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The Price Discovery Mechanism between Sovereign Bond and Sovereign CDS Market: Studies in Selected Countries

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Abstract

This paper employs the multivariate VAR model to examine the mechanic work of price discovery process between sovereign CDS market and the associated sovereign bond market in contexts of five European and Asian countries, including Vietnam, Korea, Portugal, Italy and France from the beginning of 2008 to the end of April, 2017. The study accentuates on three aspects: the short-term interaction nexus between the sovereign CDS and the associated-sovereign bond market, the long-term co-movement between them and the discovery of which market plays the leading role in the pricing process. The results evidence the short-run and long-run relationship for the two markets. Particularly, the empirical test results support for the predominant role of the sovereign CDS market in the price discovery process in the bulk of sample entities. This might suggests for the governments to use CDS prices as the future indicator for predicting the volatility of debt markets.

Keywords: Asset price**,** Asset Pricing, Bond Interest Rates, Equities, Equity Premium

JEL classification: G120

1. Introduction

In this paper, the relationship between the sovereign credit default swap (CDS) premia and bond spreads is examined in the contexts of five European and Asian countries. The finding is that the prices of the two instruments interact each other in both short-run long-run but in the different ways, owing to the difference in credit risk and liquidity risk. In detailed, the tests with empirical data indicate that the leading role in the pricing process is a tribute of either sovereign CDS market or sovereign bond market depends on countries. Comparing the testing results of different sovereigns, the CDS market tends to move ahead the other in case of more-bonds issuers, in other words, riskier countries.

To begin with, the mechanics for the pricing interaction between sovereign CDS market and bond market should be ascertained. Hull, J. (2004) defines CDS as a contract ensuring a buyer from the risk of default. The buyer of the CDS contract has the right to sell and the seller of the CDS is obliged to buy the underlying bonds for their face values when a credit event occurs. The most empirical advantage of CDS instrument is a method to convert the risky underlying bonds to risk-free bonds at the benefit of the buyer, or in other words, CDS contracts can be considered as a hedging tool against positions in bonds.

In a typical CDS contract, the seller receives the periodical premium, often said is annual payment, in return for bearing the default risk from the issuer (the sovereign). The premium is set based on the notional amount of the issue for a long-term period. In cases of credit events, the settlement of a CDS transaction can be done in either two following methods:

- The comparatively less popular method is “physical settlement” (AIMA research, 2011). By doing this, the CDS buyer delivers the sovereign bonds to the CDS seller. The seller then pays out the notional amount of the bonds delivered to the buyer. Consequently, the seller of the credit-default protection owns those bonds, whose values have been slumped due to sovereign default, whilst refunds the full of face values to the buyer of the protection.

- The second method is “cash settlement” (*ibid*). In this method, no underlying bonds are exchanged among parties. The CDS seller transfers the CDS buyer the amount of cash equivalent to the face value minus the residual values of the bonds.

From the above snap shot on how the sovereign CDS market works, it is suggested that a sovereign bond’s credit risk and liquidity risk influent its yield and then a change in the associated bond spread is a key factor in determining the premium in the CDS contract. However, the objective of the paper is to investigate more deeply whether the two prices move together in practice as theories state and if they do, which one leads the other. On that basis, the cause for the current high sovereign borrowing cost can be detected.

For these purposes, the two key questions below should be made clear:

- Do the two market co-move in the short-run and long-run?
- Which market is dominant in the price discovery dynamics?

2. Literature review

2.1. Studies on the role of sovereign CDS and Bond market in the price discovery process

2.1.1. Existing results on the role of each market in the price discovery process

The paper appears to be likely similar to the research taken by Calice, G., Chen, J. and Williams, J. (2007). They detect that whether CDS or debt market plays the determined role in the mechanics depends on the contexts of different countries. However the ebullient tendency appeared in the current financial crisis is that the CDS market went prior in most cases. Similarly, Longstaff, F. *et al* (2005) and Zhu, H. (2006) dedicate the forward movement of CDS market over bond market in the price discovery by focusing on effects of liquidity risk. Based on this approach, this paper considers a bunch of factors of liquidity risk and credit risk influent relationship between the two markets. However, we are not going to approach the aims of the paper by analysing in deep the effects of liquidity risk and credit risk to the short-term and long-term cointegration between sovereign CDS and bond market. Therefore these risks are not used as parameters in the regression equations.

