Do Commercial Banks' Foreign Claims affect Sovereign Bond Yields in the Euro Zone?

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I. Introduction

The spread of the recent financial crisis from the United States to Europe and shows the breadth and depth of globalization in financial markets. As the as crisis has deepened and persisted in Europe, some national governments have fallen under tremendous fiscal strain. The resulting poor sovereign credit ratings and high interest rates on government bonds have challenged these countries while the European Union as a whole works to stave off sovereign defaults and recapitalize banks. Spain is one such country facing economic recession and tight government financing constraints. Interestingly, Spain today has a smaller debt-to-GDP ratio than the United States, yet suffers record high yields on their bonds while the U.S. continues paying lenders comparatively low yields (Amaral and Jacobsen, 2011).

If the factors directly associated with government credibility such as the debt ratio are misleading, what are investors considering when they invest in government securities? In Europe, the financial crisis and threat of a Greek default have left some banks undercapitalized and at risk of failure. Furthermore, investors have seen large state interventions in support of the financial sector, as in the case of Ireland in September 2008 (Amaral and Jacobsen, 2011). From these two considerations, investors may be drawing a connection between banks' exposures to foreign claims, their financial vulnerability should those foreign debtors default, and state commitments to bolster banks through deficit spending to guarantee bank deposits and inject capital in an effort to stabilize the industry.

While there has been a great deal of investigation into sovereign credit ratings, yields, and yield spreads, particularly in the European Union and among developing nations, none have

explicitly considered banking sectors' foreign exposures. This paper will seek to test the hypothesis that the foreign claims of euro zone commercial banking sectors affect their governments' bond yields. In so doing, I will next review the relevant literature to contextualize my investigation and identify influences on my theory. The subsequent section will present a theoretical conceptualization of the relationship between bond prices and government bond yields. The fourth section will present information on summary statistics from a sample of 11 euro zone countries. Sections 5 and 6 will encompass the results and robustness checks of the analysis and the final section will discuss the conclusions of the investigation.

II. Review of Literature on Bond Yield Spreads

The empirical literature has generally established three overarching factors in the determination of yield spreads: a country's credit risk, investors' general risk aversion, and asset liquidity.

A credit risk factor is any factor that directly affects a government's ability to service its debts. Most studies of bond yield spreads agree that the ratios of debt and deficit-to-GDP are significant predictors of yield spread. Cantor and Parker (1996) used cross-sectional data on 49 countries from 1995 and they noted that the variables used by ratings agencies to assign sovereign credit ratings would also be predictive of yield spreads. They found GDP growth, inflation, per capita income, external debt indicators of default history and economic development to be significant explanatory variables for yield spreads.[1] In the euro zone, however, many researchers have found deficit and debt alone account for sufficient variance in bond yield spreads and are the most important credibility factors in determining risk premia and hence bond yield spreads (Attinasi et al, 2009; Broos and de Haan, 2012; von Hagen et al, 2011).

[1] Two serious limitations of their study were that by including agency credit rating directly, the significance of other variables may have been masked and their data was only cross-sectional and traced no evolution in spreads through time.

Investigators have also recently considered aggregate national banking assets and banking equity to assets as credibility factors in the determining yield spreads. Gerlach et al found when debt and deficit increase, countries with large banking sectors and low equity ratios experience a greater yield spread as investors envision bank rescues financed by state deficit spending (2010). Other research has found higher equity levels in particular have a significant negative effect on spreads in the euro zone (Klepsch and Wollmerhäuser, 2011). The argument for the inclusion of variables for these banking statistics stems from the recent financial crisis; should several major banks fail, states will rescue the industry and the subsequent deficit spending and higher public debt then lead to a widening in sovereign bond spreads. Some researchers, while again corroborating the evidence that deficit and debt ratios affect yield spreads, find that the effect of these variables increases the more the debt issued by a government is foreign-owned (Broos and de Haan, 2012). Broos and de Haan argue that at high levels of indebtedness, foreign ownership of the government's bonds will increase the sensitivity of bond yields to the debt ratio.

The second theoretical factor influencing yield spreads is general risk aversion. In times of financial turmoil, investors often turn to relatively safer liquid assets as opposed to long-term government bonds (Schuknecht et al, 2009). In other words, investors become more risk averse in times of financial turmoil, which requires countries to raise yields to sell their bonds. Many studies use indicators of financial conditions in the United States financial markets to measure general risk aversion and find they have significant impacts on bond yield spreads. Codogno et al (2003) and Attinasi et al (2009) find the spread between the yields on Moody's Seasoned AAA U.S. corporate bonds and 10-year U.S. government bonds have a significant positive impact on yield differentials between euro zone government bonds. Schuknecht et al (2009) use

the same measure, but with BBB bonds instead and also find it significant. Recently, Klepsch and Wollmerhäuser (2011) implemented the VIX index, which measures the volatility of the U.S. equity market, as a proxy variable for risk aversion. They argue this indicator reflects best the increase in investing risk and aversion due to the 2008 financial crisis and found this measure to have a significant and positive effect before and especially after the financial crisis.

