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ACADEMIEJAAR 2015 – 2016

Net International Investment Positions and Interest Rate Spreads in the Euro Area

Masterproef voorgedragen tot het bekomen van de graad van

Master of Science in de Economische Wetenschappen

Wouter Van der Veken

onder leiding van

Prof. dr. Frank Naert

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Permission

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Nederlandstalige samenvatting

Interesse in de netto internationale investeringspositie (NIIP) is sinds de conceptie van het begrip “globale onevenwichten” sterk toegenomen. In de Eurozone werd deze aandacht bovendien versterkt door de Eurocrisis. Dit is wellicht omdat ontwikkeling van Europese onevenwichten, zoals geuit in sterk negatieve NIIP’s in de perifere landen en eerder positieve NIIP’s in de kernlanden, als een van de belangrijkste oorzaken van de crisis wordt aanschouwd. Specifiek voor de Europese context, worden NIIP’s regelmatig gelinkt aan spreads. De hypothese luidt dat er een negatief verband bestaat tussen de NIIP en de spread met Duitsland. Deze hypothese wordt echter zelden beargumenteerd of empirisch onderzocht. Dit is waar deze masterproef zich situeert: ze probeert zowel argumenten samen te brengen die de mogelijkheid van een verband tussen NIIP’s en rentespreads onderbouwen als de relatie empirisch te bevestigen. Beide doelstellingen zijn mogelijks uniek in de economische literatuur.

Na een uiteenzetting over het economische belang en de correcte intepretatie van de NIIP (eerste sectie), volgt een introductie en een literatuurstudie rond het gedrag van (Europese) rentespreads (tweede sectie). In de derde sectie worden de argumenten samen gebracht die dienen ter ondersteuning van een relatie tussen spreads en de NIIP. Daar wordt in eerse instantie verwezen naar de mogelijkheid dat een sterk negatieve NIIP zorgt voor een hogere overheidsspread door de creatie van fragiliteiten in de economie. Vervolgens wordt er ook op gewezen dat een positieve NIIP geïnterpreteerd kan worden als een uitbreiding van de belastingsbasis. Immers, buitenlandse activa (en de opbrengsten daaruit) aangehouden door ingezetenen kunnen worden belast om opbrengsten te genereren voor de overheid. Verder wordt er gebruik gemaakt van intertemporele budgetrestricties voor de verschillende economische sectoren (de private sector, de overheidssector en de buitenlandse sector). Ook hieruit zal blijken dat een lage of negatieve NIIP geassocieerd kan worden met hogere spreads. Als laatste zal de aandacht kort uitgaan naar de impact van de compositie van de NIIP op rentespreads.

Na het bespreken van deze verschillende wijzen waarop spreads en de NIIP verbonden kunnen zijn, gaat de aandacht naar een empirisch onderzoek. De te testen hypothese is het bestaan van een negatief verband tussen de NIIP en spreads. Het raamwerk voor dit onderzoek wordt aangereikt door de literatuurstudie rond rentespreads in de tweede sectie. Opmerkelijk is het belang van interactie-effecten. Er wordt aangetoond dat de sterkte van de relatie tussen de NIIP en spreads geconditioneerd wordt door de mate van risico-aversie in financiële markten en de hoogte van andere macroeconomische variabelen.

Woord vooraf

Tijdens het werken aan deze masterproef heb ik hulp en bijstand gekregen uit vele verschillende hoeken. Als eerste wens ik professor Naert te bedanken. Zijn inzichten en commentaren zijn een grote hulp geweest. Bovendien heeft hij een groot aandeel gehad in het vinden van het ideale onderwerp voor deze masterproef. Vervolgens wil ik mijn ouders bedanken. Niet alleen hebben zij mij alle mogelijkheden geboden om te studeren, ze hebben mij ook onvoorwaardelijk en te allen tijde gesteund. Op aanvraag kon ik altijd rekenen op pudding, herfstcrumble, of een uitlaatklep, en alle andere, meer cruciale, mentale en logistieke ondersteuning was beschikbaar nog voor de nood zich voordeed. Wanneer nodig kon ik ook altijd op mijn zus rekenen om me eraan te herinneren dat ik voor altijd haar kleine broer zal blijven. Sommige dingen zullen nooit veranderen. Als laatste wil ik ook vele vrienden en vriendinnen bedanken voor interessante inzichten en een variëteit aan ontspanning.

Contents

List of abbreviations

BoP	Balance of payments
BPM	Balance of Payments Manual
CAB	Current account balance
CCEP	Common correlated effects pooled
CISS	Composite indicator of systemic stress
ECB	European Central Bank
EMU	European Monetary Union
ESO	Employee stock option
LIBOR	London interbank offered rate
GDP	Gross domestic product
GNP	Gross national product
IMF	International Monetary Fund
MIP	Macroeconomic Imbalance Procedure
NFI	Net factor income
NIIP	Net international investment position
SDR	Special drawing right
SGP	Stability and Growth pact
SMP	Single market programme
UIP	Uncovered interest parity

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Introduction

Interest in the net international investment position (NIIP) has increased markedly since the detection of 'Global Imbalances' (as discussed, for instance, in Eichengreen, 2004) in the world economy in the mid-2000s. The build up of "European imbalances" prior to the Euro crisis drew additional attention to the European NIIPs. More specifically, strongly negative NIIPs have been associated with economic vulnerabilities and strong increases in the sovereign spread. This thesis is an attempt to formalize, both theoretically and empirically, the relation between NIIPs and spreads in the Euro area.

To this end, the first section will give an insight in the economic interpretation of the NIIP. Next, the behaviour of interest rate spreads will be discussed. Specific attention will be paid to the specificities of the European context. A review of the literature will discuss the traditional setting in which spreads are modelled. From there, it will be clear that the NIIP is mostly absent as explanatory variable for yield spreads. The third and fourth section will try to fill this gap. In the third section, it will first be described how the Euro crisis has created increased awareness for a possible relationship between spreads and the NIIP. The remainder of the third section is dedicated to describing the different channels that may link NIIPs to spreads. In the fourth and final section, the hypothesis of a relationship between spreads and NIIPs is tested using a fixed effects framework. The most important takeaways from this thesis are summarized in the conclusion. Suggestions for further research are also presented there.

1 Defining and understanding the NIIP

In order to guarantee a maximum understanding of the NIIP, its interpretation and its macroeconomic relevance, this first section brings a theoretical review of the most important insights that emerge from theory and literature. We start with an a-theoretical definition of the NIIP. This definition is then linked to the role of the NIIP in a country's balance sheet and net worth (section 1.1). This discussion will intensively draw on the IMF's fifth and sixth balance of payments manuals (IMF, 1993, 2009a, respectively referred to as BPM5 and BPM6). Next, the relation with the balance of payments and consumption smoothing is discussed (section 1.2). Then, it is discussed that the NIIP can be interpreted as a constraint to future trade deficits (section 1.3), and finally, the focus shifts to how changes in the NIIP can be categorized (section 1.4).

1.1 Initial definition and interpretation

A fundamental framework for the definition, interpretation, and composition of the NIIP is provided by the IMF's BPM6. A country's NIIP refers to the difference between its international (or external) assets and its international (or external) liabilities. International assets refer to all financial assets held by a country's residents that represent a claim on non-residents. In BPM6, five kinds of external financial assets are distinguished: direct investment, financial derivatives and employee stock options (ESOs), portfolio investment, other investment, and reserve assets. This functional categorisation is used to divide international assets "based on economic motivations and patterns of behaviour to assist in the analysis of cross-border transactions and positions" (BPM6, p. 9). Next to this functional disaggregation of external assets, BPM6 also suggests an instrumental classification. This alternative classification uses the type of instrument that each individual asset represents to divide the external assets in different components and consists of these categories: monetary gold and SDRs, currency and deposits, debt securities, loans, equity and investment fund shares, insurance-related assets (insurance, pension and standardized guarantee schemes), financial derivatives and ESOs, and other accounts receivable/payable. The definition and categorization of international liabilities is equivalent to those for international assets. The only exception is the post reserve assets, which is the only (functional) category that is not applicable to liabilities. By definition, a country whose international assets exceed its international liabilities is said to have a positive NIIP. In the opposite case, a country is said to have a negative NIIP.

Taking the previous definition one step further, the NIIP can also be defined from the point of view of a country's balance sheet. The stock of international financial assets and liabilities (as opposed to their flow counterparts, which are recorded in the balance of payments) together with non-financial assets are the composing elements of a country's national balance sheet (BPM5, p. 160). In this respect, the NIIP is the balancing item that equilibrates both sides of the international part of this national balance sheet. Closely related to this interpretation of the NIIP is the concept of a country's net worth. The net worth can be calculated by adding the value of non-financial assets to the NIIP. Therefore, the NIIP can also be defined as "the portion of an economy's net worth attributable to or derived from, its relationship with the rest of the world" (BPM5, p.6).

1.2 Relation to the balance of payments

Another way to look at the NIIP is by starting from the balance of payments (BoP). All transactions recorded in the BoP that affect the financial account have an influence on the NIIP. Indeed, it is precisely the purpose of the financial account to record all 'net acquisitions of financial assets' and all 'net incurrence of liabilities'[1] resulting from all international transactions. Obviously, when the net acquisition of financial assets exceeds the net incurrence of liabilities, the stock of external assets grows faster than the stock of external liabilities so that the difference between the two, the NIIP, increases. Consequently, since the financial account mirrors a shortfall or excess of national savings over national investments, or equivalently, current account surpluses or deficits,[2] looking at the NIIP by starting from the balance of payments facilitates the view of the NIIP as an accumulation of savings decisions in the past.

In effect, as pointed out by, for instance, European Commission (2012), net stocks of financial assets can be the result of an efficient allocation of savings and hence consumption smoothing. Obstfeld (2012b) contrasts this kind of intertemporal trade (goods-for-assets-trade) used to smooth consumption over time with intratemporal trade (assets-for-assets-trade) used to smooth consumption over different states of nature at one moment in time. Obstfeld argues that the sharp increase in gross positions observed in recent decades reflects the increasing importance of intratemporal trade relative to intertemporal trade. This phenomenon is typically observed for smaller and financially open economies (such as the Netherlands, Switzerland, and the United Kingdom) and for the Euro area in general.

[1] In BPM6 the traditional use of credits and debits in BoP-recording was modified for the financial account. Although the use of debits and credits is still valid, the IMF chose to ensure maximal consistency between the national accounts and the NIIP and BoP by using 'net acquisition of assets' and 'net incurrence of liabilities' instead of credits and debits respectively.

[2] Current account deficits or surpluses need to be financed by selling assets (which results in a worsening of the NIIP through decreasing external assets) or borrowing funds (which leads to a worsening of the NIIP through increasing external liabilities).

Unfortunately, according to Obstfeld (2012a) and Obstfeld (2012b), such large gross positions that facilitate intratemporal trade come at the cost of potential risks to financial stability. These risks to financial stability follow from the possibility of a balance sheet crisis that emerges in the presence of such large gross positions in international assets and liabilities. The risks to financial stability arise especially in the case when countries engage in maturity and liquidity transformation. In such a situation, even a country that is a net creditor may suffer from a run on its debt liabilities and find itself in a balance sheet crisis. Another risk to financial stability that emerges from large gross external positions arises when those large gross positions are the result of tax avoidance or evasion, regulatory arbitrage, implicit government guarantees, or other distortions (Obstfeld, 2012b). An example of how avoidance of capital requirements through asset-for-asset-trade (which results in large gross external positions) contributed to the build-up of financial risks prior to 2007 can be found in Obstfeld (2012a).

Despite the fact that Obstfeld (2012b) considers consumption smoothing to result merely from intertemporal trade (visible in a current account surplus or deficit, and therefore reflected in changes in the NIIP), Lane (2000) and Lane (2001) discuss the theoretical possibility that gross positions in external assets and liabilities can smooth income, and hence consumption, over time, and this even in the absence of the consumption smoothing features of non-zero trade balances. For gross positions to yield such income smoothing properties, it is required that the resulting net investment income is countercyclical. Knowing that GNP=GDP+NFI (where NFI denotes net factor income, which contains the net investment income stemming from the gross external asset and liability positions) explains how a countercyclical NFI results in income smoothing: if GDP and NFI are negatively correlated, then volatility in GNP will be smaller than volatility in GDP since the countercyclical character of NFI partially offsets variations in GDP. Such an income smoothing property of gross international investment positions is however empirically rejected in Lane (2000).

1.3 The NIIP as a constraint to future trade deficits

Finally, under the appropriate assumptions, the NIIP can also be seen as a constraint to the country's discounted future trade balances. In this respect, a country with a negative NIIP is forced to generate surpluses on at least some future trade balances. This can be easily explained. In accordance with the model discussed in Schmitt-Grohé and Uribe (2014) (Obstfeld (2012a) presents a different approach to reach the same conclusion), we assume the current transfers between residents and non-residents (the balance of secondary income account) to be zero. Further, we restrict the primary income account to contain nothing but investment income. Under these assumptions, the calculation of the current account balance simplifies to $CAB_t = X_t^{gd} - M_t^{gd} + r \cdot NIIP_{t-1}$, where CAB_t denotes the balance of the current account at time t, X_t^{gd} and M_t^{gd} denote exports and imports of goods and services at time t respectively, and r denotes the average interest rate paid or received on $NIIP_{t-1}$, the NIIP of the previous period. As such, the term $r \cdot NIIP_{t-1}$ is the net international investment income. Making abstraction of valuation changes, we can, given the initial NIIP ($NIIP_0$), find the NIIP of the subsequent period as:

$$NIIP_1 = (1+r) \cdot NIIP_0 + X_1^{gd} - M_1^{gd}. \tag{1}$$

The general dynamics of the NIIP are given by: $NIIP_{t+1} = (1+r) \cdot NIIP_t + X_{t+1}^{gd} - M_{t+1}^{gd}$, or, rearranged:

$$NIIP_t = \frac{NIIP_{t+1}}{1+r} - \frac{X_t^{gd} - M_t^{gd}}{1+r}. \tag{2}$$

Rearranging (1) in the same way, and using (2) to substitute for $NIIP_1$, and iteratively continuing doing so n times gives, for a constant interest rate, the following expression for $NIIP_0$:

$$NIIP_0 = \frac{NIIP_n}{(1+r)^n} - \frac{X_1^{gd} - M_1^{gd}}{1+r} - \frac{X_2^{gd} - M_2^{gd}}{(1+r)^2} - \frac{X_3^{gd} - M_3^{gd}}{(1+r)^3} - \ldots - \frac{X_n^{gd} - M_n^{gd}}{(1+r)^n}. \tag{3}$$

This equation shows that the NIIP at any given point in time equals the present value of the NIIP n periods ahead minus the present value of all n intermediate trade balances. Imposing the "no-ponzi-game" constraint, to eliminate situations in which net foreign debt is never paid off but perpetually rolled over, so that the country is a net debtor in the infinite future, requires the following condition to hold:

$$\lim_{n\to\infty} \frac{NIIP_n}{(1+r)^n} \geq 0. \tag{4}$$

Additionally it would be unwise for a country to be a perpetual net creditor: this would imply that the residents abstain from consumption possibilities indefinitely. To rule out such irrational situations, condition (5) must hold:

$$\lim_{n\to\infty} \frac{NIIP_n}{(1+r)^n} \leq 0. \tag{5}$$

Combining (4) and (5) results in the transversality condition:

$$\lim_{n\to\infty} \frac{NIIP_n}{(1+r)^n} = 0. \tag{6}$$

Using this transversality condition in (1) results in:

$$NIIP_0 = -\frac{X_1^{gd} - M_1^{gd}}{1+r} - \frac{X_2^{gd} - M_2^{gd}}{(1+r)^2} - \frac{X_3^{gd} - M_3^{gd}}{(1+r)^3} - \ldots \tag{7}$$

which is the mathematical equivalent of the statement that the NIIP can be seen as a constraint to the country's discounted future trade balances. When this equation no longer holds, either the "no-ponzi-game" constraint or the transversality condition must be unfulfilled. In the former case, the NIIP has become unsustainable; in the latter case, consumption possibilities are lost. Since the global economy is a closed system in its entirety, it can be concluded that if the one applies to a certain country, the other must apply to the rest of the world.

1.4 NIIP: the mechanics

The NIIP can be calculated as international assets minus international liabilities. A straightforward conclusion is that the NIIP is determined both by the stock or volume and the valuation of international assets and liabilities. Within the BPM6-framework, changes in the NIIP are divided accordingly. First, changes in the NIIP can result from transactions recorded in the BoP that affect the financial account. Second, changes in the NIIP can also be attributed to the so-called 'other flows' that represent either 'other changes in the volume of assets and liabilities that are not transactions' or revaluations. Revaluations, typically the greatest contributor to 'other flows', captures both the effect of exchange rate changes and 'other price changes' on the value of assets and liabilities.

The relative contribution to changes in the NIIP of transactions recorded in the BoP versus valuation effects varies greatly among countries. Analysis by the European Commission (2010) points out that, typically, countries with large gross positions in external assets or liabilities tend to be more subject to valuation effects than countries with more moderate gross positions. This feature resulted in great movements in NIIPs of countries that serve as an investment base for multinational enterprises or financial intermediation centres. A back-of-the-envelope calculation in Obstfeld (2012a) finds evidence in favour of a decoupling between the current account and the NIIP. This would mean that, for all country groups (high-income, emerging, and developing), but most strikingly so for high-income countries, valuation effects have become relatively more important over time. In accordance with the analysis by the European Commission (2010), Obstfeld (2012a) links this increased importance of valuation effects to increased gross external asset and liability positions.

An analysis of the importance of valuation effects in the Euro area can be found in European Commission (2012). One conclusion regarding the period prior to the Euro crisis and regarding countries with current account deficits was that the worsening of the NIIP by the current account deficits was further amplified by valuation effects. This can be explained by a relative price effect and a net position effect.[3] The relative price effect was a major determinant for equity positions in the pre-crisis period and refers to the notion that if one country's asset prices increase faster than asset prices in the rest of the world, then this country will suffer from a decreasing NIIP. To see this, note that the value of the external assets on the asset-side of a country's international

[3] The net position effect is very briefly theoretically discussed in Obstfeld (2012a).

balance sheet is related to the foreign asset prices. Further, note that, since the international liabilities contain domestic assets held by foreigners, the value of those international liabilities is determined by the domestic asset prices. As a result, domestic asset prices that increase faster than foreign asset prices corresponds with international liabilities increasing faster than international assets. Consequently, in this case, the relative price effect results in a worsening of the NIIP. That is exactly what happened in some European growth economies in the pre-crisis era: they benefited from relatively faster asset price increases (mainly in equity), which contributed to the worsening of the NIIP. In addition to the relative price effect, the European Commission (2012) suggests that the net position effect resulted in a worsening of the NIIP as well. The negative sign of the NIIP of several peripheral European economies resulted in an even further decreasing NIIP as both global and domestic asset prices rose. the European Commission (2012) and Obstfeld (2012a) further conclude that valuation effects resulting from fluctuations in exchange rates tend to be small in Europe. Finally, it is concluded that the category 'equity' is the greatest contributor to valuation effects in Europe.

2 Traditional explanations for interest rate spreads

The previous section defined and introduced the NIIP. In this section, the behaviour of interest rates is discussed. In the first subsection, the peculiarities of European spreads will be addressed, with specific attention to the roles of the monetary unification and the Euro crisis. The second subsection will present a review of the most relevant and recent literature on sovereign yield spreads to provide the necessary background for investigating the link between the NIIP and interest rate spreads. This section will lead to the conclusion that the NIIP is not traditionally used as explanatory variable for sovereign yield spreads.

2.1 The European narrative

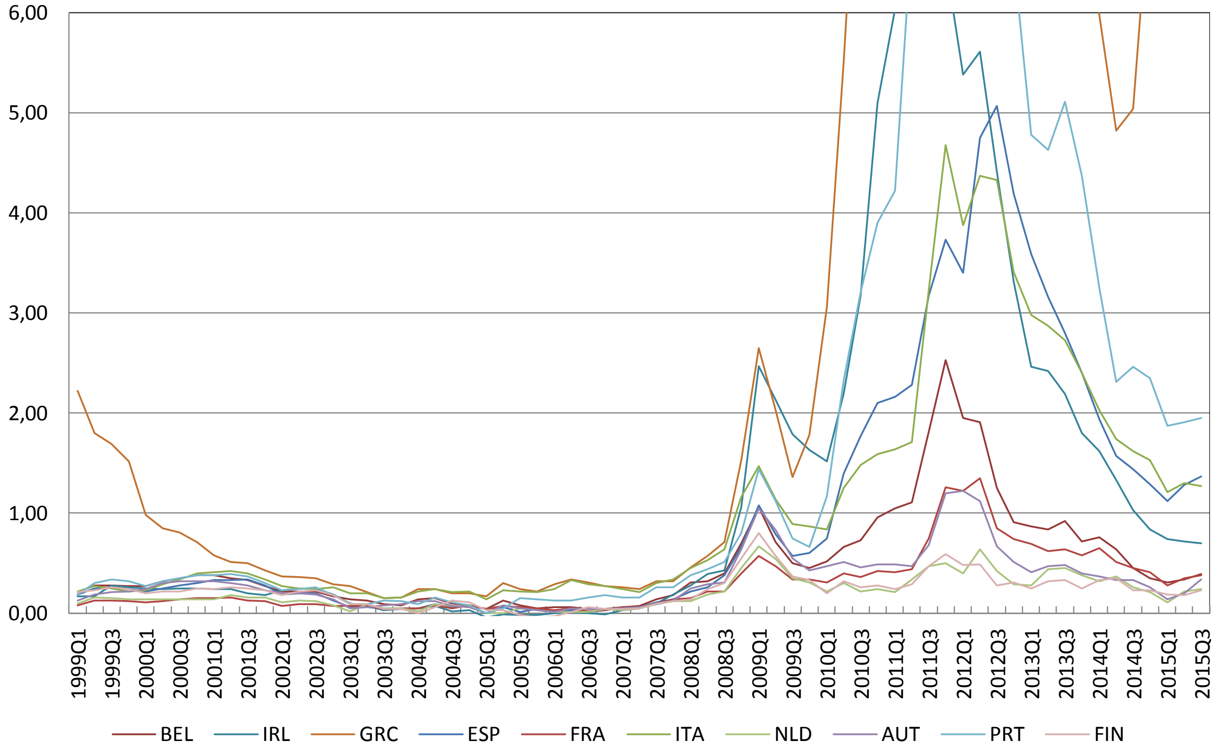
After being close to insignificant for a number of years after the creation of the monetary union, interest rate spreads took centre stage in the gloomy European economy after the financial turmoil in 2007 and 2008 (Goedl and Kleinert, 2013). Increases in the interest rate spreads that were unseen for the monetary union were both a symptom and a cause of a possible break-up of the Euro zone (see figure 1). On the one hand, they signalled the lack of confidence in some (mostly peripheral) governments. On the other hand, the unseen increases in interest rate spreads further deteriorated the sustainability of some government's debts (see, for instance, Pilbeam, 2013). It was only after the commitment of the ECB to buy an unlimited amount of sovereign bonds of any country, that interest rate spreads ceased to increase.

A general explanation for interest rate spreads is given by the uncovered interest rate parity (UIP), which is given in equation (8). The empirical validity of the UIP is not uncontested. Nevertheless, Chinn and Meredith (2005), Mehl and Cappiello (2009), Zhang (2006), and to lesser extent Chinn and Quayyum (2012), document that the empirical rejection of the UIP (a puzzle dubbed 'the forward premium puzzle') does not appear when using pairs of only advanced economies and longer horizons, such as three, five or ten years. Therefore, it appears that the UIP may indeed be relevant for the analysis of 10-year European government interest rate spreads.

$$\frac{E_t S_{t+k} - S_t}{S_t} + \sigma_t \approx i_{t,k} - i^*_{t,k} \tag{8}$$

In (8) S_t is the exchange rate at time t and $E_t S_{t+k}$ is the expected exchange rate, as of period t, k periods ahead. The exchange rate S is defined as units of domestic currency per unit of foreign currency. Hence, an increase in S corresponds with a depreciation of the domestic currency. Further, $i_{t,k}$ and $i^*_{t,k}$ refer to the domestic and foreign interest rate on a k-period bond respectively (consider i^*_t not to contain any risk premia). The difference, $i_{t,k} - i^*_{t,k}$, is the interest rate spread. In this thesis, spreads will usually be calculated using long term interest

Figure 1: Interest rate spreads for European core and periphery



Notes: Spreads are calculated using 10-year government bond yields with Germany as benchmark.
Source: Eurostat, series irt_lt_mcby_q.

rates (k = 10 year) with Germany as benchmark. Alexopoulou et al. (2009) propose to use the European wide average as benchmark. Next, σ_t is a risk premium that investors require to invest in domestic assets rather than in riskless foreign assets. The risk premium will be discussed more in depth in paragraph 2.2. Following Dötz and Fischer (2010), the risk premium is allowed to change over time. Although not represented in the formula, heterogeneity in the regulatory treatment may also contribute to interest rate differentials.

The application of the UIP to the Euro area prior to the Euro crisis explains the convergence of European interest rates in the run-up and after the monetary unification in Europe. Since exchange rate movements are eliminated in the EMU (as are the regulatory differentials), the first term in the left-hand side of equation (8) drops out, so that the spread is limited to the risk premium σ. But also after the monetary unification the UIP proves to be valuable in explaining European spreads. In 2009, the exact opposite of the described convergence was at play for Greece. Greece's commitment of permanent membership of the EMU became less credible. In Arghyrou and Kontonikas (2012), this perceived possibility of a return to a devalued Drachma was the outcome of a model with rational and optimizing investors and government. As indicated by equation (8), this led to an increase in the Greek spread due to the reintroduction of an expected exchange rate depreciation. Although the conclusions remain unchanged, a slightly more involved theoretical framework to understand the behaviour of spreads in the advent a possible exit from the monetary union is discussed in Dötz and Fischer (2010).

