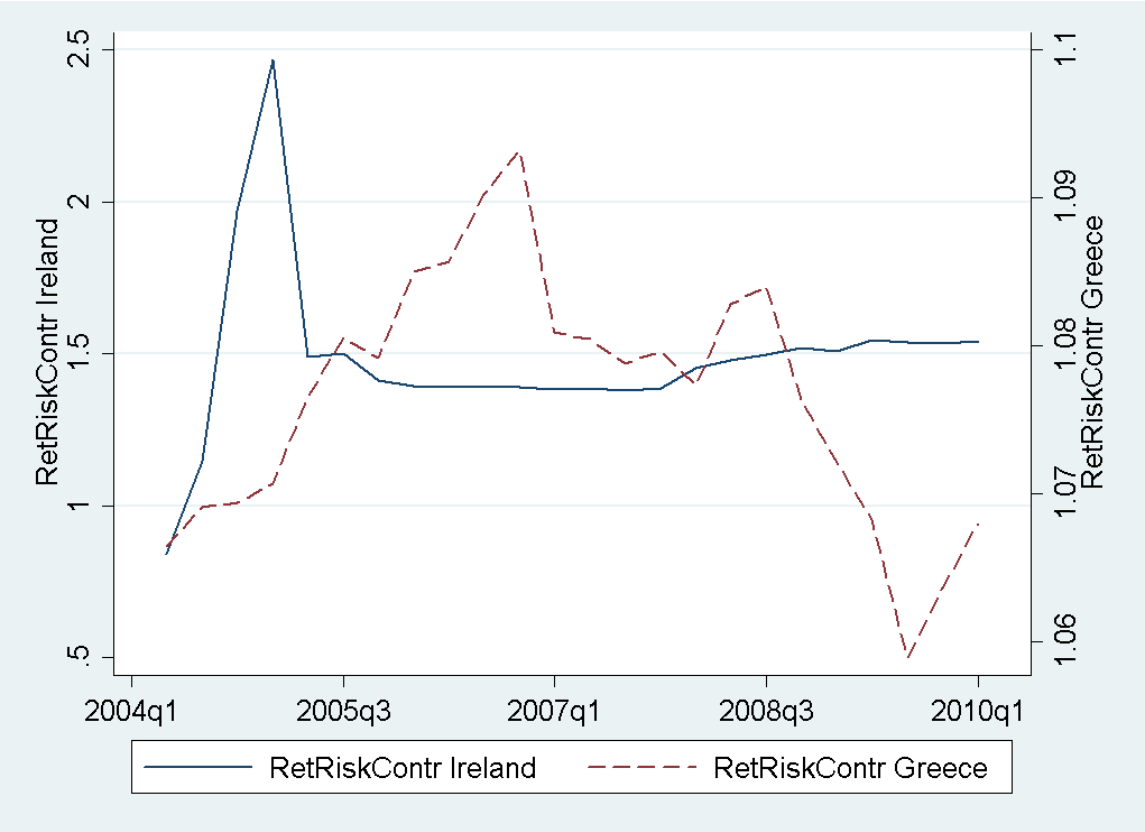


Figure 4: Return-risk measure RR and sovereign CDS Spread

This figure plots the return-risk measure against the average sovereign CDS spread for the US, Germany, Ireland and Greece as well as three groups based on the average return-risk measure over time: RRLOW consists of the one third countries with the lowest return/risk measure, RRMED the second third and RRHIGH the third top countries. Finally we add the PIIGS group. The size of each point gives the average Debt over GDP ratio for each of the countries/groups.