A proportion of the foundation of this paper is the research of Calice, G. (2012). Calice casts his analysis on the cointegration of the two markets in both short-run and long-run. Moreover, he also concludes that the contribution of CDS market in the price discovery process is non-uniform across different countries. According to him, CDS market leads in high-yield countries whilst bond market dominates in comparatively low-yield countries. Calice's detection is approximately the same as the study of Fontana, A. and Scheicher, M. (2011), who supply the evidence on the superior price discovery of CDS market in abnormal sovereign borrowers (high-yield countries). However, Fontana and Scheicher claim the CDS market to exacerbate the ongoing financial crisis and swipe its contribution, with that Calice's study gives no conclusion. Ammer, J. and Cai, F. (2011) develop the findings of those above by criticizing that the more liquid market tends to lead regardless which country is studied. They still reach to the similar conclusion that CDS market often plays leading role over bond market. To address these findings, Ammer and Cai use the VECM estimation with variables are the dynamic changes in 5-year CDS premia and bond spreads over time, which uses the cross-section data of seven sovereign entities. Other papers also find the evidence of the CDS leading in the price discovery, such as Blanco, R. *et al* (2005), Hull, J. *et al* (2004).

Notably, the research's results should be in the trend of dominant role for the CDS market over its counter part as stated in researches of Baba, N. and Inada, M. (2009); Bowe, M., Klimavicienne, A. and Taylor, A. (2009). Nonetheless, the crisis period may moderate or drive this primary movement, during which the pricing relationship has not been investigated in the above papers. Therefore this paper is going to take this financial turmoil period as the major concern in order to answer if the sovereign CDS market's supremacy is fuelled by the crisis or that is owing to the development of CDS segment recent years. Furthermore, the results for price discovery process for sovereigns have not been clear in previous studies. It can be seen in the research of Baba and Inada that they give the evidences for merely Japanese banks or Bowe, M. *et al* go to their conlusions by looking at corporate CDSs in

eight emerging countries. Thereby this paper will hopefully improve the recent findings on pricing process of sovereign credit instruments.

The research tends to contrast the findings of Jacoby, G. *et al* (2009) who state that there is no common component in the pricing process between the two markets and there is only the evidence about the link between equity market and CDS market. In the same idea with Jacoby, G. *et al*, Levy, A. (2009) argues in his study that there is no persistent pattern of one market leads the other. Analogously, Coudert, V. and Gex, M. (2010) explicates that sovereign CDS market is relatively small in comparison to debt market, thereby CDS spread can not drive the borrowing costs, specially in relative low - yield contries like developed ones.

In the AIMA research note (2011), Granger causality tests on CDS market and bond market give the result that the former is relatively cheaper than the later, which suggests that CDS market is hardly considered as the cause of high bond yields in sluggish countries. Additionally, their tests show the two markets are equally to lead or to lag the other. The paper, in one hand, is in the same idea with this work in term of the unreplacable role of sovereign CDS markets though on the other hand casts the doubt on if CDS market forces the bond market' spreads to bound or not.

Regarding the role of each market during the recent crisis, Anderson, R. (2010) advocates the CDS market has been transferring the credit risk to bond market. Augustin, P. and Tedongap, R. (2011) neutrally state that either catastrophic CDS market or bond market could engage the negative effect on the financial stability. Stulz, R. (2010); Andenmatten, S. and Brill, F. (2010) opposingly conclude the smaller role of CDS market in the financial sovereign crisis compared to bond market due to its relatively small market size. The paper, in the other way round, is to demonstrate the assertions of those above to be appropriate depend on case of low-yield or high-yield sovereigns.