The almost complete disappearance of interest rate spreads in the early 2000s, however, not only requires the elimination of expected changes in exchange rates, but also a risk premium, σ, that is close to zero. As such, it seems that, despite the no-bail-out clause in the Treaty on the Functioning of the European Union, investors deemed all countries, including the periphery, to be almost equally creditworthy (creditworthiness and other elements determining the risk premium are discussed in paragraph 2.2). In effect, Bernoth et al. (2004), and Hallerberg and Wolff (2008) show that accession to the EMU leads, to some extent, to a decoupling between government interest rates and fiscal variables that reflect a country's creditworthiness. Figure 1 confirms that, despite significant heterogeneity in country-specific fundamentals, sovereign yields for Euro countries were very close together. Manganelli and Wolswijk (2009) argue that this may reflect the inability of financial markets to assess the sustainability of fiscal policies. With hindsight, Wihlborg et al. (2010) state that markets may have been blinded by "excessive optimism". In Arghyrou and Kontonikas (2012) the observed decoupling is rationalized by the 'convergence-trading' hypothesis. This hypothesis entails that markets no longer priced the country-specific macroeconomic fundamentals. That is, investors no longer demanded a compensation for investing in bonds of sovereigns that, because of the worse macroeconomic fundamentals of the country in question, had a higher probability of default. In fact, in the model proposed by Arghyrou and Kontonikas, investors not only believed that the EMU-membership was permanent, they also considered all countries' (fiscal) liabilities to be guaranteed by other EMU-members. The same argument is made in Copeland and Jones (2001). It was only after the outburst of the credit crunch in August 2007 that differentials in macroeconomic variables were again able to explain yield spreads (Arghyrou and Kontonikas, 2012; Barrios et al., 2009, see also figure 1). These two evolutions (the elimination of expected exchange rate movements and the near disappearance of risk premia) can explain the across the board convergence in European interest rates towards the German interest rate.

One important remark regarding the role of risk premia in the monetary union remains to be made. An investor's requirement of a higher risk premium, among other things, reflects his assessment of a country's creditworthiness. Often, this ability to demand higher risk premia from governments that exhibit fiscal misbehaviour is described as the imposition of market discipline by investors (see, for instance, Bernoth et al., 2004; Faini, 2006). In Codogno et al. (2003), the presence of interest rates spreads, when they reflect a credit premium, are considered to signal a failure of the Stability and Growth pact (SGP). This should not be surprising since it is the SGPs objective to impose conservative fiscal policies and ensure creditworthiness of all EMU members. Insofar that the SGP is insufficient to impose fiscal discipline, Bernoth and Erdogan (2012) argue that the disciplinary effect of the increase in credit risk premia since the financial crisis acts as a significant and valuable supplement to the SGP. For early years of the monetary union, however, Faini (2006) believes that the punishing effect of the response of credit risk to fiscal sustainability was too small. Moreover, Naert et al. (2014, p. 175) emphasize that the Delors Report in 1989 already understood that financial markets' assessment of creditworthiness may not always be entirely adequate. In addition, Faini (2006) criticizes the de facto absence of peer punishment among members of the Euro area since November 2003 through the correct enforcement of the SGP. Consequently, he concludes that deteriorations of the country's fiscal positions were not sufficiently curtailed as neither the market nor ECOFIN sufficiently enforced fiscal discipline. Faini (2006) also expects the elimination of exchange rate movements within the Euro area to be another market sanction that has disappeared with the monetary unification.

2.2 Disaggregating the risk premium

The previous section introduced some of the peculiarities of the European sovereign spread. The formula of the UIP already showed that spreads are composed of expected exchange rate movements and a relative risk premium σ. It was also explained that, in a monetary union, exchange rates are eliminated, so that spreads are limited to differences in risk premia. Generally, such risk premia consist of a compensation for country-specific credit risk, country-specific liquidity risk, and the general pricing of risk. Explaining spreads in the monetary union therefore requires explanations for those three components. A concise review for such explanations can be found, for example, in Barrios et al. (2009) or Attinasi et al. (2009). A portfolio model explaining interest rate differentials is presented by Bernoth et al. (2004). Excellent and concise summaries of the most important literature related to the Euro area up to 2009 and 2010 can be found in Manganelli and Wolswijk (2009) and Gerlach et al. (2010) respectively. A similar review of the literature, but with a broader cross-sectional focus is presented in Haugh et al. (2009).

2.2.1 Credit risk

The theoretical explanation First of all, creditors need to be compensated for a possible value loss of their investment. Interestingly, however, Barrios et al. (2009) consider credit risk to be broader than merely a compensation for the probability of (partial) default. In addition to this default risk, Barrios et al. also consider downgrade risk and credit spread risk to be part of the more general credit risk. Downgrade risk and credit spread risk respectively refer to a possible downgrading of sovereign debt by rating agencies and the risk that the price of a bond evolves less favourable than the price of comparable bonds. Although theoretically sensible, this characterisation is of little practical relevance in most empirical research.

A theoretical analysis of government bonds' credit risk can draw on the intertemporal government budget constraint to find its determining factors. As in European Commission (2016), Goedl and Kleinert (2013), or Manganelli and Wolswijk (2009), credit risk can be tied to government solvency. A government is solvent as long as it is able to generate sufficient future primary surpluses to service its debt. Or, put differently, the government is not allowed to run a ponzi-game against its creditors. Neither would it be reasonable for a government to let counterparties run a ponzi-game against it. The combination of those two conditions results in a transversality condition for the government sector (very similar to equation (6)) that is mathematically equivalent to an intertemporal government budget constraint that represents the solvency condition that debt must be serviced by running future primary surpluses (Escolano, 2010). This intertemporal government budget constraint (present value budget constraint in Chalk and Hemming (2000)) is given by:

$$E_t \sum_{t=0}^{\infty} \frac{primary\ surplus_t}{\left(\frac{1+r}{1+g}\right)^t} = debt_0. \tag{9}$$

In this equation, $E_t(\cdot)$ is the expectations operator, $primary\ surplus_t$ is the primary surplus at time t, and $debt_0$ denotes today's stock of outstanding government debt. Both *primary surplus* and *debt* are expressed as a ratio to gdp. The real interest rate r is defined so that $1+r = \frac{1+i}{1+\pi}$, with i the nominal interest rate paid on the outstanding stock of debt and π the change in the gdp-deflator, a measure for inflation. This definition of r implies a rather stringent assumption in the analysis in Escolano (2010), namely, the absence of a risk premium. Finally, g denotes the real gdp growth rate.

The more likely it is that a government's debt level complies with the government budget constraint, the better the creditworthiness of that government.[4] If, however, the right-hand side of equation (9) exceeds the left-hand side, then investing in that government's bonds becomes more risky so that a higher risk premium is required. As in Goedl and Kleinert (2013), this is more likely when the expected future primary surpluses or the expected future growth rate are lower and the interest rate or the initial debt level are higher.

The importance of expectations in equation (9) should not be underestimated. Wrong expectations in the left-hand side of equation (9), for example as a consequence of investor mistrust, may result in understating the present value of the future primary surpluses, so that

[4] A similar, and possibly more familiar, reasoning uses the probability of default rather than the probability of the budget constraint not being met. The difference between the two approaches is however only marginal: a violation of the government budget constraint implies a ponzi-game of the government against its creditors. In this case, reasonable creditors should not expect the government to honour its debt liabilities, which is, in fact, a default. At this point, it is also worth noting that the relevant literature has developed more refined concepts of fiscal sustainability that is not yet incorporated in the yield spread literature. See, for example, Bohn (1995), Bohn (1998), Bohn (2005), Fall and Fournier (2015), Ghosh et al. (2013), and Jansen (2016) for different investigations in fiscal sustainability.

the government may be perceived to be insolvent. As a result, investors will demand a higher risk premium which will incur higher debt servicing costs. This may effectively reduce the government's (objective) ability to satisfy the budget constraint, so that wrong expectations can turn a solvent (but as insolvent perceived) government into an insolvent government. Note, however, that equation (9) is unable to deal with such time-varying risk premia and is therefore unable to capture this dynamic. Aizenman et al. (2013), De Grauwe (2012), Goedl and Kleinert (2013) and Mody (2009) addressed a similar problem of multiple equilibria.

Empirical conclusions regarding fiscal variables Empirical research generally confirms the importance of a credit premium (Dötz and Fischer, 2010). The choice of explanatory variables[5] for spreads often draws on the variables proposed by the intertemporal government budget constraint to proxy the credit premium. Government debt, primary surplus and real growth are the only variables explaining interest rate spreads in Goedl and Kleinert (2013). Interestingly, they show, in line with Gerlach et al. (2010), by allowing maximum cross-sectional heterogeneity in the slope coefficient, that the scope for poolability may be limited. In the same paper, an event study shows that the disclosure of forecasts that predict slower growth or worse public finances significantly increases the interest rate of government bonds, which is evidence in favour of the importance of the budget constraint in explaining yield spreads.

In Arghyrou and Kontonikas (2012) the one-year-ahead fiscal position and general government gross debt are used as measures for credit risk. Also Attinasi et al. (2009), Bernoth et al. (2004), Bernoth and Erdogan (2012), De Santis (2012), Faini (2006), Gerlach et al. (2010), Gibson et al. (2012), Hallerberg and Wolff (2008), Haugh et al. (2009), Schuknecht et al. (2009) and Zoli and Sgherri (2009) emphasize the importance of (expected) government debt and budget balance. In Bernoth and Erdogan (2012) the use of the expected fiscal balance is preferred because of its real time character (it is not subjected to revisions) and the credible assumption of forward looking financial markets.

In contrast, Codogno et al. (2003) found the debt-to-gdp ratio to be the only fiscal variable with some, but very limited, explanatory power. They also suggested the use of future liabilities arising from pension systems as explanatory variable, but data availability ruled this possibility out. Haugh et al. (2009) benefit from increased data availability and find a significant effect of future pension expenditures (2010-2050) on country-specific credit risk.

Bernoth et al. (2004) and Haugh et al. (2009) include the ratio of government debt service to current government revenues in addition to other fiscal variables. In the same spirit, Barrios et al. (2009) use the ratio of interest payments to government revenues. Aizenman et al. (2013)

[5]Often expressed relative to Germany.

show that fiscal space, defined as government debt and deficit as percentage of the tax base, is important in explaining credit risk.

In Barrios et al. (2009), Bernoth and Erdogan (2012) and Haugh et al. (2009) quadratic terms for debt, deficit and/or debt servicing are added to test for non-linear, credit-punishing, effects. Whereas Barrios et al. and Haugh et al. (2009) find a significant effect of the quadratic debt term on spreads, Bernoth and Erdogan show that only the squared deficit-term is significant. More evidence in favour of credit-punishing is presented in Bernoth et al. (2004).

Other fiscal measures proposed by the literature are revisions of the Commission's forecast of fiscal aggregates (Gibson et al., 2012), the use of creative accounting by fiscal authorities and fiscal transparency (Bernoth et al., 2004), and the fiscal track, a dummy variable in Haugh et al. (2009) that takes the value of one for countries that have a history of persistent fiscal deficits. Evidence in favour of interaction effects is presented in Haugh et al. (2009). They find an amplification of the size of the effect of fiscal variables on credit risk in periods of high risk aversion.

Non-fiscal variables Variables measuring credit risk do not necessarily have to be fiscal or related to the government budget constraint. In the absence of high-frequency fiscal variables, Barrios et al. (2009), Beber et al. (2009), Dötz and Fischer (2010) and Longstaff et al. (2007) use the CDS-spreads relative to Germany as a market-based indicator for credit risk (Codogno et al., 2003). Credit ratings are used by ECB (2011), De Santis (2012), Gibson et al. (2012) and Gómez-Puig (2006). Hallerberg and Wolff (2008) introduce fiscal institutions as explanatory variable for interest rate spreads.

Other non-fiscal variables that may influence the government budget constraint may be related to the banking sector (Reinhart and Rogoff, 2008). Also, Attinasi et al. (2009), Zoli and Sgherri (2009), Mody (2009), Gerlach et al. (2010) and Dötz and Fischer (2010) introduce the banking sector as possible determinant for the evolution of interest rate spreads during the Euro crisis. It is a reasonable consideration that the transfer of liabilities (and hence, risk) from the financial sector to the government sector (be it as government guarantees for interbank lending, recapitalisations, asset relief schemes or increased deposit insurance) leads to a nexus between the public budget and the banking sector. One may conclude from the discussion in Mody (2009) that the rescue of Bear Stearns in March 2008 was a precedent suggesting the possibility of a close link between public finance and troubles in banking. Indeed, both Mody (2009) and Dötz and Fischer (2010) argue that it was only after March 2008 that the financial sector affected sovereign yields. This confirms that a government's (perceived) creditworthiness may be effectively reduced by interventions in the financial sector, leading to an increased spread. The IMF has calculated that financial interventions by Euro area governments amounted up to

3,5% of gdp as of 2009. The public sector's contingent liabilities added up to an additional 2 to 5% of gdp (IMF, 2009b).

In addition to the transfer-channel, Gerlach et al. (2010), inspired by Adrian and Shin (2009), present another channel through which the banking sector may affect the government's fiscal health. The banking sector is crucial to generate aggregate liquidity and financial stability, which affect the public budget directly, but also indirectly via credit availability. This second channel is expected to reduce sovereign spreads and is shown to be present under normal financial conditions.

Attinasi et al. (2009) conduct a formal test of the relevance of the first channel, the "credit risk transfer hypothesis", and confirm that investors acknowledged this transfer of risk. They further conclude that the *size* of the public stake in the financial sector did not significantly affect the sovereign spreads. Instead, it is argued that investors' attention was focused on the credibility of the government's intervention in the banking sector. In the same spirit, Zoli and Sgherri (2009) use the 'expected default frequency of the median financial institution of each country' as explanatory variable and conclude that a higher expected default frequency significantly increases credit risk of Austrian, Irish and Italian government bonds. Relatedly, financial sector soundness is found to significantly affect sovereign spreads in Dötz and Fischer (2010).

Using total banking assets and the banking sector's equity ratio as explanatory variables, Gerlach et al. (2010) also find a significant contribution of the financial sector to government spreads. More specifically, they conclude that in uncertain times, or in periods of high aggregate risk, the size and capitalization of the banking sector act to increase the country-specific credit risk through implicit government guarantees.

Finally, in Mody (2009), the banking sector is interacted with competitiveness. He argues that the effect of the soundness of the financial sector on post-2008 yield spreads was significantly higher for countries that had suffered from high losses in competitiveness, as measured by the appreciation of the real effective exchange rate over the period 2003-2008. Similar results are reported by Dötz and Fischer (2010).

As stressed by Barrios et al. (2009) and Maltritz (2012), the relevance of competitiveness is not limited to its appearance in Mody's interaction effects. Barrios et al. argue that competitiveness (and relatedly, current account imbalances) may, in addition to traditional fiscal variables and the previously introduced banking sector, affect the creditworthiness of the sovereign borrower as well. The reasoning goes that countries with a (structural) deficit on the current account are prone to sudden stops in external financing of the domestic investment-savings gap. Such a sudden stop may adversely effect public finances. In addition, if current account adjustment within the EMU would prove to be necessary, this could only be realized through a prolonged period of disinflation which would negatively affect the government balance as well. A final argument in Barrios et al. (2009) to use the current account balance as explanatory variable for interest rate spreads is the observation that the distinction between private and public debt may become increasingly unclear as investors may expect the government to take over some of the private debt.[6] Maltritz (2012) presents other arguments in favour of including the trade balance in explanations for yield spreads. On the one hand he expects a positive trade balance to result in lower spreads because it facilitates debt servicing and signals good competitiveness. On the other hand, however, since the trade balance mirrors the financial account, a trade surplus may result from the inability to borrow abroad or foreigners withdrawing their funds.

Barrios et al. (2009), Attinasi et al. (2009), and Maltritz (2012) conclude that a high current account balance is related to lower spreads on government debt. In related research, Gibson et al. (2012) find an important effect of real effective exchange rates (competitiveness) on the Greek spread. Evidence in favour of the competitiveness-effect for a panel of EMU-countries is presented by Dötz and Fischer (2010) .

Other considerations In addition to the analysis of the significance of fiscal, financial or external variables in explaining spreads, Barrios et al. (2009) find considerable evidence in favour of interaction effects. More specifically, it is concluded that, in periods of high risk aversion (see paragraph 2.2.3), a deterioration in the budget deficit results in a stronger increase in the government spread for countries with a high current account deficit. Other evidence in favour of interaction effects is provided by Mody (2009). Next to interacting the competitiveness variable with the soundness of the financial sector, he also examines the interaction between competitiveness and government debt in his model to explain spreads. He shows that, for the crisis period, debt-ratios gain importance in explaining the behaviour of sovereign spreads when the country in question has suffered from losses in competitiveness. This is theoretically underpinned by the loss of growth potential that is associated with a loss of competitiveness. When the pre-crisis period is considered, however, Dötz and Fischer (2010) present a significantly different view. In fact, before 2008, a loss in competitiveness resulting from high inflation was associated with catch-up growth which was expected to result in a lower debt burden. Hence, losing competitiveness in the pre-crisis era resulted in a lower rather than higher sovereign spread.

Arghyrou and Kontonikas (2012), Bernoth et al. (2012) and Barrios et al. (2009) conclude that the importance of fiscal variables or credit risk in general may be state dependent. To this

[6] It can be argued that this final argument would call for the inclusion of external debt rather than the current account balance.

extent, Bernoth and Erdogan (2012) explicitly allow time variation in the estimated coefficients. A general conclusion that emerges is that although credit risk had no or almost no effect on spreads before July or August 2007, it significantly gained importance in explaining yield differentials across Europe after August 2007. This conclusion is in line with the change in investor beliefs from convergence-trading to macro-fundamental-based allocation of funds described in Arghyrou and Kontonikas (2012) and explains why empirical research in the early 2000s often finds the country-specific credit premium to be of only limited importance (as, for example in Codogno et al., 2003; Geyer et al., 2004; Longstaff et al., 2007). A contrasting view is presented in Aizenman et al. (2013). They use a wide variety of macroeconomic variables to explain credit risk measured by CDS-spreads and conclude that the explanatory power of his fiscal variables (fiscal space) was significantly *lower* during crisis-years.

2.2.2 Liquidity risk

Next, liquidity risk also requires a compensation for investors. Theoretically, the motivation for a liquidity premium follows from the transaction costs that accompany the trading in illiquid assets (Bernoth et al., 2004) but it can also represent an additional risk to which the investor is exposed. An excellent discussion of the theoretical foundations can be found in Favero et al. (2010). Market liquidity is determined by the volume of buy and sell orders and the impact of large individual transactions on the market price (depth and breadth, respectively). Barrios et al. (2009) emphasize the role of a liquid futures market and the bond issuing volume and policy as liquidity enhancing factors. Since the German bond market is the only one in Europe with a liquid futures market, it can be expected that the spread of any European country vis-à-vis Germany includes a liquidity premium. Nevertheless, Codogno et al. (2003) did not find evidence supporting the importance of a futures market for the liquidity premium.

The literature generally empirically supports the existence of a (often only small) liquidity premium. Arghyrou and Kontonikas (2012), Codogno et al. (2003), and Geyer et al. (2004) claim that the liquidity premium was small before the Euro crisis and increases in periods of monetary tightening. Beber et al. (2009) suggests that liquidity premia gain importance in periods of financial uncertainty. Also Favero et al. (2010) acknowledge the influence of financial uncertainty and the global risk factor on the liquidity premium. Some studies, however, are unable to find evidence in favour of the liquidity premium (Bernoth et al., 2006; Schuknecht et al., 2009). According to Zoli and Sgherri (2009), the liquidity premium is significant but small.

Two complicating factors arise when estimating the effect of market liquidity on yield spreads. First, as discussed by Codogno et al. (2003), the explanatory power of liquidity risk is mainly limited to high frequency data. The opposite holds for credit risk, which is essentially measured by slow moving, mostly fiscal, data. Therefore, Codogno et al. suggest to investigate the importance of the liquidity premium using high-frequency data, under the assumption that the slow-moving variables are constant.

The second complicating factor consists of the disentangling of the credit premium and the liquidity premium. As discussed in Barrios et al. (2009), Bernoth et al. (2012), Beber et al. (2009), Blanco (2001) and Copeland and Jones (2001), the sign of the effect of high debt on interest rate spreads is a priory unknown. This is the result of a two-fold relationship between government debt and the risk premium. On the one hand, higher indebtedness reduces the creditworthiness of the government in question, while, on the other hand, a higher government debt also increases the liquidity of that government's bond market. Therefore, in the absence of a good measure for liquidity, the debt-variable may pick up the liquidity effect.

These two issues call for good proxies for liquidity risk. In the existing literature, the bid-ask spread, transaction volumes and the share of one country's sovereign debt in the European total are often used measures for market liquidity (Arghyrou and Kontonikas, 2012; Attinasi et al., 2009; Bernoth et al., 2004; Bernoth and Erdogan, 2012; Favero et al., 2010).

2.2.3 The global risk factor

Finally, a global risk factor, determined by the investors' appetite for risk and the amount of risk in the economy, also influences interest rate spreads.[7] In periods of high risk and risk aversion, investors rebalance their portfolios towards less risky and more liquid assets. This observation is also called the flight-to-quality and flight-to-liquidity effect.[8] As a consequence of this rebalancing, the price of less risky and more liquid assets rises, and the yields are reduced. Overall, government bonds are considered to be a safe investment. Therefore, they tend to benefit from such a safe-haven effect which drives up their prices and reduces their yields as risk appetite makes room for risk aversion. Nevertheless, during the Euro crisis, some governments were considered to be extremely risky which made them suffer from the described portfolio rebalancing, whereas other countries, most notably Germany (Mody, 2009; Arghyrou and Kontonikas, 2012; Wagenvoort and Zwart, 2010), benefited from the rebalancing (Gropp, 2015).

[7] Codogno et al. (2003); Bernoth and Erdogan (2012); Barrios et al. (2009); Attinasi et al. (2009); Mody (2009); Favero et al. (2010); Geyer et al. (2004); Zoli and Sgherri (2009); Manganelli and Wolswijk (2009).

[8] see, for example, Bernoth et al. (2004), Beber et al. (2009), De Santis (2012), Gropp (2015), Attinasi et al. (2009), Zoli and Sgherri (2009), Haugh et al. (2009), Manganelli and Wolswijk (2009), Mody (2009), Wagenvoort and Zwart (2010), and Arghyrou and Kontonikas (2012).

Note that an increase in the global risk factor can be considered to result in an increase in the price of risk. Now, consider riskless government bonds of country A and the more risky government bonds of country B. If the price of risk increases, due to an increased risk aversion, the more risky government of country B will have to offer a higher rate on its bond, even when its riskiness remains constant. Exactly this happened during the Euro crisis. Some governments, mostly peripheral, were considered to be more risky than others, so that, when risk aversion increased in response to the financial stress and the Euro crisis, they suffered from higher yields as investors rebalanced their portfolios away from the, as risky perceived, bonds of the European periphery.

A similar mechanism is at play for the corporate bond market: an increase in risk aversion will result in an increase of the bond yields of the more risky companies and a decrease in the bond yields of the less risky companies. Briefly, the spread between risky and riskless corporate bonds will increase when the investing environment becomes more risk averse. Hence, the international risk factor, reflecting investor's risk appetite, can be accurately proxied by the yield spread of B-graded (risky) vis-à-vis AAA-graded (riskless) corporate bonds (or similar).[9] Also the the spread between US corporate bonds and US treasury yields,[10] the spread between the 10-year swap rate and the 10-year (US) government bond yield,[11] and US stock volatility or the Vix-index[12] are frequently used measures for the risk factor. Gerlach et al. (2010) and Aizenman et al. (2013) also use the Ted-spread[13] or the Refcorp spread (respecitively, the spread between the three-month LIBOR and the T-Bill rate, and the spread between the ten year agency yield and the treasury yield). Finally, although not yet incorporated in the yield-spread literature, the CISS-index (composite indicator of systemic stress) constructed by the ECB may provide insight in a European rather than world-wide common risk factor.

It is instructive to compare some of the most frequently used global risk measures. Eyeballing the normalized time-series presented in figure 2 provides some insight. Represented in the figure are the Ted-spread, the Vix-index, the US high yield spread (Baa-10y-treasury spread), the European high yield spread and the CISS-index. Unsurprisingly, all five series tend to co-move significantly. Both the period from mid-2003 to early 2007 and the period from 2013 to 2016 are characterized as fairly tranquil. The high risk-averse environment in during the financial crisis

[9]Bernoth et al. (2004); Blanco (2001); Catão and Milesi-Ferretti (2012); Codogno et al. (2003); Favero et al. (2010); Ferrucci (2003); Longstaff et al. (2007); Maltritz (2012); Manganelli and Wolswijk (2009); De Santis (2012).

[10]Arghyrou and Kontonikas (2012); Attinasi et al. (2009); Hallerberg and Wolff (2008); Bernoth and Erdogan (2012); Schuknecht et al. (2009); Zoli and Sgherri (2009); Gerlach et al. (2010); Haugh et al. (2009); Codogno et al. (2003); Maltritz (2012).

[11]Codogno et al. (2003); Favero et al. (2010); Gerlach et al. (2010); Gonzalez-Hermosillo (2008).

[12]Arghyrou and Kontonikas (2012); Beber et al. (2009); Gerlach et al. (2010); Mody (2009).