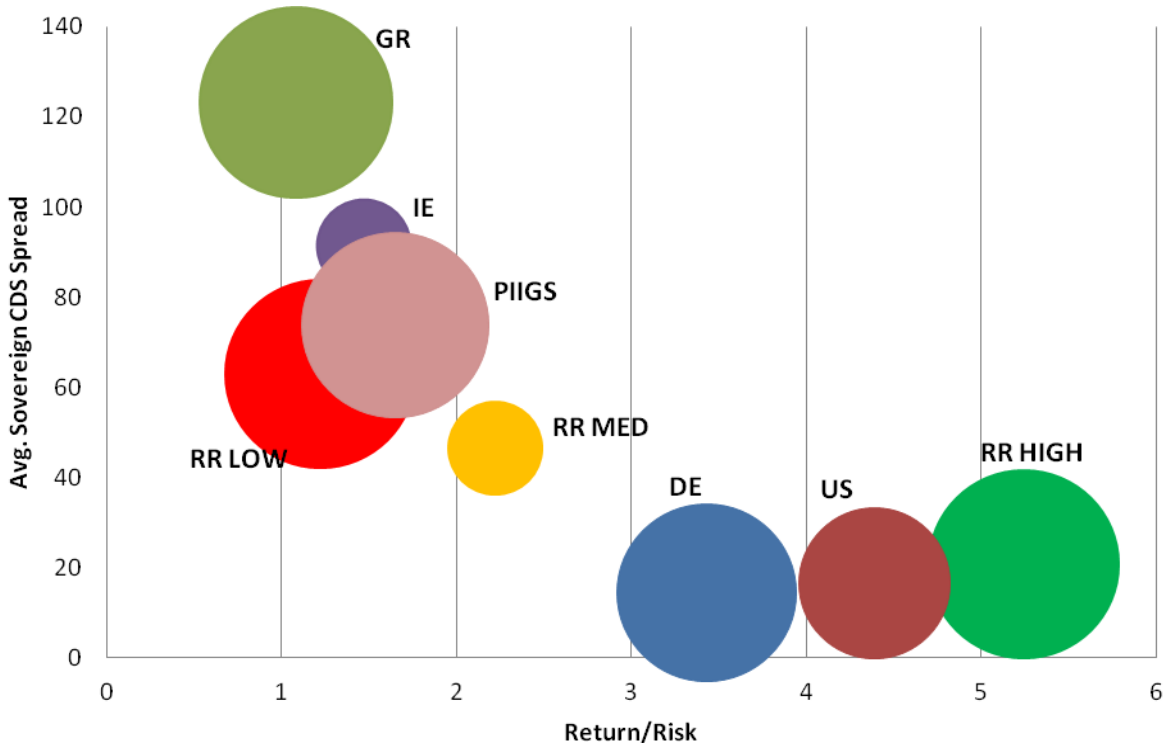


Figure 5: Sovereign-sovereign contagion

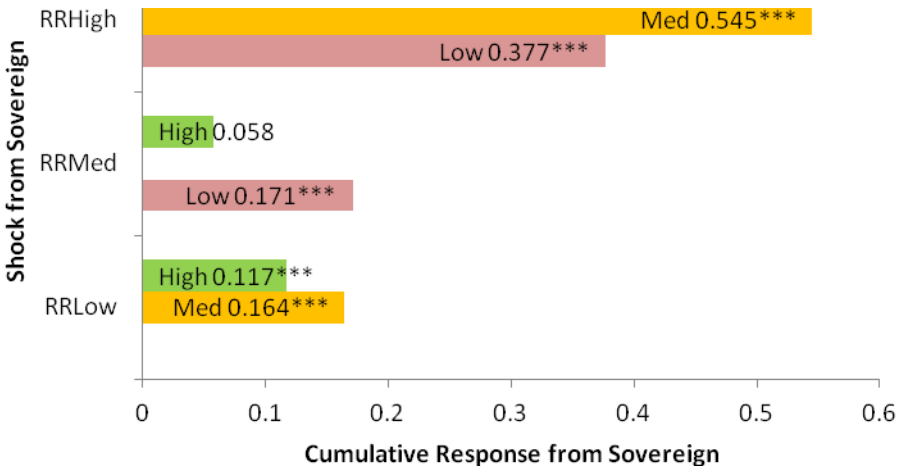
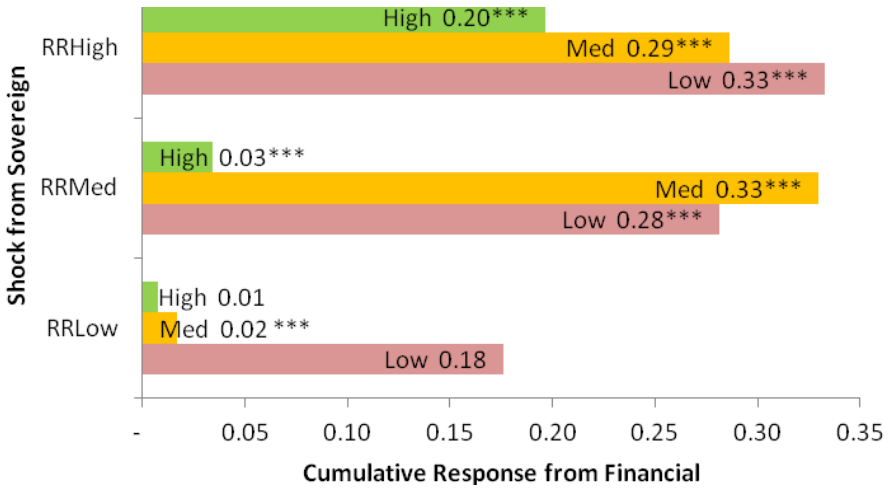
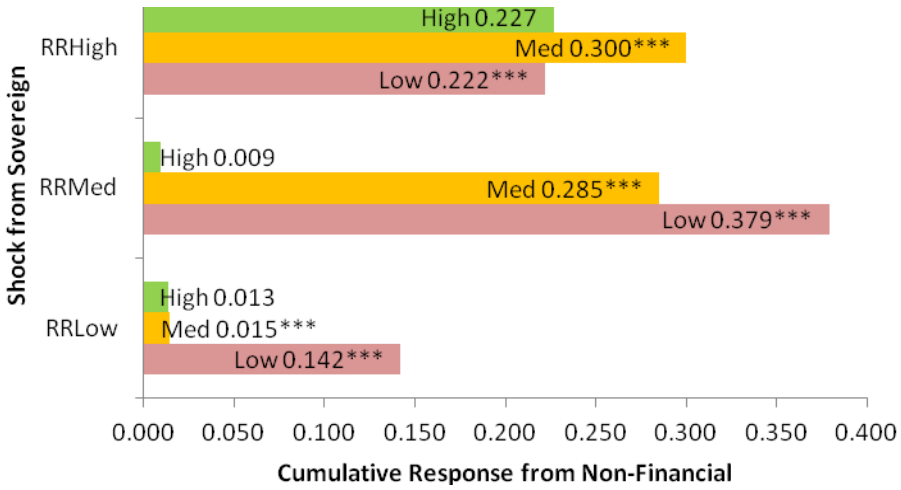


Figure 6: Contagion from sovereigns to the financial and non-financial sector

Panel A: Sovereign-financial contagion



Panel B: Sovereign-non-financial contagion