2.1.2. Existing methodology used to investigate the role of each market

The paper has a great deal in common with the paper of Calice, G. *et al* (2007) in term of ultilising the Vector Autoregression (VAR) model to acquire the relationship between the lag-values of CDS premia and bond spreads for selected countries. In their paper, the sample of nine European countries is considered and the 5 and 10-year instruments are used as benchmarks.To capture the dynamic price spill-over effect between sovereign CDS market and bond market, the sovereign bond credit spread and liquidity spreads, sovereign CDS credit and liquidity spreads are included in the VAR equations as follows:

- $BOND_{creditspread(t)} = \mu_{1(t)} + \beta_{11(t)} BOND_{creditspread(t-1)} + \beta_{12(t)} CDS_{creditspread(t-1)} + \beta_{13(t)} BOND_{liquidityspread(t-1)} + \beta_{14(t)} CDS_{liquidityspread(t-1)} + u_{1(t)}$
- $CDS_{creditspread(t)} = \mu_{2(t)} + \beta_{21(t)} BOND_{creditspread(t-1)} + \beta_{22(t)} CDS_{creditspread(t-1)} + \beta_{23(t)} BOND_{liquidityspread(t-1)} + \beta_{24(t)} CDS_{liquidityspread(t-1)} + u_{2(t)}$
- $BOND_{liquidtyspread(t)} = \mu_{3(t)} + \beta_{31(t)} BOND_{creditspread(t-1)} + \beta_{32(t)} CDS_{creditspread(t-1)} + \beta_{33(t)} BOND_{liquidityspread(t-1)} + \beta_{34(t)} CDS_{liquidityspread(t-1)} + u_{3(t)}$

- $CDS_{liquidityspread(t)} = \mu_{4(t)} + \beta_{41(t)} BOND_{creditspread(t-1)} + \beta_{42(t)} CDS_{creditspread(t-1)} + \beta_{43(t)} BOND_{liquidityspread(t-1)} + \beta_{44(t)} CDS_{liquidityspread(t-1)} + u_{4(t)}$

Where:

$\mu_{(t)}$: intercept

$u_{(t)}$: error term

$\beta_{(t)}$: coefficient

Even applying the similar VAR models, a somewhat distinctiveness about regression equations used in this paper and those above is that we are not going to explain any typical risk factor creates the leading role for one market over the other. Infact, the paper accentuates on the prices themselves rather than their pricing structures. Thus, based on the foundation above, "$BOND_{creditspread}$" and "$BOND_{liquidityspread}$" variables, "$CDS_{creditspread}$" and "$CDS_{liquidityspread}$" variables are merged into "price" variable, which is "CDS premium" or CDS_{prem} for CDS market and "bond spread" or BY_{spread} in case of bond market.

This study is in the contrastive line with results found by Jacoby, G. *et al* (2009) in term of price discovery process. Besides, the methodologies employed in their study and this paper are aslo different. Jacoby and his colleagues use monthly cross-section data in VAR model to examine liquidity shocks across the two markets:

$$LIQ_{CDS(t)} = \alpha_{CDS} + \sum_{i=1}^{p} \beta_{i,CDS} LIQ_{CDS(t-i)} + \sum_{i=1}^{p} \beta_{i,BOND} LIQ_{BOND(t-i)} + \varepsilon_{t,CDS}$$

$$LIQ_{BOND(t)} = \alpha_{BOND} + \sum_{i=1}^{p} \beta_{i,CDS} LIQ_{CDS(t-i)} + \sum_{i=1}^{p} \beta_{i,BOND} LIQ_{BOND(t-i)} + \varepsilon_{t,BOND}$$

Where:

LIQ_{CDS}, LIQ_{BOND}: CDS market and bond market liquidity shocks

α: intercept

β: coefficent

p: lag-length

ε: error term

The magnitude of the coefficients is generally small indicates that there is no immediate spill-over of liquidity shocks from the bond market to CDS market and vice versa. In the other words, the prices in one market can not affect the prices in the other. However, the paper is contrastly handling with daily time-series data rather than monthly cross-section data and as stated above, the regression equations are not investigating any individual risk affecting the prices but considering the entire prices themselves.

2.2. Studies on the short-term and long-term relationship between sovereign CDS and Bond market

The long-term cointegration between the two assets' prices in most cases of European entities and some selected Asian entities are documented in researches of Palladini, G. and Portes, R. (2011), De Wit, J. (2006), Norden, L. and Weber, M. (2004), Zhu, H. (2006), for which the paper likewise hope to get. This is likely to be acute that the possible cointegrated relationship across many other markets is neglected in those studies and the general trends may be introduced bias in their results. As the more extensions on the market size, the stronger the findings are, thus this paper would extend the existing researches firstly in term of market size and then criticise for the short-run pricing rather than only the long-run dynamic linkage.