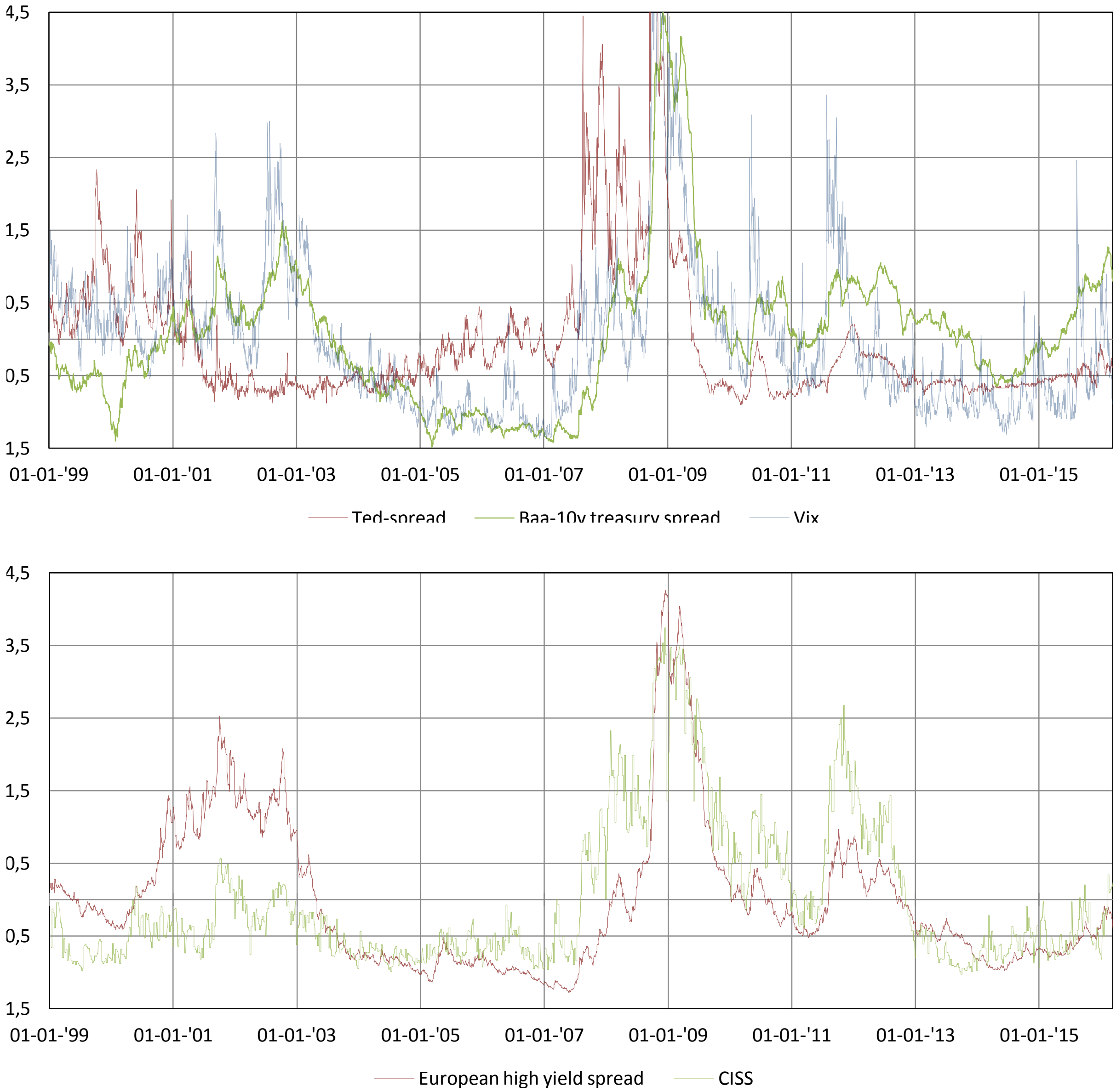
[13]According to Brunnermeier (2009) the Ted-spread picks up the effect of liquidity crises rather than global risk or global risk aversion. Despite this alternative interpretation, it remains useful to classify the Ted-spread as measuring the global risk factor rather than the liquidity premium since it is a time-series common to all countries.

and the Euro crisis is also univocally captured by all five measures. In some respects, however, the Ted-spread significantly diverges (possibly supporting the view of Brunnermeier (2009) in footnote 13) from the other series. For example, the European high yield spread, the Baa-10y treasury spread, the Vix, and to lesser extent also the CISS-index, all indicate a high level of the global risk factor in the period 2001-2003, whereas the Ted-spread tends to the opposite conclusion. Also in 2007 there appear to be substantial differences. While the Ted-spread already shoots up in early 2007 (also the CISS seems to capture this to some extent), the risk factor feeds in the other measures only after, approximately, mid-2007. Similarly, apart from a significant spike in September 2008, the Ted-spread sets course to normalisation much faster than the other series. In addition, the Ted-spread seemed to be much less responsive to the Euro crisis than the other risk measures. The CISS-index, on the contrary, appears to be particularly sensitive to the Euro crisis, which is in line with its geographical focus. Remarkably, despite being based on completely different markets, the European high-yield spread and the Baa-10y treasury spread do not seem to differ much in their appreciation of the Euro crisis. This may be due to a strong interconnectedness or the truly global influence of the Euro zone.

All the previously discussed variables can be credibly used as proxies for the global risk factor since their variation over time is expected to reflect investor's risk aversion. Zoli and Sgherri (2009), in contrast, acknowledge that risk aversion is inherently an unobservable, or: "a "deep" parameter representing the degree to which agents dislike uncertainty" (Zoli and Sgherri, 2009, p. 11). So instead of using time-series such as the corporate spread or the Vix-index that are expected to accurately reflect risk aversion, Zoli and Sgherri impose some assumptions on the data (they assume that spreads are generated by a first-order autoregressive process and an unobservable common factor, and the error terms are modelled as resulting from a GARCH(1,1) mechanism) that enable them to retrieve investor's risk aversion as the unobservable common factor.

Research often finds significant evidence in favour of the importance of the international risk factor in explaining spreads (Barrios et al., 2009; Codogno et al., 2003; Attinasi et al., 2009; Bernoth and Erdogan, 2012; Geyer et al., 2004; Longstaff et al., 2007). Additionally, the risk factor also often appears in interaction effects (Barrios et al., 2009; Codogno et al., 2003; Favero et al., 2010; Haugh et al., 2009).

Figure 2: Evolution of different measures for the global risk factor (normalized)



Notes: the Ted-spread is the spread between the LIBOR-rate (unsecured lending) and short term U.S. government bonds, see also footnote 13. The Baa-10y-treasury spread is calculated by Moody's as the spread between the Baa-rated corporate bond yield versus the yield on 10-year treasury bonds. The European high-yield (below investment grade) spread is provided by BofA Merrill Lynch (code: BAMLHE00EHYIOAS). The CISS-index is the composite indicator for systemic stress applied to Euro area data (see also: Holló et al., 2012). Vix is the CBOE volatility index. All values are normalized using the sample mean and standard deviation of daily observations between December 29, 1997 and March 11, 2016.
Sources: Fred (Ted-spread, European high-yield spread,Baa-10y treasury spread and Vix) and Statistical Data Warehouse (CISS-index).

3 Explaining interest rate spreads: a role for the NIIP?

In the previous section, the traditional explanations for interest rate differentials offered by the existing literature were introduced. In this section, the scope for including the NIIP as explanatory variable for interest rate spreads is investigated. First, it is discussed how the Euro crisis proved to be a kick-starter for linking spreads to the NIIP. Next, theoretical reasoning will support the idea of using the NIIP to explain interest rate spreads. The previous section already indicated that such arguments should relate to credit risk, liquidity risk or the global risk factor.

3.1 The NIIP explaining interest rate spreads: the European primer

Interest in the relationship between the NIIP and interest rate spreads increased significantly during and after the Euro crisis (or sovereign debt crisis). A detailed account of the sovereign debt crisis can be found, for example, in Naert et al. (2014), Peersman and Schoors (2012) or Pilbeam (2013). Recently, Baldwin et al. (2015) took initiative to compile a concise consensus narrative of the Euro crisis. Central in virtually every account of the crisis are the European interest rate spreads.

Attempts to understand the heterogeneity in the behaviour of various countries' spreads have led some researchers and observers to include the NIIP of the respective countries in the discussion. Although formal empirical evidence or a comprehensive theoretical overview are often absent, Naert et al. (2014), Gros (2011), and European Commission (2012), among others, argue that there exists a negative relationship between the NIIP and the interest rate or interest rate spread. So, apparently, the Euro crisis has been an important motivation for considering the relationship between the NIIP and interest rate spreads.

Although the Euro crisis is often referred to as a sovereign debt crisis or a fiscal crisis, it can also be characterized as a sudden-stop crisis (Baldwin et al., 2015; Merler and Pisani-Ferry, 2012; Schmitt-Grohé and Uribe, 2014; Obstfeld, 2012a). This characterisation relies on the fact that, before the crisis, some peripheral countries crucially depended on capital inflows to finance their current account deficits. Baldwin et al. (2015), for example, argue that European imbalances, and more specifcally, the large capital flows from Germany, France, and the Netherlands to Ireland, Portugal, Spain, and Greece are a *prime* cause of the Euro crisis.

One important driver for these capital inflows in peripheral countries was the sharp decrease of interest rates in those countries (Naert et al., 2014). As discussed in paragraph 2.1, the UIP, given by equation (8), can explain this narrowing of interest rates in the run-up and after the creation of the monetary union. The observed decrease in interest rates in peripheral countries resulted in a spending boom financed with foreign capital that had become a lot cheaper to attract. As argued in Baldwin et al. (2015), these capital inflows, reflected in negative and decreasing NIIPs, were not directed into productive investments that would enable the receiving countries to run surpluses on future current accounts as required by equation (7). Instead, capital inflows were directed into the housing sector and into private and government consumption. As a result, wages and costs were driven up which led to a deteriorating competitiveness. This further inhibited the possibility for those countries to generate future current account surpluses and may have provided an additional argument for investors to conclude that equality in equation (7) was no longer guaranteed. Possibly, the NIIP of some European economies was perceived to be unsustainable.

From this perspective, equation (7) may be the key to explain the behaviour of interest rate spreads across countries in the monetary union. The traditional view that spreads can be explained mostly by fiscal variables and economic growth performs quite well in empirical research (see section 2.2 for more details). Nevertheless, as addressed by Gros (2011), the Euro crisis features some puzzling results in this respect: Ireland, Spain, and Cyprus entered the Euro crisis with very low levels of gross government debt (respectively 34%, 36%, and 46% of their gdp in 2008), and yet their spreads increased enormously. As alluded to previously, this may have been a reaction of investors to the, in the light of equation (7), worrisome, evolution of the NIIPs of those countries. Belgium, in contrast, entered the Euro crisis with a much higher gross government debt (90% of gdp in 2008) but the increases in its interest rate spread did not come close to those of the peripheral countries, and the most severe spread increases in Belgium possibly resulted from a longlasting political crisis. Again, the NIIP may be a crucial part of the explanation. A discussion of a comparable puzzle in Bernoth et al. (2004) indicates that the possible importance of the NIIP might have been at play already in the early 2000s.

This contrasts the view of persistent current account deficits as a "physiological effect of the catching up process" (Giavazzi and Spaventa, 2010, p. 4). That view is very much represented in, among others, European Commission (2008) and in Blanchard and Giavazzi (2002). The latter study presents a formal model that supports the view that current account deficits and net foreign liabilities are inherently related to monetary union membership for lower income countries. Justification is provided by different arguments.[14] First, the integration of product markets through the Single Market Programme (SMP) has increased the price elasticity of foreign demand for domestically produced goods. As a result, so the reasoning goes, a lower fall in the price of domestic goods is required to generate the necessary future current account surpluses to offset the current deficits. This boils down to borrowing becoming less costly (a

[14]Arguments in addition to those presented here can be found in Blanchard and Giavazzi (2002).

lower fall in domestic prices is needed to offset, at some time in the future, today's current account deficit) and investing becoming more profitable as future goods can, for the very same reason of increased price elasticity of foreign demand, be sold at not-too-low prices. A second argument that justifies deterioration of the NIIP for lower income countries in the wake of monetary unification is given by financial integration and the benefits of the monetary union. In the model discussed by Blanchard and Giavazzi (2002), both factors result in a reduction of the premium that a borrower must pay on top of the world interest rate to borrow. That reduction of the "borrowing wedge" resulted in the first place from the elimination of exchange rate risk, but is also related to a decreased expropriation risk, elimination of capital controls and harmonized reporting requirements for firms. The lower premium results in higher investment. Thirdly, the expected increase in total factor productivity increases growth expectations for poorer countries, and within the model, this reduces domestic savings. All three arguments support the build up of current account deficits.

The model is however challenged by Giavazzi and Spaventa (2010). They conclude, with hindsight, that the model by Blanchard and Giavazzi (2002) diverges significantly from the past experience because the latter model disregards the possibility that capital inflows can be directed into the production of non-traded goods. Allowing for that possibility, it is formally shown that external sustainability, defined as the fulfilment of the external budget constraint, requires that foreign capital is used for the production of non-traded goods only to a moderate extent. Considering that housing and government services qualify as non-traded goods, Giavazzi and Spaventa support the previously discussed view of, among others, Baldwin et al. (2015).

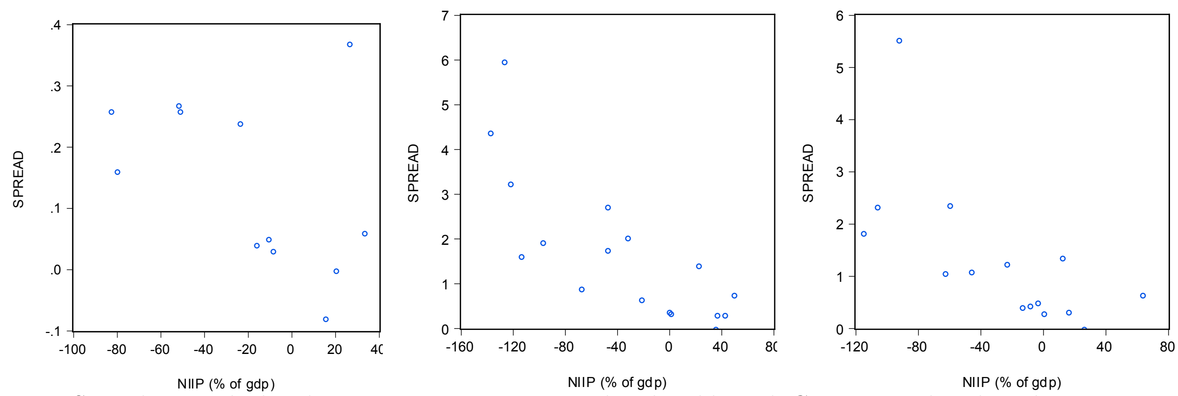
The viewpoints of, for example, Baldwin et al. (2015) and Giavazzi and Spaventa (2010) are represented in the new Macroeconomic Imbalance Procedure (MIP), part of the Six-Pack proposed by the European Commission and implemented in 2011. Together with other agreements and treaties (see Naert et al. (2014) for a review), the Six-Pack envisaged improving the economic governance of the EU. The MIP in particular is designed to detect and resolve external imbalances. In practice, macroeconomic imbalances are signalled to the Commission through the MIP-scoreboard, complemented by, if need be, in-depth reviews. The scoreboard monitors a varied set of macroeconomic variables that, when they exceed a predetermined threshold, are assumed to reflect potential imbalances. In the light of the previous discussion, it is not surprising that the NIIP and the current account are, together with other variables related to the external sector, closely watched. More precisely, a negative NIIP exceeding 35% of gdp in absolute value is considered to require close supervision. To sum up, the history of the monetary union has brought the NIIP to the attention of policymakers and academics. The next section will focus on the theoretical foundations of a relationship between the NIIP and interest rate spreads.

3.2 Baseline relationship

The review of the literature on the modelling of (European) spreads already indicated that the possible role of the NIIP as explanatory variable for yield spreads has not yet been considered, and this in spite of the previously discussed increased attention for the NIIP in post-crisis Europe. Sometimes, for example in Giavazzi and Spaventa (2010), European Commission (2012), Naert et al. (2014), or, more broadly, in Rose (2010), the existence of a link between the NIIP en sovereign spreads is explicitly suggested. Figure 3 supports those conjectures. The underlying mechanisms are however often left unaddressed. If there exists a link between the NIIP and sovereign spreads, it should go via either credit risk, liquidity risk, or the global risk factor. This section will sketch the different possible sources that may generate such a relation.

Figure 3: NIIP and sovereign spreads

(a) 2007Q1 **(b)** 2010Q2 **(c)** 2014Q2



Notes: Spreads are calculated using 10-year government bond yields with Germany as benchmark.
Sources: Eurostat, series irt_lt_mcby_q *and* bop_gdp6_q.

3.2.1 Liquidity and the global risk factor

First, since it is very improbable that the NIIP independently affects the depth or breadth of a sovereign's bond market, the liquidity channel can already be eliminated. Second, for a particular country's NIIP to feed into the global risk factor, which is determined by investors' risk appetite and the amount of risk in the economy, it must, first, be able to create risks or instability (or more unlikely, complacency), and second, those generated risks or instability must be severe enough to affect the amount of risk or risk aversion at the global level. The latter may, at first sight, suggest that a relation between the NIIP and the global risk factor is only possible for NIIPs of large countries that can individually affect the risk factor. Contagion effects, however, create the possibility that a small country's NIIP feeds into the global factor by threatening the stability or vulnerability of the small country itself, whereafter contagion to other and larger countries ultimately generates risks large enough to affect the global factor.

So, in the case of such contagion effects, problems in a small and individually insignificant country may spread to other and larger countries and eventually create risks that are very significant even at the European level. Recalling the close connection between the US-based global risk factor and the EU-based factor displayed in figure 2, we may conclude that large European risks, such as the Euro crisis, can significantly affect the global risk factor. As a result, unsustainable NIIPs may feed into the risk premium via the global risk factor, depending on the presence and severity of contagion.

The presence of contagion effects during the Euro crisis is supported by De Grauwe (2012), Merler and Pisani-Ferry (2012), Naert et al. (2014), and Baldwin et al. (2015). More rigorous analysis by Arghyrou and Kontonikas (2012) empirically confirms contagion from Greece to, in particular, Portugal, Spain and Ireland. Their methodology is however criticized by De Santis (2012) who, in line with Gande and Parsley (2005), and Candelon et al. (2011), investigates contagion in the advent of a change in the credit rating. He reports that Ireland, Portugal, Italy, Spain, Belgium, and France are particularly subject to contagion effects from Greece. Their more general conclusion is that countries with weaker fundamentals are more intensely exposed to contagion.

This relation however relates the NIIP of one country to the spreads of other countries, and, in addition, the individual effect depends on the responsiveness to contagion of those other countries, which have been shown to be heterogeneous (Arghyrou and Kontonikas, 2012; Candelon et al., 2011). In anticipation of the complexity of this relationship, the ambition to quantify it econometrically is abandoned. The next paragraphs will entirely focus on the credit premium as supporting channel for the investigated relationship.

3.2.2 Vulnerability and fragility

Frequently addressed in the literature on international investment positions is its role in the vulnerability or fragility of the domestic economy. If a negative NIIP corresponds with increased vulnerability, it may, as a result, increase its sovereign's spreads through a higher credit premium. The European Commission (2015, p. 10) states that "Vulnerabilities persist as the adjustment in external flows has not yet translated into a sizeable reduction in external indebtedness." In what follows, we refer to vulnerabilities and fragilities in the form of external crisis risk, sovereign crisis risk, and financial fragility.

The vulnerability idea is forcefully present in Catão and Milesi-Ferretti (2012). They find that a strongly negative NIIP increases the probability of an external crisis. An NIIP more negative than 50-60% of gdp is found to be a tipping point. As such, the -35% threshold adopted by the European Commission (2011) seems to be quite conservative. Probit-estimations in Catão and Milesi-Ferretti (2012) indicate that a 10% decrease in the NIIP leads to an increase of the probability of an external crisis by 0,6%. This link between the NIIP and external crisis risk provides a strong link with yield spreads since external crises usually depress economic growth and hence weigh on the budgetary balance. Additionally, Catão and Milesi-Ferretti also document that a lower current account and a higher real effective exchange rate increases external crisis risk as well. Unsurprisingly, those variables are also part of the MIP scoreboard (European Commission, 2011). Another conclusion in Catão and Milesi-Ferretti (2012) is that government debt has no direct effect on external crisis risk.

Further evidence for the vulnerability channel is given by Manasse and Roubini (2009). Based on a sample of sovereign debt crises between 1970 and 2002 they conclude that external debt is strongly related to a higher probability of sovereign debt crises. A drawback to this study is the absence of the European sovereign debt crisis in the sample. Catão and Milesi-Ferretti (2012) show for their study that the determinants for *external* crisis risk have remained largely unchanged after 2007, but Manasse and Roubini (2009) do not provide similar evidence for sovereign debt crises. Furthermore, Manasse and Roubini only consider external debt. As such they leave a significant part of the NIIP –the entire asset side and external equity liabilities– out of the picture. Related to the focus on external debt in Manasse and Roubini (2009), Aizenman et al. (2013) use external liabilities as explanatory variable for CDS-spreads. They conclude that during the crisis fiscal variables lost a significant part of their explanatory power, whereas external debt gained explanatory power.

Additionally, the literature often pays specific attention to the possible negative economic effects of gross positions.[15] If large gross positions are considered as dangerous, this would create a positive relationship between large gross positions and spreads via the credit risk premium. Obstfeld (2012a), for example, suggests that gross positions are of greater importance than net positions and that risks for financial instability mainly result from such gross positions. He doubts that the possible financial threats stemming from one individual's large liability position are neutralized by another individual's large asset position. Such a neutralization would require that the asset position of the latter can serve to finance the liability position of the former in the case that foreigners refuse to roll-over those liabilities. (Obstfeld, 2012a, p. 18) summarizes the argument as follows: "A focus on net positions does not recognize that my fellow citizens' assets are not available to pay off my debts." He concludes that the risk on financial instability, or balance-sheet crises, does not depend on the net position, but rather on the gross position.

[15] Gross positions can also be desirable. Lane and Milesi-Ferretti (2001), for instance, show that, controlling for all relevant variables, more open countries tend to hold larger gross positions. This may support the premise that open economies may use gross asset positions for income smoothing to mitigate their higher volatility. The idea is already discussed in paragraph 1.2. The apparent failure to smooth consumption using gross asset positions, empirically documented by Lane (2000), does not eliminate the intention.

Obstfeld's argument leaves room for an extension. The threat to financial stability that emerges form large liability positions results from maturity and liquidity transformation and the vulnerability of domestic balance sheets to runs on the external liabilities. Not engaging in maturity and liquidity transformation does, however, not eliminate the financial fragility. Consider the situation in which the assets are sufficiently liquid or of short maturity. In this case, a run on the external liabilities of a domestic agent can be accommodated by selling liquid assets or not rolling over credit that matures. Following the Obstfeld argument, one may conclude that no financial risks emerge from large liability positions since there is no maturity or liquidity transformation.

This conclusion may be incomplete. Assume that, in line with Obstfeld's argument, external assets do not occur on the same balance sheets as external liabilities. In this case, external liabilities are used to finance domestic assets. Now suppose that foreign investors suddenly refuse to roll-over the external liabilities on the domestic balance sheets. In Obstfeld's reasoning this would not create a balance-sheet crisis since we assumed assets to be sufficiently liquid. Extending Obstfeld's argument, we can conclude that in the described situation financial fragility may still emerge, despite the sufficient liquidity of the external assets. This conclusion follows from the fact that the foreigner's unwillingness to roll-over external financing will be accommodated by selling assets, and since all assets were assumed to be domestic, this sell-off of domestic assets can disrupt domestic asset markets or generate a domestic credit crunch, which may eventually result in financial fragility throughout the domestic economy. This source of fragility disappears when external liabilities are used to finance liquid external assets. As a result, Obstfeld's argument more accurately becomes: gross liability positions can create risks for financial stability when domestic balance sheets engage in liquidity and maturity transformation, or, in the absence of such a liquidity mismatch, fragility can still emerge when the external liabilities are used to finance (liquid) domestic assets.

Figure 4 presents additional clarification. It is a representation of a representative domestic agent's balance sheet. It shows that any balance sheet can consist of both domestic and foreign assets and liabilities.[16] In addition, figure 4 explicitly shows that assets can be either liquid or illiquid. The refusal of foreign creditors to roll-over their credit to the representative domestic agent is shown by three downward pointing arrows. Assume that domestic credit is not available in a sufficient amount to replace the foreign financing. In this case, selling the liquid assets (↓↓) is insufficient to accommodate the loss in external financing (↓↓↓). This is Obstfeld's balance sheet crisis that creates financial fragility. The extended argument states that even if there

[16] This is a credible extension of the balance sheets in Obstfeld (2012b), where it is assumed that external assets and external liabilities occur on the balance sheets of different agents. This extension is necessary to accurately reflect the balance sheets of internationally active financial institutions, multinational corporations, or investors overcoming the home bias in their portfolio's.

are enough domestic liquid assets (and no foreign assets), the sudden sell-off of liquid domestic assets (↓↓↓ instead of ↓) can cause financial fragility by disrupting the asset markets in question.

Figure 4: A representative agent's balance sheet

Assets		Liabilities	
↓ or -	Liquid external assets	External liabilities	↓↓↓
	Illiquid external assets	Domestic liabilities	
↓ or ↓↓↓	Liquid domestic assets		
	Illiquid domestic assets		

Insofar as figure 4 is a credible representative balance sheet, the NIIP (rather than gross positions) may indeed provide information on financial fragility. This to the extent that a negative NIIP signals that external liabilities are used to finance domestic assets rather than external assets. As our extension of Obstfeld's argument states, such a situation may suggest possible disruptions in domestic financial markets or a credit crunch in the advent of the inability to roll-over external liabilities, because a run on external liabilities would urge the representative agents to sell their liquid domestic assets. Those sales can disrupt the domestic asset markets or may lead to decreased extension of credit.

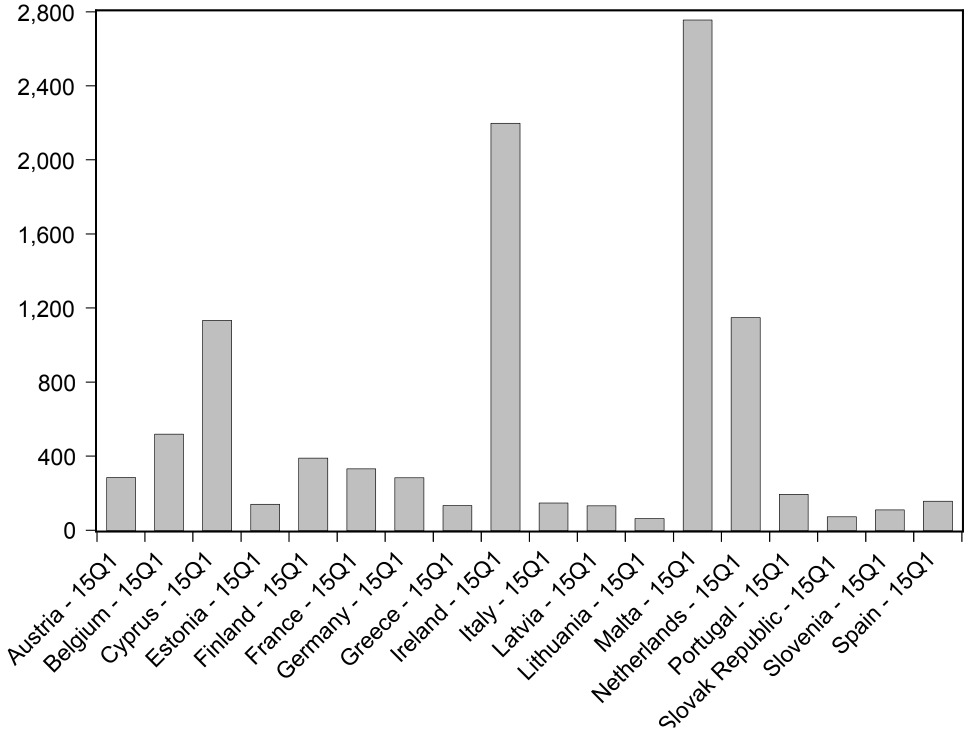
3.2.3 The taxation argument

Gros (2011) provides a link that directly relates the NIIP to the intertemporal government budget constraint (see equation (9) in paragraph 2.2.1) via taxation. According to Gros (2011) a government's tax autonomy is crucial. He argues that domestically held government debt can be taxed whereas this is not the case for foreign owned government debt. Therefore, external government debt is an intenser threat for government solvency than domestic government debt. This argument, which is only valid for the public part of the (liability side of) the NIIP, can be extended to provide a link between the *overall* NIIP and government solvency. When the private sector owns many external assets, the government can tax the privately held external assets to service its debt. Weakening the extreme character of this argument, we can, more plausibly, argue that the NIIP can be related to government solvency through its potential role as tax base. Gros asserts that a positive NIIP can provide an extension of the domestic tax base so that it can generate government revenues which contribute to present or future primary surpluses.

