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Master Thesis of International Economics

The Explanatory Power of Credit Ratings on Government Bond Yields Spreads— A Comparison Study of Developed Countries and Developing Countries

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Abstract

Credit ratings have been playing a vital role during the Greek Debt Crisis. There are plenty of researches investigating the effects of the credit ratings on explaining sovereign bond yield spreads. By dividing the samples into two country groups, we can see that the credit rating is both statistically and economically significant indicator that explains the movement government bond yields spreads in developed countries. However, there is no evidence that credit ratings have statistically a significant relation with government bond yield spreads of developing countries. Hence, we conclude that credit ratings have different explanatory powers on government bond yield spreads with respect to different countries.

Keywords: Credit rating, Government bond yield spreads

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1. Introduction

In the first speech in Congress, former Prime Minister of Greece George Papandreou announced Greece was experiencing serious fiscal issues, and the Greek government declared the deficit/GDP ratio was increased to 12.7% a few days later. From that moment on, the financial crisis that originated in the U.S. transmitted to Europe. Days after, the three main credit rating agencies downgraded the rating notches of Greece, and nowadays people are accustomed to reading news like that Moody downgraded the Greek rating notch again etc. Since, massive information shows that credit ratings play a significant and vital role in the evolution of the Greek debt crisis. Another event that can show the importance of credit ratings is that a fiscal cut bill values 12 billion euro which is known as Kunduz Agreement being carried out within one week by five Dutch parties. And, the AAA sovereign rating of Netherlands was maintained as consequence. In this investigation, we would like to dig the effects of credit ratings on the movements of sovereign bond yields spreads of developed countries and developing countries, respectively.

Credit ratings play an important role during the Euro-crisis. Evaluating the creditability of financial assets started from the middle of 19th Century. There were institutions evaluating the creditability of merchants during 1837 U.S. financial crisis. However, none of either institutions or individuals had evaluated the ratings of securities until the emergence of Moody in 1909, which sets an example to evaluate securities for following firms such as Standard Statistics Company and Fitch Publishing Company. The subjects of credit ratings contain a vast numerous financial assets and their issuers included stocks, bonds and sovereign governments etc. and with the development of credit ratings there exists more than 150 credit rating agencies, nevertheless, the three main credit agencies (Stand & Pools, Moody, Fitch) take approximately 95% marketing share of the whole market.

Credit rating agencies publish credit ratings notches of specific borrowers, which provide information of default risks of those borrowers, different agencies have different definitions of credit ratings, and nonetheless, they are more or less identical without huge gaps. The definition of a credit rating given by European Union is that a credit rating is a measurement of the creditability of securities or the creditability of issuers of securities such as firms, bonds, stocks and sovereign governments through normative and systematic evaluation (Claeys and Vasicek (2014)), in other words, a credit rating is a rank which indicates the probability of default risk.

In general, credit ratings are classified into two classes, Investment Grade and Speculative Grade, beyond the credit rating, the three agencies also publish an outlook/review which indicates the probabilities of credit agencies modifying the rating of investment grade or speculative grade of one financial asset to another counterpart grade within one or two years. In addition, an Outlook/Review/Watch List is published randomly which shows whether the credit rating of one asset is likely to be upgraded or downgraded within 90 days. The symbols of credit ratings are not identical but approximately alike, the symbols of three main credit ratings are shown in Appendix 1. Another concept that is highly correlated with credit rating is sovereign risk, which is necessary to be denoted before the literature review. Cantor and Packer (1996) believe that sovereign risk denotes the risk that the government that is the issuer of sovereign bonds cannot reimburse the principle and interest as well as the willingness of repayment by the government, which plays a significant role in sovereign risk. This idea is supported by Juttner and McCarthy (2000) and Afonso et al., (2007). Sovereign risk is separated by rating agencies into two sections: economic risks which illustrate the capability of repayment of one sovereign government; while political risks measure the willingness of conducting repayment by the government. Since Cantor and Packer (1996), credit ratings have been confirmed that they have strong explanatory power on government bonds yields, however, researches are separated into digging the effects of credit ratings on sovereign bonds yields of developed countries (Geyer et al. (2004), Schuknecht et al. (2010)), and the effects of credit ratings on government bonds yields

of developing countries (Reisen and Maltzan (1999), Ciarlone et al. (2007) etc.). Whether credit ratings have different explanatory powers on government bond yields between developed countries and developing countries is the research subject of this paper. In the first part, we will summarize the existed literature about government bond yields and credit ratings. In the second part, the data and its source will be discussed. Followed by the methodology, the empirical model and the results, robustness and the conclusion.

2. Literature Review

In this section, we will summarize the existing papers that study government bond yield spreads and credit ratings, we will discuss the determinants of government bond yields and credit ratings. And the effects of credit ratings on different securities will be discussed.

2.1. The determinants of credit rating

Although the symbols of credit rating agencies have slight differences, in general, the three main credit rating agencies adopt similar methodologies and criteria including both qualitative and quantitative analysis which encompass indicators measuring political risk, macroeconomic fundamentals, economic structure etc. Moreover, social classes, ethnic composition, income inequality, culture and ideology etc. that provide information on social aspects are all taken account into credit rating.

Regarding the weights assigned to each factor, the three credit rating agencies do not provide a clear illustration of exactly which weights are assigned to those indicators and due to other arbitrary considerations of the three main credit rating agencies, credit ratings provided by those agencies are not exactly identical. The research by Cantor and Packer (1996) on the determinants of credit ratings by conducting a systematic analysis, they used criteria adopted by Moody and Standard & Poor are approximate

identical, the main factors encompassed in the credit rating are the GDP growth rate, inflation, the foreign debt/GDP ratio, economic development and default history. Afonso (2003) identifies the result of Cantor and Packer (1996) and finds that GDP per capita is a significant indicator affected credit rating. Mellios and Paget-Blanc (2006) think corruption is a vital determinant of credit rating for developing countries. The IMF (2011) summarize the determinants for all credit ratings those are GDP per capita, public debt, fiscal resources and political & economic stability.

Al-Sakka and Ap-Gwilym (2009) study the associations between credit rating agencies; it is evident that 30%-50% information that is utilized between those agencies overlapped. Overall, disregarding the arbitrary judgments of different credit rating agencies, there are eight elements that always appear in the reports, where are income per capita, GDP growth rate, inflation, fiscal balance, external balance, foreign debt, economic development and default risk.

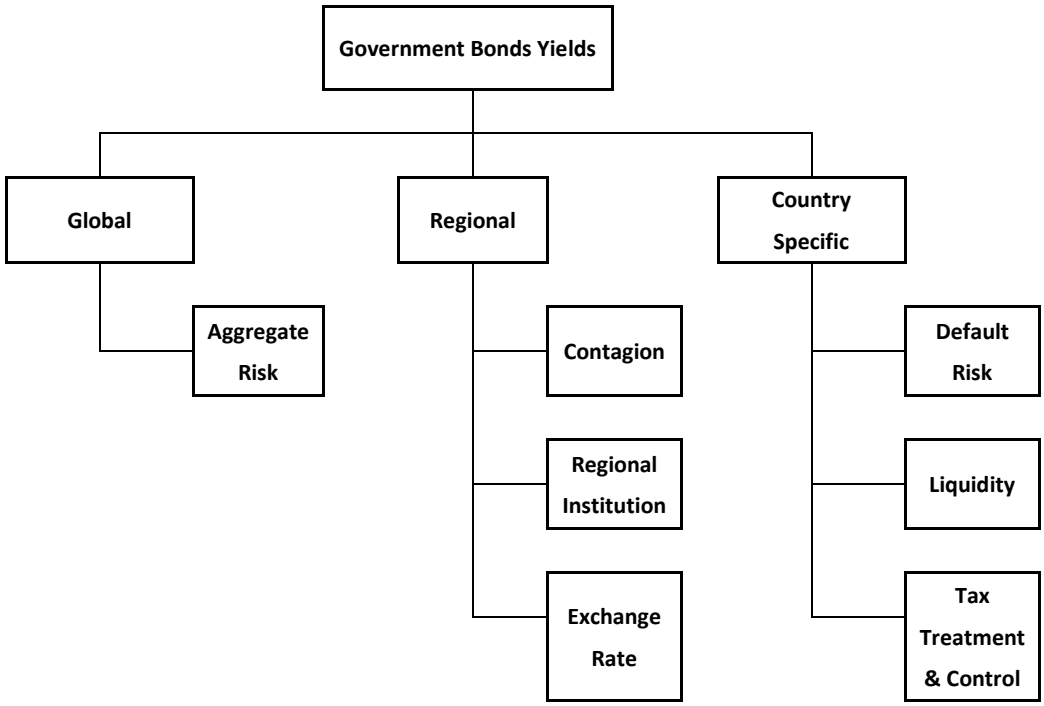
2.2. Determinants of government bonds yields

Codogno et al.(2003) categorize the determinants of government bonds yields into four types: exchange rate risk; tax treatments and controls on capital movements; liquidity risk and default risk. After conducting a uniform currency in 1999, the exchange rate factor no longer exists within Europe, only liquidity and default risk are left. However, other researchers believe that the determinants of sovereign bonds could be classified into three types: global risks; regional risks and country-specific risks. More details can see in the Figure 1, taken fromVan der Kolk (2012).