The research aims at proving the cointegration of the two markets in both short-run and long-run in normal economic conditions as in line with theories. Yet if this cointegrated relationship was weakened during financial turmoils such as in period from 2008 to 2016 or not, the answer should aslo be made clear in this paper. The foundation for the research on this price deviation comes from the study of Alexopoulou, L. *et al* (2009), who provide evidences on the decoupling movements of the bond market and CDS market due to the financial turbulence in 2007. First, they scruitinize at credit risk structure of the two assets, which includes: firm-specific factor, external economic factors and liquidity-related factors, by applying the Merton's structural debt valuation model as below.

$$\Delta CDS_{i,t}=\alpha_1 + \beta_{11}FIV_{i,t} + \beta_{12}FSR_{i,t} + \beta_{13}BOND_t + \beta_{14}IV_t + \beta_{15}SR_t + \beta_{16}TR_t + \beta_{17}EC_{i,t-1} + \varepsilon_{1t}$$

$$\Delta CS_{i,t} =\alpha_2 + \beta_{21}FIV_{i,t} + \beta_{22}FSR_{i,t} + \beta_{23}BOND_t + \beta_{24}IV_t + \beta_{25}SR_t + \beta_{26}TR_t + \beta_{27}EC_{i,t-1} + \varepsilon_t$$

Where:

α: intercept

β: coefficent

ε: error term

$CDS_{i,t}$: CDS premium for firm i's bond at time t

$CS_{i,t}$: firm i's bond spread at time t

FIV: firm-specific implied volatility

FSR: firm-specific weekly stock returns

$BOND_t$: yield offered on the 10-year benchmark bonds at time t

IV: implied volatility

SR: weekly stock return

OTR: difference between on-the-run and off-the-run yields on US government bonds

EC: lagged error from the regression equation: $CDS_{i,t}=\alpha+\beta CS_{i,t}+\varepsilon_{i,t}$

The test is run on 5-year CDSs and the underlying bonds of 29 large European financial and non-financial firms from 2004 to 2008. After running the test, they get the values of $\widehat{\beta_{17}}$ and $\widehat{\beta_{27}}$.

In the next step, the Gonzalo and Granger ratio is calculated from the equation below:

$$GG=\frac{\widehat{\beta_{27}}}{\widehat{\beta_{27}}-\widehat{\beta_{17}}}$$

If GG>=1, it can be concluded that CDS market tends to lead bond market. Their study for the second-half of 2007 shows the reverse results compared to the whole period of 2004-2007. Specifically, the GG ratio dropped from 1 to 0.83 for financial firms and from 1 to 0.66 for non-financial firms. This results assert the strengthening leading role of CDS market in the price discovery process in time of financial distress compared to normal economic postures, or in the other words, the two prices are more deviated from each other.

2.3. Existing literature on methodologies used for the price discovery

The adoption of non-linear models in this paper to estimate the link between sovereign CDS market and bond market is inspired by results of Delatte, A., Gex, M. and Villavicencio, A. (2010). These scholars in their study run tests on daily panel data cross 11 European countries over 2008-2010. First, Delatte, A. *et al* use the linearity model to test the null hypothesis of there is a linear nexus between the two markets as follow:

$$CDS_{it}= c_i+\alpha_i Bond_{it}+\varepsilon_{it}$$

Where

i: country

t: time dimension

c_i: constant term, which represents the factors defferentiate the bond spreads and CDS premia like transactional costs.

α_i: country-specific intercept

ε_{it}: vector of errors

CDS_{it} and $Bond_{it}$:CDS premia and bond spread with the same maturity

The results reject the null hypothesis, thus the authors continue the transition models:VECM, Fully Modified-OLS and Pooled Mean Group estimation and find the leading role of CDS market. The paramount benefit of non-linear tests is allowing each market's adjustment speed to transform according to different variables. Another substantial advantage of those tests is allowing the paper to contribute to recent price discovery results with relaxing the restictive assumptions of linear approach.