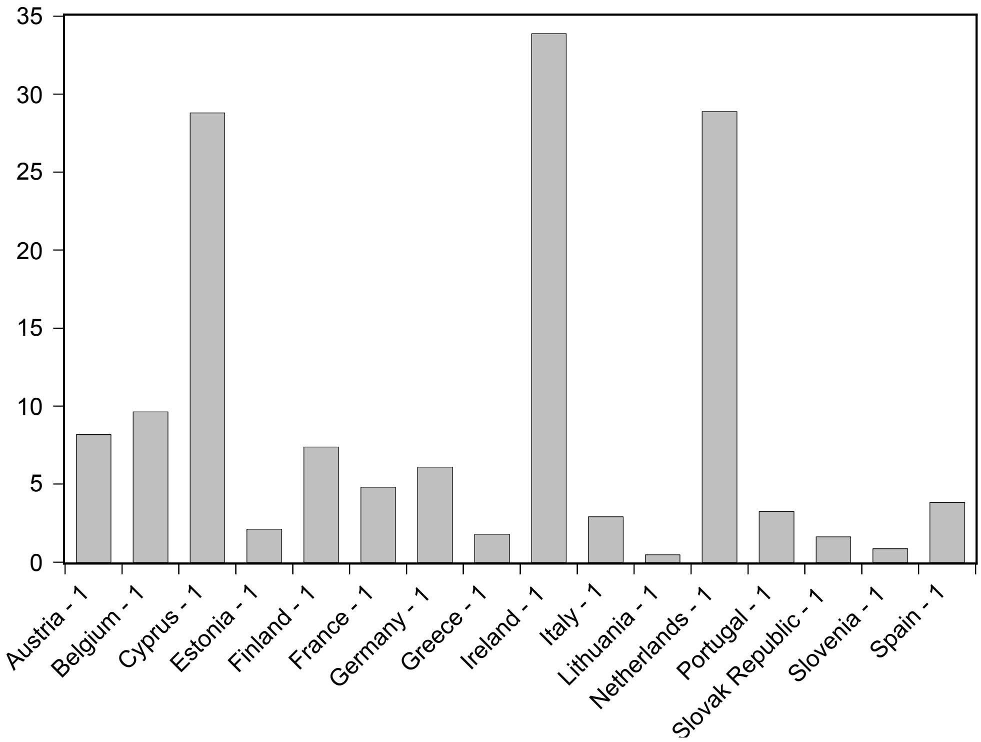
A critical remark, that is not recognized in Gros (2011), is that the tax base argument may relate gross external assets, rather than the NIIP, to government solvency. Indeed, since external liabilities are in fact domestic assets owned by foreign residents, the domestic government is bounded by treaties and international norms (Gros, 2011) to tax them.

Figure 5: The scope for the taxation argument

(a) External assets in % of gdp in 2015Q1



(b) Received investment income in % of gdp in 2015Q1



Source: IMF BoP statistics

A numerical example can provide insight in the scope of this taxation argument. Figure 5a shows that France, for example, has more or less an average amount of external assets expressed as percentage of gdp. If the French government were to decide to levy a tax of 1% on all external assets owned by its residents, it would immediately be able to reduce the outstanding amount debt by approximately 4% of gdp. In addition, figure 5b shows that, for some countries, investment income stemming from external assets amounts to a significant share of gdp. For those countries, a (supplementary) tax on external investment income can therefore generate substantial government revenues as well.

3.2.4 Integrating the government, the private sector and the foreign sector

A well known macro-economic identity may provide still another link between the NIIP and government spreads. Consider the identity $(S_t - I_t) = (G_t - T_t) + (X_t - M_t)$. The interpretation is very familiar. If one or two sectors of the private sector, the government sector or the external sector save(s), than this must be compensated by dissaving by the remaining sector(s). Or, put differently, neither sector can save when those savings are not drawn upon by the aggregate of the other sectors. For convenience and in line with this interpretation, this identity will henceforth be referred to as the SDS-identity, the "savings-dissavings-identity". As shown in Appendix B, we can derive a present value equivalent which is given by equation (10) and will be referred to as the PVSDS-identity, the "present-value-SDS". P_0 is private sector net liabilities, the negative of C_0, private sector net assets, and B_0 is government debt.

$$P_0 = -B_0 - NIIP_0 \Longleftrightarrow C_0 = B_0 + NIIP_0 \Longleftrightarrow \; NIIP_0 = C_0 - B_0 \tag{10}$$

The PVSDS makes clear that, for a given and solvent B_0 (regardless of the size of the government debt, the government commits to run the necessary primary surpluses to qualify as solvent) a more negative $NIIP_0$ must correspond with higher private indebtedness. Using the reasoning of private sector solvency discussed in Appendix B, this implies that the private sector must, in the future, save more and invest less to be solvent. Put differently, the private sector in the net debtor country will not be able to consume and invest as much in the future as the private sector in the creditor country. In such a scenario, the government of the debtor country may find it difficult to commit to the necessary primary surpluses. For the creditor country, in contrast, we can argue that its external reserves provide a source for private spending and investment in the future. Therefore, a positive NIIP may be considered as a source for economic growth.

The observation that a more negative $NIIP_0$ corresponds with higher private indebtedness takes us back to footnote 6 and the suggestion in Barrios et al. (2009), discussed in section 2.2.1. There, it was already mentioned that, certainly in times of increased risk aversion, the distinction between private and public debt may become increasingly unclear as the government may have to (or at least be expected to) take over some of the private debt. A strongly negative NIIP then signals that there is a lot of private debt that can be bailed-out.

One might argue that the PVSDS also states that the creditor countries will be willing to spend. This follows from the fact that the positive NIIP of the creditor country corresponds with future current account deficits. Or equivalently, in the future, the creditor country will draw on its net external reserves to finance an excess of consumption over its own production, or to finance an excess of investment over savings. This may enable the debtor to run surpluses on its current account so that the private or government sector will be able to run the necessary surpluses to redeem their debts. Nothing, however, requires the creditors to spend their savings in the debtor country. So, in order for the debtor country to be solvent, it must ensure a sufficient level of competitiveness vis-à-vis the creditor, so that it can attract the latter's spending.

Within a monetary union there are only two ways to generate the described rebalancing. The creditor country can inflate and reduce its competitiveness and/or the debtor country can deflate and increase its competitiveness. In the case of the Euro zone, the creditor countries, and most notably Germany, refuse to inflate, so that all responsibility for rebalancing is put on the shoulders of the periphery (Bonatti and Fracasso, 2013; Wihlborg et al., 2010). The internal devaluation that the periphery requires to rebalance will typically be generated by a compression of domestic demand and an economic recession,[17] and will almost certainly weigh on the public balance. Hence, in line with the literature review on yield spreads, investors may demand a higher credit premium for countries with a more negative NIIP, since those countries will need to go through a longer or intenser period of internal devaluation. This mechanism is not captured by the SDS-identity since that identity only relates the size of the savings and dissavings of the government, the private sector and the foreign sector to each other, without using any information on the level or growth of the gdp. And it is precisely the unfavourable effect of the internal devaluation on gdp that links the NIIP to sovereign spreads.

[17] To see that internal devaluation is generally painful, consider the following model. X and M denote exports and imports, π is inflation and $0 < u < 1$ is the unemployment rate. Subsript f indicates foreign variables. Let $X = Y_f(\pi_f - \pi)$ and $M = Y(\pi - \pi_f)$. Consider a production function (both for the domestic and the foreign economy) linear in $1-u$: $Y = \delta(1-u)$. Let the Phillips-curve be given by: $\pi = \alpha - \beta u$. In this specification, we can write:

$$X - M = 2\delta\beta(u - u_f) + \delta\beta(u_f^2 - u^2)$$

The effect of unemployment on net exports can be calculated as the partial derivative: $\frac{\partial(X-M)}{\partial u} = 2\delta\beta\,(1-u) > 0$, that is, net exports are an increasing function of the unemployment rate. The severity of the recession that is needed for debtor countries to attract the spending of the creditor countries depends negatively on the parameter δ from the production function and the steepness of the Phillips curve, β.

3.2.5 Composition of the NIIP and spreads

Also the composition of the NIIP may have an effect on spreads. As such, focussing on a specific part of the NIIP, as in Manasse and Roubini (2009), is not necessarily unlogic. Indeed, Lane and Milesi-Ferretti (2000) assert that different types of capital flows have significantly different properties. Direct investment liabilities, for example, have some widely documented and very beneficial economic properties (Braconier et al., 1999; Coe and Helpman, 1995; Rayp and Cuyvers, 2014). In addition, the European Commission (2012) argues that FDI-stocks are inherently more stable than other components of the NIIP and (see also Hobza and Zeugner, 2014) that equity liabilities in general are more desirable than debt liabilities since the dividend payments on equity can shrink in the case of an adverse economic shock, whereas the debt servicing cost remains constant over the business cycle. Similarly, Lane and Milesi-Ferretti (2000) refer to the more favourable risk sharing properties of equity versus debt: in the face of a negative domestic shock, equity liabilities will export part of the shock to the foreign investor. Catão and Milesi-Ferretti (2012) show that the net equity position (equity assets minus equity liabilities) has no effect on external crisis risk whereas the net debt position is highly significant. Possibly, the authors argue, the insignificance of the net equity position is due to an opposite effect of the equity positions in the FDI component on external crisis risk versus the effect of equity positions in portfolio investment. One may conclude that the effect of net FDI and net equity positions on yield spreads through the vulnerability channel is a priori unclear, whereas a more negative net debt position can be expected to increase crisis risk.

From the discussion in Obstfeld (2012a) it seems that Obstfeld as well, though implicitly, supports the importance of the composition of the NIIP, or more precisely, the composition of liabilities, in the relation to spreads. Since he explicitly focusses on financial troubles stemming from the inability to roll-over liabilities, he implicitly supports the view that debt liabilities pose a greater threat to financial stability than equity liabilities, as the latter do not need to be rolled-over at maturity.

4 Empirical investigation

4.1 Where are we? What lies ahead?

In the previous sections we explained what the NIIP is, how the European spreads can be explained an why the NIIP may be an important part of such explanations. In this section, we will empirically investigate the relationship between the NIIP and spreads in the Euro zone.

A variety of arguments in the previous section supports a negative relationship between the NIIP and spread. This will be the most important hypothesis to be tested in this section. In addition, the taxation argument introduces the possibility that external assets have a different impact on spreads than external liabilities. Finally, some arguments lead to the expectation that direct investment assets (liabilities) may have a more positive (less negative) effect on spreads than other components of the NIIP. In addition, the relation between equity positions and spreads may differ from the relation between debt positions and spreads. However, anticipating the empirical investigations, it should be noted that data availability impedes the testing of the latter hypothesis. The most important hypothesis that will be tested is whether or not there is a negative relationship between the NIIP and spreads.

First, in section 4.4, we will use a fixed effects model to investigate some basic relationships. Interaction effects will play an important role. Next (in section 4.5), some important problems that may invalidate the results of the fixed effects estimation are discussed. More specifically, we will deal with, nonstationarity, cointegration, and a possible break in the time-series dimension of our sample. Appendix F challenges some conclusions from the fixed effects framework. It explores the added value of the reasonably new common correlated effects pooled (CCEP) estimator for empirical yield spread models. But first, let us describe the model and data that will be used.

4.2 Guidance from the literature

The literature review of yield spreads already discussed which variables should be used when explaining interest rate spreads. We use a baseline model (fixed effects estimation) that is very close to the model used in Haugh et al. (2009). For the choice of which explanatory variables to include, we will heavily draw on the literature review on yield spreads. Obviously, fiscal variables are of crucial importance. We include government debt and the primary balance, but also debt service defined as the ratio of interest payments to government revenues (Barrios et al., 2009) is included. Additionally, two external variables are included: net exports and the real effective exchange rate (using 42 trading partners and the consumer price index as deflator).

Also in line with the literature review, growth and the risk factor, measured by the US and European high yield spreads and the CISS index are included. The use of three risk measures can act as a robustness check and, since existing studies only rarely use the CISS-index, our results will provide evidence supporting or rejecting the validity of the CISS index as a good proxy for global risk environment.

Maltritz (2012) concludes that the majority of the literature on EMU yield spreads chooses to express the explanatory variables relative to Germany. Appendix C discusses how this convention provides a scope for increasing the amount of information retrieved from financial markets. Maltritz explains that such differencing is in line with the expectation that not even Germany is entirely free of default risk. If, on the other hand, one is prepared to assume that the benchmark country is completely risk free, so that its bond yields correctly reflect the risk free rate, the suggested differencing is incorrect (this specification is used in Goedl and Kleinert, 2013; Mody, 2009). In line with the majority of the literature, our explanatory variables will also be expressed relative to Germany. With respect to the real effective exchange rate, this differencing may not be an intuitive choice. The real effective exchange rate is already a relative variable, i.e. it measures a country's price competitiveness relative to its major trading partners. Therefore, differencing with respect to Germany may be useless or wrong. In Mody (2009) the real effective exchange rate is used as a categorical variable (large or moderate appreciation/depreciation over the period from January 2003 until July 2008). De Santis (2012) and Dötz and Fischer (2010) do not seem to worry about the problem of expressing the, already relative, real effective exchange rate relative to Germany. Our results will tend to favour the relative real effective exchange rate specification, but we will not lose the alternative out of sight.

A measure for liquidity is not incorporated. The literature review already indicated that the liquidity premium tends to be small. To the extent that a sovereign's bond market's liquidity is time-invariant, the liquidity premium will be picked up by the country specific fixed effects. In addition, to the extent that the size of the liquidity premium depends on the global risk environment (Beber et al., 2009), its impact on spreads may be captured by the risk factor. Finally, as pointed out by Codogno et al. (2003), the liquidity premium is related to the short run (high frequency) market environment, rather than to the slow moving variables included in our estimations. The correlation between the liquidity premium and the included variables can therefore be expected to be low (or even absent), which avoids an omitted variable bias in our estimations.

In line with Haugh et al. (2009), the baseline empirical model incorporates interactions between all explanatory variables and the global risk factor ($x_{it}f_t$-interactions). Using these interactions, we will develop a comprehensible and innovative framework to analyse flights-to-quality. Next, we will depart somewhat more from the traditional framework by showing that a second kind of interactions, interactions between explanatory variables ($x_{it}^m x_{it}^n$-interactions) are of great importance in explaining yield spreads. In contrast to most of the yield spread literature, these interactions will be analysed more intensively. Finally, the importance of the composition of the NIIP on yield spreads will be briefly discussed. The most important conclusions are briefly summarized in section 4.4.7. But first, the dataset is introduced.

4.3 The data

Table 1 gives an overview of the datasources. Most data is retrieved from the Eurostat database and all variables are sampled at quarterly frequency. The dataset contains (unbalanced) panel data ranging from 1999Q1 until 2015Q3. All country-time observations that do not correspond with EMU-membership are eliminated. In addition, missing observations significantly reduce the number of observations. Most notably, the availability of NIIP-data is a major constraint. Table 2 gives an overview of the available NIIP-data. In order to minimize the loss of observations due to lacking NIIP-data, the Eurostat data is complemented with the IMF International Financial Statistics data. For Estonia, there is no long term government interest rate available. Therefore, along with Germany, it will not be included in estimations where the spread is the dependent variable.

In all of the following sections, suffix "3" will be added to all variables when they enter the regressions expressed relative to Germany. In the main text, this notation will not be generally adopted.

Table 1: Description of the data

Name	Description[1]
Spread	A country's 10 year government bond yield versus the 10 year German bond yield.
NIIP	Net international investment position at end of period (% of gdp)
DEBT	General government consolidated gross debt (% of gdp)
NX	Net exports = $\frac{Exports\ of\ goods\ and\ services - Imports\ of\ goods\ and\ services}{GDP^2}$ (% of gdp)
PB	Primary balance = net lending/net borrowing + interest payable (% of gdp)
REER	Real effective exchange rate, 42 trading partners, CPI deflator (index: 2005=100)
GROWTH	Quarterly growth rate based on Eurostat's gdp at market prices, current prices
DS	Debt service = $\frac{general\ government\ interest\ payable}{totalrevenues}$ (% of gdp)
BAA	US high yield spread, Baa-rated corporate yield vs. 10y treasury yield (Moody's)
EU high	EU high yield spread, below investment grade vs. risk free rate (BofA Merill Lynch)
CISS	Composite indicator for systemic stress applied to Euro area data (SDW)

[1] Variables for which no alternative data source is indicated are retrieved from Eurostat.
[2] gdp at market prices, current prices, Eurostat.

Table 2: Detail information on NIIP data

Country	IMF start	Eurostat start	End	EMU accession
Austria	2005Q1	1999Q1	2015Q3	1999
Belgium	2005Q1		2015Q2	1999
Cyprus	2008Q1		2015Q3	2008
Estonia	2008Q1		2015Q3	2011
Finland	1999Q1	2008Q1	2015Q2	1999
France	1999Q2		2015Q3	1999
Germany	2004Q1		2015Q3	1999
Greece	2004Q1		2015Q3	2001
Ireland	2011Q1	2002Q2	2015Q3	1999
Italy	2004Q1		2015Q3	1999
Latvia	-	2000Q1	2015Q3	2014
Lithuania	2004Q1		2015Q3	2015
Luxembourg	2002Q4		2015Q3	1999
Malta	2006Q1		2015Q4	2008
Netherlands	2003Q2		2015Q3	1999
Portugal	1999Q1		2015Q3	1999
Slovakia	2004Q1		2015Q3	2009
Slovenia	2008Q1		2015Q3	2007
Spain	1999Q4	2012Q4	2015Q3	1999

4.4 Fixed effects estimation

4.4.1 The first model

As discussed, our baseline econometric model is very much in line with Haugh et al. (2009). It consists of a fixed effects estimation (the Hausman test strongly rejects the consistency of the random effects estimator) and includes interactions between all explanatory variables and the risk factor ($x_{it}f_t$-interactions). Given their more or less non-standard nature, the $x^m_{it}x^n_{it}$-interactions are not yet included. Apart from the real effective exchange rate, all variables are expressed relative to Germany. Since it is unclear how the real effective exchange rate should enter the model (relative to Germany or not), each specification is estimated once for REER and once for REER3. The estimations reported in table 3 correspond to estimations based on equation (11):

$$\sigma_{it} = \sum_{k=0}^{N} \beta^k x^k_{it} + \sum_{k=0}^{N} \gamma^k x^k_{it} f_t + \gamma' f_t + \phi_i + \mu_{it}. \tag{11}$$

The variable on the left hand side, σ_{it}, is the risk premium calculated vis-à-vis Germany. On the right hand side, there are N explanatory variables with a panel dimension $(x^1_{it}, x^2_{it}, ..., x^N_{it})$. They are allowed to affect the spread directly, but also indirectly, through an interaction with the risk factor f_t. The same holds for the risk factor: it can affect spread directly but also through its interactions with the explanatory variables. The model is estimated with country-specific fixed effects (ϕ_i) that account for unobservable, time-invariant, country-specific variables. The error term is given by μ_{it}.

Table 3: Fixed effects including interactions with the risk factor

Dependent variable: spreads

Risk measure:	Baa	CISS	EU high	Baa	EU high	CISS
C	1.343634	1.428699	1.47291	7.473608	8.516758	8.988708
	(5.0470)***	(5.4998)***	(5.4782)***	(2.2123)**	(2.5148)**	(2.6985)***
NIIP3	0.000957	0.002677	0.000098	-0.00773	-0.00974	-0.00582
	(0.2282)	(0.6345)	(0.0233)	(-1.7628)*	(-2.2048)**	(-1.3128)
DEBT3	0.062629	0.084349	0.075287	0.046204	0.056281	0.068229
	(7.4414)***	(9.9399)***	(8.6203)***	(4.9519)***	(5.8474)***	(7.2437)***
NX3	0.047592	0.042137	0.050286	0.063049	0.065565	0.059358
	(6.8469)***	(6.1999)***	(7.1671)***	(8.7240)***	(8.9292)***	(8.2824)***
PB3	-0.00192	0.009019	0.008364	-0.025	-0.01676	-0.01693
	(-0.1330)	(0.6498)	(0.5733)	(-1.6415)*	(-1.0839)	(-1.1456)
DS3	0.735686	-1.54915	1.095374	5.15248	6.56942	2.238735
	(0.2232)	(-0.5088)	(0.3126)	(1.4746)	(1.7637)*	(0.6833)
GROWTH3	-0.02561	-0.01603	-0.02681	-0.02011	-0.0204	-0.01062
	(-1.9358)*	(-1.2271)	(-2.0066)**	(-1.4209)	(-1.4220)	(-0.7494)
REER3	0.289104	0.295322	0.306711			
	(8.7442)***	(9.4822)***	(9.3386)***			
REER				-0.05431	-0.0636	-0.06823
				(-1.6210)	(-1.8964)*	(-2.0703)**
RISK	0.176759	0.296278	0.220199	1.202937	1.044743	0.442328
	(1.7931)*	(3.0395)***	(2.0706)**	(0.8949)	(0.8312)	(0.4011)
RISK*NIIP3	-0.00774	-0.00621	-0.0063	-0.00708	-0.00593	-0.00589
	(-4.2104)***	(-4.3106)***	(-3.4531)***	(-3.6236)***	(-3.0327)***	(-3.8124)***
RISK*DEBT3	0.013052	0.011701	0.010702	0.009479	0.00633	0.008446
	(3.6272)***	(3.5387)***	(2.6536)***	(2.4488)**	(1.4533)	(2.3247)**
RISK*NX3	0.015213	0.017103	0.014942	0.0131	0.012127	0.014425
	(4.0032)***	(5.0048)***	(3.7211)***	(3.2215)***	(2.8160)***	(3.8673)***
RISK*PB3	0.022351	0.022102	0.028895	0.027302	0.032719	0.024503
	(1.4746)	(1.698)*	(1.8427)*	(1.671)*	(1.9335)*	(1.7343)*
RISK*DS3	2.175817	3.075787	3.213334	5.03937	6.860235	5.708845
	(0.7819)	(1.1396)	(0.9741)	(1.6878)*	(1.9319)*	(1.9586)
RISK*GROWTH3	-0.01507	-0.01129	-0.01605	-0.01643	-0.01512	-0.00823
	(-1.2753)	(-0.9916)	(-1.2726)	(-1.2968)	(-1.1112)	(-0.6659)
RISK*REER3	0.024261	0.030586	0.025587			
	(1.8975)*	(3.0754)***	(2.1789)**			
RISK*REER				-0.00857	-0.00717	-0.00025
				(-0.6441)	(-0.5779)	(-0.0231)
Observations:	576	576	576	576	576	576
R-squared:	0.6535	0.6817	0.648	0.6033	0.5935	0.6254
F-statistic:	34.2635	38.9127	33.4423	27.6317	26.522	30.3358

Panel OLS regressions with cross-sectional fixed effects. T-statistics are reported between parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance respectively.

4.4.2 Interpretation of the direct effects

One can infer from table 3 that most of the estimated coefficients are insensitive to the choice regarding the real effective exchange rate: in all specifications, a higher government debt, more net exports, and lower growth (relative to Germany) are associated with higher spreads. Aside from net exports, these relations are as expected and in line with the existing literature. The estimated coefficient to net exports suggests that more net exports is associated with a higher spread. This conclusion differs from the results reported in Attinasi et al. (2009), Barrios et al. (2009) Dötz and Fischer (2010) Gibson et al. (2012), Maltritz (2012). Unreported estimations rule out the possibility that this result is due to the fairly low spreads for countries with a current account deficit before the crisis. A possible explanation is presented by Maltritz (2012). He argues that, since the current account is a mirror of the financial account, a trade surplus may be the symptom of the inability to borrow from abroad or foreigners withdrawing their money. Another explanation for this strange result emphasizes the import-side of the net export variable. High imports may signal consumer confidence and higher disposable income, whereas low imports may signal deficient domestic demand and confidence. In this case, net exports may indeed be negatively related to spreads. However, we may expect the growth variable to, at least partially, pick up this effect.

It is quite remarkable that the relative real effective exchange rate has a positive and strongly significant effect on the spread, whereas the real effective exchange rate not expressed relative to Germany has a less significant and much smaller negative effect. The latter result indicates that better competitiveness is associated with higher spreads. Much more appealing is the former result, which indicates that better competitiveness (relative to Germany) corresponds to lower spreads. This, however, raises the question as to why expressing the real effective exchange rate (already a relative variable) relative to Germany better reflects investor's differentiation than the "absolute" real effective exchange rate. One rationalization may be that the REER3 picks up the effect of European imbalances. A variety of information criteria (Akaike information criterion, Schwartz bayesian information criterion, the Hannan-Quinn criterion, R^2, F-statistic) all conclude in favour of the model including REER3 rather than REER. We will continuously pay attention to the sensitivity of our results to changing the specification by including REER rather than REER3.

The direct effect of the (relative) NIIP on spreads is unclear. Using the relative real effective exchange rate, we cannot support the existence of a direct effect of the NIIP on the spread. In contrast, the use of REER instead of REER3 does support, in line with sections 3.2.2 and 3.2.4, the existence of a negative relationship. The evidence is unfortunately relatively weak and depends on what variable is used to proxy the risk factor. Taking into account the conclusion that general diagnostics (a variety of information criteria) prefer the REER3 specification above the REER-specification, we cannot conclude that there is a strong and direct relationship between the NIIP and spreads.

4.4.3 The impact of the explanatory variables depends on the risk factor

The interaction effects show that the impact of the explanatory variables on spreads should not be narrowed to the direct relationship quantified by the β^k-coefficients. The interaction effects indicate that the overall impact of the different variables depends on the global risk environment. Or, that the effect of the global risk factor on the spread depends on the economic characteristics of the country in question. The overall effect of any variable on the spread is given by the partial derivative: $\frac{\partial \sigma_{it}}{\partial x_{it}^k} = \beta^k + \gamma^k f_t$. For the NIIP, the direct impact (β^k) is not significantly different from zero, which results in: $\frac{\partial \sigma_{it}}{NIIP_{it}} = \gamma^k f_t$. According to table 3, γ^k has a value of around 0,006 or 0,007.