Aggregate risk denotes global instability and changes of global investors' risk aversion represented by investors' willingness to acquire a risk premium particular in the situation that the global economy experience a great recession, when investors are more risk averse they require a high risk premium.

Regional effects encompass contagion effect, exchange rate variation and regional institutions, which are the most important factors to European countries government bond yields (Beirne and Fratzscher, 2013). An overwhelming contagion is pinpointed by Santis (2012) who argues Spain, Italy, Ireland and Portugal have undergone serious contagion from Greece.

Figure 1



Source: Van der Kolk (2012)

In the end, country specific risks denote the liquidity risk and default risk, where default risk plays a more important role in the determination of sovereign bonds yields compared to liquidity risk which is measured by macro-fundamentals such as debt/GDP ratio, deficit, GDP growth rate etc. However, this does not mean that liquidity is not important. Favero, et al. (2010) confirm that government bonds yields and liquidity have a significant positive relation.

Researches related to the effects of credit ratings on financial market are classified into two parts: one studies the effects of credit rating on government bonds yields spreads, then researches focus on effects of credit ratings on CDS after CDS was invented.

Another part of researchers study the effects of credit ratings on the stock market. This will be discussed in the next section.

2.3. Effects of credit rating on financial markets

2.3.1. Effects of credit rating on government bonds yields

A government bond is a bond issued by a national government, generally with a promise to pay periodic interest payments and to repay the face value on the maturity date which is usually 5-10 years (Vernimmen et al. 2011). Katz (1974) find that credit ratings have no impact on government bond yields spreads before the credit rating is published, which implies information provided by credit rating is anticipated by market. In contrast, Hite and Warga (1997) find abnormal fluctuations of bonds returns 6-months before credit ratings are published that indicating adjustments of credit ratings are anticipated by the market and responses of credit agencies follow the perception of the market. Similarly, Steiner and Heinke (2001) get a similar result, but abnormal returns start from 90-days rather than 180-days before the publishing of credit rating, which indirectly demonstrates that rating agencies improve their efficiency. Woglom and Goldstein (1991) analyze 39 state government bonds yields spreads in the U.S. combining the credit ratings and fiscal indicators through econometric analysis and find that credit ratings actually contain information which is not contained in macroeconomic fundamentals. Thus additional information of credit ratings has been confirmed. The first seminal research of credit rating effects on government bonds yields is operated by Cantor and Packer (1996) who exploit the effects of credit rating on government bonds yields, they argue that credit ratings have strong explanatory power on government bond yields spreads through adopting data of 35 countries published by Moody and S&P and bond yields spreads during 1987-1994. More importantly, they conclude that the significant impact of credit rating downgrading to government bond yields. Meanwhile, macro-fundamentals are encompassed in the regression, it is shown that macro-fundamentals have comparatively weaker

explanatory power which means credit ratings contain not only the information included in macro-economic indicators, but also encompass information beyond macro-economic indicators. However, they do not give us a clear instruction of what kind of information it is. Following the same vein, Eichengreen and Mody (1998), Kamin and von Kleist (1999) derive similar results from Cantor and Packer's research.

Moreover, following Cantor and Packer (1996), substantial researches indicate that only downgrading and negative outlooks affect the financial market. Reisen and Maltzan (1999) extend the sample size of Cantor and Packer (1996) to 29 countries and expand the time series from 1989 to 1997. By adding emerging countries' data, particularly with data of the Mexico crisis and Asia crisis, they conclude that government bonds yields increase dramatically only when nations are labeled as negative outlook or downgraded. In addition, credit ratings also affecting emerging countries' sovereign bonds yields significantly is discovered, which is considered being perceived by markets due to abnormal fluctuations of sovereign bonds yields before the adjustment of credit ratings. In a parallel line, there are many investigations such as Larrain et al. (1997), Gonzales et al. (2008) document different effects between downgrade and upgrade which, in specific, are government bond yields are more sensitive to downgrading rather than upgrading. Nevertheless, due to the limitation of the sample size, many papers focus on emerging countries for instance, the Mexican Crisis, the Asian Crisis and the Russian Crisis only, as to the developed countries, the amount of papers is limited.

Relevant papers on the effects of credit ratings on European countries government bonds yields are limited to the European Debt Crisis. Afonso et al. (2012) pinpoint that both changes of credit rating and changes in the outlook affect sovereign bonds yields, while they distinguish the idiosyncratic effects of positive changes and negative changes, the results note that upgrading affects sovereign bonds yields within EMU countries, while downgrading affects government bonds yields for both EMU countries and non-EMU countries. They also find that market cannot anticipate the credit rating

changes 1-2 months before the announcement day. In the end, they find the credit ratings have a consistent effect on government bonds yields, it is evident that with identical credit rating grades, yields of sovereign bonds without downgrading within 6-months are significantly lower than those undergone being downgraded. Nonetheless, there are obvious flaws in Afonso et al. (2012). First of all, the data ends in October 2012, when the Greek crisis was still evolving, there were contagion effects transmitting to other European countries, therefore it is necessary to extend the time series to later periods. Second, macro-fundamentals and political factors are not being considered in that paper, which means we cannot identify the shocks of credit rating grades are exogenous or endogenous.

2.3.2. Effects of Credit rating on CDS yields spreads

Credit Default Swap (CDS) is invented by J.P. Morgan in 1994, which is standardized by the International Swaps and Derivatives Association in 1998. The early researches study the impacts of credit ratings on corporations' CDS, for example Hull and White (2004) and Norden and Weber (2004). While the studies that investigate the effects of credit rating on sovereign bonds' CDS emerge around 2010. Ismailescu and Kazemi (2010) state asymmetric effects of credit ratings on sovereign bonds' CDS by analyzing sovereign bonds' CDS daily data of 25 countries from 2nd January 2001 to 22nd April 2009. More specifically, CDS appears more sensitive to positive credit rating adjustments rather than negative adjustments. Afonso et al., (2012) relate credit ratings to sovereign CDS spreads by employing data of European countries, two conclusions are drawn from increasing abnormal returns during the period between 1-2 weeks before and after the announcement day. First of all, CDS markets have appropriate anticipation on the adjustment of credit ratings. Secondly, there are consistent impacts of credit ratings on CDS movements. Furthermore, they described a mechanism to explain the sovereign yields spreads during the debt crisis. However, we will not investigate the effects of credit ratings on credit default swap in this research.

2.3.3. Effects of credit ratings on debt financing

Codogno et al. (2003) state that the cost of deb can be influenced by government bond yields. In addition, even small volatility of sovereign bond yields could trigger tremendous change of debt cost. Kraussl (2005) adopt the same prerequisite proposed by Kaminsky and Schmukler (2002), which they refer to as the cleaning condition. More tangibly, the cleaning condition is a time window when no upgrading and downgrading occurs. Through adopting different time windows among selected emerging countries, they found that the size of debt and the volatility of sovereign bond yields are affected by credit ratings significantly; however, they did not depict a clear underlying mechanism. Broeck and Guscina (2011) suggested that the criterion of bonds issue, such as interest rate, size and maturity, are impacted significantly by the credit ratings during the crisis period. Based on sovereign bond yields from 2007 to 2009 of EMU (European Monetary Union) zone, they indicated that the credit rating downgrading had been deteriorating the government bonds issue environment for the countries with high debts and deficits. Similarly, Stancu and Minescu (2011) found the parallel result that credit rating downgrading makes the government bonds yields increase by applying data of seven central and eastern European countries.

2.3.4. Effects of credit ratings on stocks

There has been much previous research of the effect of credit ratings on the stock market. Michaelides et al., (2012) investigated the effects of credit ratings adjustments on stock prices. Brooks et al. (2004) and Hooper et al. (2008) investigated the asymmetric impacts of credit ratings on stock prices. However, in this paper, this is not of interest. And the interest of this paper is the effects of credit ratings on government bond yields.

2.3.5. The spillover effect among the Euro-zone

The spillover effects are confirmed by many empirical researches, but what is the

spillover effect? In this paper, it denotes that a shock on the financial market in one nation is caused by ratings notches changes in other countries. The spillover effect is documented by Kaminsky and Schmukler (2002) who find contagion effects between changes of credit ratings and returns of securities especially between neighboring countries, they also point out that changes of rating notches not only affect government bonds yields, but also affect stock returns. Based on the study by Kaminsky and Schmukler (2002) study, Gande and Parsley (2005) find asymmetric spillover effects of credit ratings, arguing that downgrading rating notches are associated with more significant spillover effects compared to the spillover effect of upgrading notches through extending the sample size to 34 countries and adding more control variables into the regression. Afonso et al. (2012) report strong spillover effects within EMU countries; the channel that contagion is transmitted that countries that are associated with low rating grades contaminate countries with high rating grades. They claim that uniform monetary policy and the collateral framework of the Euro-system and the European stability mechanism, which consists of sharing mechanism of default risk leads to serious contagions within EMU countries. A more general conclusion is drawn by Arezki et al. (2011), who show that the spillover effect not merely exist in government bonds trades, it also exists in CDS and stock trades. Beirne and Frarzscher (2013) classified three types of contagion effects and confirmed that the "wake-up call" contagion plays a major role during the Euro crisis.

