Implied Default Risk in European Interbank Lending Markets

By

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Abstract

This project analyzes the spread arising from trading in two portfolios based on the European debt and interbank lending markets. The analysis uses data on sovereign credit default swap spreads, zero-coupon bond yields, European Interbank Offered Rate (EURIBOR) and Euro-denominated plain vanilla interest rate swaps. I focus on the countries that are most embroiled in the European debt crisis: Portugal, Italy, Greece and Spain. The first portfolio I study contains a long position in a 5-year sovereign bond and long position in a sovereign credit default swap that expires in 5-years. The second portfolio consists of rolling over 6-month EURIBOR deposits and selling a 5-year fixed-for-floating interest rate swap. The portfolios are theoretically equivalent in terms of cash flow, and the spread between these investment strategies can be viewed as the implied default risk involved in trading in the interbank market. The spread between the return earned from Portfolio 1 and Portfolio 2 is the implied cost of insuring a EURIBOR bank deposit.

Keywords: EURIBOR; interbank lending; default risk; credit default swap; sovereign debt; interest rate swap
Dedication

This paper is dedicated to my parents and my sister for their love and encouragement throughout my education.
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I would like to thank my supervisors, Robert Jones and Alex Karaivanov, whose insights, guidance and support were an integral part of this process.
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1. Introduction

Financial markets experienced unprecedented levels of volatility in recent years. Beginning with the US mortgage crisis in late 2008, increased fear of counterparty default has pushed bank funding spreads to record-highs. Much of the liquidity stress on banks was transmitted through the interbank lending market, or “shadow banking” sector. Banks used this market to park their large deposits with other institutions to earn a nominal return over the short term, and most depositors accepted this practice as “risk-free”, though they have no legal recourse if a bank were to default. Such deposits are unsecured and not protected by depositors’ insurance (Thornton, 2009).

From late 2009, as markets began to recover from the banking crisis in the US, fears of a sovereign insolvency developed among global investors concerning some European nations, and by early 2010, markets were in a full-blown panic. Yields on sovereign debt issued by Portugal, Italy, Ireland, Spain, Greece and other members of the 17-nation monetary union rose precipitously over the course of a few weeks. Figure 1 shows the rise in yields on distressed European debt, while Figure 2 shows the relatively more stable Dutch, French and German bond markets. The catalyst for the crisis of confidence was the discovery that Greece’s debt-to-GDP ratios had reached 113%, well in excess of the 60% limit imposed by the currency union (Greece’s debt, 2011). This spurred closer examinations of the fiscal strength of other countries in the area. Regulators found that, in addition to high levels of debt for the distressed nations, countries were also experiencing stagnant economic growth and inadequate tax revenue collection. Successive downgrades of sovereign debt in the area reflected the increased likelihood that the states would default on their obligations and put additional pressures on the ability for countries to fund their operations. In the case of Greece, what began as liquidity risk evolved into a solvency crisis (European sovereign debt, 2011).

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1 Moody’s Ratings announced the following downgrades in recent years:
Volatility in financial instrument pricing during these periods of turmoil put into question a well-known no-arbitrage condition between bonds, credit default swaps and interest rate swaps based on EURIBOR. In particular, this study examines the possibility of arbitrage opportunities between two theoretically risk-free positions: one, a long position in a sovereign bond and its corresponding credit default swap and another, a short position on a plain-vanilla interest rate swap. It will be determined whether arbitrage opportunities arose during times of market stress, and whether these opportunities are the result of investors’ concerns about increased default risk in the interbank lending market. The motivation for using European sovereign debt as the benchmark portfolio is to observe the change in the size and magnitude of the spread as the possibility of sovereign default increased. The periods of focus are from 2004 Q1 to 2007 Q4 (“normal market”), 2008 Q1 to 2009Q4 (“financial crisis”) and 2010Q1 to 2011 Q2 (“sovereign debt crisis”).

**Figure 1: 10-Year Yields on Distressed European Debt**

![Graph showing 10-Year Yields on Distressed European Debt](source: Bloomberg)

- **Portugal** – A1 (from Aa2) on 7/13/10, A3 on 3/15/11, Baa1 on 4/15/11, Ba2 on 7/15/11
- **Italy** – A2 (from Aa2) on 10/4/11
- **Greece** – A2 (from A1) on 12/22/09, A3 on 4/22/10, Ba1 on 6/14/10, B1 on 3/7/11, Caa1 on 6/1/11, Ca on 7/25/11
- **Spain** – Aa1 (from Aaa) on 9/30/10, Aa2 on 3/10/11, A1 on 10/18/11

Fitch and S&P rating agencies announced analogous downgrades.
The first section of this paper describes the financial instruments and their behaviour during the recent market disturbances, namely the banking crisis in 2008/2009 and then the ensuing sovereign debt crisis in 2010 to present. The theory behind the no-arbitrage conditions and construction of the portfolios will be discussed in the second section. The third section will describe the data and methodology, and the results and conclusions will be discussed in the final sections.
2. Financial Market Conditions: Overview

2.1 Interbank Lending

The interbank lending market refers to the subset of bank-to-bank transactions that take place in the money market, a part of the financial system where investors can trade in short-term instruments and access liquidity funding. Banks make short-term loans to each other in the interbank lending market, generally for one week to 12-months. The rate of interest that is charged is called the EURIBOR, an acronym for European Interbank Offered Rate. The rate itself, which rises and falls with the overnight rate set by central banks, has little information regarding credit risk; instead, analysts often observe the so-called EURIBOR-OIS spread as an indicator of risk. The overnight indexed swap (OIS) is a form of interest rate swap, where the buyer receives the fixed rate on a notional amount, called the OIS rate, in exchange for the geometric average of a reference rate for overnight deposits. For Euro dollar deposits, the reference rate is the Euro Overnight Index Average (EONIA). These deposits are essentially unsecured loans, paid to “rent” another bank’s overnight deposit at the central bank and they do carry default risk. However, it is assumed that the market can more accurately gauge default one day in advance, and hence, this default risk is small. The spread between the EURIBOR and OIS is considered an indicator of liquidity and relative stress in the money markets. When perceived credit risk is high, depositors will demand a higher premium for longer deposits (Thornton, 2009).