Thispaper has a great deal in common with the paper of Calice, G. *et al* (2011) in term of ultilising the non-linear method, which is the Vector Autoregression (VAR) model, to acquire the relationship between the lag-values of CDS premia and bond spreads for selected

European countries. In the other research, Calice, G. (2012) addresses the relationship between sovereign CDS and bond market by using modern time-series techniques: Johansen's cointegration tests, Granger test and VECM, which are going to be duplicated in this reseach . These tests are going to be adopted as they can be considerred as proxies for price discovery. The chronology of the methodologies for testing the price discovery process as suggested is followed (*ibid*). The Granger causality tests will be ultilised as the starting point to provide the short-run linkage between the two assets' prices. Next to is the Johansen cointegration tests in purpose to give the pattern of one market precedes the other in the long-run. Inspite of that, both the Johansen and Granger tests only give evidence on the short-run and long-run comovement but not the tandem relationship. For this reason, given that the sovereign CDS premia and bond spreads are cointegrated in the former tests, the VECM framework is used further to measure the speed of narrowing the price discrepancies from the two market short-run tendency.

For all the tests, the study will be differentiated to existing literature using this scaling for price discovery in term of lag-length selection. For example, the Granger tests in Andenmatten, S. and Brill, F. (2010) rely on 4-day lags for Portugal, 3-day lags for Italy and 2-day lags for the rest of sovereign markets.

3. Data description

3.1. Data collection

To approach the purposes of this paper, the comparison of prices on sovereign CDS markets and bond markets will be implemented, then it is important that the CDS premia and bond spreads are comparable. Moreover, there are two impediments should be overcome: to have sufficient data on liquid CDSs and to obtain the whole range of the underlying bonds' spreads. Reasonably, the paper is limited to five selected countries, they are: Portugal, Italy, France, Korea and Vietnam.

For the sovereigns, the CDS market was rather small and lack of liquidity before 2008 and the concerns about the sovereign debt turbulence precisely raised after the collapse of Lehmon Brothers in 2008. Another limitation is the awkwardness to access the entire historical transaction data on sovereign CDS market. By comparing the data collection of different organizations, period from 2008 owns the most sufficient daily numbers. Therefore, the author starts the study from January 1st, 2008 to April 31th , 2017, which means the 3040 daily data is seized. The paper is also limitted to the 10-year sovereign bond and CDS as at which maturity the sovereign CDS are most-traded. Moreover, due to the heterogeneity in the CDS and debt markets across sovereigns in the paper's sample, there is no assumption about the homogeneity of pricing dynamics. On that basis, the examining of the price discovery processes are conducted for each country separately during the same time period.

Due to the tests consist of the examining the long-term cointegration between the two markets, daily data appears to be the firmest compared to monthly or weekly frequencies. On that basis, the daily data of the two markets is collected. The data for CDS market is collected from Datastream and ADB website(asianbondsonline.adb.org). For bond market,

daily yields are collected from the Wall-Street Journal (http://europe.wsj.com) in combination with DataStream source, Vietnam Investment Review (Vir.com.vn) and ADB website (asianbondsonline.adb.org).

3.2. Unit root tests and stationary data

In this section, the author is examining the auto-correlation of individual CDS premium and bond spread data by Dickey-fuller test because this is the prerequisite for applying further regression models. All the data must be first-order cointegrated or stationary, means I(1), as in the way paradigms forecast to enable the robustness of the Granger causality, Johansen cointegration and VECM tests. Otherwise, if data is low-order cointegrated, means I(0), it should be removed. The Dickey-fuller test has the null hypothesis of the non-stationarity of series data. The testing results are summarized in tables below.

Table 1. Unit root tests results for sovereign bond markets

	Augmented Dickey-Fuller t-statistic	Test critical value 1% level	Test critical value 5% level	Test critical value 10% level
France	-14.4029	-3.43591	-2.86388	-2.56807
Italy	-18.1510	-3.43592	-2.86389	-2.56807
Portugal	-17.2506	-3.43595	-2.8639	-2.56808
Vietnam	-15.9898	-3.43592	-2.86389	-2.56807
Korea	-18.6781	-3.43592	-2.86389	-2.56807

Table 2. Unit root tests results for sovereign CDS markets

	Augmented Dickey-Fuller t-statistic	Test critical value 1% level	Test critical value 5% level	Test critical value 10% level
France	-14.7458	-3.43592	-2.86389	-2.56807
Italy	-16.5687	-3.43592	-2.86389	-2.56807
Portugal	-14.7118	-2.56701	-1.9411	-1.61651
Vietnam	-16.7428	-2.56701	-1.9411	-1.61651
Korea	-18.9511	-2.56702	-1.9411	-1.61651

The tables above summarize the unit root tests without a trend for the sovereign CDS premia and bond spreads in each market. It can be seen from the results that all the Augmented Dickey-Fuller t-statistic values are smaller than test critical values of 1%, 5% and 10% level. The corresponding conclusion is that the null hypothesis is rejected and this signifies there is the stationarity in the prices for each sovereign. These results also suggest

the two markets to price market risks equally in the long-run. Additionally, the results pledge for market forces to abolish any arbitrage opportunities exist between the two markets for the long-term.