Much investigation has explored the role of liquidity in bond markets, the third theoretical factor influencing yield spreads. In liquid markets, investors face low transaction costs and may trade their assets frequently. As liquidity decreases, investors will demand a compensation for the risk of being unable to make timely low-cost trades and therefore yields will climb higher. Some studies represent the relative liquidity of bonds with bid-ask spreads and the volume of government bonds outstanding and find such variables are as or more significant than credit factors (Gómez-Puig, 2006; Beber et al, 2009). Codogno et al (2003) additionally used the trading volume and the raw quantity of bonds available at the bid and ask prices as proxy indicators of liquidity, where a higher trading volume or market size suggests greater liquidity and less risk to investors. Codogno et al, however, found none of their indicators of liquidity to be statistically significant, although trading volume was their strongest estimator. One explanation for the lack of significant findings in the Codogno et al analysis could be multicollinearity among these liquidity variables. Overall, the size of government bond markets (measured by the total amount of sovereign debt issuance as a fraction of all debt issued in a sample) is a common measure of liquidity which has a significant positive effect on bond spreads (Bernoth, 2004; Gómez-Puig, 2006; Attinasi et al, 2009).

The influences of liquidity factors and general risk aversion factors are well-established, as is the effect of the debt and deficit-to-GDP ratio. Less well-understood, are the relationships

between the banking industry, globalization, and government bond yields. My paper seeks to expand this knowledge by following the argument of Gerlach et al (2010) and considering the results of Broos and de Haan (2012). Like Gerlach et al (2010), I expect that the banking sectors pose risks to national governments and that investors expect governments to rescue or relieve banks during times of financial crisis (see Gerlach et al, 11). Similar to Broos and de Haan, I also expect that increased globalization and foreign financing enhance the effects of banking and credibility risks on bond yields. This investigation aims to expand these two areas of yield determination research by considering the effect of the banking industries' foreign claims on the respective government's bond yields. This paper will also consider the size of government bond markets as a measure of liquidity, and its impact on bond spreads. The next section will illustrate how credibility factors, liquidity, and general risk aversion play a role in the determination of bond yield spreads.

III. Theory

What determines the yield of bonds is how much investors expect they will earn from the bond or the yield to maturity.[2] The risk of default, the potential costs of making bond transactions, and the general perceived risk in financial markets decrease this expected bond yield.

Consider an international capital market of investors and borrowers in which investors are lenders and sovereign national governments are borrowers. Assume that investors' goal is to maximize returns on their investment (loan) while governments intend to sell bonds (borrow) such that they meet an exogenous financing target. In other words, the amount of securities

[2] "The effective interest rate that a bondholder will earn if the bond is held until maturity. Yield-to-maturity takes into account the bond's purchase price, its current market price, the coupon rate, which is the interest rate that the bond pays, and the amount of time remaining until the bond matures. Yield-to-maturity is the most accurate representation of how much a bond [sic] will actually receive if the bond is held until maturity" ("Yield-to-maturity").

issued at any given time is inelastic and only investors' demand for bonds determines their market interest rate. Investors demand is solely determined by the probability of receiving the full yield to maturity of a bond. In an ideal world, all government bonds are identical and governments will sell all bonds necessary at risk free interest rates to meet a financing goal. Additionally in this ideal world, investors will expect to receive *Y* on all government bonds, or all of what they invest plus the interest earned on that investment.

$$[1] \quad Y = 1 + r$$

Suppose, however, that sovereign government bonds are no longer identical and some are subject to default risk such that these governments have a probability of default of $1 - P(x)$, where $0 \leq P(x) \leq 1$ and x is a set of variables affecting the chances of default. Thus the expected yield on risk bearing country *i*'s becomes:

$$[2] \quad Y_i = (1 - P(x_i))(1 + r)$$

Additionally, the investor knows bonds have some amount of liquidity, l, where higher liquidity implies a higher expected yield for the investor. This is strictly in the sense that the investor may maximize their returns by approaching the expected yield to maturity should they trade the bond before maturation. Thus this variable has a positive relationship to yield.

$$[3] \quad Y_i = \big(1 - P(x_i)\big)(1 + r) + l_i$$

To consider a yield spread, we compare the yield of a risk-bearing bond to a bond considered risk free and perfectly liquid. In the euro zone context, German bonds are traditionally assumed to be the perfectly liquid, risk free bond. The expected return on the risky bond was presented in equation [3]; the expected return of the risk free bond (German) is as follows:

$$[4] \quad Y_g = (1 + r)$$

Therefore the difference in the expected return between Germany and country *i*'s bonds becomes:

$$[5] \quad Y_g - Y_i = (1 + r) - \big(1 - P(x_i)\big)(1 + r) - l_i$$

or after division and substitution,

$$[6] \quad \frac{Y_g - Y_i}{Y_g} = 1 - \big(1 - P(x_i)\big) - \frac{l_i}{Y_g}$$

Now the general risk aversion, v, of investors is added, which will positively impact the expected yields of all financial assets as investors become more pessimistic. In particular, it will increase the spread in expected yields as German bonds will still be risk free *relative* to all other bonds. Lastly, to complete the theoretical equation, I add *i* and *t* subscripts to represent the variables for each country *i* at time *t.*

$$[7] \quad \frac{Y_{gt} - Y_{it}}{Y_{gt}} = 1 - \big(1 - P(x_{it})\big) - \frac{l_{it}}{Y_{gt}} + v_{it}$$

The left-hand side term of the equation expresses the yield differential between the foreign y_{it} and German bond y_{gt}, or the difference between what the investor would have taken home by investing in a riskless German versus another foreign bond. The expression $1 - \big(1 - P(x_{it})\big)$ is the yield premium over German securities resulting from default risk. The third term on the right-hand side reflects the premium on liquidity, and the last term represents the investors' general risk aversion. Essentially, for governments to sell their exogenously determined amount of bonds, they must raise interest rates, *r*, and thus expected yields, to compensate for the added risk and lower liquidity of their bonds relative to the benchmark German bond. In other words, governments must pay the credit risk, liquidity, and risk aversion premia in the form of higher yields to sell their bonds.