The behavior of the EURIBOR-OIS spread provides significant information regarding the perceived riskiness of unsecured deposits with banks. For instance, the average spread was roughly 12 basis points between January 1, 2004 and December 31, 2007. The spread had begun to widen in August of 2007, as banks began to reveal large losses on consumer loans and mortgage-backed securities. The average for the subsequent 2 years (ending December 31, 2009) was 87.5 basis points, over 7 times the previous average. Furthermore, at the peak of the financial
crisis on October 10, 2008, the funding spread had widened to 215bps. Another way to put it, banks required 2.15% more per annum to deposit their funds with a bank for 6 months, versus the alternative of depositing directly with the central bank. Chart 1 shows how this spread has behaved over the entire sample period.

**Figure 3: EURIBOR-OIS Spread for the period beginning 2004 Q1 to the end of 2011 Q2**


### 2.2 Interest Rate Swaps

Interest rate swaps are the most widely traded derivative, according to the ISDA, and like credit default swaps, they are traded over-the-counter (2010). The instruments allow two parties to exchange interest rate cash flows and are commonly used to hedge risk from other investments. The payments from each counterparty, or “leg” of the swap, will be defined in terms of currency and interest rate and based on a notional amount. The most basic form of the swaps is called fixed-for-floating, same currency swaps (or “plain vanilla” swaps). The party that pays the fixed rate leg is said to be long on the swap and is bullish on interest rates for the duration of the swap contract. For example, on June 30, 2011, a 5-year, fixed-
for-floating rate EUR-denominated swap is quoted at 2.81%. The investor that is long on the swap will pay 2.81% interest annually, over 5 years, on the notional amount of the contract and receive EURIBOR (plus a fixed spread of some number of basis points, if specified in the swap contract) on a semi-annual basis. For the sake of illustration, suppose that the EURIBOR rate is also 2.81%. If interest rates remain unchanged over the life of the contract, then the net cash flow exchanged will be zero. If the investor believes that interest rates will rise in the future, the investor expects to receive cash flows from his counterparty.

The spreads on interest rate swaps over yields of comparable German bunds widened during the financial turmoil. At the peak of the banking crisis, the spread on a EUR-denominated swap over a generic 5 year German bund widened to over 100 basis points, from an average of 19 basis points over the preceding 3 years. Part of the widening could be due to increased demand for the safety and liquidity of sovereign bonds. However, it is conceivable that swap spreads were also affected by a perceived increase in counterparty credit risk in swaps. Some securities, such as commodities are traded through exchanges or brokers and investors are required to post collateral, called a margin, in the form of cash or “safe” securities to cover some or all of their counterparty’s credit risk exposure. As these contracts are not subject to margining nor are they mediated through an exchange, therefore, either party can be exposed to counterparty risk, depending on how the yield curve has changed since the initiation of the contract (Matordomo, Peña, & Romo, 2009).

2.3 Credit Default Swaps

The size of the CDS marketplace has grown from $918 billion notional outstanding in 2001 to $62.1 trillion at its peak in 2007 (ISDA, 2010). Since its early days as a means to free up regulatory capital, other CDS variations have developed,

---

2 While a much quoted statistic in financial commentary, it is somewhat misleading. CDS contracts, like many other options contracts, cannot simply be terminated. To unwind a position, investors must engage in another contract of equal notional value. For example, to exit from a long position (buy protection) on a 5-year, $10 million notional CDS, an investor must sell protection for the same maturity and notional value. In this case, the net value protected in the marketplace is $nil.
such as basket default swaps, indexed CDS, funded CDS, as well as loan-only CDS. In addition to corporate entities, CDS can be purchased on sovereign governments, special purpose vehicles, as well as issuers of asset backed securities. The variations available do not stray away from the basic credit default swap contract. Though the contracts are the second most prevalent form of derivatives behind interest rate swaps, they are traded “over-the-counter” (rather than on an exchange) and there exist only few, if any, regulatory restrictions at the global level (Mengle, 2009).

In light of the escalating situation in the Eurozone, investors began to hedge their exposure to a sovereign default. This is often done through entering into so-called “credit default swaps”, that is, contracts that provide protection for the face value of a bond or loan issue by a debtor. Similar to insurance, the buyer enters into a contract with a seller, who promises to protect the buyer against a loss event, which would erode the value of the asset. In this case, unsecured loans, or bonds, are the assets under protection. The buyer engages in two markets, the asset market and the derivatives market. In the asset market, the buyer provides an unsecured loan to a third-party, the reference entity. In this case, the reference entity is the sovereign state. In the derivatives market, the buyer purchases protection in the form of a credit default swap. The buyer pays a fee (“the CDS spread”) to the insurer, the magnitude of which should monotonically reflect the likelihood of default. The assets under protection can be sold to the insurer for its face value if the third-party is deemed to be in default, as defined in the bond covenants. In its simplest form, a single-name bond CDS contract can be purchased to cover a notional dollar amount of loss from default by a debt-issuing entity, in exchange for an annual premium, paid over the life of the contract. For example, an Insurer may offer a contract to cover default by country X over the next 5 years, up to $10 million, for a fee of 150 basis points (bps) per annum. The fee of 150 bps translates to 1.5% of the notional value (or $150 000 per year). If country X experiences a default event, as defined by the CDS contract, at any time during those 5 years, the Policyholder can deliver the bonds issued by X, up to the notional amount, in exchange for $10 million in cash. Chart 2 shows the evolution of sovereign credit default swaps over the past 7 years.
The increasing cost of CDS over this period is indicative of the increasing likelihood of default for the countries in this study.