2.4. Government Bond Yields and Macro-fundamentals

Geyer et al. (2004) studied four EMU members' sovereign yields with respect to Germany as a benchmark and confirmed the strong and significant economic associations between macro-fundamentals, the current account balance, industrial production and sovereign yields. Ciarlone et al. (2007) investigated seven selected emerging countries' government bond yields by employing a factor analysis. They drew the conclusions that improving macro-fundamentals have significantly positive impacts on reducing the sovereign bond yields differentials, where the short term and the long

term interest rate are applied as the proxies of liquidity and the U.S. stock market index is employed as an indicator of general market risk. Alexopoulou et al. (2009) investigated the determinants of government bond yields within the EU (European Union) by employing an error correction model, which is divided into a short term and a long term model. The results indicate that the debt-to-GDP ratio and external debt are significantly negative correlated with EU sovereign bond yields in the long-run term. Moreover, they found that the effects of macro-fundamentals are idiosyncratic depending on the specifications of short-term or long-term. Inflation, real GDP growth, debt and deficit-to-GDP ratio have been confirmed to impact government bond yields of emerging countries significantly by Jaramillo and Weber (2012). They adopted panel threshold method allowing different coefficients among the distinctive regimes, where the coefficients are determined endogenously by the value of global risk factor – the VIX index. Interacting the EMU dummy with macro-fundamentals, the debt-to-GDP ratio, the budget surplus-to-GDP ratio in their study, Schuknecht et al. (2010) found that the basic economic indicators could still interpret a great percentage of sovereign bond yields volatility even after the Lehman Brothers collapse. Furthermore, the central government deficit plays a more vital role during the crisis period, which is in line with the findings of Beirne and Frarzscher (2013) who explain this phenomenon as "wake-up call" contagion. Broos and de Haan (2012) argued that foreign ownership of government debts makes the government bond yields of EU more sensitive to the debt-to-GDP ratio. Specifically, the positive impact of foreign ownership of government debt on sovereign bond yields is identified particularly among the PIIGS countries.

3. Data Description

In this part, all the data used in the thesis will be discussed. All the variables used in the regressions are divided into two categories: the developed countries and the developing countries. The developed countries are all chosen from Europe, while developing countries are selected from Asia and Latin America and Africa. In this investigation,

the key interest is investigating whether the credit ratings have different explanatory power on government bond yield spreads of developed and developing countries. Consequently, the timespan of the time series employed in this thesis should be as long as possible. Considering the data quality and availability, the data starts from January 2000 to December of 2014. The country list of developed countries are: Germany, Netherlands, Belgium, France, Italy, Spain, Portugal, Ireland; the developing countries are: Brazil. China, Russia, Malaysia, South Africa, India, Indonesia. Originally we want to include the rapid developing emerging economy Vietnam in this investigation. However, the data of Vietnam is extremely poor, for instance, annual data of the deficit and the debt of central government is accessible for 10 years only. As for the liquidity, at least half of the data of the liquidity of Vietnam is missing. Taking the data quality into consideration, we decided to exclude Vietnam.

The variables used in this investigation are 10 years generic government bond yields with respect to US 10 years government bond yields, the spreads between US AAA corporate bonds and US BBB corporate bonds which is employed as proxy of aggregate risk to measure the global risk. Besides, the crisis dummy is added in our regressions, and thus the aggregate risk is covered by the two variables mentioned above. Codogno et al. (2003) conclude that conducting a uniform currency in 1999 exchange rate risk no longer exists in the Europe. Nevertheless, since we are doing a global horizon research with respect to US government bond yields, the exchange rate factor deserves to be included in our research. As we described in the literature review, the determinants of government bond yields are divided into three categories: global risk, regional risk and country specific risk. As for the regional risk, besides the exchange rate risk, the contagion effect of debt crisis is represented by 10 years government bond yields of Greece. In addition, bid-ask price spreads of government bonds are included to represent the liquidity risk. Moreover, by including the unemployment rate, debt/GDP ratio, GDP growth rate, current account balance of GDP, central government budget balance, the default risk is covered. The credit ratings is also involved in this investigation to check whether additional information about country specific default

risk is included in the credit ratings.

As we can see from Table 1, the yield spreads of the developed countries are tremendous lower than the spreads of the developing countries. In addition, the macro-fundamentals' statistics of the developed country group are also lower than those statistics of the developing country group except the deficit to GDP. More importantly, the variation of the credit ratings' linear transformation for the developing group is less than the variation of the developed group, by contrast, the variation of credit ratings' logistic transformation for developing countries is higher than the variation of logistic transformation for developed countries. This phenomena is caused by the different transformation methods.

Moreover, we display the correlation table in the Appendix 2, as we can see from the Appendix 2, both credit ratings transformations are correlated to macro-fundamentals but not at high levels.

3.1. Sovereign Bonds Yields

As the dependent variable, the 10 years maturity government bond yields are used in our empirical research. The data of 10 years government bond yields is available via Bloomberg. However, the 10 years maturity government bonds of China is accessible from 14th November 2005 to 31st December 2014. The data of Indonesia 10 years government bond yields starts from 22nd July 2003 and the data of Russia's 10 year government bond yields starts from 27th December 2000. Meanwhile, the data of 10 years Thai government bond yields starts from 7th August 2000, meaning that small part of observations are missing. In the end, we decided to use the data from 1/4/2000 to 12/31/2014 for both groups.

TABLE 1
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Panel A Developed Country					
Yields Spreads	30961	44.868	172.450	-171.392	1554.928
Liquidity Spreads	30212	0.021	0.083	-0.079	1.575
Exchange Rate	30961	1.236	0.183	0.827	1.599
Unemployment Rate Spreads	30961	2.572	3.990	-5.230	19.030
Debt Spreads	30961	-14.982	25.483	-59.910	53.130
GDP Growth Spreads	30961	-0.539	3.174	-8.100	10.500
Current Account Spreads	30961	3.565	4.926	-8.060	14.160
Deficit Spreads	30961	2.667	3.309	-20.390	10.050
Average linear	30961	1.816	0.296	0.550	2.000
Average logistic	30961	1.887	0.281	0.455	2.000
Contagion	30905	7.723	6.264	3.230	37.101
Aggregate Risk	30961	-245.499	84.763	-426.057	-137.849
Panel B Developing Country					
Yields Spreads	24350	294.996	274.963	-199.848	1726.750
Liquidity Spreads	19270	0.033	0.031	-0.075	0.468
Exchange Rate	24147	0.107	0.093	0.015	0.339
Unemployment Spreads	24246	6.639	16.049	-9.030	56.390
Debt Spreads	24350	-60.250	28.946	-114.730	9.280
GDP Growth Spreads	24350	3.512	3.722	-10.700	15.220
Current Account Spreads	24350	7.883	5.394	-2.520	22.170
Deficit Spreads	24350	1.577	5.530	-17.420	17.900
Average linear	24350	1.282	0.259	0.433	1.700
Average logistic	24350	1.428	0.384	0.197	1.910
Aggregate Risk	24219	-255.047	84.371	-426.057	-137.849

3.2. Aggregate Risk

Codogno et al.(2003), Gerlach et al.(2010) and Santis(2012) employed aggregate risk to measure global risk. The variable they used is the spread between US sovereign bonds and US BBB rated corporate bonds. As time goes on, some researchers use the VIX index to measure aggregate risk, for example, Beirne and Fratzcher (2013). As many other research papers argued, the AAA rated US corporate bonds could be interpreted as risk-free assets as well. Especially after 2008 financial crisis, US sovereign bonds are not safe as before anymore. Therefore, we replace the US sovereign

bonds with the US AAA rated corporate bonds as a proxy of aggregate risk. The data of US AAA corporate bond yields and BBB corporate bond yields are accessible via the Bank of America Merill Lynch which is obtainable though Bloomberg. In this paper, we assume the aggregate risk is positively correlated with yields spreads.

3.3. Contagion

There are plenty of academic papers focusing on the contagion effect of PIIGS countries. Beirne and Fraztzcher (2013) confirmed that fundamental contagion, which is also interpreted as "wake-up call" contagion plays a key role during the crisis. In their regressions, a crisis dummy interacting with macro-fundamentals is applied to measure fundamental contagion. However, in our investigation, we are not interested in which type the contagion is. Instead, we need an easily accessible and economically significant proxy to measure the contagion effect. Arghyrou and Kontonikas (2012) provide an indicator with strong explanatory power, namely the Greek sovereign bond yield spreads. Following the same logic Santis (2012) accounts for contagion effect by using Greek sovereign credit ratings movements as proxy. In this thesis, we would also measure the contagion effect by adopting the Greek 10-years government bond yields. We will examine the hypothesis of a positive relation between contagion and sovereign yield spreads.

3.4. Liquidity

Based on previous studies, liquidity could be quantitative in various approaches. Beber et al.(2009) and Favero et al.(2010) confirmed bid-ask price spread is the best indicator to measure the liquidity at a highly significant level compared with other indicators, for instance, trading volume and size of debt. Therefore, in this investigation, bid-ask price spreads is employed to measure liquidity risk. The bid and ask prices are obtained from Bloomberg, using bid-price subtracting ask-price. We hypothesize liquidity positively affects yield spreads.