As the right-hand side parameters of the equation cannot be measured directly, they must be represented with proxy variables based on empirical work. These parameters are government fiscal performance or credibility factors, a liquidity factor, and a general risk aversion factor. Consider domestic banks' foreign claims, the experimental variable, as one such credibility factor.

Countries whose banks have a large amount of foreign claims will experience higher bond yields because there is greater risk of state bank rescues or reliefs. If the economy in a borrowing country undergoes a drastic contraction, borrowers may default on their loans. The risk of such an occurrence increases with the number of countries to whom a bank lends (especially in the case of a recessionary contagion) and with the extent to which each additional country is economically unreliable. The defaults may be unsustainable for the lending institutions and they may need government rescue, and therefore the probability that state rescue packages will be implemented increases. Governments in Europe in the past several years have been willing to rescue banks, which increases deficit and debt-to-GDP ratios. Investors financing bank relief measures ultimately view these governments as less capable of servicing their debt and will not invest unless they are paid a premium for the additional risk with higher bond yields. Investors may anticipate this risk if they see a nation's banks more or less heavily exposed to the risk of default on their foreign loans.

It follows from the literature to include the government deficit-to-GDP ratio and debt-to-GDP ratio (*debt*) as credibility factors in estimating bond yields. For simplification in bringing the theory to the data, however, I will consider government surplus instead of deficit, where a negative surplus is a positive deficit. These are direct factors that play into the risk of government default because a high debt-to-GDP or low surplus-to-GDP ratio (*surplus*) increases

the probability that governments will be unable to pay their debts and would therefore increase bond yields. As in calculating a yield spread, these values will be made relative to Germany by subtracting the contemporaneous values for all other countries. This measure is more meaningful in the euro zone context and is closer to what investors likely consider in their choice to invest. It is important to note that the expected sign for the surplus coefficient in the estimated equation for yield spread is positive, while for foreign claims and debt the expected sign is negative. In summary, we have defined the *x* variables of the theoretical equation as follows.

$$[8] \quad x_{it} = foreign\ claims_{it} + surplus_{it} + debt_{it}$$

The remaining factors are liquidity and investors' general risk aversion. The liquidity factor will be represented by the aggregate euro value of securities issued by country *i* at time *t* as a fraction of the total value of all bonds issued by countries *i* and Germany at time *t*. This is thought to capture the size and efficiency of the bond market. The more debt in bonds a country issues, the larger and more efficient its capital markets are, the less costly it will be to trade those bonds, and therefore the lower the yield spread from Germany will be. As a proxy for general risk aversion, I will follow the method used by Klepsch and Wollmerhäuser (2011) and use the VIX, which measures the volatility of the U.S. equity market constructed from call and put volatilities from S&P 500 index options.[3] The greater the VIX, the greater the volatility in the U.S. equity market, and the more risk averse investors will be, implying higher government bond yields. The expected signs of these variables' coefficients are negative and positive, respectively.

$$[9] \quad l_{it} = issuance\ ratio_{it} \qquad [10] \quad v_{it} = VIX_{it}$$

[3] Put and call options refer to stock options wherein the bearer will buy (call option) stock at a certain price or before a particular date or sell (put option) stock within an agreed time at a specific price.

As can be observed in the data studied in this paper and in the literature, the 2008 financial crisis brings about a paradigm shift in yield spread estimation. With the collapse of Lehman Brothers in September of that year and announcements of large state rescues of endangered financial institutions within the euro zone, yield spreads reached historic highs. To account for the unique influence of the crisis and subsequent turbulence, I will add a time dummy for the crisis beginning in the third quarter of 2008 and expect that its coefficient's sign will be positive to indicate the increase in bond yield spreads during that period.

With the variables now clarified, the initial spread equation, [7], can be simplified into the following reduced form guiding equation for OLS estimation.

$$[11] \quad Y_{it} = \alpha + \beta_1 foreign\ claims_{it} + \beta_2 surplus_{it} + \beta_3 debt_{it} + \beta_4 issuance\ ratio_{it} + \beta_5 VIX_{it} + \beta_6 crisis_{it} + \varepsilon_{it}$$

Y_{it} is the difference in yield between Germany and the *i*-th country's bonds at time *t*, and α is the constant term, and ε is the stochastic error term. The next section will describe the data used for the above variables.

IV. Summary Statistics

To estimate the guiding equation, we need data for each variable in the equation for each country in the euro zone over the chosen time range and at a synchronized frequency. The sample I use consists of quarterly observations of these variables from the fourth quarter of 2003 to the third quarter of 2011. The countries represented in the sample are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, The Netherlands, Portugal and Spain.