Convention for CDS payment changes as an entity becomes more risky to insure. Though not part of the sample period in this study, the cost for a credit default swap contract on 5 year Greek sovereign debt rose to 7318.25 basis points in September 2011, which prices in a 98% chance of default. The seller of CDS demanded $5.8 million upfront and $100,000 annually to insure $10 million of Greek debt for up to 5 years (Moses, 2011). Market convention usually dictates upfront payments when annual payments would exceed $100,000 or $500,000, depending on the contract negotiated.

**Figure 4: Sovereign Credit Default Swap Spreads between 2004 and 2011**

![Sovereign Credit Default Swap Spreads](image)

Source: Bloomberg

### 2.4 Sovereign Bonds

Yields on European sovereign debt have risen to record high levels in recent years. For example, the implied zero-coupon yield on a 5 year Greek issue increased to 18.25% on June 16, 2011. The historical average from 2004 to 2007 was 3.65% and sovereign bond yields above 6% are viewed to be unsustainable (Greenspan, 2011). The higher yields reflect investors' demand for a greater premium to compensate for this additional risk. Traditionally, valuation of government debt
issued by developed country sovereigns has treated default as a very low probability event. Hence, modelling is typically oriented towards interest rate risk or liquidity risk, rather than default or counterparty risk (Cantor & Packer, 1996). The situation in Europe is unique, as the formation of a currency union limits the range of tools each individual nation has to rebalance their books. In particular, many countries with control over their currency will choose to inflate away exceedingly unmanageable debt obligations (Sturzenegger & Zettelmeyer, 2007). Euro-zone countries, barring an exit from the union, have limited monetary control, and thus, a combination of fiscal austerity measures and co-ordinated default are the only options at this time.

Some notable economists, including former Federal Reserve Chairman Alan Greenspan, cite the formation of the monetary union as major reason for the debt crisis (2011). Yields on Spanish, Italian, Portuguese and Greek bonds were historically much greater than the yields on issuance since adopting the euro. However, since the creation of the euro, periphery Eurozone nations have enjoyed bond yields similar to the yields of neighbouring Germany and France. The cheap credit allowed the economies of Greece, Italy, Portugal and Spain fund their growth through global credit markets. Firms were able to pay high wages, business earned large profits and governments created generous social programs, similar to those of their wealthy neighbours to the north. However, the structural insufficiencies of Southern European economies did not justify the low yields of sovereign debt. The countries in the periphery are relatively uncompetitive in terms of trade, have a low productivity work force, unsustainable demographic mix and poor revenue collection practices to support their massive fiscal deficits. Furthermore, the savings rates amongst households in France and Germany vary drastically from those in Greece, Italy, Portugal and Spain. The cultural divide, evidenced from household to the state level, helped generate the massive debt-to-GDP ratios that plague Southern European countries. The strength of the euro and the low yields on Euro-denominated sovereign bonds better reflect the fiscal positions, current account balances and productivity of the German and French economies.
Between 2008 and 2010, many European nations expanded their balance sheets, using the funds mainly to help their domestic banking sectors weather to global economic turmoil triggered by the US sub-prime mortgage crisis. The debt-to-GDP levels increased roughly 20% for the sample of countries in Table 1. There is an expectation that governments will wind down their balance sheets as the economy recovers in their respective countries. However, the onset of the sovereign debt crisis has hampered economic growth in even fiscally strong countries and the debt-to-GDP ratio remains high across most of the Eurozone. While countries like the Netherlands and Germany are still able to borrow, and at even lower yields than before the sovereign debt crisis, other countries are being penalized for their high debt levels. The main difference in the Northern European economies is their competitive export market, both within Europe and internationally, as reflected in their current account balances (Greenspan, 2011).

Table 1: The North-South Divide

<table>
<thead>
<tr>
<th></th>
<th>Average Yield pre-Crisis</th>
<th>Average Yield since Crisis</th>
<th>Debt-GDP in 2007</th>
<th>Debt-GDP in 2010</th>
<th>Current Account</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>4.57%</td>
<td>6.32%</td>
<td>63.60%</td>
<td>92.90%</td>
<td>-8.94%</td>
</tr>
<tr>
<td>Italy</td>
<td>4.54%</td>
<td>4.28%</td>
<td>103.47%</td>
<td>119.00%</td>
<td>-3.92%</td>
</tr>
<tr>
<td>Greece</td>
<td>4.85%</td>
<td>10.61%</td>
<td>89.50%</td>
<td>142.80%</td>
<td>-10.36%</td>
</tr>
<tr>
<td>Spain</td>
<td>4.41%</td>
<td>4.63%</td>
<td>36.20%</td>
<td>60.10%</td>
<td>-9.56%</td>
</tr>
<tr>
<td>Germany</td>
<td>4.20%</td>
<td>2.90%</td>
<td>64.90%</td>
<td>83.20%</td>
<td>5.55%</td>
</tr>
<tr>
<td>France</td>
<td>4.31%</td>
<td>3.25%</td>
<td>63.90%</td>
<td>82.40%</td>
<td>-0.02%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>4.35%</td>
<td>3.14%</td>
<td>45.50%</td>
<td>62.60%</td>
<td>6.46%</td>
</tr>
</tbody>
</table>

^Yield is on 10 year benchmark government issue. Source: Bloomberg

^^Pre-Crisis: 1999Q1 - 2009Q4 Since Crisis: 2010Q1 - 2011Q2

^^^ Current Account as a % of GDP as of 6/30/11

Source: IMF World Economic Indicators
3. Cash-and-Carry Strategy

To test the idea that the EURIBOR rate is inherently risky, two portfolios are constructed, one using a fixed rate sovereign bond and a credit default swap, the other uses a vanilla interest rate swap and a rolling EURIBOR deposit. Suppose a bank has €10 million that it needs to park; it has the option to lend the money to a government in the form of a bond purchase, and protect against a sovereign default with a purchase of a CDS, or it can deposit the cash with another banking institution in exchange for EURIBOR and sell an interest rate swap at EURIBOR to lock in a fixed return. If banks believe that EURIBOR deposits are more or less default-free, as was the case was for years prior to the 2008/09 financial collapse, then both of these positions will reveal the cost of funding a default-free position over 5-years. These two assets (or portfolios) are theoretically equivalent in terms of payoffs and liquidity, and any observed spread between these funding strategies, defined as the difference in return on investment, can be viewed as compensation for the expected flow of default losses from trading in the interbank market. The magnitude of this spread will give an indication of the implied cost of risk in the interbank funding markets. The spread, which is the return expected on an investment in Portfolio 2 less the return on an investment in Portfolio 1, will be constructed for distressed European countries, Portugal, Italy, Spain and Greece.