For an average value of the risk factor (see table 4), an NIIP in % of gdp that is 50 percentage points lower than that of Germany (this corresponds more or less with a zero NIIP) results, on average and ceteris paribus, in an increase of the spread with around 2 base points. Clearly, in tranquil times, the NIIP does not materially contribute to spreads. An increase in the risk factor to two standard deviations above its average value results in a stronger impact of the NIIP-gap with Germany on the spread: a zero NIIP (NIIP-gap of 50%) is now associated with an increase in the spread spread of around 60 to 80 base points. At the height of the Euro crisis, the risk factor easily rose three standard deviations above its average value (see figure 2), which, according to our estimations resulted, on average and ceteris paribus, in an increase of the spread with 100 base points for a zero NIIP.

For the European periphery, with an NIIP-gap vis-à-vis Germany of around 150% (Greece, Cyprus, Ireland, Portugal, and Spain), this meant that three percentage points of their spread with Germany was solely due to their very negative NIIP. One may conclude that although the direct impact of the NIIP on spreads is not significant, its importance in interactions with the risk factor should not be ignored. These conclusions are robust, regardless of which risk measure is included and regardless of whether the real effective exchange rate is expressed relative to Germany or not.

Table 4: Mean and standard deviation of risk measures

	Baa	EU high	CISS
Mean	0.075943	0.001931	0.048789
Std. Dev.	0.978843	1.022041	0.995062

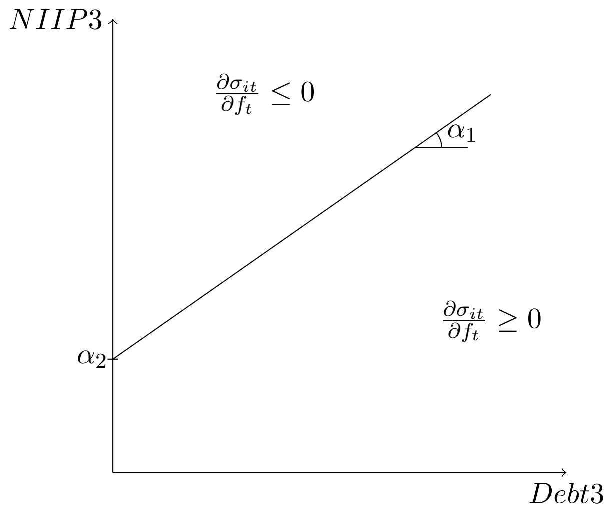
4.4.4 Using interactions with the risk factor to analyze flights-to-quality

It is already emphasized that the $x_{it}f_t$-interactions may be quite important. Note that the impact of the risk environment on spreads is given by the partial derivative $\frac{\partial \sigma_{it}}{\partial f_t} = \gamma' + \sum_{k=0}^{N} \gamma^k x_{it}^k$. The extent to which an increase in the risk factor (more risk aversion, a higher price for risk) affects the sovereign's spread, depends on the values of the different explanatory variables (x_{it}^k). For example, a higher government debt significantly magnifies the increase in spreads that follows from a more unfavourable risk environment. Conversely, a higher NIIP mitigates the spread increases resulting from increases in the risk factor.

The puzzling result of the counterintuitive sign of net exports in both the REER3 and REER specifications, and the counterintuitive sign of REER in the second specification, also emerge in the interaction effects: more net exports (in both specifications) and better competitiveness (when not expressed relative to Germany) are associated with stronger spread increases when the global risk environment worsens. Put differently, net exporters and competitive countries are more intensively shunned by investors when those investors require a higher compensation for taking risk. It is as if, in periods of risk aversion, investors rebalance their portfolios away from competitive countries with strong exports.

The inclusion of the $x_{it}f_t$-interactions allows us to relate our estimation output to the analysis of flights-to-quality. The approach to detect the flight-to-quality phenomenon (discussed in section 2.2.3) from estimations à la equation (11) is new, but very straightforward. If we assume that Germany benefits from such an effect[18] then we know that if another country's spread does *not* increase in the face of increased risk aversion, it must benefit from the same flight-to-quality effect. Indeed, if the country would not benefit from such a flight while Germany does, its spread should increase. According to this reasoning, the flight-to-quality effect can be defined as $\frac{\partial \sigma_{it}}{\partial f_t} \ngtr 0$ (or $\frac{\partial \sigma_{it}}{\partial f_t} \leqslant 0$). Using the information in (the first column of) table 3, we find that when a country's net exports, primary balance, and the real effective exchange rate are equal to those of Germany, that country will benefit from the flight-to-quality effect when $NIIP3_{it} \geq \frac{0.013052}{0.00774} Debt3_{it} + 22.83$. This condition is more generally illustrated in figure 6, where its is given by $NIIP3_{it} \geq \alpha_1 Debt3_{it} + \alpha_2$. The slope α_1 increases as the parameter estimated to the $Debt3{*}f_t$-interaction rises and the parameter to the $NIIP3{*}f_t$-interaction falls (in absolute value). The drawn curve shifts up (α_2 rises) when the risk factor, net exports, primary balance, or the relative real effective exchange rate rise.

Figure 6: Analyzing flights-to-quality



We conclude that the flight-to-quality effect is at play for countries with a sufficiently high NIIP and a sufficiently low government debt. More precisely, based on the US-high-yield estimates and using REER3, for a given level of f_t, NX3, PB3 and REER3 (i.e. ceteris paribus),

[18] Gropp (2015), Barrios et al. (2009), Mody (2009) find evidence in favour of the flight-to-quality status of the German Bund. Many other authors (for instance Beber et al., 2009; Blanco, 2001; Mayordomo et al., 2015) find broader evidence in favour of flights-to-quality. They show that the phenomenon is not necessarily limited to the German bond market.

each extra percent of government debt (as % of gdp) above the German debt level must be "compensated" by an NIIP (in % of gdp) that is an extra 1.69 ($\approx \frac{0.013052}{0.00774}$) percent higher than that of Germany. Or, conversely, an NIIP that is one percent of gdp lower than Germany's, requires, ceteris paribus, a government debt that is $\frac{1}{1.68} \approx 0.59$ percent of gdp lower than Germany's in order for that country to benefit from a flight-to-quality. The results from regressions that include the EU high-yield spread or the CISS-index as risk factors are quite similar (1.70 and 1.88, respectively). Using REER instead of REER3 also yields very comparable results (1.34, 1.07, and 1.43 for the Baa, EU high, and CISS index respectively). The generally lower values when using REER corresponds to the higher estimate for α_2 , following from the higher (but insignificant) estimates for γ'. The remaining interaction effects show that as net exports, primary balance, the real effective exchange rate (all relative to Germany), or the risk factor are higher, a higher NIIP3 is required for a given Debt3 in order to profit from flights-to-quality.

4.4.5 Adding interactions between explanatory variables

The interaction effects included until now are $x_{it}f_t$-interactions. They proved to be a valuable part of the overall relationship between the explanatory variables and the sovereign spread. In addition, those interactions proved valuable in analysing flights-to-quality. Although not standard in the yield spread literature, some authors also emphasize interactions between explanatory variables ($x_{it}^m x_{it}^n$-interactions). Mody (2009), for example, suggest that government debt more severely affects spreads for countries that have suffered more from losses in competitiveness. Barrios et al. (2009) argues that a budget deficit leads to stronger increases in the sovereign's spread for countries with a current account deficit. In this section, such interactions will be analysed more closely. In contrast to the investigations in Barrios et al. and Mody, we will not limit the investigated interactions to some a priori determined relations. Instead, we will allow all possible interactions to affect spreads, which results in specifications given by equation (12).

$$\sigma_{it} = \sum_{k=0}^{N} \beta^k x_{it}^k + \sum_{m \neq n} \underline{\eta_{m,n} x_{it}^m x_{it}^n} + \sum_{k=0}^{N} \gamma^k x_{it}^k f_t + \gamma' f_t + \phi_i + \mu_{it} \tag{12}$$

$$\forall m, n = 1, \ \dots\ , N$$

The results are reported in table 5. Again, the results are reported for each of the measures for the global risk factor, once using REER3 and once using REER. All other variables are expressed relative to Germany. Interactions that are insignificant for all six specifications are excluded from the table. Comparing the results to those presented in table 3 shows that all $x_{it}f_t$-interactions remain unchanged. Less comforting is the observation that the direct impact of almost all not-interacted variables disappears when the $x_{it}^m x_{it}^n$-interactions are included. This should not be too surprising since the interaction effects facilitate an additional relationship between the explanatory variables and the spread, and allow the size of this relationship to depend on the other explanatory variables. The former direct relationship may therefore be spread over the different interactions. The loss of significance does not apply to the coefficients estimated to REER3 and REER. They remain almost unchanged and show the same puzzling result as discussed in section 4.4.2 (opposite, and for REER also counterintuitive, signs). Surprisingly, debt service (relative to Germany) becomes significant for the REER3 estimations and net exports has the expected sign for the REER estimations. Again, a variety of information criteria suggests that the models using REER3 should be preferred.

Fortunately, the most interesting results do not depend on how the real effective exchange rate enters the model. The interactions with the risk factor confirm the conclusions from section 4.4.4. The estimates for α_1 in the condition $NIIP3 \geq \alpha_1 Debt3 + \alpha_2$, based on the results in table 5 and using REER3, equal 1.60, 2.01, and 1.90 when using the US high yield spread, the European high yield spread, and the CISS index respectively. Again, using REER yields lower values. This may, again, be due to the higher (but insignificant) estimates for the intercept (α_2). Using the US high yield spread, the European high yield spread and the CISS index results in estimations for α_1 of, respectively, 1.27, 1.38, and 1.52.

One merit of the estimations in table 5 is that they allow to check for the presence of the interaction effects suggested by Barrios et al. (2009) and Mody (2009) (see section 2.2.1). The NX3*PB3-interaction term is significant and negative at the 5% level of significance. This supports the conclusion in Barrios et al. (2009) that budget deficits result in a stronger increase in the government spread for countries with a higher current account deficit. The results also support the interaction effects suggested by Mody (2009): the interaction REER3*Debt3 is positive and strongly significant in all specifications, which endorses Mody's conclusion that the spreads of countries with a deteriorated competitiveness reacted more strongly to increases in debt.

Equally interesting are the interactions that include government debt (recall that the direct impact of debt on spreads disappeared upon including $x_{it}^m x_{it}^n$-interactions; the interaction effects, however, are all the more interesting). They indicate that the effect of government debt on spreads crucially depends on other, country-specific, characteristics and the risk factor. More specifically, for the REER3 estimations, investors consider a higher debt to be less problematic, in the sense that a given increase in government debt requires a smaller increase in the credit premium, when the NIIP is high, the net exports are low, the real effective exchange rate is low, and growth is low. Net exports and growth enter this relationship with a counterintuitive sign.

Table 5: Fixed effects including all cross-variable interactions

Dependent variable: spread						
REER*:	Relative to Germany (REER3)			Not relative to Germany (REER)		
Risk measure:	Baa	EU high	CISS	Baa	EU high	CISS
C	0.264532	0.211811	0.137149	3.082401	4.53427	3.966699
	(0.7806)	(0.6261)	(0.4205)	(0.6116)	(0.8869)	(0.8017)
NIIP3	-0.00428	-0.00606	-0.00479	-0.03734	-0.03355	-0.00436
	(-0.9340)	(-1.3300)	(-1.0740)	(-0.5520)	(-0.4871)	(-0.0663)
DEBT3	0.001874	0.002249	0.011141	0.120011	0.17056	0.329527
	(0.1111)	(0.1338)	(0.693)	(0.9856)	(1.3345)	(2.6465)***
NX3	0.01659	0.016882	0.014823	-0.32256	-0.29733	-0.44302
	(1.2317)	(1.2565)	(1.161)	(-1.8083)*	(-1.6366)	(-2.4840)**
PB3	0.021323	0.028068	0.029872	-0.12825	-0.08828	-0.08743
	(0.7551)	(0.9943)	(1.1209)	(-0.3555)	(-0.2427)	(-0.2562)
DS3	20.63328	21.52332	20.30187	-37.1178	-43.8869	-44.1503
	(2.0031)**	(2.1107)**	(2.1002)**	(-0.5869)	(-0.6939)	(-0.7403)
GROWTH3	-0.00691	-0.00923	0.00247	-0.2949	-0.36248	-0.28577
	(-0.3733)	(-0.4936)	(0.1416)	(-1.2344)	(-1.5020)	(-1.2569)
REER*	0.179894	0.202252	0.206706	-0.01758	-0.03244	-0.02738
	(4.1319)***	(4.7299)***	(5.0977)***	(-0.3512)	(-0.6392)	(-0.5578)
RISK	0.197219	0.240925	0.280873	1.408912	1.620292	1.910974
	(2.2196)**	(2.5870)***	(3.2392)***	(1.0438)	(1.2584)	(1.6778)*
RISK*NIIP3	-0.00531	-0.00498	-0.00558	-0.00663	-0.00659	-0.00691
	(-3.2129)***	(-3.0898)***	(-4.2567)***	(-3.5060)***	(-3.4508)***	(-4.4422)***
RISK*DEBT3	0.008474	0.010051	0.011061	0.008448	0.009079	0.010491
	(2.5144)**	(2.7912)***	(3.6952)***	(2.1678)**	(2.1257)**	(2.8848)***
RISK*NX3	0.011455	0.01306	0.017956	0.008247	0.010246	0.013942
	(3.1739)***	(3.4503)***	(5.2239)***	(1.9892)**	(2.3197)**	(3.3733)***
RISK*PB3	0.014552	0.018882	0.004115	0.032889	0.036871	0.021646
	(1.096)	(1.3846)	(0.3603)	(2.1255)**	(2.2830)**	(1.6195)
RISK*DS3	-0.04682	-1.23283	-0.56198	2.956602	2.672497	4.895684
	(-0.0169)	(-0.4006)	(-0.2168)	(0.9153)	(0.73)	(1.5971)
RISK*GROWTH3	-0.01345	-0.01429	-0.00591	-0.02209	-0.02433	-0.0089
	(-1.2465)	(-1.2828)	(-0.5920)	(-1.7709)*	(-1.8495)*	(-0.7611)
RISK*REER3	0.021543	0.028137	0.035427	-0.01083	-0.01278	-0.01517
	(1.8493)*	(2.6076)***	(3.6958)***	(-0.8111)	(-1.0076)	(-1.3495)
NIIP3*DEBT3	-0.0002	-0.00026	-0.00036	-0.00012	-0.0002	-0.00029
	(-1.7487)*	(-2.2658)**	(-3.2207)***	(-0.9214)	(-1.4812)	(-2.2048)**
NIIP3*NX3	-0.00014	-0.00014	-5.2E-05	0.000368	0.000356	0.000336
	(-0.9808)	(-0.9586)	(-0.3746)	(2.3175)**	(2.2249)**	(2.1858)**
NIIP3*DS3	0.088847	0.088924	0.137761	0.144853	0.144803	0.188715
	(1.0285)	(1.0365)	(1.6861)*	(1.4343)	(1.4295)	(1.9650)**
NIIP3*GROWTH3	-0.00028	-0.00036	-0.0005	-0.00039	-0.00043	-0.00059
	(-0.9834)	(-1.2779)	(-1.8490)*	(-1.1826)	(-1.3054)	(-1.8617)*
DEBT3*NX3	0.000523	0.000562	0.000762	-0.00048	-0.0005	-0.00038
	(2.3786)**	(2.5586)**	(3.5872)***	(-1.9526)*	(-2.0309)**	(-1.6052)
DEBT3*DS3	0.051502	0.036449	0.009729	0.715087	0.725314	0.721054
	(0.4841)	(0.3438)	(0.095)	(6.2540)***	(6.3409)***	(6.6021)***
DEBT3*GROWTH3	0.00199	0.002109	0.002297	0.003935	0.004339	0.004553
	(2.6945)***	(2.8808)***	(3.3322)***	(4.7115)***	(5.1853)***	(5.7994)***
NX3*PB3	-0.00244	-0.00203	-0.00107	-0.00315	-0.0027	-0.00169
	(-2.7316)***	(-2.2964)**	(-1.2489)	(-2.9916)***	(-2.5499)**	(-1.6682)*
NX3*DS3	0.079722	0.08719	-0.04264	0.319992	0.331235	0.223568
	(0.6174)	(0.6776)	(-0.3480)	(2.1915)**	(2.2533)**	(1.6056)
NX3*GROWTH3	0.001115	0.001207	0.001548	0.001017	0.000993	0.001433
	(1.4034)	(1.5183)	(2.0398)**	(1.1258)	(1.0886)	(1.6458)*
DS3*GROWTH3	-2.43885	-2.55759	-2.52442	-3.73917	-4.08376	-3.96024
	(-3.6039)***	(-3.8204)***	(-4.0167)***	(-4.9867)***	(-5.4438)***	(-5.6322)***
NIIP3*REER3	-0.00221	-0.00242	-0.00237	0.000325	0.000256	0.000007
	(-3.5963)***	(-3.9925)***	(-4.1358)***	(0.4815)	(0.3737)	(0.0112)
DEBT3*REER3	0.004035	0.004409	0.00427	-0.00118	-0.00169	-0.00316
	(3.8050)***	(4.1849)***	(4.1960)***	(-1.0025)	(-1.3608)	(-2.6099)***
NX3*REER3	-0.00739	-0.00654	-0.00482	0.004051	0.003825	0.005213
	(-4.4020)***	(-3.8759)***	(-2.9954)***	(2.3156)**	(2.1478)**	(2.9836)***
DS3*REER3	-0.81901	-0.8811	-0.49479	0.596361	0.678662	0.665879
	(-1.6500)*	(-1.7949)*	(-1.0670)	(1.005)	(1.1432)	(1.1912)
GROWTH3*REER3	0.004412	0.004182	0.003762	0.003183	0.003839	0.003249
	(2.2328)**	(2.1376)**	(2.0311)**	(1.3365)	(1.5983)	(1.4316)
Observations:	576	576	576	576	576	576
R-squared:	0.7586	0.7608	0.7851	0.6776	0.6733	0.7076
F-statistic:	32.2882	32.6829	37.5419	21.5976	21.1792	24.8668

Panel OLS regressions with cross-sectional fixed effects. T-statistics are reported between parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance respectively.

More closely related to the subject of this thesis, many NIIP-interactions appear to be important explanatory variables as well. The interaction effect with the risk factor is slightly smaller than in previous estimations, but the order of magnitude and significance remain unchanged. Again, and in line with the conclusion for debt, there is no direct relationship between the NIIP and spreads. Nevertheless, the interaction effects show that a more unfavourable risk environment, a more indebted government and a higher (less competitive) real effective exchange rate (relative to Germany) result in stronger increases in spreads when the NIIP worsens.

Let us analyse the NIIP-related results in table 5 in greater detail. In an average risk environment, a country with a real effective exchange rate at the same level as Germany, and a government debt-to-gdp ratio that is 30% higher than Germany's,[19] a zero NIIP-to-gdp-ratio (NIIP3=50%) results in a spread that is 32 to 55 base points (depending on which risk measure is used) higher than if that country's NIIP would equal Germany's. In periods of increased risk aversion (risk factor two standard deviations above average), this extra risk premium for an NIIP that is 50% lower than Germany's ranges from 83 to 113 base points. The impact of the NIIP on spreads can therefore be considered as of economic importance.

The meaning of the other interaction effects can be interpreted similarly to the interpretation of the NIIP-interactions and the debt-interactions just discussed.

4.4.6 The composition of the NIIP

Section 3.2.5 already indicated that different components of the NIIP may have different effects on the domestic economy. It was for example argued that heterogeneity in the debt and equity instruments in the NIIP may give rise to heterogeneity in the effects of the various NIIP-components on sovereign spreads. The disaggregation of the NIIP provided by the IMF does however not allow for such differentiation in our estimations. Instead, the IMF dataset allows us to split the NIIP in direct investment, other investment, financial derivatives, portfolio investment, and reserve assets. In this section, the possibility of heterogeneity in the impact of those various components on spreads is empirically analysed. In addition, the taxation argument in section 3.2.3 suggests that the impact of assets on spreads may differ from the impact of liabilities. Also this question will be addressed in this section.

Tables 6 and 7 report the results of estimations that are very similar to those in the previous sections (all $x_{it}f_t$ and $x_{it}^m x_{it}^n$-interactions are included in the estimation, but only the relevant results are reported). The only change with respect to the previous tables is the disaggregation of the NIIP. In each table, NIIP3 is split up in its composing parts. In the first six columns of each

[19] This debt assumption more or less corresponds to the last observations for Belgium, and Ireland since 2012, and is on the conservative side for the debt levels of Italy, Greece, and the recent past of Portugal.

table, the asset positions and the liability positions enter the estimated equations separately, while in the last six columns of each table assets and liabilities are netted against each other for each component of the NIIP. All estimations are performed twice. First, in table 6 there are twelve "full specifications" in which all components of the NIIP are included (either netted or not). Unfortunately, these estimations suffer from strong reductions in the number of included observations due to the limited availability of the financial derivatives data. To avoid this strong reduction in the sample size, table 7 reports the results for twelve "reduced specifications" in which the financial derivatives component of the NIIP is excluded. Hence, the results in table 7 benefit from a significantly increased sample size, but, as discussed in appendix D, some results should be interpreted with caution.

The results in table 6 are not at odds with the a priori expectations. The various components of the NIIP (both for the netted specifications — columns 1 to 3 — and the non-netted specifications — columns 6 to 7) mostly have the wrong sign (although only rarely significant) for the REER3 specifications, while the REER specifications show very appealing results. Nevertheless, this advantage of the REER specification over the REER3 specification disappears when the included number of observations is increased by using the reduced specifications in table 7. There, all coefficients, without exception, have the correct sign. Moreover, the behaviour of the unreported interaction effects is roughly similar to their behaviour in previous estimations. Again, various diagnostics and information criteria are in favour of the REER3 specifications. Quite surprising, the direct effects from the different components of the NIIP are significant, whereas, previously, in table 5, the aggregate NIIP had no significant direct relationship with the spread. If anything, these results support the existence of a negative relation between the NIIP and spreads.

Given the problem of the omitted variable bias discussed in appendix D, it is difficult to ascertain whether or not the impact of the different components of the NIIP on spreads is homogeneous. The REER specifications in table 6 seem to confirm: all point estimates lie fairly closely together. The results in table 7 diverges from this conclusion, but taking into account the omitted variable bias, it would be premature to conclude in favour of a heterogeneous impact of the different components.

The hypothesis that for each component of the NIIP the asset position's impact on the spread is symmetrical to the impact of the liability position can be tested by comparing the R^2s of various equations. More specifically, using table 7, one can compare the Baa-REER3 estimation in which assets and liabilities are allowed to have a different impact on spreads for all components of the NIIP with the Baa-REER3 estimation in which assets and liabilities are restricted to have a symmetrical impact on spreads. Comparing all six unrestricted estimations with their corresponding restricted equations (for three risk factors, once using REER3 and once using REER), and calculating the appropriate test statistic, we conclude that at least for one component of the NIIP the restriction of a symmetrical impact of the asset and liability positions is invalid. Unreported results show that only for the other investment component the restriction of a symmetrical impact of the asset position versus the liability position is valid. For direct investment and portfolio investment we must conclude that assets have a different impact on the spread than liabilities.

At first sight, this may support the taxation argument discussed in section 3.2.3. However, based on the taxation argument, we would expect that, on top of the other channels that link the NIIP to spreads, external assets have the additional benefit of being a possible tax base. This additional benefit should show up in a stronger negative (i.e. decreasing) impact of external assets on the spread. For portfolio investment, this is indeed the case, but for direct investment, the point estimates suggest the opposite scenario.