At the heart of this investigation are the data representing the aggregate foreign claims of domestic banks and the domestic credit extended by banks. Together, these two statistics can be combined in a ratio for a reasonable indicator of the relative amount of foreign exposure

domestic banking sectors have in the euro zone. This indictor allows for meaningful comparisons between national banking industries and contains the information that is hypothesized to influence investors' investment decisions and therefore bond yields. Ideally, these data would come at quarterly frequency for all members of the euro zone and claims would be ultimate risk basis. Ultimate risk basis means that claims are allocated to the country where the ultimate risk lies if the borrower should default; for instance if a French bank's loan to Mexico were guaranteed by a Dutch bank, the loan would be recorded as the Dutch bank's claim.

The data on foreign claims I used are taken from the Bank for International Settlements (BIS) Consolidated Banking Statistics and are collected at quarterly intervals and on an ultimate risk basis. For total foreign claims, the BIS sums banks' cross-border claims, the local claims of foreign affiliates of the banks in foreign currency, and local claims of foreign affiliates in local currency. Regarding domestic claims, the banking survey statistics of the International Financial Statistics database of the International Monetary Fund (IMF) is used. The database collects data on aggregate commercial banking institutions' lending to domestic borrowers for most countries at monthly, quarterly, and annual frequency. There were incomplete data on domestic credit for some countries in some periods, but generally there were data for the sample countries and sample time span.

The dependent variable is the government bond yield relative to that of Germany (i.e. the yield spread relative to 'riskless' Germany). Ideally, the yield on 10-year government bonds would be analyzed following previous studies and as closer representation of the assets investors see on the market. Fortunately, The IMF's International Financial Statistics provide these data for all countries in this sample. Specifically, they record the simple monthly average of daily

secondary market yields on 10 year government bonds, of which I use the value recorded for the last month of each quarter.

Data on the credibility statistics "central government surplus-to-GDP" and "public debt-to-GDP" are critical to any bond yield investigation. Ideally, quarterly data would be available for both to match the frequency of the dependent variable yield, but the only data available on debt-to-GDP were annual. Therefore, these data were linearly interpolated over the time range to expand the number of observations. Interpolation means interpretation must be made with caution, but the debt-to-GDP ratio is a control variable and therefore not essential to the hypothesis. The surplus-to-GDP ratio is taken from the European Central Bank's (ECB) Statistical Warehouse, which keeps these data at quarterly and annual frequency for most European countries. The public debt-to-GDP ratio comes from the Organization for Economic Cooperation and Development's StatExtracts database, and both ratios were made relative to Germany by subtracting the contemporaneous ratio for German surplus and debt.

Variables for liquidity and general risk aversion are also included in the guiding equation. These variables would ideally capture the theoretical influence of liquidity premia and any risk premia on yields derived from general levels of riskiness in financial markets. Although imperfect, the share of a country's total bond issuance (in euro) relative to the size of the total issuance of near substitutes—other countries' issuances—will capture liquidity risk. Quarterly data on gross issuances are available from the ECB's Statistical Warehouse, which I then used to compute quarterly securities issued ratios. The VIX is an indicator of the volatility in U.S. equity markets available from the Chicago Board Options Exchange (CBOE). It is measured as the closing price in U.S. dollars on options of the CBOE's S&P 500 Index fund and is a proxy

for the general risk level in financial markets. Higher prices indicate greater risk aversion. I converted these month-end closing prices to quarterly averages.

Table 1 presents the summary statistics, listing each variable and the associated summary statistics. Of first importance, all variables are converted in percentage point terms for this analysis. There are 11 countries and 32 time periods (quarters) and therefore should be 352 observations. Germany's debt-to-GDP and surplus-to-GDP are not reported in the data for the last three periods of the series, however, causing yield spread to have 33 missing values. Removing these and several other missing observations, 304 observations were left for analysis. The extremely high maximum for the foreign to total claims ratio is reasonable because some countries in the sample have small domestic markets but large globalized financial sectors. Some countries did not issue any securities in a given period, and therefore the minimum of the securities issued ratio is zero.

V. Analysis and Main Results

The data constitute a balanced panel with 304 observations, which allows for a wide variety of analyses. A fixed effects regression is the most appropriate technique for the main regression. There are many country specific unobserved effects on yield in the euro zone which this type of regression will control, and in addition, the results of the Hausman Specification Test confirm this selection.[4] Before moving further, however, I address the main estimation issues arising in this dataset.

The first two estimation issues I consider are heteroskedasticity and serial correlation, which if present, would decrease the accuracy of statistical significances. Considering the appropriate model as a fixed effects regression, I produce a modified Wald statistic calculated for

[4] Hausman χ^2 statistic was 342.34 with a p-Value of 0.00

the group of variables, which was unlikely enough that I conclude there is heteroskedasticity.[5] Using the Wooldridge Test for autocorrelation to determine the existence of serial correlation, the F-statistic of the test was sufficiently improbable that I conclude there is serial correlation in the data.[6] Conveniently, both of these errors are reparable by using robust standard errors, which are used for the main estimation and robustness checks.