3.1 Portfolio 1 - Credit Default Swap and Sovereign Bond

This portfolio is constructed by making a loan to a sovereign nation, in the form of a €10-million bond purchase, and purchasing a credit default swap from a derivatives dealer. The bond provides a stream of coupon payments to the bondholder, on a semi-annual basis, while the credit protection premiums are paid to the dealer on a quarterly basis. The final payment to the bondholder consists of the face value of the bond and the last coupon payment. The cash flows are illustrated in Figure 5a. As we are using this portfolio as the base case, the
assumption is that the credit default swap dealers will not default; the investor’s position is fully hedged. A further assumption on this portfolio is the fact that there is no upfront payment required. In “normal” markets, this is an appropriate assumption. However, during times of stress in sovereign bond markets, the CDS spreads widen to levels where dealers would likely require an upfront fee and this assumption is violated. This will be discussed in the results.

Figure 5a: Cash flows from a long position in a Sovereign Bond and corresponding CDS

3.2 Portfolio 2 - Interest Rate Swap and EURIBOR Deposit
Most EUR-denominated interest rate swaps use the EURIBOR as the reference rate. The quoted rate on the interest rate swap is on the fixed rate portion of the contract; in general, the rate received on the floating leg will be EURIBOR plus a basis point spread, as determined between parties in the contract. The asset swap package consists of a deposit at EURIBOR, rolled over for 5 years plus a fixed-floating interest rate swap. We receive EURIBOR plus our €10-million principle at the end of 6-months, and redeposit with the bank. This is illustrated in Figure 5b. This rolling-over of the deposit would only be done if the deposit-accepting bank is still a
Figure 5b: Cash flows from a long position in a EURIBOR deposit and short position in a fixed-for-floating, EUR denominated interest rate swap

Investor makes a €10-million deposit for 6 months with a EURIBOR-worthy bank

Investor sells a 0.7% annual fixed-for-floating interest rate swap, based on EURIBOR

Interest rate swap counterparty pays fixed interest rate on €10-million notional to Investor

Investor pays EURIBOR to interest rate swap counterparty

0

0.5

1

5

Bank pays EURIBOR to Investor
Investor pays EURIBOR to interest rate swap counterparty

This pattern of cash flow repeats until the end of the interest rate swap contract at year 5.

No Default Case:
Investor rolls over deposit with the same bank
OR
Investor deposits with a different EURIBOR-worthy bank if current institution has been downgraded

Default Case: Investor invests another €10-million with a EURIBOR-worthy bank, in order to keep funding their interest rate swap commitment

EURIBOR quoting bank. We will assume that the bank will always accept deposits. If the bank’s rating has fallen during this time receive EURIBOR plus our €10-million principle at the end of 6-months, and redeposit with the bank. This is illustrated in Figure 5b. This rolling-over of the deposit would only be done if the deposit-accepting bank is still a EURIBOR quoting bank. We will assume that the bank will always accept deposits. If the bank’s rating has fallen during this time (i.e. is no longer providing a quote for the EURIBOR calculations), the investor can deposit with another EURIBOR bank. This will not affect the results. Over the one-year swap contract, we pay the swap counterparty the EURIBOR funds we receive from the bank for our deposit. In return, the counterparty will pay us the agreed upon fixed-rate. For our purposes, we will also assume that the counterparty on the interest rate swap is a third-party, different from the institution we have deposited with. If the deposit-accepting bank and the swap counterparty were the same entity, we
would introduce endogeneity in the probabilities of default for the interest rate swap and for the deposit. We take the probability of default by the interest rate swap counterparty as given.

3.3 Cash-and-Carry Strategy: Is this a true arbitrage opportunity?

The EURIBOR rate was widely regarded as a risk-free rate of return in financial markets. The banks that accept deposits and provide quotes have “a first class credit standing, high ethical standards and an excellent reputation”. Many financial institutions take this to mean that the probability of bank default on EURIBOR deposits is minimal, which suggests that the two portfolios created for this study are theoretically equivalent in terms of risk, subject to all of the assumptions made. However, during times of stress in the market, a crisis of confidence arises and there is an increase in perceived risk amongst lenders and borrowers. In particular, banks are no longer willing to lend to one another, or require higher premiums to accept risk.

We assume in that the assumptions of the fundamental theorems of asset pricing hold. Specifically, the necessary and sufficient conditions for a market to be arbitrage-free are market completeness and the derivative’s price is the discounted expected value of the future payoff under the unique risk-neutral measure. This risk neutrality is constructed by constructing all the future probabilities of loss such that it incorporates all the risk premia that would be paid under real-world expectations. This is called the risk-neutral probability distribution and it is used to value the derivatives, by taking the expected value of future payoffs. Thus, the condition of no-arbitrage is satisfied.