3.5. Default risk

The default risk of one country can be indicated by two distinctive categories: the macroeconomic fundamentals and credit ratings. The default risk is measured by multiple macro-fundamentals: the unemployment rate, the debt to GDP ratio, the GDP growth rate, the current account balance and the fiscal balance. Through analysis of previous papers, a positive relation between debt GDP ratio and government bond yield should be detected. High debt/GDP ratio implies that the large amount of debt needs to be reimbursed, hence the default risk will be increased with rising debt/GDP ratio. Similarly, it is evident that the deficit GDP ratio also has a positive connection with government bond yields since the mechanism of deficit/GDP on country's default risk is paralleled with the debt/GDP. The current account balance should be negatively correlated with the government bond yields. On account of a relatively high current account deficit, it is more difficult to maintain the fiscal balance because the high current account deficit suggests that a large amount of money is borrowed from other countries. The GDP growth rate is found to negatively affect government bond yields in emerging countries. It is very rare to include GDP growth rate to explain the government bond yields of developed countries. However, Santis (2012) introduced GDP growth rate as a robustness check and found a significant effect of it on interpreting government bond yields in the Eurozone. The unemployment rate is an economic indicator of potential default risk. A high unemployment rate is more likely to result in a high default risk to repay the interests of government debts. In this case, we select the unemployment rate, the debt GDP ratio, the GDP growth rate, the current account balance and the deficit to GDP ratio to measure the country specific default risk.

3.6. Credit Ratings

One of the crucial data is credit ratings, for which this thesis chooses Moody, Fitch and S&P credit ratings via Bloomberg considering the popularity and the authoritativeness.

Whereas, the intuitive obstacle we are faced with is how to transform the alphabetical notches into digital data. The notches of Fitch and S&P are identical while Moody's notches are slightly different. Defining 1 as highest quality (AAA) and 20 as bankrupt and default, Beirne and Fraztzcher (2013) applied S&P notches linear transformation in their research. Follow the same vein, De Santis (2012) transformed S&P, Fitch and Moody's credit rating notches into linear increasing numeral scores, where a high numeral score corresponds to a high default risk. Moreover, De Santis (2012) also took credit rating outlooks and watches into the consideration. +0.5 is set for the first negative outlook or watch and +0.25 is set for the second negative. Accordingly, the first and second positive outlook or watch are defined as –0.5 and -0.25 respectively. By contrast, Cantor and Packer (1996) set triple A rating notch as 2.0, and every following downgraded notch 0.1 less than the last notch, until the default grade c which is assigned to be 0. Van der Kolk (2012) adopted a similar method with Cantor and Packer (1996) in the same vein with Larrain et al., (1997) incorporating outlooks and watches with official credit rating notches. "*The concrete methodology of transformation is to incorporate outlooks and watches by subtracting or adding half of the difference between the rating score with a negative (positive) outlook and the rating one notch lower (higher).*"[1] In this paper, we would like to follow Van der Kolk (2012)'s method. The details of credit ratings' notches transformation are exhibited in the appendix. The AAA is transformed to 2 and C is transformed to 0. Thus, we suppose a negative relation between credit ratings and sovereign bond yield spreads.

4. Methodology

To examine whether credit ratings have different explanatory power on developed and developing countries' government bond yields respectively, the panel regressions are estimated by dividing the countries into two groups. In the first section of this part, we will conduct unit root tests to examine the stationarity of the variables and in the second

[1] Kolk (2012）

part, co-integration tests will be performed. The third part will discuss the specifications of regressions between the two groups in detail.

4.1. Unit Root Test

It is well known that there exists a probability of spurious regression when the econometric investigation includes non-stationary time series, especially when applying OLS estimation.

In order to prevent spurious regression, conducting unit root tests before starting the key regressions is necessary. In the time series analysis, the DF test (Dickey-Fuller Test) is the most popular one. The mechanism of DF test is based on an autoregressive model and the test specification is as following Equation 1:

$$\Delta y_t = \alpha + \delta t + \theta y_{t-1} + e_t \qquad (1)$$

With the null hypothesis $\theta = 0$, which indicates no unit root existing, the alternative hypothesis is $\theta < 1$, which indicates the existence of unit root. A more advanced ADF test (Augmented Dickey-Fuller Test) is invented with allowing higher-order autoregressive factor. However, the shortcoming of ADF test is obvious: it is applicable to the single section time series analysis only. Considering the investigation we conducted, a panel unit root test is required. In general, examining the unit root in panel data is still fast developing and the unit root in panel data is still a hot issue in econometrics research. The first generation panel unit root tests are more or less based on the ADF test. The representatives of the first generation panel unit root tests are, for example, LLC test (Levin-Lin-Chu test) and IPS test (Im-Pesaran-Skin test), whose null hypothesis are both no existence of unit root while the alternative hypothesis are existence of unit root. Due to the complexity of testing unit root in panel form, conducting one specific unit root test only is likely to give us wrong results. Moreover, considering the request of the extremely balanced data of conducting unit root test by Stata, in this part we use Eviews 8.0 to test the unit root. It could be clearly seen from the Appendix 4 that most of the variables contain one unit root. The exceptions are GDP

growth spreads of both developed and developing countries, liquidity spreads of developed country group, and deficit spreads and unemployment rate spreads of developing country group. For those variables mentioned above, the LLC test has a contradictive outcome to the IPS test and Fisher type tests' outcomes. Consequently, there are more difficulties in distinguishing the unit root process in those variables. The reasons why different tests show the contrasting outcomes are probably structure break or degenerated time trend etc. In this paper we will not discuss the reasons and solutions behind the intuitively contradictive results. For all the tests, either LLC test or IPS and Fisher-type tests, the null hypotheses are common unit root process or all individual unit root process. The rejection of null hypothesis does not imply that all series are of stationarity without unit roots. Hence, a panel version of the KPSS test (Kwiatkowski, Phillips, Schmidt and Shin test) is proposed by Hardi. The test is known as Hardi test where the null hypothesis is that all the series are stationary and accordingly the alternative hypothesis is that all the series are non-stationary. For the variables that have ambiguous processes of unit root, the Hardi test is conducted to identify the unit root processes in those series. As shown in the Table 3, after conducting the Hardi test, we can confirm that all the variables are non-stationary. Next, we plan to identify the number of unit roots among the variables proposed. As Table 3 suggested, after taking the first differences of all variables, the first differences of variables are stationary, and integration of order one for all the variables can be concluded accordingly.

4.2. Co-integration

Co-integration is a revolutionary development for econometrics. As we discussed above, the variables involved in the regressions might be non-stationary and are likely to result in spurious regressions. However, Engle and Granger (1987) proposed that variables which have identical stochastic time trend might be co-integrated, indicating that the linear combination of nonstationary series might generate a stationary series where unbiased and consistent estimator could be obtained. The prerequisite of finding co-integration is that all the series should have the same integrated orders. Otherwise,

taking difference is required for series which have higher integrated orders. Furthermore, the co-integration tests are generally divided into two types, one of which is testing the stationarity of residuals of co-integrational regressions. The idea of this test is proposed by Engle and Granger (1987), and it is similar with the concept of long-run equilibrium. The effects of unit root is probably canceled out when the regressions involve more than two no-stationary series. As a result, if the co-integration system is in equilibrium on average, the residuals of co-integration regression should be stationary; if not, non-stationary residuals series should be witnessed. Based on a VAR model, Johansen and Juselius proposed another type of co-integration test focusing on verifying the regressive coefficient. Because the co-integration test proposed by Johansen and Juselius is a complex process, in this part, we will not discuss it in detail.

Following the same vein of multivariate time series analysis, panel data co-integration tests are invented. Kao (1999) and Pedroni (1999) developed panel co-integration test

TABLE 2

Kao Co-integration Test

Co-integration with Linear Transformation					
	Developed Country Group			Developing Country Group	
	t-Stat	Prob.		t-Stat	Prob.
ADF	-5.468	0.000	ADF	-3.449	0.000
Co-integration with Logistic Transformation					
	Developed Country Group			Developing Country Group	
	t-Stat	Prob.		t-Stat	Prob.
ADF	-5.260	0.000	ADF	-3.406	0.000

Null hypothesis: no co-integration Alternative hypothesis: Existence of Co-integration

on the basis of Engle and Granger (1987) via checking the stationarity of residuals of co-integration regression. Moreover, Maddala and Wu (1999) proposed a more advanced method employing the Johansen co-integration test statistics to construct a Fisher statistic, which follows Chi-square distribution with degree of freedom 2N, where N is the number of individuals of panel data. In this section, we use the Kao test

to verify the existence of a co-integration relation. As shown in Table 2, the null hypothesis of no co-integration existing is significantly rejected in both the developed country group and developing country group. Accordingly, we can conclude that co-integration relations exist in both groups, and therefore a panel regression without using the first differences could be conducted.