The third estimation I consider is non-stationarity, which if present, would potentially cause spurious correlation between the dependent and independent variables. This would invalidate the statistical significances of the coefficients. Using a version of the Dickey-Fuller Test, I conclude that the yield spread, relative debt-to-GDP, and VIX index are non-stationary. Furthermore, testing the residuals of the fixed effects regression for stationarity, the result suggests there is no cointegration among the variables.[7] To resolve this issue of potential spurious correlation, I estimate the equation in first differences (the entire equation for simplicity of interpretation). After changing the specification to a first difference equation, the non-stationary variables become stationary except for relative debt-to-GDP. I then analyze its second difference and determine it was stationary. Therefore, the guiding equation becomes the following.

$$[12] \quad Yield\ Spread_{it} - Yield\ Spread_{it-1} = \alpha + \beta_1(foreign\ claims_{it} - foreign\ claims_{it-1}) + \beta_2(surplus_{it} - surplus_{it-1}) + \beta_3(debt_{it} - debt_{it-2}) + \beta_4(issuance\ ratio_{it} - issuance\ ratio_{it-1}) + \beta_5(VIX_{it} - VIX_{it-1}) + \beta_6 crisis_{it} + \varepsilon_{it}$$

The last estimation issue I investigate is multicollinearity, which could again result in inaccurate hypothesis testing and statistical significance. The correlation coefficients suggest

[5] The Wald χ^2 test statistic (p-Value) was 2409.40 (0.00).
[6] The Wooldridge F statistic (p-Value) was 938.540 (0.00).
[7] The Fisher χ^2 test statistics (p-Values) for yield spread, relative debt-to-GDP, VIX index, and the residuals were 12.69 (0.94), 10.87 (0.98), and 22.19 (0.45), and 25.76 (0.26), respectively.

that only the VIX index and Crisis dummy are severely correlated.[8] Calculating variance inflation factors, the factors for the VIX index and Crisis dummy were only about two for each. Therefore multicollinearity is a moderate estimation issue in this analysis, but both variables will remain in the main estimation as guided by theory.

Accounting for estimation issues, the main regression is performed following equation [13] above.[9] Table 2 presents the results of this regression. As presented in the table, the number of observations used in the estimation is smaller than that in the sample. This is because the calculation of first and second differences necessarily causes the loss of the first observations in each variable's time series.

The results show that the coefficient on the Foreign Claims to Total Ratio is negative and not statistically significant. This is surprising in two ways: one, I expect foreign claims to have a significant effect on bond yield spreads, and two, I expect a positive sign. A negative sign suggests that increases in the amount of foreign claims a country has actually decreases the difference between that country's bond yields and those of Germany. One explanation for this negative relationship is that, investors may see large amounts foreign claims as a sign banks have diversified their lending and therefore risk. If the particular banking industry's host country or any particular foreign country goes through a severe economic contraction and borrowers default on their loans, the banks will still have a large amount of secure claims and can cover their losses. This line of reasoning could be investigated in further research.

Relative Debt-to-GDP, the VIX Index, and the Crisis Dummy, are all significant variables at the 10-percent level with signs congruent with theory. An increase of one percentage point in relative debt-to-GDP during two previous quarters correlates to an increase

[8] The correlation coefficient was 0.72. The variance inflation factors for the VIX index and Crisis dummy were 2.10 and 2.20, respectively.
[9] Using the xtregar command in Stata, 11th edition.

in the yield spread of approximately 0.06 percentage points during the first previous quarter. This coefficient is moderately economically significant considering the standard deviation of yield spreads presented in Table 1. The crisis dummy is additionally economically significant and the VIX index is of marginal economic significance in this regression, both with positive signs. Lastly, neither the relative surplus-to-deficit or securities issued ratios were significant, as I would expect from the theory. Moreover, the sign of the coefficient on the securities issued ratio is positive, contrary to what theory suggests. One possible explanation is that, given the time range of the sample, several euro zone countries with low levels of credibility factors increased their debt issuance in an attempt to refinance their governments and take fiscal policy measures to stimulate their economies. Thus larger securities issued ratios come from countries with a higher yield spread than would be expected in normal economic times and the correlation is positive. The following section will present robustness checks to verify conclusions from the main results.

VI. Robustness Analyses

In this section several variations of estimations of bond yield spread are conducted to substantiate the conclusions of the main results. Table 3 presents the results of the first robustness check, in which the main regression is repeated, but without the crisis dummy variable. These results show that this alteration of equation [12] has almost no effect on the estimated coefficients except that the constant becomes significant. This is reasonable given that the crisis dummy variable had been explaining the drastic shift in bond yield spreads after September 2008, and with the removal of the crisis dummy, that variance is likely attributed to the constant term.

Table 4 presents several robustness checks using a robust fixed effects regression, which uses the within variance of the variables for estimation. By using this regression technique, spurious correlation could be present in the estimation because of non-stationarity in the variables. Nevertheless, it is all the more useful as a robustness check to corroborate the evidence from the main regression that the foreign claims ratio is not significant if it is not even significant because of spurious correlation. Regression (i) shows the main results, while regression (ii) presents a simple fixed effects estimation of equation [11], the guiding equation without differencing. Regression (iii) estimates the equation when the bond yield spread is transformed to its natural log, which might allow a closer fit to the data. Regression (iv) follows the specification of Broos and de Haan (2012) in including relative surplus and debt-to-GDP ratios squared. The log of the securities issued ratio is included instead of the standard securities ratio to attempt to achieve a closer fit to the data. Lastly, regression (v) performs a fixed effects regression only for a subsample of data before the fourth quarter of 2008, the first peak in yields from the financial crisis in Europe.