4. Findings

4.1. Linkage in the short-run

The table below reports the Granger causality test results for period from 2008 to April 31th 2017.

Table 3. Granger causality test results for 2008-2017

Country	H_0: BY_{spread} does not cause CDS_{prem}		H_0: CDS_{prem} does not cause BY_{spread}	
	F-Statistic	Probability	F-Statistic	Probability
France	4.16225	0.01581	8.80671	0.00016
Italy	0.92644	0.42728	20.6825	4.80E-13
Portugal	3.53291	0.00712	26.2571	7.80E-21
Vietnam	1.68741	0.18546	31.7823	3.70E-14
Korea	0.48963	0.61298	3.19471	0.04135

At the significance level of 5%, if the probability is greater than 5%, the null hypothesis can not be rejected, otherwise, the other hypothesis should be accepted. Overall, there is a clear evidence in four out of ten countries that there is stronger Granger causality from CDS_{prem} to BY_{spread} and both the two markets play roles in the price discovery process. The explaination for each sovereign is following:

- In the cases of France and Portugal: the probablilities are always smaller than 5%, then the null hypotheses are rejected, which means the BY_{spread} Granger causes the CDS_{prem} and vice versa or there is a bidirectional Granger causality existing.

- In the cases of Italy, Vietnam and Korea: the probability for the test (IA) is greater than 5%, thereby the null hypothesis can not be debated. In other words, the BY_{spread} does not Granger cause the CDS_{prem}. Nevertheless, for the test (IB), the probability is smaller than 5%, thus the CDS_{prem} does Granger cause the BY_{spread}. On that basis, only the CDS market contributes to the dynamic price discovery process in the short-run.

4.2. Linkage in the long-run

In this section, the long-run equilibrium relationship between the CDS market and bond market for sovereigns will be discussed after the short- run cointegration between them is detected above. The results of Johansen cointegration tests are summarised in the table below:

Table 4. Trace test and Max-Eigenvalues test results

Country	Number of cointegrated vectors	Trace statistic	5% Critical value		Max-Eigenvalues statistic	5% Critical value	
France	None	10.06041	15.49471	Accept	16.56307	14.26460	Reject
	At most 1	3.497402	3.841466	Accept	3.497402	3.841466	Accept
Italy	None	18.03941	15.49471	Reject	17.51655	14.26460	Reject
	At most 1	0.522868	3.841466	Accept	0.522868	3.841466	Accept
Portugal	None	29.62788	15.49471	Reject	29.56393	14.26460	Reject
	At most 1	0.063956	3.841466	Accept	0.063956	3.841466	Accept
Vietnam	None	14.49258	15.49471	Accept	14.37778	14.26460	Reject
	At most 1	0.114798	3.841466	Accept	0.114798	3.841466	Accept
Korea	None	18.62365	15.49471	Reject	13.96209	14.26460	Accept
	At most 1	4.661552	3.841466	Reject	4.661552	3.841466	Reject

Generally, the long-term cointegration exists in cases of all five countries. To pass the Trace and Max-Eigenvalues test to demonstrate the long-term equilibrium relationship between the two markets, either the Trace statistic or Max-Eigenvalues statistic should be smaller than its 5% critical value. The results interpretation and cointegration equation for each country is followed.