Finally, we also assume that there are zero-transaction costs. In reality, trades are costly and there will be a threshold greater than zero for which engaging in these trades will be profitable to the investor (Hull, 2005).
4. Data and Methodology

Four types of data were collected over the period January 1, 2004 to June 30, 2011. The longer focus of this study allows for the comparison of the spread during the three notable periods in recent financial history. The period from 2004Q1 to 2007Q4 will be the baseline for “normal market conditions” in this study. Due to the severely limited credit conditions that European financial institutions faced in the wake of the US banking crisis, the period from 2008Q1 to 2009Q4 will also be analyzed. Lastly, from 2010Q1 onward, global financial markets became increasingly concerned over the sovereign debt of some Eurozone nations. In particular, this study focuses on the four nations that have the largest debt-to-GDP ratios, namely, Portugal, Italy, Greece and Spain.

The financial instruments needed to create the portfolio positions are sovereign bond yields, credit default swap spreads, interbank lending rates and interest rate swap spreads. The following time-series data were extracted from Bloomberg.

4.1 Sovereign Zero-Coupon Bond Yields Indexes

These yields are derived by stripping the par coupon curve and are calculated using Bloomberg’s yield curve application. Using a set of coupon bonds, bills, swaps or a combination of these instruments, the discount factors are calculated for each tenor, using standard bootstrapping methods. The discount factors are then used to infer the zero-coupon yield (Rate profile, n.d.).

The zero-coupon bond yields are used to create an index of daily par yields, the yield-to-maturity required on the sovereign bond in order for it to sell at face value. On the par yield curve, the coupon rate will equal the yield-to-maturity of the security, which is why the bond will trade at par. The par yield index is created by solving for the coupon rate, \( R \), given the zero-coupon yields, \( r_t \), in the following:
\[
\frac{R}{2} \sum_{t=1}^{10} \left\{ \frac{1}{1 + \left( \frac{r_t}{2} \right)^t} \right\} + 100 \frac{1}{1 + \left( \frac{r_{10}}{2} \right)^{10}} = 100
\]

where \( t = 0.5, 1, 1.5, 2, ..., 10 \) for the number of years until that payment stream is received.

### 4.2 Credit Default Swap Spreads

Bloomberg reports a composite index of CDS spreads quoted by 3rd party contributors. As these derivatives are traded “over-the-counter”, meaning there is no central clearing house through which margins are posted and trades are recorded, it is unclear whether or not the prices quoted by the contributors are actually transacted upon. However, given the construction of the composite, the index price is in the mid-range amongst the contributors and it can be assumed that, for a given index price, there is at least one protection seller willing to transact. Since these payments are made quarterly to the derivatives dealer, the quoted annual rates are discounted using the own-country 3-year zero-coupon yields, as downloaded from Bloomberg. The justification of using the 3-year yield is that it is approximately half-way through our funding horizon. Assuming that the yield curve is not humped, the 3-year yield is a good proxy for the return that the funds could have otherwise earned.

### 4.3 European Interbank Offered Rate (EURIBOR)

The EURIBOR is a rate based on the averaged interest rates at which Eurozone banks offer to lend unsecured funds to other banks in the euro wholesale money market. It is often used as a reference rate for other financial instruments, such as floating rate bonds and credit derivatives. The EURIBOR is quoted for spot value and on an Actual/360 day-count convention. The rate is calculated daily by a third-party; after panel banks submit their quotes for all 15 EURIBOR maturities, the top and bottom 15% of quotes are eliminated and published rate is the average of
remaining quotes (EURIBOR). As these funds are rolled over every 6 months, then the cash flows are already semi-annual (European Banking Federation, 1997).

4.4 Fixed-for-Floating Interest Rate Swap
These derivatives allow one party to exchange a stream of interest payments for another party’s stream of cash flows. Most swaps are entered with dealers, who then seek to limit their exposure to interest rate risk by entering into off-setting swaps with other counterparties. In addition to swap dealers, major market participants include financial institutions and other corporations, international organizations such as the World Bank, government-sponsored enterprises, corporate bond and mortgage-backed securities dealers, and hedge funds (Mengle, 2009). Since the fixed legs of these swaps are paid annually, the payments were discounted using the German 3-year zero-coupon yield.

4.5 A Note on Discounting
Two of the instruments in question have payments at semi-annual intervals, and cash flows did not need to be adjusted: sovereign bond coupons and the EURIBOR payments. However, credit default swap fees are paid at quarterly intervals, while the fixed leg of the interest rate swap is paid at annual intervals; both instruments required “adjustment” in order to value the cash flows at semi-annual intervals. As this paper tests the validity of treating the EURIBOR rate as risk-free, it cannot be used as the discount factor. The 3-year German bund yield is reasonable proxy for the discount factor for the interest rate swap as the Germany economy is fiscally sound and its debt is also denominated in euros, thus its yield is a reasonable proxy for the return that could have otherwise been earned. However, to maintain the unique characteristics of countries which may be reflected in the sovereign yield, own-country 3-year yields were used to discount sovereign credit default swap spreads. The streams of payment from both the CDS and sovereign bond terminate if and when default occur, regardless of whether the instrument has reached maturity. The fair-market value of the contracts is computed by using the expected present value of the cash flows, E*[PV] under “risk-neutral probabilities”.
The present value is given by discounting at the appropriate risk-free interest rate. For a given promised future payment, $E^*[PV]$ is multiplied by the risk-free present value factor and then, multiplied by the probability of survival to that date. This is given by:

$$e^{-rt} \times e^{-pt} = e^{-(r+p)t}$$

where $p$ is the probability of default to year $t$, and $r$ is the risk-free rate. The combined $(r+p)$ term is the discount rate implied by the bond prices and the CDS rate. Since one of the assumptions is that default is discovered only at the end of the contract and there is zero recovery in the event of default, this discount rate is given by the own-country par coupon yield for the $t$-year bonds. If there is an assumption of partial recovery, the probability of default can be replaced with $(1-v)p$, where $v$ is the proportion of recovery.

The return generated from Portfolio 1 is the yield received on the investment in the sovereign bond less the payment for the credit default swap. This is calculated for a €10 million investment in bonds from Portugal, Italy, Greece, Spain and Germany.