Table 6: Effect of the composition of the NIIP on spreads: full specification

Dependent variable: spread

REER*:	REER3			REER			REER3			REER		
Risk measure:	Baa	EU high	CISS	Baa	EU high	CISS	Baa	EU high	CISS	Baa	EU high	CISS
A_DI3	0.008453	0.008856	0.010145	-0.03912	-0.04291	-0.04226						
	(0.8451)	(0.8594)	(0.9601)	(-2.2466)**	(-2.3938)**	(-2.2499)**						
L_DI3	-0.00767	-0.00836	-0.00943	0.040461	0.043711	0.04301						
	(-0.7459)	(-0.7868)	(-0.8669)	(2.3073)**	(2.4213)**	(2.2714)**						
A_OI3	0.014057	0.014267	0.016405	-0.03145	-0.03594	-0.03575						
	(14224)	(1.3945)	(1.5626)	(-1.8441)*	(-2.0541)**	(-1.9517)*						
L_OI3	-0.01378	-0.01432	-0.01718	0.030573	0.034714	0.034079						
	(-1.3674)	(-1.3859)	(-1.6177)	(1.7964)	(1.9896)*	(1.8664)						
A_FD3	0.005152	0.001386	0.000982	-0.0294	-0.04268	-0.0451						
	(0.1986)	(0.0568)	(0.0398)	(-0.9423)	(-1.3587)	(-1.4263)						
L_FD3	-0.00149	0.002505	0.001694	0.031015	0.044018	0.045629						
	(-0.0533)	(0.095)	(0.0629)	(0.9446)	(1.3317)	(1.365)						
A_PI3	0.012425	0.012697	0.015121	-0.03389	-0.03848	-0.0377						
	(1.3086)	(1.2894)	(1.5037)	(-2.0044)**	(-2.2075)**	(-2.0620)**						
L_PI3	-0.0129	-0.01307	-0.01562	0.033144	0.03783	0.037026						
	(-1.3616)	(-1.3388)	(-1.5653)	(1.9561)	(2.1689)**	(2.0260)**						
A_DI3-L_DI3							0.015066	0.015542	0.018889	-0.03154	-0.03694	-0.03571
							(1.6665)	(1.6825)	(2.0187)**	(-1.8702)*	(-2.1406)**	(-1.9830)*
A_FD3-L_FD3							-0.0127	-0.0108	-0.01142	-0.05692	-0.06061	-0.05966
							(-0.5890)	(-0.5171)	(-0.5255)	(-2.0813)**	(-2.2064)**	(-2.1071)**
A_OI3-L_OI3							0.018417	0.018791	0.022345	-0.02672	-0.03241	-0.03191
							(1.9883)**	(1.9983)**	(2.3233)**	(-1.5975)	(-1.8995)*	(-1.7921)*
A_PI3-L_PI3							0.01758	0.017989	0.02207	-0.02838	-0.03408	-0.03274
							(1.9639)**	(1.9671)**	(2.3827)**	(-1.7031)*	(-1.9995)*	(-1.8379)*
A_RA3	-0.0356	-0.00613	-0.09116	-0.16329	-0.15357	-0.23873	0.006445	0.027058	-0.06239	-0.09868	-0.10964	-0.20673
	(-0.3236)	(-0.0573)	(-0.8464)	(-1.4640)	(-1.3897)	(-2.1500)*	(0.0624)	(0.2665)	(-0.6020)	(-0.9349)	(-1.0546)	(-1.9648)
DEBT3	0.026168	0.030367	0.03588	-0.10864	-0.17276	-0.12423	0.037191	0.040166	0.050754	-0.10898	-0.18567	-0.13877
	(1.0266)	(1.1828)	(1.3359)	(-1.0033)	(-1.5210)	(-1.0449)	(1.5143)	(1.6317)	(1.9956)**	(-1.0030)	(-1.6577)*	(-1.1859)
NX3	0.11453	0.092175	0.093572	0.407369	0.293475	-0.07032	0.109546	0.091143	0.090281	0.441589	0.351275	-0.01441
	(5.0131)***	(4.3926)***	(4.1515)***	(1.4337)	(1.1008)	(-0.2720)	(4.8554)***	(4.3698)***	(4.0509)***	(1.5667)	(1.3449)	(-0.0570)
PB3	-0.0736	-0.09129	-0.0801	0.05254	0.200105	0.314558	-0.08029	-0.09447	-0.08538	0.01001	0.157267	0.283572
	(-2.3470)**	(-2.9612)***	(-2.5642)***	(0.2077)	(0.8291)	(1.2791)	(-2.5903)***	(-3.0956)***	(-2.7539)***	(0.0397)	(0.6604)	(1.1664)
DS3	-3.07373	2.036118	-0.7803	93.32192	95.1258	96.59987	-6.89098	-2.43114	-7.50631	84.59313	86.80965	86.25281
	(-0.2054)	(0.1416)	(-0.0517)	(1.8682)*	(1.9249)*	(1.8832)*	(-0.4718)	(-0.1744)	(-0.5145)	(1.701)*	(1.7822)*	(1.7137)*
GROWTH3	0.040294	0.051213	0.046446	-0.01568	-0.05332	-0.06506	0.033203	0.047181	0.046036	-0.01313	-0.03868	-0.04707
	(1.8621)*	(2.5314)**	(2.2352)**	(-0.1230)	(-0.4315)	(-0.5120)	(1.7528)*	(2.6880)***	(2.5530)**	(-0.1062)	(-0.3256)	(-0.3854)
REER3	-0.05702	-0.00202	0.040719	-0.005	-0.0278	-0.05973	-0.07825	-0.01393	0.026159	-0.03712	-0.05426	-0.08748
	(-0.7093)	(-0.0277)	(0.5414)	(-0.0923)	(-0.5815)	(-1.2125)	(-0.9912)	(-0.1944)	(0.3522)	(-0.7244)	(-1.2404)	(-1.9653)**
BAA	0.201727	0.482716	0.2197	-4.39805	-4.36209	-2.10559	0.473298	0.648273	0.285052	-4.24793	-4.38378	-2.19681
	(0.6096)	(1.8665)*	(1.7444)*	(-1.9393)*	(-2.4726)**	(-2.4216)**	(1.6488*)	(2.9200)***	(2.4956)**	(-1.9396)*	(-2.5990)***	(-2.6187)***
Observations:	178	178	178	178	178	178	178	178	178	178	178	178
R-squared:	0.942	0.9445	0.9399	0.9382	0.9379	0.9324	0.9402	0.9431	0.9381	0.9357	0.9366	0.9311
F-statistic:	35.0766	36.7629	33.7817	32.8049	32.646	29.8135	37.8117	39.8078	36.4119	34.99	35.5037	32.4873

Panel OLS regressions with cross-sectional fixed effects. T-statistics are reported between parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance respectively. For the explanatory variables, the variable X_ XX3 refers to direct investment, other investment, financial derivatives, portfolio investment, and reserve assets when XX is respectively DI, OI, FD, PI, and RA. The variable in question is an asset position when X = A, and is a liability position when X = L. X_XX3 - X_XX3 refers to net positions of the NIIP-component XX.

Table 7: Effect of the composition of the NIIP on spreads: reduced specification

Dependent variable: spread

REER*:		REER3			REER			REER3			REER	
Risk measure:	Baa	EU high	CISS	Baa	EU high	CISS	Baa	EU high	CISS	Baa	EU high	CISS
A_DI3	-0.0042	-0.00738	-0.00959	-0.0145	-0.01842	-0.02469						
	[-0.8380]	[-1.4653]	[-1.9812]**	[-1.1242]	[-1.4082]	[-2.0056]**						
L_DI3	0.006883	0.009941	0.012052	0.016698	0.020457	0.026473						
	[1.3729]	[1.9655]**	[2.4783]**	[1.3038]	[1.5745]	[2.1674]**						
A_OI3	-0.01136	-0.01378	-0.01422	-0.02715	-0.03153	-0.0359						
	[-2.1218]**	[-2.5507]**	[-2.7334]***	[-2.1540]**	[-2.4628]**	[-2.9841]***						
L_OI3	0.01616	0.018287	0.018581	0.032668	0.036812	0.041049						
	[3.0019]***	[3.3440]***	[3.4971]***	[2.6169]***	[2.9008]***	[3.4374]***						
A_PI3	-0.00581	-0.00839	-0.01014	-0.01929	-0.02265	-0.0285						
	[-1.1566]	[-1.6512]	[-2.0641]**	[-1.5141]	[-1.7527]*	[-2.3421]**						
L_PI3	0.004809	0.007614	0.009744	0.017201	0.020737	0.026701						
	[0.9575]	[1.5071]	[1.9990]**	[1.3419]	[1.5958]	[2.1798]**						
A_DI3-L_DI3							-0.00782	-0.01027	-0.01184	-0.02589	-0.02901	-0.03423
							[-1.5462]	[-2.0161]**	[-2.3927]**	[-2.0098]**	[-2.2220]**	[-2.7874]***
A_OI3-L_OI3							-0.01144	-0.01312	-0.01283	-0.03575	-0.03931	-0.04265
							[-2.0918]**	[-2.3735]**	[-2.3955]**	[-2.8191]***	[-3.0534]***	[-3.5268]***
A_PI3-L_PI3							-0.00956	-0.01164	-0.01299	-0.02832	-0.03106	-0.03561
							[-1.8765]*	[-2.2668]**	[-2.6068]***	[-2.2246]**	[-2.4092]**	[-2.9376]***
A_RA3	0.030853	0.045762	0.070364	-0.12722	-0.13024	-0.11999	-0.09453	-0.07731	-0.05081	-0.20171	-0.20054	-0.17251
	[0.5970]	[0.8841]	[1.4395]	[-2.1066]**	[-2.1230]**	[-2.0614]**	[-2.3833]**	[-1.9574]*	[-1.3622]	[-4.7460]***	[-4.7113]***	[-4.2949]***
DEBT3	-0.01654	-0.01746	-0.01445	0.152832	0.235243	0.37235	-0.01645	-0.01697	-0.00993	0.17951	0.258717	0.385652
	[-0.7883]	[-0.8354]	[-0.7251]	[1.1415]	[1.6594]*	[2.7247]***	[-0.7623]	[-0.7905]	[-0.4839]	[1.3327]	[1.8206]*	[2.8216]***
NX3	0.010881	0.010406	-0.00403	-0.07617	-0.0213	-0.12176	0.01574	0.015506	0.000984	-0.12036	-0.05724	-0.15617
	[0.6774]	[0.6519]	[-0.2662]	[-0.3549]	[-0.0975]	[-0.5822]	[0.9554]	[0.9491]	[0.0631]	[-0.5520]	[-0.2583]	[-0.7355]
PB3	0.000729	0.005524	0.005778	-0.21035	-0.19036	-0.17217	0.006634	0.01168	0.015448	-0.18323	-0.17732	-0.16247
	[0.0233]	[0.1768]	[0.1959]	[-0.5393]	[-0.4853]	[-0.4705]	[0.2057]	[0.3639]	[0.5087]	[-0.4613]	[-0.4446]	[-0.4365]
DS3	9.047835	9.383232	8.650244	1.555968	-0.68542	18.13037	15.43961	16.1667	15.87111	9.283744	7.744281	25.30213
	[0.7805]	[0.8170]	[0.8003]	[0.0235]	[-0.0103]	[0.2913]	[1.3039]	[1.3806]	[1.4353]	[0.1381]	[0.1150]	[0.4008]
GROWTH3	0.006288	0.004466	0.018973	-0.16487	-0.21966	-0.18599	-0.00841	-0.00989	0.004499	-0.20652	-0.26182	-0.22006
	[0.3026]	[0.2143]	[0.9727]	[-0.6779]	[-0.8931]	[-0.8076]	[-0.3970]	[-0.4663]	[0.2256]	[-0.8344]	[-1.0479]	[-0.9403]
REER*	0.12465	0.157279	0.133132	-0.08332	-0.09313	-0.06752	0.173809	0.207483	0.191043	-0.06469	-0.07844	-0.05098
	[2.2380]**	[2.8970]***	[2.5952]***	[-1.6799]*	[-1.8403]*	[-1.4240]	[3.1129]***	[3.8101]***	[3.7136]***	[-1.2914]	[-1.5362]	[-1.0631]
BAA	0.09354	0.137053	0.149495	0.252743	0.900386	1.962496	0.172204	0.211262	0.239987	0.75242	1.423531	2.428123
	[0.9682]	[1.3655]	[1.5743]	[0.1814]	[0.6727]	[1.6455]*	[1.7973]*	[2.1169]**	[2.5614]**	[0.5320]	[1.0505]	[2.0179]**
Observations:	501	501	501	501	501	501	501	501	501	501	501	501
R-squared:	0.795	0.7981	0.8206	0.7213	0.7167	0.7491	0.7812	0.7851	0.8076	0.7087	0.705	0.7386
F-statistic:	30.7543	31.335	36.2615	20.5162	20.0566	23.6707	30.1055	30.8144	35.4089	20.5171	20.1523	23.8276

Panel OLS regressions with cross-sectional fixed effects. T-statistics are reported between parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance respectively. For the explanatory variables, the variable X_ XX3 refers to direct investment, other investment, financial derivatives, portfolio investment, and reserve assets when XX is respectively DI, OI, FD, PI, and RA. The variable in question is an asset position when X = A, and is a liability position when X = L. X_XX3 - X_XX3 refers to net positions of the NIIP-component XX.

4.4.7 So, what explains yield spreads?

In sections 4.4.3, 4.4.4, and 4.4.5 we showed the importance of the NIIP in explaining yield spreads. More specifically, it was shown that accounting for interaction effects can be of substantial importance when explaining yield spreads. In the case of $x_{it}f_t$-interactions, investor's portfolio rebalancing in the face of increased risk aversion is allowed to be heterogeneous across countries and dependent on each country's fundamentals. In fact, any variable's impact on the spread can be allowed to be heterogeneous and dependent on other variables by including $x_{it}^m x_{it}^n$-interactions.

Interpreting the $x_{it}f_t$-interactions, we found that a lower NIIP leads to an increase of a country's spread sensitivity to increases in the global risk factor. Further building on those interactions, we also showed that a sufficiently high NIIP can allow a country to be on the benefiting side of a flight-to-quality. Finally, we interpreted the $x_{it}^m x_{it}^n$-interactions and concluded that the impact of the NIIP on spreads depends on other variables and can be quite sizeable, certainly in episodes of risk aversion. To conclude, we have found considerable support for a negative relation between the NIIP and sovereign yield spreads.

In section 4.4.6 we investigated the possibility of heterogeneity in the relations of the different components of the NIIP with the spread. First, limitations in data availability hindered testing the hypothesis of a different impact of equity assets and liabilities versus debt assets and liabilities. Second, data availability also impeded the investigation of whether or not there is heterogeneity in the relation of the five components of the NIIP and the spread. In order to have sufficient observations, we had to reduce the specification by not incorporating the financial derivatives component of the NIIP. In appendix D, it is shown that this may invalidate some of the remaining estimates. Finally, one conclusion clearly emerged: for the other investment component, we concluded that assets and liabilities have a symmetrical impact on spreads, whereas for portfolio investment and direct investment assets and liabilities are not symmetrically related to spreads.

Another conclusion from the reported results is that the choice of using REER3 or REER is not of material importance for the main conclusions with respect to the interaction effects. Therefore, in the remainder of the analysis, the focus will be on the REER3 specifications. These are ones that are generally preferred by a variety of information criteria.

4.5 Nonstationarity, cointegration and a break in the relationship

In anticipation of econometric concerns, this section shows that the results from the previous section are not merely the result of spurious relations. In addition, we show that, although the model explaining interest rate spreads clearly changed since the onset of the crisis, the results from the previous section do not materially change when the sample is restricted to contain crisis and post-crisis years only. In fact, the previously reported results are well suited for analysis of the post-2007 sample period, and actually quite unhelpful for analysis of pre-crisis spreads.

Readers for whom the mere confirmation of the robustness of the previously reported results suffices, may want to skip this section and directly go to the conclusion. Readers interested in the econometric grounds for the confirmation of the robustness of the results will appreciate the analysis in sections 4.5.1 and 4.5.2. Finally, the results in section 4.5.3 are interesting for anyone with questions on the impact of the financial and Euro crisis on the behaviour of yield spreads.

4.5.1 Nonstationarity

Although the framework introduced in section 4.4 is not uncommon in the literature, a more involved approach may be necessary to guarantee correct estimates and inference. More precisely, when both the dependent variable and the explanatory variables are integrated of order 1 (I(1)), any significance of the latter can be merely the outcome of spurious results. This is an important remark that is also addressed by Goedl and Kleinert (2013). If, however, nonstationary variables are found to be cointegrated, this criticism becomes invalid and our results can be expected to benefit from the attractive property of super-consistency.

Although some authors find considerable evidence in favour of nonstationarity of European spreads (Goedl and Kleinert, 2013; De Santis, 2012; Alexopoulou et al., 2009), table 8 shows that our data yields less clear-cut conclusions. The reported results are the p-values of four different panel unit root tests (Levin et al., 2002; Im et al., 2003; Maddala and Wu, 1999), allowing for individual effects. All tests test the null hypothesis of a unit root against the alternative of no unit root. The LLC-test assumes a common unit root process for all cross-sections. All unit root tests include an individual intercept and no trend. Although the results in table 8 are not extremely unambiguous, we may conclude that European spreads behave stationary in normal times (1999Q1-2007Q1), and nonstationary during the crisis-period. The fact that in the last column of table 8 (2013Q2-2015Q3) spreads test as nonstationary in an environment of economic normalization can be the result of a lack of power of the unit root tests due to a too short time dimension, or it can signal that the behaviour of spreads has not yet normalized.

Table 8: Unit root tests for spread: p-values

	Full sample	1999Q1-2007Q1	2007Q2-2013Q1	2013Q2-2015Q3
LLC	0.0.0654	0.0000	0.0546	0.0029
IPS	0.0417	0.0240	0.2780	0.7922
ADF-Fisher	0.3739	0.0016	0.3660	0.8986
PP-Fisher	0.5568	0.0015	0.8909	0.7419

The same pattern is also, more or less, present in the (unreported) Augmented Dickey-Fuller unit root tests for the global risk factor. Although neither measure for the global risk environment provides a clear conclusion, three out of five risk measures suggest that before the crisis the risk factor behaved stationary, whereas after 2007 it tests as nonstationary, and increasingly so when the second sample period is constrained to contain only the crisis-episode (instead of considering the period from 2007 until the end of the sample). Surprisingly, this conclusion is not supported (or in the case of the Baa-spread even reversed) by the European and American high yield spreads. Given their behaviour in figure 2, this should not be surprising.

Although it is rather clear that debt and the NIIP are nonstationary variables (using the unit root tests from table 8), the components of the NIIP behave quite heterogeneously. It appears that the debt component of direct investment assets is nonstationary, whereas the equity component seems to behave stationary. Direct investment liabilities (both debt and equity) generally test as stationary. Overall, portfolio investment assets test as nonstationary whereas portfolio investment liabilities mostly test as stationary. For other investment, both liabilities and assets seem to behave stationary. One can hardly find any theoretical back-up for this extremely heterogeneous behaviour of the different components of the NIIP. The other (control) variables are less problematic. Net exports, primary balance, growth and debt service are almost certainly stationary, and so are the interaction effects, with the exception of REER3*NIIP3, REER3*Debt3, and Debt3*NIIP3. Unsurprisingly, the real effective exchange rate is probably nonstationary.

4.5.2 Cointegration

When using time-series variables, the use of such non-stationary dependent and explanatory variables may result in spurious relationships, that is, the OLS-estimator $\hat{\beta}$ is an inconsistent estimator for the population parameter β. However, when using panel data, this unfortunate property of the OLS-estimator disappears. Technical discussions on the asymptotic behaviour of the estimated parameters can be found, for instance, in Phillips and Moon (1999a) and Phillips and Moon (1999b). Baltagi (2008) intuitively explains that the cross-sectional dimension in panel data adds a considerable amount of information that leads to a stronger overall signal of a possible relation between the regressor and the regressand. Nevertheless, common practice in applied econometric panel analysis still recommends the performance of panel cointegration tests. In contrast to, for example Attinasi et al. (2009) and others, we do not address the persistence of spreads by building a dynamic panel model. Instead, we will try to establish a cointegrating relationship between nonstationary variables.

First, a comforting note. The general procedure to deal with not cointegrated nonstationary variables is first differencing. Table A.1 in appendix A shows that first differencing of the nonstationary variables (NIIP3, Debt3, and REER3) leaves the estimated coefficients to the interaction effects broadly unchanged. One disturbing result in this table is the observation that an increase in the government debt ratio ($D(DEBT3) > 0$) is associated with a lower spread. This is at odds both with theory and common sense. The three pair-wise interactions between debt, NIIP, and the real effective exchange rate are also nonstationary. Table A.2 in appendix A shows that when those interactions also enter the model first differenced, the coefficients to most of the other estimates remain, again, broadly unchanged. The conclusion from tables A.1 and A.2 that the first differencing of the nonstationary but possibly not cointegrated variables does not alter the main conclusions from section 4.4, is a very comforting result.

Cointegration tests, however, suggest that this differencing is not necessary. The Maddala-Wu cointegration test provides ample support in favour of cointegration ($p = 0.0014$). The cointegrating regression regresses the spread on all nonstationary variables and nonstationary interaction effects. Given the conclusion that the residuals are stationary, we can infer the presence of a cointegrating relationship and be confident that none of the reported results are the product of spurious correlations.

4.5.3 A break in the relationship?

The discussion in section 2 already introduced the possibility that investor's behaviour may have changed since the financial and Euro crises. Theoretical and empirical support for this premise is given by, among others, Arghyrou and Tsoukalas (2010), Arghyrou and Kontonikas (2012), Barrios et al. (2009), Dötz and Fischer (2010), Mody (2009), and Wihlborg et al. (2010). The model used in section 4.4 can provide an additional test for this hypothesis by splitting the sample in two subsamples, with a breakpoint somewhere in 2007 or 2008. Although Dötz and Fischer (2010) and Mody (2009) suggest a break in March 2008, when Bear Stearns was rescued, figures 1 and 2 suggest that mid-2007 may be an appropriate breakpoint as well.

To analyse the question of a change in the behaviour of spreads over the period from 1999-2015, we split the sample in 2007Q2 and fit a model including all significantly important $x_{it} f_t$

and $x_{it}^m x_{it}^n$-interactions to the two subsamples separately. The analysis is limited to models using REER3 instead of REER. This is motivated by the general preference for the REER3 model of different diagnostics. Table 9 reports the results. In line with the analysis in the previous section, table A.3 shows that the results are robust against first differencing of the nonstationary variables and interactions.

Some very surprising results emerge. To give an impression: 60% of the estimated coefficients switch sign for all risk measures in the post-2007Q2 period (although not all of them are significantly different from zero). In addition, 11 variables or interactions gain a high degree of significance (significant at the 10% level for all three risk measures *and* significant at the 5% level for at least one risk measure) in the second sample period, while being insignificant for the pre-2007Q2 subsample. This supports the conclusion of different authors (see earlier in this subsection and in section 2) that investor's behaviour changed markedly since the onset of the financial turmoil.

More specifically, a first way in which investor's behaviour changed is reflected in the estimated coefficients to government debt. Whereas a government debt-to-gdp ratio that is 10% of gdp higher than that of Germany resulted in an increase in the spread with more than 20 base points before the crisis (not taking into account the interactions), this effect entirely disappears, but possibly creeps into interaction effects, after the crisis. Secondly, the interaction between government debt and the risk factor exhibits a negative sign before the crisis, indicating that, as the global risk environment worsened, more indebted countries faced less severe increases in their spreads than less indebted countries. Given the fact that this conclusion only holds when the European and US high yields are used to proxy the risk environment, and taking into account the behaviour of those risk measures in the early 2000s (see figure 2.2.3), it may be conjectured that this counterintuitive result stems from the period from end 2000 to early 2004 which is characterised by a risk averse environment in combination with low spreads. The risks here, might have been largely situated in the US, and the portfolio rebalancing in response to this increased risk possibly shifted bond holdings from the corporate to the government sector, without discriminating across governments and therefore leaving spreads unaffected. Thirdly, other interaction effects are broadly unimportant before the crisis, and those who are (borderline) significant have the opposite sign of the interaction after 2007Q2. For example, the interaction between the NIIP and the risk factor shows an unexpected positive sign before 2007Q2, and the same holds for the NIIP-debt-interaction.

The change in investor behaviour is also visible in figure 7. Panel (a) shows that when the model is estimated using the full sample, the predicted yield spreads for the first subsample are generally higher than their true, observed, counterparts, whereas the actual and fitted values for the second subsample are generally closely related (panel b). Using a separate estimation

Table 9: Fitting the model on two subsamples

Dependent variable: spread						
Sample period:	1999Q1-2007Q2			2007Q3-2015Q3		
Risk measure:	Baa	EU high	CISS	Baa	EU high	CISS
C	0.148218	0.166068	0.224891	0.105829	-0.14888	-1.10192
	(2.2884)**	(2.5056)**	(2.2206)**	(-0.1542)	(-0.2145)	(-1.6305)
NIIP3	-0.00131	-0.00139	0.000513	-0.00794	-0.01154	-0.01813
	(-0.7031)	(-0.7816)	(-0.2134)	(-0.9821)	(-1.4171)	(-2.2818)**
DEBT3	0.023902	0.023866	0.024202	-0.01587	-0.01606	-0.04077
	(4.0413)***	(4.2066)***	(4.2734)***	(-0.6066)	(-0.6120)	(-1.6015)
NX3	-0.00446	-0.004	-0.00528	0.044726	0.043167	0.022894
	(-1.6641)*	(-1.4702)	(-1.3299)	(3.1285)***	(3.0171)***	(1.6081)
PB3	0.008073	0.006889	0.005872	-0.00239	-0.00526	-0.0257
	(1.3492)	(1.1313)	(0.9575)	(-0.0597)	(-0.1315)	(-0.6927)
REER3	-0.03281	-0.02865	-0.05752	0.131687	0.157021	0.13305
	(-1.3909)	(-1.2165)	(-1.5850)	(1.7749)*	(2.0674)**	(1.7918)*
GROWTH3	0.005127	0.005257	0.003561	-0.00126	0.001311	0.012344
	(1.28)	(1.3032)	(0.8888)	(-0.0439)	(0.046)	(0.4688)
DS3	-0.66156	-0.60624	-1.14449	14.34615	14.3756	10.24493
	(-0.3980)	(-0.3631)	(-0.6719)	(0.8445)	(0.8498)	(0.6523)
BAA	-0.01295	0.026491	0.098221	0.151901	0.166526	0.156632
	(-0.2819)	(0.5578)	(0.8296)	(1.1628)	(1.3134)	(1.1968)
BAA*NIIP3	0.001619	0.002256	0.005066	-0.00515	-0.00454	-0.00664
	(1.7022)*	(2.2506)**	(1.7209)*	(-2.4346)**	(-2.2822)**	(-3.8983)***
BAA*DEBT3	-0.00415	-0.00267	-0.0036	0.012386	0.011862	0.016043
	(-3.3047)***	(-2.0646)**	(-1.1330)	(3.6579)***	(3.7282)***	(5.9336)***
BAA*NX3	-0.00274	-0.00335	-0.00618	0.012277	0.012517	0.012148
	(-1.6377)	(-1.7602)*	(-1.1640)	(2.3644)**	(2.4837)**	(2.3835)**
BAA*REER3	0.00445	0.004547	-0.0578	0.026315	0.031485	0.045582
	(0.2803)	(0.2779)	(-1.1120)	(1.9252)*	(2.5080)**	(3.9296)***
NIIP3*DEBT3	0.000125	0.000106	0.000098	-0.00024	-0.00031	-0.00065
	(2.5687)***	(2.2676)**	(2.0598)**	(-1.4520)	(-1.8415)*	(-3.9463)***
NIIP3*PB3	0.00031	0.00032	0.000238	0.000492	0.000399	0.000097
	(1.8129)*	(1.8928)*	(1.4393)	(1.4011)	(1.1399)	(0.3)
NIIP3*REER3	0.000386	0.000266	0.00004	-0.00254	-0.00284	-0.00349
	(1.1721)	(0.821)	(0.1211)	(-2.7399)***	(-2.9873)***	(-3.8393)***
NIIP3*GROWTH3	0.000129	0.00014	0.000161	-0.00042	-0.00046	-0.00046
	(1.2459)	(1.3603)	(1.5657)	(-1.0739)	(-1.1887)	(-1.2834)
NIIP3*DS3	-0.00331	-0.0045	-0.01057	0.006567	0.005895	0.030957
	(-0.1463)	(-0.1977)	(-0.4580)	(0.0471)	(0.0424)	(0.2407)
DEBT3*NX3	0.000009	0.000001	0.00001	0.000857	0.000921	0.001009
	(0.127)	(0.0179)	(0.1386)	(3.3885)***	(3.6363)***	(4.2815)***
DEBT3*PB3	-5.5E-05	-0.0001	-8.4E-05	-0.00061	-0.00075	-0.00087
	(-0.2787)	(-0.5169)	(-0.4203)	(-0.9990)	(-1.2449)	(-1.5640)
DEBT3*REER3	-0.00207	-0.00163	-0.00125	0.004638	0.005034	0.005732
	(-2.3198)**	(-1.8577)*	(-1.4245)	(3.3587)***	(3.5648)***	(4.2698)***
DEBT3*GROWTH3	-0.00022	-0.00025	-0.00029	0.001947	0.001984	0.002015
	(-1.0410)	(-1.1468)	(-1.3198)	(2.0434)**	(2.0814)**	(2.2829)**
NX3*PB3	-0.00037	-0.00039	-0.00033	-0.00256	-0.00219	-0.0015
	(-1.1689)	(-1.2023)	(-1.0393)	(-2.1403)**	(-1.8162)*	(-1.3435)
NX3*REER3	-0.00078	-0.00043	0.000205	-0.00994	-0.00901	-0.00642
	(-0.9454)	(-0.5369)	-0.2525	(-4.7700)***	(-4.2570)***	(-3.1379)***
NX3*GROWTH3	-0.00011	-0.00012	-0.0002	0.00159	0.001688	0.002421
	(-0.4832)	(-0.5177)	(-0.9249)	(1.5583)	(1.6578)*	(2.5545)**
PB3*GROWTH3	0.000012	-0.00028	-0.00027	0.005978	0.006503	0.00611
	(0.0144)	(-0.3223)	(-0.3113)	(1.5986)	(1.742)*	(1.7714)*
REER3*GROWTH3	-0.00226	-0.00201	-0.00133	0.004434	0.0043	0.003866
	(-1.1094)	(-0.9746)	(-0.6349)	(1.8738)*	(1.8228)*	(1.7695)*
REER3*DS3	-0.32697	-0.35278	-0.31552	-0.82581	-0.87051	-0.38436
	(-0.5509)	(-0.5822)	(-0.4917)	(-1.5296)	(-1.6284)*	(-0.7789)
GROWTH3*DS3	0.228192	0.195964	0.18921	-2.44741	-2.44747	-2.17367
	(1.1311)	(0.9641)	(0.9189)	(-2.8354)***	(-2.8304)***	(-2.7188)***
Observations:	180	180	180	396	396	396
R-squared:	0.8607	0.8582	0.8543	0.7649	0.7667	0.8001
F-statistic:	21.4689	21.0234	20.3739	26.6401	26.9002	32.7722

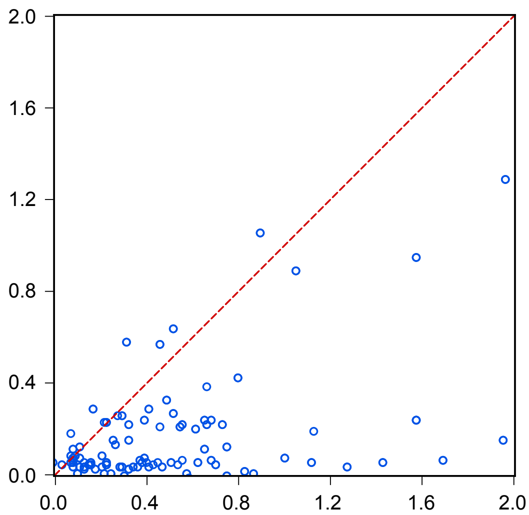
Panel OLS regressions with cross-sectional fixed effects. T-statistics are reported between parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level of significance respectively.

for each subsample results in a significant better fit for the first period (panel c) and almost no change for the second period (panel d). This significant improvement in predicted values for the first sample period shows that the full-sample model does not accurately explain yield spreads before the crisis and that investor's behaviour effectively changed. The increases in spreads since the Euro crisis are not only the result of increased risk aversion and deteriorated fundamentals, it is also the result of a change in investor behaviour. More evidence in favour of the change in the investor behaviour is presented in appendix E.