Throughout all of the fixed effects regressions, the foreign claims ratio is insignificant, which corroborates the results of the main estimation. The relative debt-to-GDP ratio and VIX index variables are significant and positive in all estimations except the last, which again matches the main results. Notably in regression (iii) foreign claims does have the hypothesized positive sign. In regression (iv), both the relative surplus and debt-to-GDP ratios squared became significant, which suggests a quadratic relationship between them and yield spreads and underlines the importance of these factors in the determination of yield spreads. The constant term becomes significant in all of the fixed effects regressions as well, which is especially logical in the final regression. Before the crisis, yield spreads were relatively small, and therefore one

constant value can estimate the yield spread accurately. The change to a negative sign for the constant term in the fixed effects regression is likely explained by the crisis. Since yield spreads climb dramatically during the end of the sample, when the financial crisis occurred, it is necessary for the y-intercept to be negative in order for the positively sloping estimation line to be best-fit. The first difference of yield spread doesn't exhibit this extremity and therefore the line can be fit with a positive intercept.

Table 5 presents a random effects estimation and two pooled regressions. These techniques permit possible spurious correlation, but also provide some insight into the data. Regression (i) presents the main results of the differenced equation, while regression (ii) is a random effects regression of equation [11]. This is the first regression to find the foreign claims ratio as significant and also contrasts with the main results in finding the crisis to be insignificant. The change in the significance of the crisis dummy may be explained by the fact that a random effects model uses both within and between variance in the estimation of coefficients. There is likely sufficient variance between countries so as to diminish the crisis dummy's explanatory power for yields. Furthermore, when including between country variance, it appears there is a negative correlation between the foreign claims ratio and bond yields. Not only does this weaken the conclusions of the main results, but it also implies the hypothesis that foreign claims increase yields is inaccurate at least in its prediction of the sign of the correlation.

In regression (iii) a pooled regression is used with equation [11] and foreign claims, relative debt-to-GDP, and the crisis dummy again match the main results, while the relative surplus-to-GDP and, for the first time, the securities issued ratio, become significant. The securities issued ratio, however, does not have the expected sign, which may result because countries with relatively higher debt and deficit levels may have increased their bond issuance

during the financial crisis in efforts to stabilize and stimulate their economies, while other ostensibly more austere countries issued no more bonds than usual.

Regression (iv) runs the same regression except it includes an interaction between the foreign claims ratio and the crisis dummy to test whether the effect of the foreign claims ratio changes in the midst of the financial crisis and subsequent turbulence in the euro zone. This regression finds foreign claims and foreign claims during the crisis to be significant and the sign of the foreign claims ratio to be negative, both of which disagree with the main results and hypothesis. The relative surplus-to-GDP and securities issued ratio are also significant while the VIX index and crisis dummy lose their significance, contrary to the main regression. Overall, the results of the pooled regressions seem ambiguous regarding the effect of foreign claims on bond yield spreads, but corroborate the importance of a country's debt-to-GDP in determining bond yield spreads. Results also suggest the importance of a country's surplus-to-GDP and securities issued ratio in that determination. The next section will discuss the conclusions drawn from the above analyses.

VII. Conclusion

In this study I seek to determine whether a euro zone country's commercial banks' foreign claims affect the yields of that country's long-term bonds. My hypothesis is that higher levels of foreign claims would increase a country's bond yields relative to Germany, a country which is considered relatively risk free in the euro zone. To measure the affect, if any, of foreign claims on bond yields, I structured the dependent variable as the spread between the German 10-year government bond yield and other euro zone countries' 10-year government bond yields.

From the analysis, foreign claims do not have a significant effect on bond yield spreads, accounting for other theoretical determinants such as relative debt-to-GDP. Although in only a

few cases of robustness checks is the foreign claims ratio significant, the sign is almost always negative, which suggests that even if there were a relationship between foreign claims and yields in the euro zone, it would not be a positive one as I hypothesized. The debt-to-GDP is the most persistently significant variable and suggests that increases in a euro zone country's debt-to-GDP relative to Germany will increase its government bond yields relative to Germany's. Another strong determinant is the VIX volatility index, although the effect is not as consistent.

This investigation contributes to the literature by following the direction of Gerlach et al (2011) in considering the importance of financial markets in public finance and bond yield determination. Although the results disprove the hypothesis, the literature now has robust evidence that a banking sector's foreign claims do not influence the yields of their host government's bonds.

There are several important shortcomings of this analysis and the results it produces. Many bond yield investigations rely on data of monthly or even daily frequency, which was not available to me in this analysis. Secondly, studies often will include more than one control variable for liquidity and risk aversion, but the data were not available on the additional variables the literature suggests for this study. The time frame of this study is heavily biased by the effects of the 2008 financial crisis and subsequent turmoil in euro zone financial markets.

To improve upon this study, there are several directions future research could take. First, the study could be divided in two, where data during and after the crisis at a higher frequency could be used to analyze in more depth what variables affect bond yields in each economic environment. Second, another study could attempt to estimate yields directly without the framework of a spread comparison with Germany and with a different theoretical approach to yield estimation, such as including the financial sector variables of Gerlach et al (2010). This

broader theoretical approach could be brought to data covering more countries and periods to investigate why U.S yields are relatively low. Third, other measures may exist besides commercial banks foreign claims to measure the affects of a financial contagion on sovereign bond yields, such as the foreign claims of the national governments themselves. Last, this research did find a consistent negative, though insignificant, relationship between the yield spread and foreign claims. With a more complete theory and more frequently recorded data, perhaps this relationship could be conclusively determined and quantified.