**Sovereign Bond Yield less CDS premium = Return on investment in Portfolio 1**

By investing €10 million in Portfolio 2, the investor receives EURIBOR from the deposit-taking bank and passes this payment through to the interest rate swap counterparty. In exchange, the investor receives the fixed interest rate swap rate. This is the return on Portfolio 2.

**Fixed interest rate swap rate = Return on investment in Portfolio 2**

The spreads analyzed in this study are the differences between the return on an investment in Portfolio 1 for a specific country and Portfolio 2.
A positive spread is interpreted to be a compensation for the additional risk an investor takes on to deposit with a EURIBOR bank, rather than to invest in an insured, government bond. If a hypothetical five year CDS on EURIBOR deposits existed, then it is expected that the cost of this hypothetical swap would be priced equivalent to the positive spread between Portfolio 2 and Portfolio 1. The two portfolios would then be identical: the investor would have the same upfront cost, receive the same fixed flow of payments over 5 years and face the same risk (in this case, zero risk as both positions are covered by a non-defaulting CDS counterparty). The spread between Portfolio 1 and Portfolio 2 is the implied cost of insuring a EURIBOR bank deposit.

To illustrate the construction of the return and the spread, we will use the data for Greece on October 9, 2008.

### Table 2: Calculating the implied cost of EURIBOR default – An Example

<table>
<thead>
<tr>
<th></th>
<th>basis points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual CDS fee</td>
<td>82</td>
</tr>
<tr>
<td>3 year Greek yield</td>
<td>406</td>
</tr>
<tr>
<td>Adjusted Semi-Annual CDS fee</td>
<td>41</td>
</tr>
<tr>
<td>Zero-coupon par yield</td>
<td>217</td>
</tr>
</tbody>
</table>

**Return on Portfolio 1**

217 - 41 = 176

**Portfolio 2:**

<table>
<thead>
<tr>
<th></th>
<th>basis points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate swap</td>
<td>433</td>
</tr>
<tr>
<td>3 year German yield</td>
<td>325</td>
</tr>
<tr>
<td>Adjusted Semi-annual interest rate swap</td>
<td>215</td>
</tr>
<tr>
<td>EURIBOR</td>
<td>545</td>
</tr>
</tbody>
</table>

**Return on Portfolio 2**

545 - 215 = 330

**Spread = Portfolio 2 return less Portfolio 1 return = 330 - 176 = 154**

This spread reflects the implied cost of insuring EURIBOR deposits on October 9, 2008, as calculated from Greek data. An investor who committed €10 million to Portfolio 1 with Greek bonds and CDS and Portfolio 2 would stand to earn an “arbitrage profit” of €154 000. However, EURIBOR deposits are not default-free as widely regarded by the market and as such, the risk profiles of the two portfolios are different. The €154 000 of “arbitrage profit” is actually the implied cost of insurance against default of a EURIBOR bank. The spread will differ depending on which set of country data is being used in the calculation. However, considering that market force will arbitrage away any significant differences, it is expected that the range of implied costs of insurance will be very small.
5. Results and Discussion

Table 3 summarizes the results of the spread calculated for each of the 5 countries. The result of our analysis provides some insight into how financial markets behave during times of bank stress. Examining the spreads in Figure 6a – 6e, it is clear that during the banking crisis in 2008/2009, there was a significant premium built into Portfolio 2 to compensate for the additional perceived default risk. From peak to trough, premium rose 377bps on average across the 4 distressed countries. The more distressed countries at the time (in terms of debt/GDP ratio and economic growth prospects) Portugal and Greece experienced greater swings in the spread, moving 405 bps and 450 bps, respectively, from peak to trough. The less distressed countries, Italy and Spain experienced smaller swings. During times of banking sector stress, in the “Financial Crisis” period, the standard deviation of the spread also widened for all countries. This is an indication that there were significant market dislocations and price discovery in these instruments was difficult. As a lack of liquidity and low transaction volumes were major factors in the market during those months, this is not a surprising result.

Figure 6a: Spread in Returns using Portuguese bonds and CDS
Figure 6b: Spread in Returns using Italian bonds and CDS

Figure 6c: Spread in Returns using Greek bonds and CDS
Figure 6d: Spread in Returns using Spanish bonds and CDS

Spain

Figure 6e: Spread in Returns using German bonds and CDS

Germany
<table>
<thead>
<tr>
<th></th>
<th>Portugal</th>
<th>Italy</th>
<th>Greece</th>
<th>Spain</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004Q1 to 2007Q4 - Normal Market</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>-56.89579</td>
<td>-57.5303</td>
<td>-58.4656</td>
<td>-44.7559</td>
<td>-56.3167</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>52.519477</td>
<td>51.68217</td>
<td>51.94231</td>
<td>46.5702</td>
<td>53.79262</td>
</tr>
<tr>
<td>Maximum</td>
<td>74.778032</td>
<td>71.16914</td>
<td>68.16735</td>
<td>76.3075</td>
<td>77.78197</td>
</tr>
<tr>
<td><strong>2008Q1 to 2009Q4 - Financial Crisis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>103.98228</td>
<td>99.5061</td>
<td>105.5447</td>
<td>101.0827</td>
<td>105.6928</td>
</tr>
<tr>
<td>Minimum</td>
<td>-168.455</td>
<td>-166.947</td>
<td>-174.93</td>
<td>-158.529</td>
<td>-164.274</td>
</tr>
<tr>
<td>Maximum</td>
<td>166.72047</td>
<td>164.8054</td>
<td>158.0569</td>
<td>165.4836</td>
<td>170.5308</td>
</tr>
<tr>
<td><strong>2010Q1 to 2011Q2 - Sovereign Debt Crisis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>-115.2384</td>
<td>-92.1704</td>
<td>-155.561</td>
<td>-95.6755</td>
<td>-85.8579</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>53.839922</td>
<td>29.99432</td>
<td>47.46139</td>
<td>31.40789</td>
<td>31.72694</td>
</tr>
<tr>
<td>Minimum</td>
<td>-238.3063</td>
<td>-143.689</td>
<td>-291.821</td>
<td>-148.598</td>
<td>-153.86</td>
</tr>
<tr>
<td>Maximum</td>
<td>-17.52057</td>
<td>-42.4773</td>
<td>-26.851</td>
<td>-25.6231</td>
<td>-18.6632</td>
</tr>
<tr>
<td><strong>2004Q1 to 2011Q2 - Entire Sample Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>-58.67585</td>
<td>-48.1067</td>
<td>-64.994</td>
<td>-45.842</td>
<td>-54.3848</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>77.223265</td>
<td>71.56769</td>
<td>82.30875</td>
<td>71.35567</td>
<td>70.61989</td>
</tr>
<tr>
<td>Minimum</td>
<td>-238.3063</td>
<td>-166.947</td>
<td>-291.821</td>
<td>-159.699</td>
<td>-164.274</td>
</tr>
<tr>
<td>Maximum</td>
<td>166.72047</td>
<td>164.8054</td>
<td>158.0569</td>
<td>165.4836</td>
<td>170.5308</td>
</tr>
</tbody>
</table>