5. Empirical Model Specification and Regression Results

5.1. The baseline model

The model we used in this investigation will follow the model of Van der Kolk (2012)'s model. The baseline model will include all the variables mentioned above except for the variables measuring the credit ratings. The measures of credit ratings will be included later to assess the explanatory power of credit ratings on government bonds yield spreads. The model specification in this thesis is as follows (Equation 2):

$$y_{i,t} - y_{b,t} = \alpha_i + \beta_1(y_{i,t-1} - y_{b,t-1}) + \beta_2(L_{i,t} - L_{b,t}) + \beta_3 Exchange_{i,t} + \beta_4(X_{i,t} - X_{b,t}) + \beta_5 Crisis_t + \beta_6 Contagion_{i,t}{}^2 + \varepsilon_{i,t} \quad (2)$$

Where, the $X_{i,t}$ is a vector of macro-fundamentals discussed above, and crisis represents a crisis dummy measuring the effect of 2008 financial crisis. The dummy is set to equal 1 after 9/14/2008 when the Lehman Brothers announced to be bankrupted until the end of the sample period 12/31/2014 since we believe that the global economy is still recovering, whereas before the date of bankruptcy announcement the dummy is set to equal 0. As discussed in many academic articles, the lags of bond yield spreads have explanatory power on the bond yield spreads in the current period. As a result, the first lag of dependent variable government bond yield spreads is included in all the regressions we estimate, grasping the effects that variables of current period cannot capture. In addition, another vital reason of including first lag of dependent variable is that serial autocorrelation is identified with Durbin-Watson statistic equaling 0.03 when

[2] The contagion effect variable is added for developed countries only.

excluding first lag of dependent variable. The notion *i* represents the individual country in the panel, while *b* indicates the benchmark country, which in this case is US. Exchange represents the exchange rate of target countries' currency with respect to US Dollar. Moreover, country fixed effects which measure the unobserved time-unvarying determinants of dependent variable are included and suggested by $\alpha_i$in the equation 2.

5.2. The extended model

As we discussed in section 5.1, the macro-fundamentals vectors are incorporated in the regressions to identify the default risk of target groups. While in the extended model, we will check whether credit ratings have additional explanatory power on interpreting government bond yield spreads or it is just a summary statistics to measure the country's default risk. In order to investigate that, we will add the credit rating transformation into the baseline model. The model specification is as below:

$$y_{i,t} - y_{b,t} = \alpha_i + \beta_1(y_{i,t-1} - y_{b,t-1}) + \beta_2(L_{i,t} - L_{b,t}) + \beta_3 Exchange_{i,t} + \beta_4(X_{i,t} - X_{b,t}) + \beta_5 Crisis_t + \beta_6 Contagion_t{}^3 + \beta_7\ Credit\ rating_{i,t}\ + \varepsilon_{i,t} \quad (3)$$

5.3. Regression results

The main results are illustrated in the Table 5 and Table 6, where the first column is the result of regression, which does not include the country specific default risk measured by credit ratings. As we can see from the Table 5 column 1, the yield spreads are significantly affected by the first lag of yield spreads with the coefficient equaling 0.99, and hence the auto regression of government bond yields is identified. Moreover, the liquidity risk, exchange rate and country specific default risk are all economic determinants of sovereign bond yields with highly statistically significant effects. The liquidity risk is an important factor affecting the sovereign bond yields. With 1 basis points increase in liquidity spreads, 1.391 basis points of yield spreads increased (ceteris paribus). At the same time, the exchange rate is identified to have economically

[3] The contagion effect variable is added for developed countries only.

significant effect on explaining the differences between government bond yields which is positively correlated with sovereign bond yields spreads at 1% level. As Table 3 column 1 indicates, the country specific default risk components, which are measured by unemployment rate, debt GDP ratio, GDP growth rate, current account balance GDP ratio and fiscal balance GDP ratio, have significant explanatory power on sovereign bond yields. However, debt GDP ratio and deficit GDP ratio are negatively correlated with sovereign bond yields, a finding contrasting with many research results of Europe version investigations. One potential reason to interpret the negative signs of debt, deficit and current account is that the macro-fundamentals of US are out of equilibrium. For example, the debt and deficit GDP ratio of US are relatively high, making the debt, deficit and current account spreads negative when taking US as benchmark. Nevertheless, with the globalization moving on, US is still the safe haven for investors, and the US government bonds are still the most secure assets for investors considering their stable and low borrowing costs. The relatively high macro-fundamentals' data combined with the relatively low borrowing costs of US government is possibly a potential interpretation of the negative sign of debt and deficit. As we expected, the current account has a negative sign, which is consistent with the theory that high current account deficit implies outflow of funds of one country which in turn increases the indebtedness of the central government, resulting in potential default risk. And high current account deficit means one country borrows more money from other countries that implies high default risk. The GDP growth is positively correlated with sovereign bond yields at a 1% significance level. This phenomenon, which is opposite to theoretical hypothesis and previous studies like Maltritz (2012) that the GDP growth should be negatively relevant to sovereign bond yields, is very interesting. The overall state of nation's economy is an important indicator of a country's default risk, and the result could be possibly interpreted as that GDP growth rate is not an economic indicator measuring default risk but just a proxy of measuring the returns of investments, high GDP growth rate implies high returns of investments, and this is in line with capital inflows among fast developing countries. The contagion effect is also proved to be significantly related to sovereign bond yields among European countries, and so is the

global risk. More particularly, the significant economic effect of global

TABLE 3

Panel Regressions for Developed Country Group

Variables	1 Yields Spreads	2 Yields Spreads	3 Yields Spreads
Average linear credit rating		-2.580***	
		(0.561)	
Average logistic credit rating			-1.812***
			(0.435)
Yields lag	0.990***	0.988***	0.989***
	0.000687	(0.000792)	(0.00078)
Liquidity Spreads	13.91***	14.67***	14.35***
	(1.01)	(1.024)	(1.016)
Exchange Rate	1.479***	1.598***	1.651***
	(0.378)	(0.379)	(0.380)
Unemployment Spreads	0.0774***	0.0291	0.0508**
	(0.025)	(0.0271)	(0.0258)
Debt Spreads	-0.00266	-0.0181***	-0.0127**
	(0.00541)	(0.00637)	(0.00592)
GDP Growth Spreads	0.0506***	0.0495***	0.0494***
	(0.0168)	(0.0168)	(0.0168)
Current Account Spreads	-0.0692***	-0.0893***	-0.0977***
	(0.02370)	(0.0241)	(0.0246)
Deficit Spreads	-0.0920***	-0.111***	-0.116***
	(0.0184)	(0.0188)	(0.0193)
Contagion	0.0914***	0.103***	0.105***
	(0.0129)	(0.0132)	(0.0133)
Aggregate Risk	0.00758***	0.0118***	0.0104***
	(0.00127)	(0.00156)	(0.00144)
Lehman Dummy	0.899***	0.697***	0.785***
	(0.200)	(0.204)	(0.201)
Constant	-0.653	4.991***	3.337***
	(0.409)	(1.293)	(1.041)
Observations	30,164	30,164	30,164
R-squared	0.997	0.997	0.997
Number of Country id	8	8	8

Standard errors in parentheses * significant at 10% level; ** significant at 5% level ***significant at 1% level

crisis has been identified. The Lehman dummy with 0.899 basis point of sovereign bond yields increased after. The announcement day of Leatherman Brother bankrupted. The R-square of regression is 0.997, suggesting that the model is well specified and has strong explanatory power on sovereign bond yields of the developed country group.

In the second column, the linear transformation of credit ratings is added into regression, and all the variables are extremely significant except the unemployment rate. Thus, additional information contained in the credit ratings has confirmed. The credit ratings have been confirmed highly significant and with the correct sign. The credit ratings having captured all the effects measured by unemployment could be a possible interpretation for this phenomenon. However, different from previous studies focusing on sovereign bond yields within Euro-zone, the default risk measured particularly by debt, deficit GDP growth rate and current account balance is still significantly correlated with sovereign bond yields. This implies that the credit rating agencies might consider the uniformity of economics institute of European Union, like tax treatment, government debt restriction etc., but rating agencies do not consider the heterogeneity between Europe and America. As a result, the effects of debt etc. are not captured by credit ratings in this investigation. The coefficients of other variables besides unemployment measuring liquidity risk, exchange rate risk and country specific default risk are all economically significant at the same level with signs in line with column 1. However those are slightly changed after including credit ratings into regression. More comparably, when using the logistic transformation of credit ratings, the absolute value of coefficient of credit ratings goes up by approximately 30% compared with the value of linear transformation, and the magnitude of the explanatory power of credit ratings increased. This More interestingly, the coefficient of unemployment rate which is in line with the coefficient of excluding credit ratings becomes significant now, implying logistic transformation may not capture the effect of unemployment suggesting logistic credit ratings is a distinctive indicator of default risk independent from macro-fundamentals' indicators.