Before the 2008 financial crisis the European Union has tried to impose greater fiscal discipline on euro zone members to promote stability and growth and prevent runaway fiscal insolvency and sovereign default in its financially weakest members. One challenge countries have faced throughout the crisis to the present is difficulty in raising revenues financed by bond issuance. Based on this investigation's results, limiting a country's debt-to-GDP should indeed be an effective policy for the European Union to maintain in order to reduce bond yield spreads in the euro zone and promote economic harmony and stability.

References

Amaral, Pedro, and Margaret Jacobsen. "Why Some European Countries and Not the U.S?" *Federal Reserve Bank of Cleveland Economic Trends* 2 Dec. (2011). Web. 9 Apr. 2012. <http://www.clevelandfed.org/research/trends/2011/1211/01gropro.cfm>.

Arora, Vivek, and Martin Cerisola. "How Does U.S. Monetary Policy Influence Sovereign Spreads in Emerging Markets?" *IMF Staff Papers*. 48.3 (2001): 474. Print.

Attinasi, Maria-Grazia, Cristina Checherita, and Christiane Nickel. *What Explains the Surge in Euro Area Sovereign Spreads During the Financial Crisis of 2007-09?* Frankfurt am Main: European Central Bank, 2009. Print.

Beber, Alessandro, Michael W. Brandt, and Kenneth A. Kavajecz. "Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market." *The Review of Financial Studies*. 22.3 (2009): 925-957. Print.

Bernoth, K., von Hagen, J. and L. Schuknecht (2004), Sovereign risk premia in the European government bond market, ECB Working Paper Series, No. 369.

Broos, M, and Haan J. de. "Government Bond Yields and Foreign Ownership of Debt." *Applied Economics Letters*. 19.5 (2012): 435-438. Print.

Cantor, Richard, and Frank Packer. "Determinants and Impacts of Sovereign Ratings." *The Journal of Fixed Income*. 6.3 (1996): 76. Print.

Codogno, Lorenzo, Carlo Favero, Alessandro Missale, Richard Portes, and Marcel Thum. "Yield Spreads on EMU Government Bonds." *Economic Policy*. 18.37 (2003): 503-532. Print.

Eichengreen, Barry, and Ashoka Mody, 2000a, "What Explains Spreads on Emerging Market Debt?" Sebastian Edwards, ed.: *Capital Flows and the Emerging Economies: Theory, Evidence, and Controversies* (The University of Chicago Press, Chicago).

Gerlach, Stefan, Alexander Schulz, and Guntram B. Wolff. *Banking and Sovereign Risk in the Euro Area*. Frankfurt, M: Dt. Bundesbank, Press and Public Relations Div, 2010. Print.

Gómez-Puig, M. "Size Matters for Liquidity: Evidence from EMU Sovereign Yield Spreads." *Economics Letters*. 90.2 (2006): 156-162. Print.

Klepsch, Catharina, and Timo Wollmerhäuser. "Yield Spreads on EMU Government Bonds — How the Financial Crisis Has Helped Investors to Rediscover Risk." *Intereconomics* 46.31 June (2011): 169-76. Print.

Schuknecht, L, G Wolswijk, and Hagen J. von. "Government Risk Premiums in the Bond Market: Emu and Canada." *European Journal of Political Economy*. 25.3 (2009): 371-384. Print.

von, Hagen J, L Schuknecht, and G Wolswijk. "Government Bond Risk Premiums in the EU Revisited: the Impact of the Financial Crisis." *European Journal of Political Economy*. 27.1 (2011): 36-43. Print.

"Yield-to-maturity." *Webster's New World Finance and Investment Dictionary*. Hoboken: Wiley, 2003. *Credo Reference*. Web. 26 April 2012.

Table 1: Summary Statistics

Independent Variable	Obs.	Mean	Std. Dev.	Minimum	Maximum
Bond Yield Spread	304	0.512	0.960	-0.57	8.43
Foreign Claims to Total Ratio	304	0.712	0.190	11.43321	90.20201
Relative Surplus-to-GDP	304	-1.277	6.030	-34.311	12.27061
Relative Debt-to-GDP	304	21.477	27.980	-20.979	103.436
Securities Issued Ratio	304	0.094	0.092	0	34.53159
VIX Index	304	21.003	9.621	11.19	51.723
Crisis Dummy (2008:4)	304	0.362	0.481	0	1

Sources: IMF International Financial Statistics, BIS Consolidated Banking Statistics, OECD StatExtracts, ECB Statistical Warehouse, CBOE.

Table 2: Main Results for Bond Yield Spread

Independent Variable	
Foreign Claims to Total Ratio	-0.00368
	(0.00354)
Relative Surplus to GDP	-0.00185
	(0.00221)
Relative Debt-to-DGP	0.0599*
	(0.0341)
Securities Issued Ratio	0.00354
	(0.00389)
VIX Index	0.00625**
	(0.00250)
Crisis Dummy (2008:3)	0.139**
	(0.0593)
Constant	0.0187
	(0.0399)
Observations	276
Number of Countries	11
R-squared-Within	0.121
R-squared-Between	0.3196
R-squared-Overall	0.1222

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: All variables are their first difference except for Relative Debt-to-GDP, which is a second difference.