Also, as expected, the standard deviation of the average across countries was quite minimal during “Normal Market” and “Financial Crisis” periods, 5.67 and 6.13 basis points, respectively. This is not surprising, as the market forces at work during these times affected all the countries similarly. Investors were fearful that bank failures in the US could affect the viability of banks in Europe. Systemic risk, which is the knock-on effect of one failed bank on the entire banking system, was elevated...
during the financial crisis due to the shortage of liquidity, as reflected in the higher EURIBOR rate (Table 4a).

Table 4a - Summary Statistics on EURIBOR and Interest Rate Swaps

<table>
<thead>
<tr>
<th>Period</th>
<th>Swap Rate</th>
<th>EURIBOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004Q1 to 2007Q4</strong> - Normal Market</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.67</td>
<td>2.99</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.58</td>
<td>0.93</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.62</td>
<td>1.92</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.9</td>
<td>4.92</td>
</tr>
<tr>
<td><strong>2008Q1 to 2009Q4</strong> - Financial Crisis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.57</td>
<td>3.08</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.84</td>
<td>1.73</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.61</td>
<td>0.99</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.21</td>
<td>5.45</td>
</tr>
<tr>
<td><strong>2010Q1 to 2011Q2</strong> - Sovereign Debt Crisis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>2.45</td>
<td>1.23</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.37</td>
<td>0.25</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.68</td>
<td>0.94</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.23</td>
<td>1.79</td>
</tr>
<tr>
<td><strong>2004Q1 to 2011Q2</strong> - Entire Sample Period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.4</td>
<td>2.66</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.78</td>
<td>1.33</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.68</td>
<td>0.94</td>
</tr>
<tr>
<td>Maximum</td>
<td>5.21</td>
<td>5.45</td>
</tr>
</tbody>
</table>

However, during the “Sovereign Debt Crisis” period, the standard deviation of the average spread across countries was 28.3, significantly higher than during other periods. This can be explained by the discovery of structural differences amongst the European countries. Investors were fearful of sovereign default by Greece, Spain and Italy, while France and Germany were seen as “safe-havens”, which are relatively secure debt markets. Adding to the cross country differences is the interconnectedness of the sovereign bond and banking systems. Under the Basel
rules, the global regulatory system for banks, the sovereign debt of any OECD country carries a zero risk-weight against bank capitalization requirements. Due to this rule, many banks were heavily invested in Eurozone sovereign debt, which was formerly considered safe investments. However, during the study period, both Portugal and Greece received bailouts, as their fiscal and economic deterioration was revealed, while the global economy kept a close eye on Spain. As observed in Table 4b, the par yield on zero-coupon sovereign bonds decreased for “safe-havens” bonds, such as German and Italian bonds, while the yields increased for distressed countries like Portugal, Greece and Spain.

Table 4b - Summary Statistics on Par Yields on Sovereign Bond Issues

<table>
<thead>
<tr>
<th></th>
<th>Portugal</th>
<th>Italy</th>
<th>Greece</th>
<th>Spain</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2004Q1 to 2007Q4 - Normal Market</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.56</td>
<td>3.6</td>
<td>3.63</td>
<td>3.5</td>
<td>3.49</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.52</td>
<td>0.55</td>
<td>0.52</td>
<td>0.54</td>
<td>0.51</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.57</td>
<td>2.57</td>
<td>2.64</td>
<td>2.47</td>
<td>2.52</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.68</td>
<td>4.8</td>
<td>4.75</td>
<td>4.68</td>
<td>4.64</td>
</tr>
<tr>
<td><strong>2008Q1 to 2009Q4 - Financial Crisis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>3.63</td>
<td>3.75</td>
<td>4.33</td>
<td>3.5</td>
<td>3.06</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.59</td>
<td>0.55</td>
<td>0.58</td>
<td>0.59</td>
<td>0.74</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.7</td>
<td>2.77</td>
<td>3.19</td>
<td>2.64</td>
<td>2.12</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.95</td>
<td>5.16</td>
<td>5.71</td>
<td>4.85</td>
<td>4.71</td>
</tr>
<tr>
<td><strong>2010Q1 to 2011Q2 - Sovereign Debt Crisis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>5.77</td>
<td>3.27</td>
<td>11.5</td>
<td>3.72</td>
<td>2.07</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>2.62</td>
<td>0.53</td>
<td>3.94</td>
<td>0.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Minimum</td>
<td>3.03</td>
<td>2.61</td>
<td>4.79</td>
<td>2.79</td>
<td>1.32</td>
</tr>
<tr>
<td>Maximum</td>
<td>13.45</td>
<td>4.27</td>
<td>20.8</td>
<td>4.96</td>
<td>2.87</td>
</tr>
<tr>
<td><strong>2004Q1 to 2011Q2 - Entire Sample Period</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>4.02</td>
<td>3.57</td>
<td>5.38</td>
<td>3.54</td>
<td>3.09</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.54</td>
<td>0.59</td>
<td>3.57</td>
<td>0.59</td>
<td>0.78</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.57</td>
<td>2.57</td>
<td>2.64</td>
<td>2.47</td>
<td>1.32</td>
</tr>
<tr>
<td>Maximum</td>
<td>13.45</td>
<td>5.16</td>
<td>20.8</td>
<td>4.96</td>
<td>4.71</td>
</tr>
</tbody>
</table>