The results of developing country group are listed in the Table 4, the outcomes are mostly comparable with the developed country group. For the developing country group, the lag of yield spreads are still significant determinant with a coefficient 0.995 of yield spreads movements. In addition, the exchange rate risk, current account balance, deficit and global risk do not play significant roles in explaining the sovereign bond yields of developing country group. Moreover, even for significant variables, the magnitude of the effects are quite different compared with the effects of developed group. For example, when the unemployment rate increases by 1 percentage point, the sovereign bond yields increased by 0.176 basis point correspondingly, which is more than twice as the effect of unemployment rate on sovereign bond yields for the developed group. This indicates that the market may assign more weight to unemployment on evaluating the default risk of developing economies than they do for developed economies. For the GDP growth rate, the coefficient of GDP growth rate for developing country group is approximately two times as the coefficient of developed group, which are 0.104 and 0.0506 respectively. As for the crisis dummy, the result indicates that the global crisis affects emerging economies more seriously than developed economies, with coefficients of 2.203 compared with 0.899. The second column of Table 4 shows that adding linear transformation of credit ratings does not add more effectively explanatory power on sovereign bond yields movement. Meanwhile, the debt GDP ratio becomes less significant at a 90% confident level with the coefficient basically unchanged. When replacing the linear transformation by the logistic transformation, nothing is significantly changed except that debt GDP ratio is now significant at a 5% significance level. The credit ratings do not have any explanatory power on sovereign bond yields' volatility, suggesting that credit ratings are not good proxies to measure country specific default risk of emerging countries and credit ratings do not add extra explanatory power of the other control variables. This is different from the conclusions got in previous studies. Furthermore, the R-square of developing country's group is 0.992, which is a little bit lower than R-square of developed country group. It is confirmed that the credit ratings do not have distinctive

explanatory power on elucidating sovereign bond yield spreads of developing countries. And we could argue properly that the credit agencies do not grasp the particular features of emerging economies which affect emerging country's sovereign bond yields.

TABLE 4
Panel Regressions for Developing Country Group

Variables	1 Yields Spreads	2 Yields Spreads	3 Yields Spreads
Average linear credit rating		-0.011	
		(1.782)	
Average logistic credit rating			0.185
			(1.151)
Yields lag	0.995***	0.995***	0.995***
	(0.000722)	(0.000728)	(0.000725)
Liquidity Spreads	15.64***	15.64***	15.62***
	(3.701)	(3.705)	(3.703)
Exchange Rate	7.488	7.492	7.512
	(5.841)	(5.871)	(5.843)
Unemployment Spreads	0.176***	0.175***	0.179***
	(0.0551)	(0.0581)	(0.0594)
Debt Spreads	0.0328**	0.0327*	0.0341**
	(0.0146)	(0.0175)	(0.0167)
GDP Growth Spreads	0.104***	0.104***	0.104***
	(0.0271)	(0.0271)	(0.0272)
Current Account Spreads	-0.0228	-0.0228	-0.0223
	(0.0372)	(0.0373)	(0.0374)
Deficit Spreads	0.00209	0.00208	0.00249
	(0.0187)	(0.0188)	(0.0189)
Aggregate Risk	-0.00258	-0.00257	-0.0027
	(0.00255)	(0.00275)	(0.00265)
Lehman Dummy	2.023***	2.021***	2.064***
	(0.48)	(0.554)	(0.544)
Constant	-1.09	-1.076	-1.364
	(1.08)	(2.488)	(2.021)
Observations	19,113	19,113	19,113
R-squared	0.992	0.992	0.992
Number of Country id	7	7	7

Standard errors in parentheses * significant at 10% level; ** significant at 5% level ***significant at 1% level

In this investigation, we will not discuss why credit ratings have various explanatory power on explaining sovereign bond yields in a global horizon.

6. Robustness

6.1. Autocorrelation & Heteroscedasticity

6.1.1. The GLS Estimations

In this part, we will discuss several potential biases which may affect our investigation results in order to prevent the jeopardy of spurious regressions. As we mentioned above in the empirical results section, the current bond yields are highly autoregressive, and therefore we added the first lag of bonds yields spreads as an explanatory variable. However, it is still plausible that the residuals of the regression contain the information beyond the range captured. Hence, the first issue of robustness check is autocorrelation. According to Verbeek (2012), the GLS (General Least Square) is robust to autocorrelation/heteroscedasticity. In this model a low standard error is assigned with high weight, while high standard error is distributed with a low weight. The first column of Table 5 shows the results of a panel general least square estimation with cross-section weights. Interestingly, the absolute value of coefficient of credit rating decreases from 2.58 to 1.131, where more than half of the value disappears. Meanwhile, the significance level goes down from 1% to 5%. Moreover, aside from the fact that the unemployment rate is not significant, the debt/GDP ratio is not significant as well now. The possible explanation of this phenomena can be that the deficit/GDP ratio and the credit ratings have already captured the effects of debt on sovereign bond yields. Furthermore, the coefficients of the Lehman dummy, deficit and contagion reduced by 50% approximately. The fourth column illustrates the case using the logistic transformation. And as we can see from Table 5, in the same vein of linear

TABLE 5

Robustness Checks for Developed Country Group

Variables	1 Yields Spreads	2 Yields Spreads	3 Yields Spreads	4 Yields Spreads	5 Yields Spreads	6 Yields Spreads
	Linear Transformation			Logistic Transformation		
	GLS	White	GMM	GLS	White	GMM
Average linear	-1.131**	-2.431**	-2.409**			
	(0.557)	(1.134)	(1.134)			
Average logistic				-0.893*	-1.702*	-1.681
				(0.478)	(0.894)	(0.0894)
Yields lag	0.992***	0.989***	0.989***	0.992***	0.989***	0.989***
	(0.000729)	(0.000792)	(0.0028)	(0.000719)	(0.0027)	(0.0027)
Liquidity Spreads	11.434***	14.374***	14.36***	11.284***	14.08***	14.06***
	(1.248)	(5.084)	(5.084)	(1.246)	(5.058)	(5.058)
Exchange Rate	1.088***	1.592**	1.596**	1.116***	1.641**	1.645**
	(0.326)	(0.711)	(0.711)	(0.326)	(0.716)	(0.716)
Unemployment Spreads	0.0239	0.025	0.0251	0.0324	0.045	0.046
	(0.0236)	(0.027)	(0.027)	(0.022)	(0.03)	(0.03)
Debt Spreads	-0.00885	-0.0161	-0.0127	-0.0074	-0.011	-0.011
	(0.0061)	(0.0124)	(0.0124)	(0.0059)	(0.011)	(0.011)
GDP Growth Spreads	0.0564***	0.0491	0.0491	0.0562***	0.049	0.049
	(0.01390)	(0.0351)	(0.0351)	(0.0139)	(0.035)	(0.0351)
Current Account Spreads	-0.0607***	-0.0883***	-0.0883***	-0.0649***	-0.096***	-0.096***
	(0.0182)	(0.0195)	(0.0195)	(0.0182)	(0.0204)	(0.0204)
Deficit Spreads	-0.0612***	-0.111***	-0.111***	-0.0638***	-0.116***	-0.116***
	(0.0186)	(0.0285)	(0.0286)	(0.0189)	(0.03)	(0.03)
Contagion	0.061***	0.1004***	0.1004***	0.061***	0.102***	0.102***
	(0.01)	(0.0296)	(0.0296)	(0.01)	(0.03)	(0.03)
Aggregate Risk	0.0069***	0.0112**	0.0112**	0.0065***	0.0099**	0.0099**
	(0.00124)	(0.0044)	(0.0044)	(0.00117)	(0.004)	(0.004)
Lehman Dummy	0.352**	0.681	0.684	0.382**	0.763	0.766
	(0.177)	(0.5025)	(0.5029)	(0.174)	(0.509)	(0.509)
Constant	2.082*	4.652*	4.5996*	1.586	3.084	3.033
	(1.251)	(2.635)	(2.636)	(1.098)	(2.145)	(2.147)
Observations	30,157	30,157	30,157	30,157	30,157	30,157
R-squared	0.996	0.997	0.997	0.996	0.997	0.997
Number of Country id	8	8	8	8	8	8

Standard errors in parentheses Standard errors in parentheses * significant at 10% level; ** significant at 5% level ***significant at 1% level

TABLE 6
Robustness for Developing Country Group

VARIABLES	1 Yields Spreads	2 Yields Spreads	3 Yields Spreads	4 Yields Spreads	5 Yields Spreads	6 Yields Spreads
	Linear Transformation			Logistic Transformation		
	GLS	White	GMM	GLS	White	GMM
Average linear	-0.452	1.067	1.052			
	(0.672)	(1.978)	(1.978)			
Average logistic				-0.089	0.691	0.702
				(0.724)	(1.2146)	(1.2151)
Yields lag	0.997***	0.996***	0.996***	0.997***	0.996***	0.996***
	(0.000578)	(0.001719)	(0.0017)	(0.00058)	(0.0017)	(0.0017)
Liquidity Spreads	0.342	14.96***	15.07***	0.3381	14.98***	15.09***
	(0.70)	(4.386)	(4.3858)	(0.6871)	(4.3995)	(4.3989)
Exchange Rate	-1.013	0.298	0.111	-1.644	0.739	0.548
	(2.868)	(6.1717)	(6.1717)	(2.7502)	(5.9288)	(5.9297)
Unemployment Spreads	-0.0078	0.1486*	0.150*	-0.007	0.151*	0.153*
	(0.018)	(0.08)	(0.08)	(0.018)	(0.0826)	(0.0826)
Debt Spreads	-0.002	0.028	0.0279	-0.0005	0.027	0.027
	(0.0047)	(0.0228)	(0.0228)	(0.0044)	(0.0211)	(0.0212)
GDP Growth Spreads	0.009	0.1011**	0.1007**	0.008	0.101**	0.100**
	(0.0067)	(0.0482)	(0.0482)	(0.0066)	(0.0482)	(0.0481)
Current Account Spreads	0.011	-0.004	-0.005	0.011	-0.004	-0.004
	(0.0142)	(0.0334)	(0.0334)	(0.0142)	(0.0332)	(0.0332)
Deficit Spreads	-0.0001	0.005	0.009	-8.00E-05	0.005	0.009
	(0.0186)	(0.0188)	(0.0191)	(0.0018)	(0.0189)	(0.0192)
Aggregate Risk	-0.0006	-0.0033	-0.003	-0.0007	-0.003	-0.003
	(0.0007)	(0.0039)	(0.004)	(0.0007)	(0.0039)	(0.0039)
Lehman Dummy	0.014	1.638*	1.623*	0.036	1.626*	1.622*
	(0.1001)	(0.8956)	(0.8953)	(0.0949)	(0.858)	(0.8579)
Constant	1.138	-2.15	-2.1148	0.784	-1.834	-1,834
	(0.783)	(2.6313)	(2.636)	(0.9486)	(2.056)	(2.0572)
Observations	19,110	19,110	19,110	19,110	19,110	19,110
R-squared	0.999	0.997	0.997	0.999	0.998	0.998
Number of Country id	7	7	7	7	7	7