Table 3: Difference Estimation Robustness Analysis

	Regression Coefficients	
Independent Variable	(i)	(ii)
Foreign Claims to Total Ratio	-0.00368	-0.00391
	(0.00354)	(0.00347)
Relative Surplus to GDP	-0.00185	-0.00187
	(0.00221)	(0.00217)
Relative Debt-to-DGP	0.0599*	0.0564*
	(0.0341)	(0.0337)
Securities Issued Ratio	0.00354	0.00358
	(0.00389)	(0.00382)
VIX Index	0.00625**	0.00655***
	(0.00250)	(0.00247)
Crisis Dummy (2008:3)	0.139**	-
	(0.0593)	-
Constant	0.0187	0.0752**
	(0.0399)	(0.0347)
Observations	276	276
Number of Countries	11	11
R-squared-Within	0.121	0.0589
R-squared-Between	0.3196	0.8013
R-squared-Overall	0.1222	0.0636

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: All variables are a first difference except Relative Debt-to-GDP, which is a second difference. (i) Main results, (ii) Crisis Dummy removed.

Table 4: Fixed Effects Robustness Analyses

	Regression Coefficients				
Independent Variable	(i)	(ii)	(iii)	(iv)	(v)
Foreign Claims to Total Ratio	-0.00368	-0.00565	0.0102	-0.00640	0.0000
	(0.00354)	(0.00473)	(0.0253)	(0.00431)	(0.0024)
Relative Surplus to GDP	-0.00185	-0.00171	-0.0243	-0.000834	-0.0096
	(0.00221)	(0.00307)	(0.0178)	(0.00334)	(0.0115)
Relative Surplus to GDP Squared	-	-	-	0.000403**	-
	-	-	-	(0.000188)	-
Relative Debt-to-DGP	0.0599*	0.150***	0.0790*	0.0787***	-0.0018
	(0.0341)	(0.0120)	(0.0418)	(0.0119)	(0.0022)
Relative Debt-to-GDP Squared	-	-	-	0.000900***	-
	-	-	-	(0.000106)	-
Securities Issued Ratio	0.00354	0.00273	0.0209	-	0.0026
	(0.00389)	(0.00499)	(0.0293)	-	(0.0031)
Log of Securities Issued Ratio	-	-	-	-0.0316***	-
	-	-	-	(0.0115)	-
VIX Index	0.00625**	0.0115***	0.0293*	0.0128***	0.0011
	(0.00250)	(0.00293)	(0.0164)	(0.00273)	(0.0043)
Crisis Dummy (2008:3)	0.139**	-0.177*	0.876*	-0.143	-
	(0.0593)	(0.0988)	(0.479)	(0.0882)	-
Constant	0.0187	-2.366***	-6.230***	-1.950***	0.3410***
	(0.0399)	(0.0660)	(0.774)	(0.0878)	(0.0796)
Observations	276	293	293	293	183
Number of Countries	11	11	11	11	11
R-squared-Within	0.121	0.3996	0.082	0.5878	0.0119
R-squared-Between	0.3196	0.2831	0.2141	0.3738	0.2536
R-squared-Overall	0.1222	0.1399	0.2065	0.2009	0.1007

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: (i) Main Results, variables in first or second (if Relative Debt-to-GDP) difference, (ii) robust fixed effects, (iii) robust fixed effects using log of bond yield spread, (iv) robust fixed effects with relative debt and deficit ratios squared, log of securities issued ratio, (v) robust fixed effects pre-crisis subsample.

Table 5: Random Effects and Pooled Estimation Robustness Analyses

	Regression Coefficients			
Independent Variable	(i)	(ii)	(iii)	(iv)
Foreign Claims to Total Ratio	-0.00368	-0.00944*	-0.00217	-0.00616***
	(0.00354)	(0.00499)	(0.00156)	(0.00168)
Total Foreign Claims Ratio * Crisis	-	-	-	0.0122***
	-	-	-	(0.00373)
Relative Surplus to GDP	-0.00185	-0.00535	-0.0382***	-0.0408***
	(0.00221)	(0.00351)	(0.0130)	(0.0130)
Relative Debt-to-DGP	0.0599*	0.0507***	0.00974***	0.00950***
	(0.0341)	(0.00679)	(0.00346)	(0.00338)
Securities Issued Ratio	0.00354	0.000929	-0.0168***	-0.0168***
	(0.00389)	(0.00560)	(0.00425)	(0.00425)
VIX Index	0.00625**	0.0105***	-0.00747	-0.00801
	(0.00250)	(0.00339)	(0.00655)	(0.00659)
Crisis Dummy (2008:3)	0.139**	0.0744	0.763***	-0.106
	(0.0593)	(0.109)	(0.178)	(0.211)
Constant	0.0187	-0.00228	0.447**	0.746***
	(0.0399)	(0.443)	(0.180)	(0.196)
Observations	276	304	304	304
Number of Countries	11	11	-	-
R-squared-Within	0.121	0.6038	-	-
R-squared-Between	0.3196	0.2354	-	-
R-squared-Overall	0.1222	0.1616	0.375	0.388

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: (i) Main Results, variables in first or second (if Relative Debt-to-GDP) difference, (ii) robust random effects, (iii) robust pooled regression, (iv) robust pooled regression with interaction.