- France

In Trace test, for both catalog “None” and “At most 1”, the Trace statistic numbers are less than the critical values of 5% level or the null hypotheses can not be rejected. Thus this test does not prove the cointegration nexus between the two markets for long-term. In contrast, the results from Max-Eigenvalues test disclose one cointegration vector existing between

CDS_{prem} and BY_{spread} variables. This also unveils the long-term interrelation between the two markets adjusted to the cointegrating equation following:

$CDS_{prem} = 0.179793-0.255055\ BY_{spread}$

(0.37668)

- Italy

It can be seen from both the Trace test and Max-Eigenvalues test results that in the "None" catalog, the statistical values are larger than the corresponding critical values at 5% level. Thereby, these tests fail to accept the null hypotheses. Moreover, for the "At most 1" catalog, the both tests dedicate together the smaller critical values than the 5% critical values, which represents the existence of a cointegration equation between CDS_{prem} and BY_{spread}. It is the following equation:

$$CDS_{prem} = -0.208774 – 1.19633\ BY_{spread}$$

(0.11727)

- Portugal

The results from both Trace test and Max-eigenvalues test support for the other hypotheses rather than the null hypotheses at 5% level of significance. Furthermore, the results show the negative cointegrated relationship between sovereign CDS premia and bond spreads, which is:

$$CDS_{prem} = -0.139821 – 1.255424\ BY_{spread}$$

(0.04165)

- Vietnam

The Trace test can not reject the null hypothesis owing to smaller value of the Trace critical value compared to the 5% critical value. Yet the Max-Eigenvalues test casts the support for the long-run co-movement between the two sovereign markets by rejecting the null hypothesis at the "None" catalog and accepting the null hypothesis at the "At most 1" catalog. The cointegration relationship is expressed in the equation below:

$$CDS_{prem} = -0.093835 – 1.261284\ BY_{spread}$$

(0.12936)

- Korea

The tests for the Korean markets give results of two cointegrating vectors for Trace test, whereas no cointegration vector for Max-eigenvalues test. Overall, the combination of the two tests evidences on the positive co-movement of the two markets in the long-term as in the equation below:

$$CDS_{prem} = 0.445897 + 0.656949\ BY_{spread}$$

(0.19689)

4.3. Price discovery

After evaluating the long-run relation between thefive sample sovereign CDS and bond markets, it is now turned to analyzing which market plays the leading role in the price discovery process for the cases of countries where the cointegrating relationship exists. This also means the examining is procedured for all five countries. The lead-lag relationship is estimated by Vector-error correction model (VECM) and Granger and Gonzalo ratio (GG ratio) would be employed to measure the relative contribution of CDS premium and bond spread to the price discovery process. In addition to that, contributions of CDS market and bond market denoting by α_1, α_2 in that order are going to be showed as well as their standard errors expressed in brackets.

Table 3 reports the VECM results applied for 10-year sovereign CDS premia and bond spreads of five countries for the period from 1st January 2008 to 31th April 2017. The ratio $\frac{\alpha_2}{\alpha_2 - \alpha_1}$ (GG ratio) gives conclusion about which market moves ahead. If GG ratio is larger than 0.5, then the CDS market leads the bond market and reversely.

Table 5. Vector Error Correction Model estimations

Country	Contribution of BY_{spread}			Contribution of CDS_{prem}			GG ratio
	$\boldsymbol{\alpha_2}$	(Std. error)	P-value	$\boldsymbol{\alpha_1}$	(Std. error)	P-value	
France	0.012110	(0.005426)	0.0258	-0.00481	(0.00299)	0.1077	0.71572
Italy	0.042893	(0.011026)	0.0001	-0.00049	(0.00578)	0.9331	0.98871
Portugal	0.062809	(0.018567)	0.0007	0.03074	(0.01000)	0.0022	1.95856
Vietnam	0.061539	(0.014297)	0.0000	0.00711	(0.00618)	0.2500	1.13063
Korea	0.028087	(0.008160)	0.0006	-0.0176	(0.00749)	0.0189	0.61477

The null hypothesis for the VECM test is that a coefficient (alpha) is not significant, or in other words, there is no long-run causality running from the independent variables to the dependent variable in the corresponding cointegrated equation. In case a p-value is larger than 5%, then the null hypothesis is accepted and vice versa. The results of which market plays the leading role by the rejection or acceptance to the null hypothesis should be in line with results from comparing GG ratios with 0.5. Table 3 gives evidences on the significant positive values of $(\alpha_2 - \alpha_1)$ in all nine sovereign markets, then the GG ratios approach are credible.

The fact that the two markets represent different roles in the price discovery process depends on the cases of different countries as explained in details as follow:

- France

It is inevitable that the sovereign CDS market drives over the bond market in the long-run cointegration pricing process as the GG ratio is 0.71572, which is larger than 0.5. Moreover,

the coefficient of the CDS market, α_1, is unsignificant at 5% significance level, which means the null hypothesis is accepted or there is no long-term causality running from bond spreads to CDS premia.