Despite high debt/GDP ratio and slow growth, Italy’s bond market was relatively well-functioning until Q3 2011, which is beyond the scope of this paper.
5.1 Factors Impacting the Spread

It is somewhat surprising that the spread is negative throughout the “Normal Market” and “Sovereign Debt Crisis” periods. During these times, the return on Portfolio 1 is higher than expected, while the return on Portfolio 2 is lower than expected. There are essentially 5 elements impacting the spread, and the result could be due to:

5.1.1 The zero-coupon par yields are too high

It is likely that during the “Sovereign Debt Crisis” period, investors are wary of Eurozone bonds, and yields can be elevated due to lack of demand for the instruments. Also, when the overall economy is performing well, as it did during the “Normal” market period, investors may prefer other investments that yield higher return, such as corporate bonds and equity.

5.1.2 The rates used to discount the CDS rate are too high

These rates are the own-country, zero-coupon 3-year par yields. See the explanation for 5.1.1

5.1.3 The rates used to discount the interest rate swap are too high

These rates are the German zero-coupon 3-year par yields. See the explanation for 5.1.1

5.1.4 The quoted CDS spreads are too low

The market perception of sovereign default risk is priced into the size of the CDS spread. It is plausible that during “Normal” conditions, the market could price
the likelihood of default lower than is indicated in the swap market. Furthermore, CDS markets are much less liquid than interest rate swap markets, and thus, price discovery is less accurate. Likewise, during the “Sovereign Debt Crisis”, there may be few sellers of sovereign debt CDS. However, despite the lack of liquidity, investors would be expected to err on the side of caution and price CDS much higher than warranted.

5.1.5 The interest rate swap rates are too low

This indicates that there are many market participants wishing to short an interest rate swap and receive a fixed payment in lieu of a floating payment. The market is thus, “bearish” on interest rates. During the “Sovereign Debt Crisis” interval, this is a definite possibility, as slow economic growth warranted monetary stimulus from the European Central Bank. However, during “normal market” times, cheap credit offered by banks resulted in elevated inflation. The market should have expected monetary tightening, higher interest rates, and thus, demand a higher fixed swap rate.

There is also an option value associated with Portfolio 2 that was not considered in this analysis. We assumed that the investor required an investment for the entire 5 year period, regardless of market conditions and that the investor would roll over the EURIBOR leg of the portfolio every 6 months. However, to unwind his position, the investor can simply decline to roll over the EURIBOR deposit and enter into a second transaction to reverse the interest rate swap (i.e. buy an interest rate swap with the same terms). The shorter term of Portfolio 2 and a feasible exit strategy could have resulted in the lower return.

Recent market news indicates that several assumptions made for this exercise may be breached. In particular, there is a generally accepted notion that developed economies cannot default on their bonds. Clearly, the liquidity and solvency pressures on Greece and Italy in recent months have shown that default is
certainly possible. Recent developments also test the assumption regarding what actions by the reference entity constitute a default. Formerly, any payment less than face value on an asset would trigger a CDS event. However, the “voluntary private participation” of 50% haircuts on Greek bonds, as proposed by the European Commission and Euro-area leaders is a litigious issue. While ratings agencies have deemed the haircuts a default event, the leaders of the member states were careful to propose the haircut as strictly voluntary, as not to trigger CDS defaults and thus, create a banking crisis (Greece: Voluntary, 2011). However, this also means that bondholders, who purchased CDS under the assumption that their risk positions were hedged, are now fully exposed to the sovereign default problems in Southern Europe. What this new proposal means for the future of sovereign CDS markets will be interesting. If bondholders are not insured as they expect, the market for such instruments may cease to exist.

6. Conclusion

Further research on this subject is warranted from these initial findings. A follow-up analysis to these findings include a comparison of this spread (the implied cost of interbank lending market default) and market-quoted bank CDS rates, as both would measure the cost of default protection on unsecured loans to the banking sector. It would also be interesting to repeat this exercise with non-distressed sovereign bonds. This would remove several of the confounding factors discussed in Part 4.

Using data from the European interbank lending markets, sovereign bond markets and global derivatives markets, this study finds a portfolio strategy that reflects the implied cost of default protection in European interbank lending markets. During times of financial crisis, there is a significant premium built into interest rate swap rates. The sellers of swaps require a greater premium to engage in a contract, as EURIBOR rates (the floating rates) are expected to rise due to increased risk of a bank defaulting on the EURIBOR loan. As summarized in Table 5,
the portfolios constructed in this paper quantify this spread and find that the average positive premium investors could earn was 44.6 bps. This can also be considered the spread that a counterparty would quote on a theoretical EURIBOR CDS.

Table 5 - Implied Cost of EURIBOR Default Protection - Revisited

<table>
<thead>
<tr>
<th></th>
<th>Portugal</th>
<th>Italy</th>
<th>Greece</th>
<th>Spain</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>46.071578</td>
<td>42.01373</td>
<td>43.69639</td>
<td>49.72541</td>
<td>40.84327</td>
</tr>
</tbody>
</table>

Unlike Table 3, this considers only the positive portion of the spread. For all 5 nations, the spread turned positive on August 10, 2007 and reverted to negative on January 5, 2009.
References