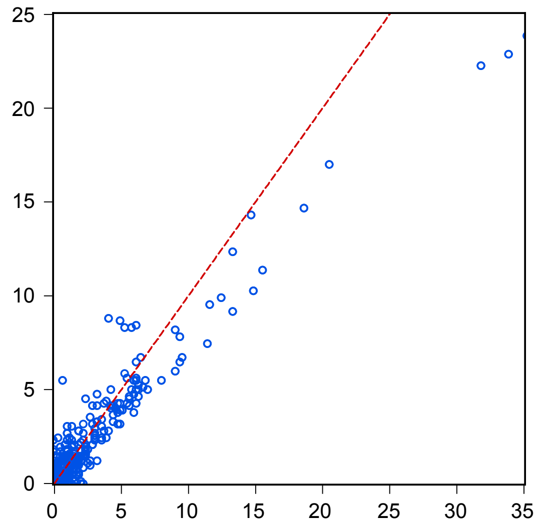
This brings us to the post 2007Q2 interactions. They are invariably very close to the previously reported results, and hence the main conclusions remain unchanged. The flight-to-quality condition discussed in section 4.4.4 is now given by $NIIP3 \geq \alpha_1 Debt3$, with $\alpha_1 = \{2.40,\ 2.61,\ 2.41\}$ for the Baa, EU high, and CISS estimates respectively. The fact that these estimates are on the high side may correspond to the absence of a constant ($\alpha_2 = 0$) or it may indicate that, the change in investor behaviour consisted of, inter alia, a higher required compensation (in terms of the NIIP) for government debt in order to perceive a country as worthy to flee to in periods of increased risk aversion. Once again, it should be stressed that the point estimates for the second subsample are strongly comparable to the point estimates for the full sample so that the conclusions from section 4.4 also hold for the second subsample specifically. For both subsamples, the residuals test as stationary, which supports the existence of a cointegrating relationship between the nonstationary variables. Moreover, as shown in table A.3 in appendix A, the most important results are, without exception, robust to first differencing of the nonstationary variables, so that, again, the results are robust to the possible absence of cointegration.

Figure 7: Fitted and actual values for two subsamples and two models

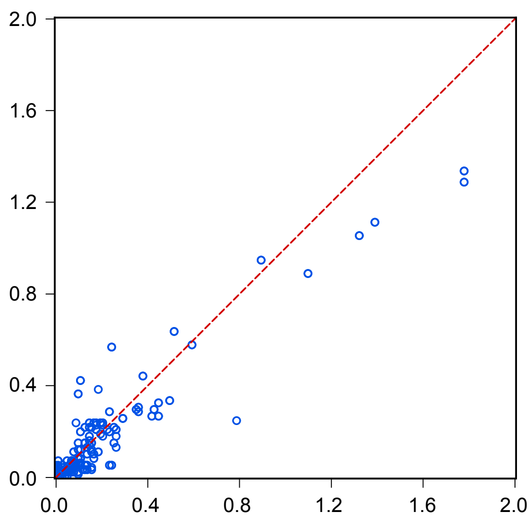
(a) 1999Q1-2007Q2, full sample



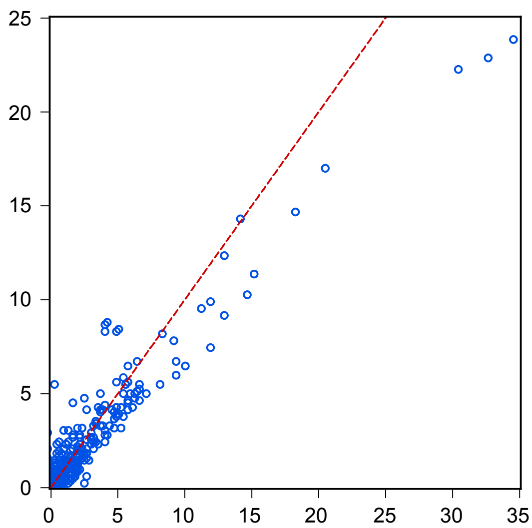
(b) 2007Q3-2015Q3, full sample



(c) 1999Q1-2007Q2, splitted sample



(d) 2007Q3-2015Q3, splitted sample



Notes: The actual value of interest rate spread is on the vertical axis, the fitted value is on the horizontal axis. For panels (a) and (b) the fitted value is based on the model in the first column of table 5. This model is estimated with the full sample, using the US high yield spread as risk measure, and incorporating all $x_{it}f_t$ and $x^m_{it}x^n_{it}$-interactions. For panels (c) and (d) the fitted values are obtained from the models in the first (panel c) and fourth (panel d) columns of table 9. Again, the US high yield spread is used as risk measure.

Conclusion

This thesis investigates the existence of a relationship between spreads and the NIIP. Interest in such a relationship has been spurred by the Euro crisis that has drawn a lot of attention to the possibility of such a relation. Various authors have supported the existence of this relationship, and this thesis finds both theoretical and empirical support. Possibly, this thesis is the first work that incorporates the NIIP in the (European) yield spread literature. In addition, it may also be the first time that arguments supporting this act are brought together.

Theoretically, different arguments underpin the existence of a relationship between the NIIP and spreads. First, strongly negative NIIPs may create vulnerabilities and fragilities in the economy that feed into the sovereign spread. Second, the NIIP may also be related to the tax base. From the literature review on yield spreads in section two, it is clear that such a "taxation argument" is valid to motivate the existence of a relation between the NIIP and spreads. Also the use of intertemporal budget restrictions of the different economic sectors (private sector, government sector, and foreign sector) provides a rationale for the a relationship between spreads and the NIIP. Finally, the composition of the NIIP may also affect the relation under investigation.

Also empirical support for a link between the NIIP and the spread is presented. The workhorse empirical framework consists of a fixed effects estimation. This thesis contributes to the yield spread literature not only by illustrating and explaining the importance of the NIIP in explaining spreads. The empirical methodology shows that allowing for interaction effects may be crucial to capture the entire relationship between the explanatory variables and the spread. More specifically, interactions between the explanatory variables and the risk factor, and interactions among the explanatory variables are shown to be important. The analysis of such interaction effects leads to the conclusion that the impact of the NIIP on spreads depends on the global risk environment and the values of other variables in the model. Additionally, this thesis uses some of these interaction effects to analyse flights-to-quality, a phenomenon observed in sovereign bond markets, in an innovative way. This analysis allows us to conclude that the answer to the question of whether or not a country is safe enough to flee to in periods of increased risk aversion depends on different macroeconomic variables. Using the *ceteris paribus* clause, it can be stated that, in order for a country to be safe enough to flee to, it must have a low government debt and a high NIIP, or compensate a high (low) government debt with a high (low) NIIP (or vice versa).

Despite the confirmation of the existence of a relationship between the NIIP and spreads, many questions remain. For example, as was already briefly mentioned in footnote 4, new, and possibly more accurate, ways have been developed to analyse fiscal sustainability. In relation to the yield spread literature, further research may focus on the incorporation of the results of that growing research area. Also research on external sustainability, and sustainability of the NIIP, may draw on those new insights. In addition, appendix C shows how the yield spread literature may benefit from a sizeable increase in information retrieved from financial market data. Future research can investigate this opportunity. On the empirical side, research related to flights-to-quality may find it interesting to analyse to what extent the framework developed in section 4.4.4 can be extended. Moreover, future research will be able to benefit from increased data availability, which will enhance the analysis of the effect of the composition of the NIIP on spreads.

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A Additional tables

Table A.1: First differencing nonstationary variables

Dependent variable: spread			
Risk measure:	CISS	Baa	EU high
D(NIIP3)	0.011622	0.011286	0.011162
	(1.7275)*	(1.5729)	(1.5636)
D(DEBT3)	-0.09055	-0.08309	-0.08563
	(-4.6665)***	(-4.0412)***	(-4.1584)***
D(REER3)	-0.09324	-0.03135	-0.04557
	(-1.4943)	(-0.4720)	(-0.6885)
NX3	0.023377	0.035217	0.0343
	(2.7186)***	(3.8231)***	(3.6655)***
PB3	-0.05083	-0.04376	-0.0442
	(-1.9274)*	(-1.5397)	(-1.5716)
DS3	25.91875	22.76836	23.58787
	(3.4663)***	(2.8284)***	(2.9641)***
GROWTH3	0.033944	0.014534	0.017277
	(1.7692)*	(0.7114)*	(0.8401)
BAA	0.286938	0.261631	0.277335
	(3.3419)***	(2.9432)***	(2.9260)***
BAA*NIIP3	-0.00631	-0.00556	-0.00588
	(-4.7781)***	(-3.2696)***	(-3.5037)***
BAA*DEBT3	0.01319	0.009819	0.010818
	(4.5365)***	(2.9564)***	(3.0071)***
BAA*REER3	0.040058	0.027021	0.029106
	(4.3085)***	(2.3479)**	(2.7298)***
BAA*NX3	0.018722	0.012983	0.013515
	(5.3035)***	(3.4868)***	(3.4255)***
BAA*DS3	-1.8887	0.221196	-1.20907
	(-0.7732)	(0.0853)	(-0.4047)
BAA*GROWTH3	-0.00156	-0.00639	-0.00768
	(-0.1548)	(-0.5879)	(-0.6757)
BAA*PB3	0.009281	0.020616	0.027878
	(0.8105)	(1.5115)	(1.9821)**
NIIP3*DEBT3	-0.0005	-0.0003	-0.00039
	(-7.7961)***	(-4.5658)***	(-5.7890)***
NIIP3*PB3	-0.00028	0.000074	-4.6E-05
	(-1.1633)	(0.2867)	(-0.1813)
NIIP3*REER3	-0.00488	-0.00431	-0.00485
	(-10.6804)***	(-8.8889)***	(-9.8265)***
NIIP3*GROWTH3	-0.00049	-0.00041	-0.00045
	(-1.7506)*	(-1.3664)	(-1.5060)
NIIP3*DS3	0.175811	0.12503	0.131573
	(2.3443)*	(1.5718)	(1.6738)*
DEBT3*NX3	0.000687	0.000542	0.000589
	(3.7932)***	(2.8262)***	(3.0758)***
DEBT3*PB3	-0.00166	-0.00154	-0.00162
	(-3.6860)***	(-3.2259)***	(-3.4156)***
DEBT3*REER3	0.002084	0.002235	0.002171
	(2.5751)**	(2.5664)**	(2.5499)**
DEBT3*GROWTH3	0.002002	0.001723	0.001912
	(3.3072)***	(2.6545)***	(2.9499)***
NX3*PB3	-0.00158	-0.00307	-0.00282
	(-1.8079)*	(-3.3821)***	(-3.1322)***
NX3*REER3	-0.0062	-0.00842	-0.00776
	(-4.3221)***	(-5.6397)***	(-5.2058)***
NX3*GROWTH3	0.002077	0.001438	0.001509
	(2.8488)**	(1.8826)*	(1.9720)**
PB3*GROWTH3	0.005153	0.004111	0.004382
	(1.9251)*	(1.4138)	(1.5222)
REER3*DS3	-0.3363	-0.79907	-0.7722
	(-0.8118)	(-1.8077)*	(-1.7750)*
GROWTH3*DS3	-1.90632	-2.01335	-2.15423
	(-3.4876)***	(-3.4176)***	(-3.6720)***
Observations:	557	557	557
R-squared:	0.788	0.7597	0.7608
F-statistic:	42.1967	35.9025	36.1095

Table A.2: First differencing of nonstationary variables and interactions

Dependent variable: spread			
Risk measure:	CISS	Baa	EU high
C	2.010571	2.021156	2.190345
	(13.4365)***	(13.5035)***	(14.1169)***
D(NIIP3)	0.000842	0.007513	0.004327
	(0.0708)	(0.6361)	(0.3573)
D(DEBT3)	-0.03366	-0.03737	-0.02709
	(-1.0827)	(-1.2027)	(-0.8493)
D(REER3)	-0.02374	-0.00255	-0.00277
	(-0.2605)	(-0.0278)	(-0.0295)
NX3	0.098774	0.094978	0.10286
	(12.5691)***	(11.7808)***	(12.1011)***
PB3	-0.06009	-0.04958	-0.04682
	(-1.9008)*	(-1.5479)	(-1.4411)
DS3	3.81084	9.200068	7.574347
	(-0.5135)	(-1.231)	(-0.987)
GROWTH3	0.021104	0.011327	0.013791
	(-0.8713)	(-0.462)	(-0.5435)
CISS	0.317683	0.30666	0.301295
	(3.1282)***	(3.0761)***	(2.7646)***
CISS*NIIP3	-0.00556	-0.00895	-0.00575
	(-3.6488)***	(-4.8085)***	(-3.0358)***
CISS*DEBT3	0.014074	0.015121	0.009934
	(4.1201)***	(4.2131)***	(2.4708)**
CISS*REER3	0.00772	0.00345	-0.00868
	(-0.7316)	(-0.2716)	(-0.7368)
CISS*NX3	0.016966	0.018386	0.014025
	(4.1625)***	(4.5032)***	(3.1789)***
CISS*DS3	-4.10109	-1.93382	-1.10459
	(-1.4297)	(-0.6745)	(-0.3247)
CISS*GROWTH3	0.003079	-0.00605	-0.00244
	(-0.256)	(-0.4987)	(-0.1872)
CISS*PB3	0.014638	0.035362	0.029041
	(-1.0747)	(2.3343)**	(-1.7931)*
D(NIIP*DEBT)	-8.2E-05	0.000051	0.000034
	(-0.3400)	(-0.2175)	(-0.1394)
NIIP3*PB3	0.000204	0.000422	0.000397
	(-0.7148)	(-1.4481)	(-1.3538)
D(NIIP*REER)	-0.00013	-0.00014	-0.00023
	(-0.1077)	(-0.1131)	(-0.1780)
NIIP3*GROWTH3	-0.00074	-0.00058	-0.00064
	(-2.0355)**	(-1.5643)	(-1.6992)*
NIIP3*DS3	-0.14529	-0.05741	-0.10768
	(-2.1305)**	(-0.8565)	(-1.5710)
DEBT3*NX3	-0.00024	-0.0002	-0.00024
	(-1.1052)	(-0.9406)	(-1.1032)
DEBT3*PB3	-0.00192	-0.00169	-0.0018
	(-3.7839)***	(-3.3292)***	(-3.4912)***
D(DEBT_REER)	-0.00205	-0.00092	-0.00139
	(-0.9373)	(-0.4181)	(-0.6156)
DEBT3*GROWTH3	0.002456	0.002109	0.002393
	(3.4334)***	(2.9095)***	(3.2304)***
NX3*PB3	-0.00322	-0.00407	-0.00403
	(-3.1439)***	(-4.0614)***	(-3.9426)***
NX3*REER3	-0.01383	-0.01444	-0.01479
	(-8.9280)***	(-9.4663)***	(-9.5408)***
NX3*GROWTH3	0.002232	0.001747	0.001742
	(2.5681)**	(2.0415)**	(1.9758)**
PB3*GROWTH3	0.003407	0.002463	0.002389
	(-1.077)	(-0.7626)	(-0.7276)
REER3*DS3	0.403728	0.30063	0.235532
	(-0.9184)	(-0.7081)	(-0.5426)
GROWTH3*DS3	-2.65317	-2.5655	-2.85925
	(-4.0166)***	(-3.8162)***	(-4.1716)***
Observations:	557	557	557
R-squared:	0.7025	0.7027	0.6868
F-statistic:	26.8107	26.84	24.904

Table A.3: Second subsample: first differencing of nonstationary variables and interactions

Dependent variable: spread

	2007Q3-2015Q3		
Risk factor:	Baa	EU high	CISS
C	2.471992	2.140003	2.594625
	(11.1089)**	(14.0449)**	(11.8056)**
D(NIIP3)	0.009797	0.007961	0.000852
	(0.6564)	(0.665)	(0.0577)
D(DEBT3)	-0.01556	-0.01676	-0.02129
	(-0.4112)	(-0.5301)	(-0.5687)
NX3	0.119735	0.103092	0.12415
	(9.1062)***	(12.2578)***	(8.9371)***
PB3	-0.02909	-0.05359	-0.0394
	(-0.6711)	(-1.6761)*	(-0.9214)
D(REER3)	-0.03106	0.009056	-0.06612
	(-0.2436)	(0.0972)	(-0.5297)
GROWTH3	0.017999	0.004557	0.026794
	(0.5129)	(0.1806)	(0.7879)
DS3	3.547273	10.59441	-7.48456
	(0.2565)	(1.4213)	(-0.5228)
BAA	0.102369	0.27599	0.107144
	(0.7357)	(2.6228)***	(0.7906)
BAA*NIIP3	-0.00648	-0.00452	-0.00402
	(-2.8402)***	(-2.6303)***	(-2.2767)**
BAA*DEBT3	0.013425	0.008324	0.012049
	(3.7253)***	(3.1645)***	(4.1247)***
BAA*NX3	0.014979	0.015341	0.012768
	(2.7027)***	(3.5261)***	(2.2465)**
BAA*REER3	-0.00013	-0.01341	0.010604
	(-0.0089)	(-1.1899)	(0.8807)
D(NIIP3*DEBT3)	0.000322	0.000089	0.000134
	(1.1498)	(0.3686)	(0.4797)
NIIP3*PB3	0.000452	0.000322	0.000224
	(1.1897)	(1.1129)	(0.5985)
D(NIIP3*REER3)	-0.00015	-0.00057	-0.00015
	(-0.0894)	(-0.4452)	(-0.0931)
NIIP3*GROWTH3	-0.00055	-0.00045	-0.00073
	(-1.1807)	(-1.2031)	(-1.6145)
NIIP3*DS3	-0.09929	-0.09357	-0.19235
	(-0.9062)	(-1.3747)	(-1.6910)*
DEBT3*NX3	0.000109	-0.00019	0.000051
	(0.4096)	(-0.8737)	(0.1924)
DEBT3*PB3	-0.00103	-0.00189	-0.00141
	(-1.6353)	(-3.7143)***	(-2.2787)**
D(DEBT3*REER3)	-0.00141	-0.00234	-0.00225
	(-0.5192)	(-1.0265)	(-0.8493)
DEBT3*GROWTH3	0.002375	0.003101	0.002326
	(2.3390)**	(3.9984)***	(2.2897)**
NX3*PB3	-0.00326	-0.00385	-0.00248
	(-2.4584)**	(-3.7820)***	(-1.8737)*
NX3*REER3	-0.01668	-0.01533	-0.01586
	(-7.9511)***	(-9.9547)***	(-7.2758)***
NX3*GROWTH3	0.001874	0.001443	0.002392
	(1.7035)*	(1.6382)	(2.1830)**
PB3*GROWTH3	0.006657	0.004053	0.007174
	(1.6698)*	(1.2635)	(1.8198)*
REER3*GROWTH3	0.004577	0.005807	0.003869
	(1.7702)*	(2.5343)**	(1.5092)
REER3*DS3	0.604635	0.277596	0.770102
	(1.1908)	(0.6498)	(1.472)
GROWTH3*DS3	-2.55858	-3.30636	-2.25123
	(-2.7529)***	(-4.7686)***	(-2.4044)**
Observations:	395	557	395
R-squared:	0.7288	0.6887	0.7348
F-statistic:	21.9403	26.3923	22.6156

B Derivation of the PVSDS

In paragraph 1.3 we discussed the condition for external sustainability. It was given by equation (7), which, in a compressed form and with switched signs, is given by:

$$NIIP_0 = -\sum_{t=0}^{\infty} \frac{X_t^{gd} - M_t^{gd}}{(1+r)^t}. \tag{7}$$

Remember that the superscript gd is added to X_t and M_t to emphasize that they only refer to imports and exports of goods and services (recall that current transfers and the balance of labour income were assumed to be zero and that investment income entered the derivations separately as $rNIIP_{t-1}$).

In the paragraph on credit risk (§2.2.1) the condition for sustainability of the government debt was expressed by equation (9). In this equation, mathematically derived in Escolano (2010), all variables were expressed as percentage of gdp. Let now ps_t and B_t denote the primary surplus and government debt in absolute values, that is, not expressed in relation to gdp. This modification results in the elimination of the economic growth rate in the intertemporal government budget constraint, so that comparability between the condition for external sustainability and the condition for government debt sustainability is maximized. The modified budget constraint is given by equation (13).

$$B_0 = \sum_{t=0}^{\infty} \frac{ps_t}{(1+r)^t} \tag{13}$$

The same principles can be applied to the private sector. The private sector as an aggregate is solvent only when it satisfies its own intertemporal budget constraint. Funds lent and borrowed within the private sector do not affect the solvency of the aggregate private sector since, in that case, the liability of one person cancels out the asset of the other person. The derivation here is very much in line with the derivation of the solvency condition for the external sector in paragraph 1.3. For the private sector we can define $S_t^* = S_t + rP_{t-1}$. The second term will be positive or negative depending on whether the private sector is a net creditor ($P_{t-1} < 0$) or a net debtor ($P_{t-1} > 0$). The dynamics of the private debt or asset position then becomes: $P_1 = (1+r)P_0 - (S_t^* - I_t)$. Calculations in line with those under paragraph 1.3 result in this solvency condition for the private sector:

$$P_0 = \sum_{t=0}^{\infty} \frac{S_t^* - I_t}{(1+r)^t}. \tag{14}$$

The equation states that a private sector that is indebted vis-à-vis the other sectors must, at some point in the future, run 'private surpluses' to redeem its debt. Such private surpluses can be generated by saving more (consuming less) and investing less. Conversely, if P_0 is negative so that the private sector is a net creditor to the other sectors, it will be able to invest more than it saves at some point in the future.

Let us now turn to a well-know macroeconomic identity: $(S_t - I_t) = (G_t - T_t) + (X_t - M_t)$. The interpretation is very familiar. If one or two sectors of the private sector, the government sector or the external sector save(s), than this must be compensated by dissaving by the remaining sector(s). Or, put differently, neither sector can save when those savings are not drawn upon by the aggregate of the other sectors. For convenience and in line with this interpretation, this identity will henceforth be referred to as the SDS-identity, the "savings-dissavings-identity".

It is now clear that the superscript gd in equation (7) is necessary to distinguish the balance of goods and services, $X_t^{gd} - M_t^{gd}$ (which excludes investment income) as it appears in the external constraint, from the current account balance as it appears in the SDS-identity. In the SDS-identity, the term $X_t - M_t$ incorporates both the balance of goods and services and investment income stemming from external assets and liabilities. Hence, we can rewrite the term $X_t - M_t$ as:

$$X_t - M_t = X_t^{gd} - M_t^{gd} + rA_{t-1}^d - rL_{t-1}^d - rL_{t-1}^g. \tag{15}$$

In this equation investment income related to the NIIP ($rNIIP_{t-1}$) is split in three parts: rA_{t-1}^d, the interest payments that domestic households receive on external assets from foreigners (it is implicitly assumed that the government does not own any externals assets); rL_{t-1}^d, the interest payments from private domestic debtors to their foreign creditors; and rL_{t-1}^g, the interest payable on government bonds held by foreigners. Note, for completeness of the reasoning, that we are still assuming the absence of transfers (secondary income account is zero) and that the primary income account consists exclusively of investment income stemming from external assets and liabilities (the balance of labour-income is zero).

