WHAT'S BEHIND SOVEREIGN RISK? AN ANALYSIS OF THE INFORMATION CONTENT OF CDS SPREADS FOR THE UNITED STATES AND GREECE

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Resumen

A través del uso de información sobre los CDS, correspondiente al periodo de la crisis global 2008-2010, el presente artículo examina el riesgo soberano de los Estados Unidos y Grecia. Seguimos la metodología sugerida por Varga (2009, 2010) para medir el contenido de información de los márgenes de los CDS de ambas economías. El análisis revela lo siguiente: (1) existe una relación positiva, estadísticamente significante entre los márgenes de los CDS y la probabilidad de default soberano en ambos casos; (2) sin embargo, para los EE.UU., en comparación al caso de Grecia, la aversión al riesgo en los mercados globales implica un decrecimiento medio pequeño en el riesgo soberano; y (3) el estimado de riesgo específico-país de riesgo soberano es 64% y 68% para los EE.UU. y Grecia, respectivamente.

Palabras clave: *Riesgo soberano, Credit Default Swap, margen de riesgo, calificaciones crediticias, Grecia, Estados Unidos.*

Abstract

This paper examines sovereign risk for the United States and Greece using CDS information during the period of global crisis, 2008-2010. We followed the methodology suggested by Varga (2009, 2010) to measure the informational content of CDS spreads for both economies. Also, a country-specific effect of sovereign CDS premium was estimated. The analysis reveals the following: (1) there exists a statistically significant positive relationship between CDS spreads and the probability of sovereign default in both cases; (2) however, for the US, risk aversion in global markets implies an average small decrease in sovereign risk, in contrast to the case of Greece; and (3) the estimated country-specific risk of sovereign risk is 64% and 68% for the US and Greece, respectively.

Keywords: *Sovereign risk, Credit Default Swap, risk spread, credit ratings, Greece, United States.*

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INTRODUCTION

Since the emergence of the fiscal deficit problem in Greece in 2009, sovereign risk has been prominent in media and analyst commentary, attracting attention in the global financial market. The term *sovereign risk* refers to the risk that the government may default on its debt obligations [Collin-Dufresne and Goldstein (2001), Zhu (2004), Revoltella, Mucci and Mihaljek (2010)]. Generally, when the government does not have sufficient revenue from tax receipts to repay bonds that are due to mature, it is necessary to issue additional bonds. Therefore, sovereign risk includes the uncertainty of repaying upcoming bond maturities when the government is unable to acquire new debt.

There are some techniques for measuring sovereign risk. The most common are ratings from external agencies such as S&P, Fitch and Moody's. However, ratings may not provide a broad understanding about country-specific risk that is related to government decisions. Secondly, it is possible to assess the government's performance through bond yield premiums, by determining the amount of the yield an investor expects to receive in exchange for assuming the credit risk. Nevertheless, this method has an essential shortcoming in that it is difficult to obtain a valid measure of risk-free bond in practice. Finally, analyzing sovereign risk with Credit Default Swaps (CDS) information has become more important since the market for credit derivatives has expanded significantly in recent years (Shino and Takahashi, 2010).

This paper examines sovereign risk in the United States and Greece using CDS data for the last years. The main purpose of the research is to compare both countries' risk of default by analyzing the informational content of CDS premium. Following Varga's (2009, 2010) methodology, we conducted Ordinary Least Square (OLS) estimations of CDS spreads for both countries using daily data for the period of 2008-2010. This data was retrieved from Bloomberg, whose original source is CMA.

The main results of this research are the following: the relationship between CDS spreads and probability of default is stronger in the case of the United States. A possible explanation could be the distress of bondholders since the US economy is more stable. The correlation between the CDS spreads and the VIX index is negative for the United States but positive for Greece. This means that if world markets become unstable, savers would demand bigger amounts of US bonds. Finally, we estimated the proportion of risk on CDS spreads that can be attributed only to the country related risk. For both cases, this share was about 64-68% on average.

The paper is structured as follows: Section 2 provides the theoretical framework on which the analysis focuses. Section 3 discusses the relevant literature and empirical studies about sovereign risk and CDS information. Section 4 provides an overview of the data and econometric estimation used to compare the US and Greek performance on public debt. Section 5 contains the empirical analysis, the results and the comparison of sovereign risk between the United States and Greece. Finally, in Section 6 we present the conclusions of this study.