Standard errors in parentheses Standard errors in parentheses * significant at 10% level; ** significant at 5% level ***significant at 1% level

transformation, the change of the effect of credit ratings is tremendous, and the coefficient of logistic transformation of credit ratings is -0.893 instead of -1.812 when the logistic transformation is used. The other variables follow the same patterns of movement as column 1 indicates.

The GLS estimations of developing country group are listed in the Table 6 column 1 and column 4. The credit ratings have a very negligible effect on sovereign bond yields without statistically significant explanatory capability. Moreover, it is shown that all the variables do not have statistically significant effects on sovereign bond yield spreads, except for the first lag of the yields itself. This indicates that the yield spreads is highly autoregressive for developing countries. And we see the same for the logistic transformation.

6.1.2. The White Cross-section Standard Error & Covariance

Proposed by Baltagi et al. (2007), the standard error assumptions of panel data are too restrictive to the real application of panel data. Panel data regressions are likely to suffer from autocorrelation and heteroscedasticity. And due to the varying sizes of cross-section samples, heteroscedasticity may appear in empirical research. For the sake of preventing the spurious regression, we adopt White cross-section standard error to deal with the autocorrelation and heteroscedasticity simultaneously. The result of adopting White cross-section standard error is shown in the Table 5 column 2 and column 5, the coefficient of linear credit rating transformation is slightly affected, equaling -2.43 instead of -2.58. Nevertheless, the significance level moves to the 95% confident interval rather than the 99% confident interval without White cross-section standard error. Following same pattern, the coefficient of logistic transformation changed mildly. But most importantly, the logistic transformation of credit ratings is significant at 10% level with p-value equaling 0.0568, exceeding the 5% confident interval slightly. Adopting the White cross-section standard error, the GDP growth rate and Lehman dummy become insignificant, implying that the credit ratings have indeed captured the

effects of GDP growth and global crisis on sovereign bond yields.

The results of developing countries for White standard errors is displayed in Table 6 column 2 and column 5. As we see from the table, liquidity risk, exchange rate risk, and country specific risk do not play statistically significant roles in explaining sovereign bond yields. The only factor which affects developing countries' sovereign bond yields is the bond yields themselves, and the regression using the logistic transformation is similar.

6.2. Endogeneity

In this section, the endogenous issue will be explored. Gonzalez-Rozada and Yeyati (2008) argued about omitted variables in investigating the bond yield spreads of emerging markets. Van der Kolk (2012) discussed reverse causality of bonds yields and credit rating, using 1st to 4th credit rating' lag as instrument variables. The debt and deficit we used in this investigation seem to affect sovereign bonds yields, and in turn the debt and deficit are affected by government bond yields as well. The increase of government bond yields also increases the government debts and deficits. This is because with increasing interests of government bonds, governments have to repay more to investors. Furthermore, as many observers discussed, other variables such as capital formations suffer from the omitted variable bias. Hence, we need a more general and more robust method to estimate the true power of credit ratings on explaining the sovereign bonds yields. In this section, the GMM (General Method of Moment) approach will be conducted to investigate the true causal effects. The basic idea of the GMM approach is multiple instrument variables, which satisfies conditions that the expectation of the regression's residual interacted with the instrument variables is zero when the variables are set to be endogenous, otherwise, the expectation of the residual and exogenous variables is zero and size of bank sector could also have significant explanatory power on interpreting the movement of sovereign bond yields spreads, consequently, our investigation may when the variables are set to be exogenous. In this

investigation particularly, the mathematic expression is as follows:

$$\mathrm{E}\big[\big(Yields\ Spreads_{i,t} - \alpha_i - \beta_1 Liquidity\ Spreads - \beta_2 Exchange\ Rate - \beta_3 Unemployment\ Spreads - \beta_4 Debt\ Spreads - \beta_5 GDP\ Growth\ Spreads - \beta_6 Current\ Account\ Spreads - \beta_7 Deficit\ Spreads - \beta_8 Aggregate\ Risk - \beta_9 Contagion - \beta_{11} Credit\ ratings - \beta_{12} lehman - \beta_{13} Yields\ Spreads\ lag\big) Z_i\big] = 0^4 \quad (4)$$

Verbeek (2012) proposed that the lags of endogenous variables could be good instruments in many dynamic panel applications. Thus, we use the first lags of debt spreads, deficit spreads and credit ratings as instrument variables by assuming that the first lags are correlated with current debt, deficit and credit ratings, but not correlated with current yields spreads and residuals. The result is shown in Table 5 column 3 and column 6. The results are similar with the ones of the regressions with White cross-section standard error. We will not describe the details in this section.

The GMM estimation of developing country group is listed in the Table 6 column 3 and column 6, in the identical vein with developed country group. The results of GMM estimations are in line with the panel linear estimation with White cross-section standard error.

We also run the regressions for developing country group without liquidity and excluding China respectively, the results do not change significantly.

7. Conclusion

Credit ratings played a crucial role in the global crisis and the European debt crisis, particularly when the Greek rating was downgraded by the credit rating agencies. As many researchers argued, the credit ratings may have a bias when evaluating the default risks of developing countries. However, in this investigation we do not provide more insights into the extent to which the developing countries suffered from the bias. The

[4] Z_i is instrument variables if the variable is endogenous, otherwise Z_i is the variables of the control variables which are set to be exogenous.

different explanatory powers of credit ratings on explaining the sovereign bonds yields among developed and developing countries with respect to US sovereign bonds yields are confirmed in this investigation. The econometric results suggest that credit ratings provide additional information on explaining the movements of European sovereign bonds yields with respect to benchmark US sovereign bonds yields. The econometrics results also indicate that either credit ratings or country specific factors do not have any statistically significant explanatory power on the sovereign bond yield spreads between developing countries and US. The results are derived from panel datasets of two distinctive country groups, namely, Germany, Belgium, France, Italy, Spain, Netherlands, Ireland and Portugal for the developed country group, and China, India, Indonesia, Russia, Malaysia, South Africa and Thailand for developing country group, spanning from 1/4/2000 to 12/31/2014[5]. Moreover, credit ratings are a summary statistic that is completely refusing in this investigation. Specifically, for the developed countries, adding credit ratings into the regression does not affect the significance of country specific default risk factor such as current account balance and deficit/GDP. In contrast to the developed country group, credit ratings do not provide any information on interpreting the movement of sovereign bond yields with regard to U.S. counterpart. There are still limitations in our investigation. First of all the heteroscedasticity is still unsolved even we have applied the White cross-section standard error. Secondly, the data quality of developing country group is poor. The amount of observations is tremendously smaller than developed country group within the same period. That is a potential source which makes our analysis not able to capture the true causal relation between the credit ratings and sovereign bond yield spreads. Interestingly, according to the original data the variation of credit ratings for developing countries is more fluctuating than the variation of developed countries, but the econometric analysis showed that credit ratings do not add any additional explanatory power on sovereign bond yield spreads, the reasons behind this phenomena need to be discovered.

[5] For developing group, the timespan is also from 1/4/2000 to 12/31/2014, but with less observations because the missing data.