The term $G_t - T_t$ in the SDS-identity can also be rewritten. To this end, use equation (16). It applies the definition that the overall government deficit equals the primary deficit (or the negative of the primary surplus) plus the interest burden of government debt. Additionally, equation (16) splits the total amount of outstanding government debt B_t in two constituting parts: L_t^g, the government debt held by foreigners, which gives rise to interest payments rL_{t-1}^g to foreigners which also appears in equation (15); and B_t^d, the government debt held by domestic households, which will appear in equation (17).

$$G_t - T_t = -ps_t + rL_{t-1}^g + rB_{t-1}^d \tag{16}$$

Finally, we can rewrite $S_t - I_t$ using the definition that $S_t = S_t^* - rP_{t-1}$ and additionally using that $rP_{t-1} = rL_{t-1}^d - rA_{t-1}^d - rB_{t-1}^d$. Here, $rL_{t-1}^d - rA_{t-1}^d$ are interest paid on private sector liabilities (all in the hands of the foreign sector since (a) the government is assumed not to own any assets with private sector counterparts, and (b) assets and liabilities between private sector agents cancel out) and interest received on private sector international assets, respectively. The term rB_{t-1}^d is again the interest paid by the government on government debt owned by the private sector.

$$S_t - I_t = S_t^* - I_t - rL_{t-1}^d + rA_{t-1}^d + rB_{t-1}^d \tag{17}$$

In order to finally derive the PVSDS, substitute equations (15), (16), and (17) in the SDS-identity. This delivers:

$$S_t^* - I_t - rL_{t-1}^d + rA_{t-1}^d + rB_{t-1}^d = (-ps_t + rL_{t-1}^g + rB_{t-1}^d) + X_t^{gd} - M_t^{gd} + rA_{t-1}^d - rL_{t-1}^d - rL_{t-1}^g. \tag{18}$$

In this identity all terms related to interest payments cancel out, so that (18) reduces to:

$$S_t^* - I_t = -ps_t + (X_t^{gd} - M_t^{gd}). \tag{19}$$

Knowing that the SDS-identity must hold at every time t it can be shown that the following must hold as well:

$$\sum_{t=0}^{\infty} \frac{S_t^* - I_t}{(1+r)^t} = \sum_{t=0}^{\infty} \frac{-ps_t}{(1+r)^t} + \sum_{t=0}^{\infty} \frac{X_t^{gd} - M_t^{gd}}{(1+r)^t} \tag{20}$$

Using equations (7), (13), and (14) gives us, finally, the PVSDS:

$$P_0 = -B_0 - NIIP_0 \qquad or \qquad C_0 = B_0 + NIIP_0, \tag{21}$$

with $C_0 = -P_0$ private sector assets. Note that these final substitutions require the assumption that all debtors are solvent. If not, the present value of, for example, $X_t^{gd} - M_t^{gd}$ will be smaller than $NIIP_0$. Indeed, for an insolvent external sector the transversality condition does not hold, so that equation (7) must be modified: $NIIP_0 = -\sum_{t=0}^{\infty} \frac{X_t^{gd} - M_t^{gd}}{(1+r)^t} - \mu$. The excess external indebtedness, that is, the share of net external liabilities (the negative of the NIIP) that is not covered by future current account surpluses, is captured by the term μ. The part of the NIIP that is covered by future current account surpluses is the first term, let it be denoted by $NIIP'$. This term μ is equivalent to the term $\frac{NIIP_n}{(1+r)^n}$ in equation (3) under paragraph 1.3. Taking this into account, the last substitution to become the PVSDS yields:

$$P_0 = -B_0 - NIIP' - \mu \qquad or \qquad C_0 = B_0 + NIIP' + \mu. \tag{22}$$

C A suggestion for the yield spread literature

It is common practice in the yield spread literature to estimate an equation like this:

$$r_a - \bar{r} = \sigma_a = \alpha + \sum_{k=0}^{N} \beta_k (x_a^k - \bar{x}^k) + \mu_a. \tag{23}$$

In which r_a represents the interest rate for country a and $\bar{r}$ the interest rate for a benchmark country. N is the number of explanatory variables. The impact of variable x_a^k, which enters the equation after differencing with respect to a benchmark value $\bar{x}$, on the spread σ_a equals β_k. If this is the true model that explains yield spreads, this appendix suggests how the yield spread literature can increase the amount of information retrieved from financial market data.

The idea is simple: subtract equation (23) for country 2 from the same equation for country 1. This delivers:

$$r_a - \bar{r} - r_b + \bar{r} = \sigma_{1,2} = \sum_{k=0}^{N} \beta_k (x_1^k - \bar{x}^k) - \sum_{k=0}^{N} \beta_k (x_2^k - \bar{x}^k) + \mu_1 - \mu_2 \tag{24}$$

In which $\sigma_{1,2}$ is the spread between country 1 and country 2. Let $\mu_{1,2} = \mu_1 - \mu_2$. Equation (24) can be rewritten as:

$$r_a - r_b = \sigma_{1,2} = \sum_{k=0}^{N} \beta_k (x_1^k - \bar{x}^k - x_2^k + \bar{x}^k) + \mu_{1,2},$$

which simplifies to:

$$\sigma_{1,2} = \sum_{k=0}^{N} \beta_k (x_1^k - x_2^k) + \mu_{1,2}. \tag{25}$$

This shows that the parameters β_k cannot only be estimated by regressing the spread of country 1 vis-à-vis a benchmark country on the variables x_a expressed relative to that benchmark. According to the model in equation (23), the same parameters β_k can be identified from regressing the spread between any two countries on the between-those-countries-difference of the included country specific explanatory variables.

D The composition of the NIIP: omitted variable bias

Some coefficient estimates in table 7 should be interpreted with extra caution. Since the results in that table come from specifications that exclude the financial derivatives component of the NIIP (in order to avoid the exclusion of many observations due to the limited availability of financial derivatives data), the reported coefficients may suffer from an omitted variable bias.

The omitted variable bias occurs when a relevant explanatory variable that is correlated with the other (included) explanatory variables is omitted. In this case, the coefficient estimates of the included variables with which the omitted variable is correlated are inconsistent estimates of the true parameters (Gujarati and Porter, 2009). For the specification: $y_{it} = \beta_1 + \beta_2 x_{it}^1 + \beta_3 x_{it}^2 + \mu_{it}$, omitting the variable x_{it}^2 by estimating $y_{it} = \alpha_1 + \alpha_2 x_{it}^1 + \epsilon_{it}$ leads to a biased estimation ($\hat{\alpha}_2$) for population parameter β_2. It can be shown that:

$$E(\hat{\alpha}_2) = \beta_2 + \beta_3 \frac{cov(x_{it}^1, x_{it}^2)}{var(x_{it}^2)}. \tag{26}$$

In addition, also the estimator for $var(\beta_2)$ is biased. This bias does not disappear when the sample size grows, and increases as the correlation between the included and the omitted variables increases.

Table D.1: Covariances and correlations with net financial derivatives

	Correlation	P-value[1]	Covariance	$\frac{Cov}{Var^2}$
Net DI3	-0.20951	0.0003	-563.725	-2.99988
Net OI3	0.641762	0.0000	763.4095	4.062507
Net PI3	-0.05126	0.3811	-158.466	-0.84328
RA3	-0.09187	0.1160	-1.52891	-0.00814

[1] P-value of the null hypothesis of no correlation.
[2] Variance of net financial derivatives = 187.9158.

Table D.1 can provide insight in the severity of the omitted variable bias. The second column indicates that net financial derivatives, the omitted variable, is not correlated with reserve assets or net portfolio investment. Hence, we do not expect an omitted variable bias for the coefficients estimated to those parameters (the second term in equation (26) is zero, so that $E(\hat{\alpha}_2) = \beta_2$). Conversely, net direct investment shows a significant and negative correlation with net financial derivatives, and other investments is significantly positively correlated with net financial derivatives. From tables 6 and 7 we know that net financial derivatives is negatively associated with spreads (β_3 in equation (26) is smaller than zero). Taking into account the sign of the correlations in table D.1, the negative relationship with spreads of both net direct investment and net other investment (β_2 in equation (26) is smaller than zero), and the formula in equation (26), we expect that, for table 7, the estimated values for the coefficient to net direct investment are biased towards zero, and that the coefficients to net other investment are overestimated. Put differently, the estimate for net direct investment can be considered as conservative (a lower bound for the true relationship), whereas the estimate for net other investment probably is an overestimation.

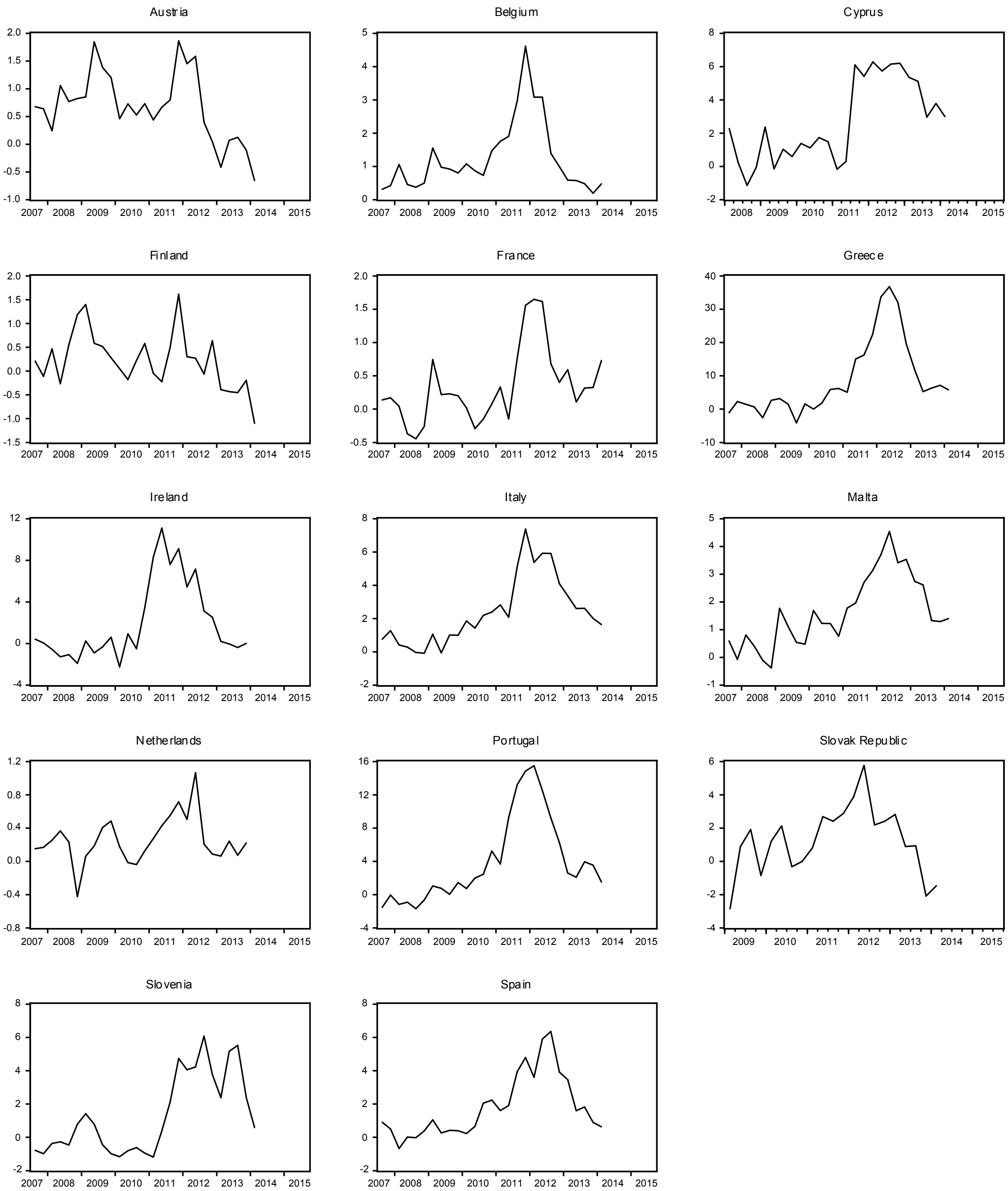
E Separating exogenous shocks from the change in investor behaviour

It is possible to determine to what extent the spread increases are due to the change in investor behaviour. Let the first subsample model be given by: $y_{it} = \hat{\beta}_1 + \hat{\beta}_2 x_{it} + \hat{\epsilon}_{it}$, and the second subsample model by: $y^*_{it} = \hat{\gamma}_1 + \hat{\gamma}_2 x^*_{it} + \hat{\epsilon}^*_{it}$. A * denotes the second subsample. The predicted values $\hat{y}_{it}$ and $\hat{y}^*_{it}$ are given by: $\hat{y}_{it} = y_{it} - \hat{\epsilon}_{it}$, and $\hat{y}^*_{it} = y^*_{it} - \hat{\epsilon}^*_{it}$. Let $\hat{\tilde{y}}^*_{it}$ denote the predicted values for the dependent variable y^*_{it} when the first subsample model (with the parameters $\hat{\beta}_1$ and $\hat{\beta}_2$) is applied to the explanatory variables of the second subsample (x^*_{it}), so that $\hat{\tilde{y}}^*_{it} = \hat{\beta}_1 + \hat{\beta}_2 x^*_{it}$. Obviously, $\hat{\tilde{y}}^*_{it}$ is not very good approximation for y^*_{it}. The difference between the two is partly due exogenous shocks and partly due to the use of the wrong model. The exogenous shocks are estimated by $\hat{\epsilon}^*_{it}$, therefore, we can write: $y^*_{it} - \hat{\tilde{y}}^*_{it} = \xi^*_{it} + \hat{\epsilon}^*_{it}$. It is ξ^*_{it} in which we are interested, let us call it “the model error.” It gives an impression of how big the difference between the two models is. If the first sample model and the second sample model are fairly closely related, we expect ξ^*_{it} to be small: the observed values of y^*_{it} are in this case close to the values that the first model would predict for y^*_{it} given the second subsample explanatory variables x^*_{it}. Conversely, if the two models are very different, the prediction for y^*_{it} based on the first subsample model will greatly differ from the true values y^*_{it} (i.e. $\hat{\tilde{y}}^*_{it}$ is very different from y^*_{it}), because a completely wrong model was used to generate the predictions ($\hat{\tilde{y}}^*_{it}$). Using the definitions introduced above, we can find the model error as follows:

$$\xi^*_{it} = (\hat{\gamma}_1 - \hat{\beta}_1) + (\hat{\gamma}_2 - \hat{\beta}_2) x^*_{it}. \tag{27}$$

This approach also suggests that investor behaviour considerably changed after the crisis. Figure E.1 shows that the model error severely increased, indicating that the first sample model became increasingly useless as the Euro crisis unfolded.

Figure E.1: Model errors per country



F Using the CCEP estimator

This appendix describes the use of the CCEP estimator for modelling yield spreads. In a first section, the estimator is introduced in a fairly intuitive way. Next, it is described how an ordinary leas squares regression can be used to obtain CCEP estimates. Finally, the scope to apply the CCEP estimator for yield spread modelling is explored and some results (unreported but available upon request) are discussed.

F.1 Intuitive description of the estimator

Assume that dependent variable y_{it} is explained by the following model:

$$y_{it} = \alpha_i + \boldsymbol{\beta}' \boldsymbol{x}_{it} + \gamma_i F_t + \epsilon_{it}, \tag{28}$$

where α_i is a cross-sectional fixed effect, $\boldsymbol{\beta}$ and $\boldsymbol{x}_{it}$ are vectors of coefficients and explanatory variables respectively, F_t is an unobserved common factor with country specific factor loadings γ_i, and ϵ_{it} is the error term. From equation (28) we can derive $\bar{y}_t = \bar{\alpha} + \boldsymbol{\beta}' \bar{\boldsymbol{x}}_t + \bar{\gamma} F_t + \bar{\epsilon}_t$, where a bar denotes averaging over cross sections as represented in these definitions:

$$\bar{y}_t = \frac{1}{N} \sum_{t=1}^{N} y_{it}, \qquad \bar{\alpha} = \frac{1}{N} \sum_{t=1}^{N} \alpha_i, \qquad \bar{\boldsymbol{x}}_t = \frac{1}{N} \sum_{t=1}^{N} \boldsymbol{x}_{it},$$
$$\bar{\gamma} = \frac{1}{N} \sum_{t=1}^{N} \gamma_i, \qquad \bar{\epsilon}_t = \frac{1}{N} \sum_{t=1}^{N} \epsilon_{it}.$$

The latter equation allows us to write: $F_t = \frac{\bar{y}_t - \bar{\alpha} - \boldsymbol{\beta} \bar{\boldsymbol{x}}_t - \bar{\epsilon}_t}{\bar{\gamma}}$. Using this expression for the unobserved common factor in equation (28) results in the following model that can be estimated with least squares:

$$y_{it} = \alpha_i + \boldsymbol{\beta}' \boldsymbol{x}_{it} + \gamma_i \frac{\bar{y}_t - \bar{\alpha} - \boldsymbol{\beta}' \bar{\boldsymbol{x}}_t - \bar{\epsilon}_t}{\bar{\gamma}} + \epsilon_{it} \tag{29}$$

F.2 Practical implementation

The model in equation (29) can be easily estimated using OLS. The author has also publicised this explanation on the internet. It can be consulted following this link:
http://economics.stackexchange.com/questions/10872/pesarans-ccep-estimator-in-eviews.

Consider a panel data set consisting of three cross-sections (a, b, and c) and three time-periods (1, 2, and 3). Let $\mathbf{y}$ denote the column vector with the observations of the dependent variable, $\mathbf{x}$ the column vector with observations of the first explanatory variable, and $\mathbf{z}$ the column vector with observations of the second explanatory variable. The vector $\boldsymbol{x}_{it}$ from the main text is in this example given by $[\mathbf{x}\ \mathbf{z}]$. The vectors $\mathbf{x}$, $\mathbf{y}$, and $\mathbf{z}$ take these forms respectively:

$$\mathbf{y} = \begin{bmatrix} y_{a1} \\ y_{a2} \\ y_{a3} \\ y_{b1} \\ y_{b2} \\ y_{b3} \\ y_{c1} \\ y_{c2} \\ y_{c3} \end{bmatrix}, \qquad \mathbf{x} = \begin{bmatrix} x_{a1} \\ x_{a2} \\ x_{a3} \\ x_{b1} \\ x_{b2} \\ x_{b3} \\ x_{c1} \\ x_{c2} \\ x_{c3} \end{bmatrix}, \qquad \text{and } \mathbf{z} = \begin{bmatrix} z_{a1} \\ z_{a2} \\ z_{a3} \\ z_{b1} \\ z_{b2} \\ z_{b3} \\ z_{c1} \\ z_{c2} \\ z_{c3} \end{bmatrix}.$$

Let $\bar{y}_i = \frac{1}{3}(y_{ai} + y_{bi} + y_{ci})$, with $i = 1, 2, 3$, and equivalently for x and z: $\bar{x}_i = \frac{1}{3}(x_{ai} + x_{bi} + x_{ci})$ and $\bar{z}_i = \frac{1}{3}(z_{ai} + z_{bi} + z_{ci})$, both for $i = 1, 2, 3$.

The CCEP estimator, allowing for one common factor, can be obtained by finding the least squares estimates $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\gamma}_a$, $\hat{\gamma}_b$, and $\hat{\gamma}_c$ for the corresponding population parameters β_1, β_2, γ_a, γ_b, and γ_c, in the following equation:

$$
\begin{bmatrix} y_{a1} \\ y_{a2} \\ y_{a3} \\ y_{b1} \\ y_{b2} \\ y_{b3} \\ y_{c1} \\ y_{c2} \\ y_{c3} \end{bmatrix} = \beta_1 \begin{bmatrix} x_{a1} \\ x_{a2} \\ x_{a3} \\ x_{b1} \\ x_{b2} \\ x_{b3} \\ x_{c1} \\ x_{c2} \\ x_{c3} \end{bmatrix} + \beta_2 \begin{bmatrix} z_{a1} \\ z_{a2} \\ z_{a3} \\ z_{b1} \\ z_{b2} \\ z_{b3} \\ z_{c1} \\ z_{c2} \\ z_{c3} \end{bmatrix} + \gamma'_a \begin{bmatrix} \bar{y}_1 \\ \bar{y}_2 \\ \bar{y}_3 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \gamma'_b \begin{bmatrix} 0 \\ 0 \\ 0 \\ \bar{y}_1 \\ \bar{y}_2 \\ \bar{y}_3 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \gamma'_c \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \bar{y}_1 \\ \bar{y}_2 \\ \bar{y}_3 \end{bmatrix} - \beta_1 \gamma'_a \begin{bmatrix} \bar{x}_1 \\ \bar{x}_2 \\ \bar{x}_3 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \beta_1 \gamma'_b \begin{bmatrix} 0 \\ 0 \\ 0 \\ \bar{x}_1 \\ \bar{x}_2 \\ \bar{x}_3 \\ 0 \\ 0 \\ 0 \end{bmatrix}
$$

$$
-\beta_1 \gamma'_c \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \bar{x}_1 \\ \bar{x}_2 \\ \bar{x}_3 \end{bmatrix} - \beta_2 \gamma'_a \begin{bmatrix} \bar{z}_1 \\ \bar{z}_2 \\ \bar{z}_3 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \beta_2 \gamma'_b \begin{bmatrix} 0 \\ 0 \\ 0 \\ \bar{z}_1 \\ \bar{z}_2 \\ \bar{z}_3 \\ 0 \\ 0 \\ 0 \end{bmatrix} - \beta_2 \gamma'_c \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \bar{z}_1 \\ \bar{z}_2 \\ \bar{z}_3 \end{bmatrix} + \phi_a + \phi_b + \phi_c + \mu_{it}.
$$

Here, ϕ_a, ϕ_b, and ϕ_c are cross-sectional fixed effects, and μ_{it} a well-behaved error-term. The parameters $\gamma'_{a,b,c}$ are related to the γ_i's from equation (29) as follows: $\gamma'_i = \frac{\gamma_i}{\bar{\gamma}}$ for $(i = a, b, c)$. The estimation at hand is straightforward to implement since all vectors in the estimated equation can be constructed from the original dataset.

An interesting remark is that if the six β's that appear together with the γ's are not restricted to be equal to each other and equal to the first two β's (i.e. estimating the additional parameters $\gamma_a'^1$, $\gamma_b'^1$, $\gamma_c'^1$, $\gamma_a'^2$, $\gamma_b'^2$, and $\gamma_c'^2$ instead of the linear combinations $\beta_1\gamma'_a$, $\beta_1\gamma'_b$, $\beta_1\gamma'_c$, $\beta_2\gamma'_a$, $\beta_2\gamma'_b$, and $\beta_2\gamma'_c$), the number of common factors allowed in the model is not restricted to one. This, however, results in the necessity to estimate a great number of parameters, depending on the number of cross-sections and explanatory variables.

F.3 Application to yield spreads

The CCEP estimator (Pesaran, 2006) is only rarely used in the yield spread literature. Nevertheless, Erdal and Özge (2015) and Özatay et al. (2009) show that there may be a significant scope for analysis. Based on Pesaran (2006) and Kapetanios et al. (2006), they discuss some of the beneficial properties of the use of the CCEP estimator to model yield spreads. Of course, the single most attractive feature is the fact that the CCEP framework allows to find consistent estimates for the parameters β^k in equations such as (12) without explicitly including some proxy for the global risk environment. In CCEP estimations, the inherent unobservable character of the risk environment is captured by allowing unobserved time series to influence the dependent variable heterogeneously across cross-sections. The CCEP estimator, in addition, is a consistent and efficient estimator even when the unobserved common factors are nonstationary. Moreover, the possible invalidation of inference due to cross-sectional dependence, a common problem in macroeconomic panel data, is eliminated to the extent that the cross-sectional dependence results from the influence of common factors.

A first important drawback of the use of the CCEP estimator in modelling yield spreads is its inability to quantify the direct impact of the global risk environment. The interaction effects can still be estimated, but that still requires the use of proxies for the unobserved risk factor. Another important drawback of the CCEP estimator in general is its intensive consumption of degrees of freedom. If the number of common factors allowed in the estimated model is not restricted to one, the number of parameters to be estimated equals $k + n(2 + k)$, with k the number of explanatory variables and n the number of cross-sections. For the model in table 5 this means the use of 508 degrees of freedom. With only 576 observations in the sample, this model is not likely to be useful. Moreover, considering the conclusion from subsection 4.5.3 that the identified relations mainly stem from the post-2007Q2 period, the available number of degrees of freedom may in effect be considerably smaller than 576, since a considerable part of the sample (the pre-2007Q2 period) does not provide any information on the relations of interest.

Taking into account the latter drawback, it may be necessary to reduce the number of explanatory variables. We may for example opt to leave out the $x_{it}^m x_{it}^n$-interactions and focus on establishing a direct relationship. Although the conclusions from the fixed effects framework showed that this may discard a great deal of important relationships through interaction effects, this approach would be in line with the traditional attention of the existing literature. In addition to reducing the number of explanatory variables, imposing the presence of only one common factor, as in the derivation of equation (29), also strongly reduces the consumption of degrees of freedom.

In order to avoid the necessity to make the trade-off between preserving degrees of freedom on the one hand and not imposing the restriction of the presence of only one common factor on the other hand, a variety of models is estimated. The interactions with the risk factor are, in line with the fixed effects estimations, estimated in threefold: once using the US high yield spread, once using the European yield spread, and once using the CISS index. The results are not sensitive to the included risk factor.

To summarize the results, we find considerable evidence supporting a direct relationship between the NIIP and spreads. More elaborately, a gap in the NIIP-to-gdp-ratio vis-à-vis Germany of 10% of gdp results, on average, in a spread that is 10 to 15 base points higher, regardless of the risk environment. Also a higher government debt leads in all specifications to higher spreads. In most specifications, higher debt service has the counterintuitive effect of reducing spreads. As in previous estimations also net exports is counterintuitively associated with spreads. In some specifications a higher primary balance is found to significantly reduce spreads.

Turning to the interaction effects, a first conclusion is very reassuring: the interaction between the NIIP and the risk factor in the CCEP estimation is very close to the estimates for that interaction in previously reported results. Moreover, it is rarely insignificant. A second conclusion is not so much in line with the previously reported results. The interaction between government debt and the risk factor is always negative (and generally significantly so). This observation suggests that a more risk averse global investing environment leads to smaller spread increases for countries with a high government debt.

Moreover, the CCEP estimator challenges some conclusions of the fixed effects estimations in the main text. First, although it is not recognized by the fixed effects estimations, there may well be a direct relationship between spreads and the NIIP. Second, the debt*risk interaction is problematic when using the CCEP estimator. Third, the counterintuitive relationship between net exports and spreads appears both in the fixed effects estimations and in the CCEP estimations.