THEORETICAL FRAMEWORK

Credit derivatives are instruments that transfer risk from one party to another. The most common is the Credit Default Swap (CDS), which exchanges a stream of periodic payments for an agreement to pay a notional amount if a specified third entity, called the reference entity, defaults on a bond or a loan. When referring to a country, this reference entity is the sovereign government.

The CDS is priced using an assumption of "recovery of face value". This means that if a bond defaults in the future, we can assume its post-default value will be a fraction R, recovery rate, of its par value plus accrued interest. How to price a CDS? Following Hull and White (2000), the buyer of the protection pays a premium in the form of a regular fixed payment S (% annualized) for the duration of the protection period, or up to a default event. In the event of default, the protection seller will pay the difference between the par and the post-default value of the bond2. Therefore, the expected present value of the "premium" leg of the CDS is:

$$(1) \qquad S\left[\sum_{j=1}^{m}\left(1-Q(t_j)\right)P(0,t_j)\Delta t_j + \int_0^T q(t)\,AI(t)\,P(0,t)\,dt\right]$$

The two terms in equation 1 correspond to premium payments and payments of accrued premiums, respectively. If we assume that in the event of a future default, the recovered amount is R times par plus accrued interest, the expected present value of the protection leg of the CDS is:

$$(2) \qquad \int_0^T q(t)\left[100-R\left(100+AI(t)\,C_R(T)\right)\right]P(0,t)\,dt$$

Hence, the market value of a CDS is the difference between the two legs. At initiation of a CDS, the spread is set to the value $S=S_{CDS}(T)$ such that the two legs of the CDS are equal and the CDS has zero initial value. By solving from equation 2 for the spread:

$$(3) \qquad S_{CDS}(T)=\frac{\int_0^T q(t)\left[100-R\left(100+AI(t)\,C_R(T)\right)\right]P(0,t)\,dt}{\sum_{j=1}^{m}\left(1-Q(t_j)\right)P(0,t_j)\Delta t_j + \int_0^T q(t)\,AI(t)\,P(0,t)\,dt}$$

Equation 3 gives the value of a par CDS spread, with the default probability curve used as an input3. When trying to study the functioning of sovereign CDS markets, Varga (2009, 2010) made a respectable contribution. Such research examines the position of the

[2] For simplicity of notations, we assume that the bond coupon payment dates and premium payment dates coincide.

[3] Conversely, if we have a curve of par CDS spreads, we can use a bootstrap procedure to infer the default probability curve. See Lipman and Wood (2005) for a broad explanation.

Hungarian sovereign CDS in relation to the global derivatives market. Primarily, in order to assess the extent to which changes in risk premium can be attributed to global risk appetite and to country-specific factors, it analyzes the information contained in the observable CDS spreads. In doing so, Varga (2009, 2010) developed a simple model that relates CDS spreads and credit ratings in the following manner:

$$\log(CDS_{i,t}) = \alpha_t + \beta_t(CR_{i,t}) + \varepsilon \quad (4)$$

where $CDS_{i,t}$ is the CDS spread of country i on day t, and $CR_{i,t}$ is the average credit rating of country i on day t. Based on the parameters of equation 4, a rating-implied estimate for the CDS spread be calculated (equation 5). Also, a country-specific part of the spread can be obtained as the difference between the actual and estimated CDS spread (equation 6):

$$\hat{CDS}_{H,t} = \exp\left[\alpha_t + \beta_t(CR_{H,t})\right] \quad (5)$$

$$DIF_{H,t} = CDS_{H,t} - \hat{CDS}_{H,t} \quad (6)$$

where $DIF_{H,t}$ is the part of the CDS premium that is not justified by global developments affecting credit risk.

In summary, with the basics of pricing CDS from the Hull-White credit default swap model and the decomposition of CDS spreads approach developed by Varga (2009, 2010) as a theoretical framework, this research analyzes the differences in sovereign risk between the American and Greek economies in the most recent years. We then go further by analyzing the precise country-risk element attributed to sovereign CDS spreads; this could be viewed as a more accurate measure of sovereign risk.

THE CREDIT DEFAULT SWAP APPROACH TO MEASURE SOVEREIGN RISK: THEORY AND EVIDENCE

In relation to the current events in Europe, the term *sovereign risk* has been used to widely characterize the large public deficits and very high government debt levels of some countries, specifically Greece. According to Sarandi (2010), such ongoing increases in budget deficits and debt are causing the market to question whether countries, particularly those situated in continental Europe, will be able to repay bonds as they mature.