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APPENDICES

APPENDIX 1

Credit Rating Notches

	Symbols		Moody's Five Year Default Rates		
	S&P/Fitch	Moody	Idealized	Corporate	Sovereign
Highest Quality	AAA	Aaa	0.003		
High Qualityy	AA+	Aa1	0.068		
	AA	Aa2	0.142	0.247	0
	AA-	Aa3	0.261		
Strong payment capacity	A+	A1	0.467		
	A	A2	0.73	0.806	0
	A-	A3	1.1	2.027	2.437
Adequate payment capacity	BBB+	Baa1	1.58		
	BBB	Baa2	3.05		
	BBB-	Baa3	5.28		
likely to fulfil obligations	BB+	Ba1	8.41		
	BB	Ba2	11.86	11.444	8.079
	BB-	Ba3	16.12		
High-risk obligations	B+	B1	20.71		
	B	B2	27.05	26.24	10.572
	B-	B3	36.314		
Vulnerable to default	CCC+	Caa1	48.75		
	CCC	Caa2	69.821		
	CCC-	Caa3			
Near or in bankruptcy or default	CC	Ca		52.35	32.458

Source: IMF (2010)

APPENDIX 2-1

Correlation of Variables - Developed Country Group

Probability	YS	AR	LINEAR	LOG	CON	C&A	DEBT	DEFICIT	EXCHANGE	GDP	LIQUIDITY	UNEM
YS	1.0000											
AR	-0.2949	1.0000										
	0.0000											
LINEAR	-0.6592	0.5139	1.0000									
	0.0000	0.0000										
LOG	-0.6555	0.4990	0.9598	1.0000								
	0.0000	0.0000	0.0000									
CONTAGION	0.5559	-0.5328	-0.3006	-0.2942	1.0000							
	0.0000	0.0000	0.0000	0.0000								
C&A	-0.2924	-0.0915	0.2518	0.1347	-0.0183	1.0000						
	0.0000	0.0000	0.0000	0.0000	0.0015							
DEBT	0.0128	0.3022	-0.2631	-0.1562	-0.2238	0.0129	1.0000					
	0.0265	0.0000	0.0000	0.0000	0.0000	0.0255						
DEFICIT	0.0278	-0.1351	-0.0348	-0.0403	0.1980	0.0874	0.1313	1.0000				
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000					
EXCHANGE	0.2075	-0.5652	-0.1826	-0.1680	0.1901	0.0152	-0.3439	0.1363	1.0000			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0083	0.0000	0.0000				
GDP	-0.2514	0.3215	0.2786	0.2483	-0.2202	0.0350	-0.0049	0.0026	-0.1887	1.0000		
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.3937	0.6553	0.0000			
LIQUIDITY	0.7705	-0.1767	-0.4751	-0.5177	0.3860	-0.1638	0.0476	0.0809	0.0961	-0.1592	1.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
UNEM	0.2818	-0.1801	-0.5294	-0.4939	0.0272	-0.2606	0.1319	-0.2254	-0.0101	-0.1331	0.1562	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0794	0.0000	0.0000	

APPENDIX 2-2

Correlation of Variables - Developing Country Group

Probability	YS	AR	LINEAR	LOG	C&A	DEBT	DEFICIT	EXCHANGE	GDP	LIQUIDITY	UNEM
YS	1.0000										
AR	0.0250	1.0000									
	0.0006										
LINEAR	-0.5941	-0.1072	1.0000								
	0.0000	0.0000									
LOG	-0.5870	-0.1193	0.9922	1.0000							
	0.0000	0.0000	0.0000								
C&A	-0.4657	0.4098	0.4742	0.4573	1.0000						
	0.0000	0.0000	0.0000	0.0000							
DEBT	0.1311	0.7952	-0.2787	-0.2813	0.2831	1.0000					
	0.0000	0.0000	0.0000	0.0000	0.0000						
DEFICIT	-0.1913	-0.2507	0.2724	0.2654	0.0201	-0.4599	1.0000				
	0.0000	0.0000	0.0000	0.0000	0.0055	0.0000					
EXCHANGE	-0.2257	-0.0547	0.4811	0.4435	0.6405	0.0247	-0.0138	1.0000			
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0006	0.0571				
GDP	-0.1010	0.1654	0.0005	-0.0489	0.0775	0.0940	0.0603	0.0192	1.0000		
	0.0000	0.0000	0.9468	0.0000	0.0000	0.0000	0.0000	0.0080			
LIQUIDITY	0.0717	-0.2142	-0.1387	-0.1451	-0.1503	-0.3435	0.0000	-0.0340	-0.1370	1.0000	
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9997	0.0000	0.0000		
UNEM	0.7190	0.0788	-0.5304	-0.5568	-0.1952	0.0710	-0.1539	0.0170	-0.0706	0.3721	1.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0187	0.0000	0.0000	

All variables are defined as follows:

YS: Yield Spreads AR: Aggregate Risk

LINEAR: Credit ratings linear transformation

LOG: Credit ratings logistic transformation

C&A: Current account Spreads

UNEM: Unemployment Rate Spreads

APPENDIX 3

Data Summary

Variables	Proxy	Source	Database	Frequency
Yields Spreads	10 years maturity sovereign bonds yields- 10 years U.S. government bond yields	Markit	Bloomberg	Daily
Aggregate Risk	US AAA corp - U.S. BBB corp	Merill Lynch	DataStream	Daily
Contagion	Greek 10 years government bond yields	Markit	Bloomberg	Daily
Liquidity	Bid-ask price spreads	Markit	Bloomberg	Daily
Current Account	Current account balance as % of GDP	Eurostat/Oxford Economics	Bloomberg/DataStream	Quarterly
Debt to GDP	Domestic debt as % of GDP	Eurostat/Oxford Economics	Bloomberg/DataStream	Quarterly
Deficit to GDP	Expected deficit as % of GDP	Eurostat/Oxford Economics	Bloomberg/DataStream	Quarterly
GDP Growth Rate	GDP growth rate	Eurostat/Oxford Economics	Bloomberg/DataStream	Quarterly
Uemployment	Unemployment as of total population	Eurostat/Oxford Economics	Bloomberg/DataStream	Quarterly
Credit rating	Average value of linear and logistic tranformation	S&P, Fitch, Moody	Bloomberg	

APPENDIX 4

Summary of Unit Root Test

Level

P-value of rejection of null hypothesis

Variables	Developed Countries						Developing Countries					
	LLC	Breitung	IPS	ADF-Fisher	PP-Fisher	Hardi	LLC	Breitung	IPS	ADF-Fisher	PP-Fisher	Hardi
Yields Spreads	0.217	0.460	0.961	1.000	1.000	0.000	0.333		0.015	0.030	0.007	0.000
Liquidity Spreads	1.000	0.000	0.000	0.000	0.000		1.000	0.000	0.000	0.000	0.000	0.000
Exchange Rate	0.999	0.602	0.997	1.000	1.000		0.999	0.922	0.998	0.999	0.999	
Unemployment Spreads	0.468	1.000	1.000	1.000	0.999		0.997	0.998	0.996	0.876	0.864	
Debt Spreads	0.931	1.000	1.000	1.000	1.000		0.497	0.982	0.991	0.908	0.912	
GDP Growth Spreads	0.290	0.000	0.000	0.000	0.000	0.000	0.343	0.000	0.000	0.000	0.000	0.000
Current Account Spreads	0.989	1.000	1.000	1.000	1.000		0.143	0.792	0.954	0.981	0.981	
Deficit Spreads	0.501		0.151	0.271	0.264		0.668	0.000	0.000	0.000	0.000	0.000
Aggregate Risk	0.217	0.460	0.961	1.000	1.000		0.217	0.460	0.961	1.000	1.000	
Contagion	0.000	0.000	0.005	0.040	0.662	0.000						

First Difference

P-value of rejection of null hypothesis

	Developed Countries						Developing Countries					
Variables	LLC	Breitung	IPS	ADF-Fisher	PP-Fisher	Hardi	LLC	Breitung	IPS	ADF-Fisher	PP-Fisher	Hardi
Yields Spreads	0.000	0.000	0.000	0.000	0.000	0.915	0.000	0.000	0.000	0.000	0.000	0.903
Liquidity Spreads	0.000	0.000	0.000	0.000	0.000		1.000	0.000	0.000	0.000	0.000	0.575
Exchange Rate	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
Unemployment Spreads	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
Debt Spreads	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
GDP Growth Spreads	0.000	0.000	0.000	0.000	0.000	0.997	0.000	0.000	0.000	0.000	0.000	0.143
Current Account Spreads	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
Deficit Spreads	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	1.000
Aggregate Risk	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000	
Contagion	1.000	0.063	0.000	0.000	0.000	0.710						

APPENDIX 5

Credit Rating Transformation

	Notches		Linear		Logistic	
	S&P/Fitch	Moody	Stable	Negative outlook	Stable	Negative outlook
Highest Quality	AAA	Aaa	2.00	1.95	2.00	1.995
High Quality	AA+	Aa1	1.90	1.85	1.99	1.975
	AA	Aa2	1.80	1.75	1.96	1.935
	AA-	Aa3	1.70	1.65	1.91	1.875
Strong payment capacity	A+	A1	1.60	1.55	1.84	1.795
	A	A2	1.50	1.45	1.75	1.695
	A-	A3	1.00	1.35	1.64	1.575
Adequate payment capacity	BBB+	Baa1	1.30	1.25	1.51	1.45
	BBB	Baa2	1.20	1.15	1.36	1.275
	BBB-	Baa3	1.10	1.05	1.19	1.095
Likely to fulfill obligations, ongoing uncertainty	BB+	Ba1	1.00	0.95	1.00	0.905
	BB	Ba2	0.90	0.85	0.81	0.725
	BB-	Ba3	0.80	0.75	0.64	0.565
High-risk obligations	B+	B1	0.70	0.65	0.49	0.425
	B	B2	0.60	0.55	0.36	0.305
	B-	B3	0.50	0.45	0.25	0.205
Vulnarable to default	CCC+	Caa1	0.40	0.35	0.16	0.125
	CCC	Caa2	0.30	0.25	0.09	0.065
	CCC-	Caa3	0.20	0.15	0.04	0.025
Default	CC	Ca	0.10	0.05	0.01	0.005
	C	C	0.00	0	0.00	0

Source: Kolk (2012)