- Italy

The similar conclusion as the case of France is hold for Italy. The GG measurements are 0.98871 and 1.16609 respectively, which are far over 0.5. Additionally, the p-values for the coefficients of CDS market both give clue that the null hypotheses can not be rejected. Therefore, in circumstances of Italy, the sovereign CDS markets play the more active role than its counterpart in the price discovery process.

- Portugal

It can be seen that the two alphas are far less than 5%, thereby this dedicates the two coefficients α_1, α_2 are statistically significant. This is also equivalent to state that the both markets contribute to the price discovery. However, the GG ratio is 1.95856 larger than 0.5. Hence, the sovereign CDS market is still considerably more dominant than the sovereign bond market.

- Vietnam

The p-value for α_1 in the case of Vietnamese markets does favour the null hypothesis that the bond spreads, which are independent variables, do not cause the CDS premia, which are dependent variables. This is also consistent with the GG ratio smaller than 0.5, that shows the CDS market tends to be more leading in the price discovery.

- Korea

The roles of sovereign CDS and sovereign bond market in Korea have a great deal in common with those in Portugal. The p-values for the two alphas are both less than 0.5 then the null hypotheses fail to negative the long-run causality from each market to the other. The empirical test results unveil that there is causality from the CDS premia to the bond spreads and vice versa, then the sovereign CDS market practically plays the same part as the sovereign bond market does. Eventhough, the larger value of GG ratio compared to 0.5 gives the claim that the sovereign CDS market is slightly dominant over the other in the long-term pricing discovery.

In summary, there is a robust one-way linkage from the sovereign CDS market to the sovereign bond market in four out of five countries. In details, by empirical tests, the faster price adjustment speed tributes to the sovereign CDS market for all five countries. Thereby in five sample sovereigns, the trend of leading movement of the CDS market over the bond market is predominated. Among group of entities where the CDS markets are more dynamic, a common feature might be realized that these countries have relatively higher averege yield than those in group of sovereign bond markets taking the favour.

5. Recomendations

The findings above hightlight the **short-run** interlinkage between the two markets in cases of France and Portugal and the one-way affect from the CDS prices to the bond prices in cases of Italy, Korea and Vietnam. Moreover, the papergives evidences on the **long-term**co-integration linkage between sovereign CDS premia and bond spreads in all of five selected countries.The additional detection is the **price leadership** role of the sovereign CDS market over its associated bond market in cases of four out of five countries and this is reinforced following the financial turbulence. This evidence also suggests that the country-specific factors influence considerably the sovereign credit risks. Based on the domination of the sovereign CDS market in the price discovery, sovereign CDS premia can be used as the signal for market regulation. For instance, a slump or soar in the CDS premia should give the advance signal for a decline or growth of the bond yields in the same maturity. This is considerably meaningful in context of developing entities such as Vietnam because the average interest rate of the financial market, which can be delegated by bond yield, acting as the major indicator. Besides, it is likely to be acute that though a credit derivatives market is newer and smaller but is a better source of information on predicting the prices than larger and longer-established market like bond market.

The results of this research can be stated to be robust as they are in the same ideas with the bulk of previous researches about the leading role of sovereign CDS market over sovereign bond market such as the studies of Coudert, V. and Gex, M. (2010); Delis, M. and Mylondinis, N. (2011). Moreover, it could be possible to distinguish the paper's findings and the conclusion of Zhu, H. (2006) and Houweling, P. *et al* (2001). Zhu, H. advocates that in the long-run, the CDS premium and bond spread change in the same direction but in the short-run, the relationship is not identical. With the similar conclusion, Houweling, P. *et al* further claim that the equilibrium between bond spreads and CDS spreads is not established and these spreads always change over time.

This study is not in-deep in learning about the deviation of the two markets from the long-term equilibrium, then more researches need being done. This is because the regresstion equations do not take into account the macroeconomic factors like stock market indice, exchange rates or shocks and the market players involving are not considerred. In the concern about the economic policies different among the sovereigns, a specific policy on credit derivative instruments, such as issuance policy or taxation policy, might distort the cointegration between the two markets. However in the scope of this research, the author does not bring them into consideration, thereby it should be commanded more tests if these aspects might affect the price discovery mechanism./.

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