The question whether suck risk premia can be identified empirically and how large they are has attracted considerable interest in recent literature [Goldstein and Woglom (1992), Bayoumi, Goldstein and Woglom (1995) and Poterba and Rueben (1997)]. Furthermore, Packer and Suthiphongchai (2003) state that although sovereign CDS constitutes only a minor growing part of the CDS market, observed quotes on government CDS have risen markedly since 2003.

Specifically, the measurement of sovereign risk using CDS information has grown significantly over recent years. One important methodology is the credit spreads between the bond market and the CDS market of a country. With reference to Zhu (2004), through the inspection of comparisons of these kinds of premiums, he extends the existing studies by not only studying the long-term pricing accuracy in the CDS market relative to the bond market, but also looking into the fundamental factors that explain the price differentials and the short-term dynamics between these two markets. What is proven is that in the long run, the CDS premiums tend to be priced equally in the bond premiums; however, in the short run, the relationship between the two can vary. Therefore, the objective of this method is to address two important questions: firstly, is credit risk priced equally between the derivatives market and the traditional cash market? Secondly, which market moves more quickly in response to changes in credit conditions?

International cross-country evidence on the mechanics of sovereign risk pricing has also been established. Remolona, Scatigna and Wu (2008), reconcile existing conflicts in the sovereign debt literature arising from the inability of existing frameworks to differentiate the market pricing of sovereign risk from the risk itself in emerging markets. Their empirical framework is consistent with stochastic models of default (Duffie and Singleton, 2003). Using their particular model, Remolona et al. (2008) decompose sovereign risk – CDS spread – through the expected loss from sovereign default and the risk premium. Moreover, the authors recommend further research on the microstructural effects of liquidity on sovereign debt valuations in the CDS market. A similar methodology is used in Varga (2009, 2010) and is applied to the Hungarian economy; however, this last research focuses mainly on the probability of default only.

On the other hand, despite the significance of CDS measurement of sovereign risk, there are some other studies that present an alternative approach. According to Shino and Takahasi (2010), a CDS premium does not reflect a country's fiscal situation, as they are susceptible to investors' speculative motives due to low market liquidity. This means that bondholders are influenced by the price fluctuations of CDS and this method therefore does not give a comprehensive measure of the sovereign risk of a country. For example, in the United States the growth rate of CDS has not risen to a recognizable level, despite facing a large decline in the fiscal balance and only amounts to about 1% of outstanding CDS worldwide. Thus, these expansions in CDS spreads do not mean investors are more concerned about fiscal matters in the US, compared to other economies.

However, Shino and Takahasi (2010) regress CDS premiums in four continental European countries (Greece, Portugal, Italy and Spain), which account for a large percentage of the outstanding CDS globally, and those of the US, UK and Japan which cover only a small proportion of outstanding CDS, on their spreads between government bond yield and the Overnight Index Swap (OIS).

Finally, an intriguing aspect of CDS information is observed in Gilbert (2010). It would appear that financial markets have in fact deduced most of the fiscal information from governments through CDS spreads. Despite this, price quotes in the derivative market are not directly related to the volume contracts traded. For example, in July 2010 the United

States had a net notional outstanding sovereign CDS of about $1.9 US billion, while the number of contracts was substantially low at 438. On the contrary, the net notional outstanding of CDS in Greece was about $6.9 US billion, whereas the number of contracts was around 3,977.

In general, as evidence suggests, under normal market conditions the CDS spreads are a useful source of information for the sovereign risk of a country. However, the recent crisis has shown that the CDS spreads might lead to some underpricing or overpricing of fundamentals in the case of excessively low or excessively high risk aversion (Revoltella et al., 2010).

DATA AND EMPIRICAL FRAMEWORK

The model to follow is fundamentally the one offered by Varga (2009, 2010). Moreover, to model the changes in global risk aversion we proceed to use the Chicago Board Options Exchange Volatility Index – the well-known VIX index [McGuire and Schrijvers (2003); Varga (2009); Revoltella et al. (2010)]. The VIX helps to identify more precisely periods of financial market disruption. This approach is preferable than to the use that of crisis dummies, which is somewhat arbitrary. The selection of this approach is justified, not only because it selects CDS spreads as the measure of sovereign risk, but also because it relates the determinants credit premia with country-specific factors.

Data. Our sample set comprises daily data for the period 2008-2010 covering the United States and Greece markets (Table 1). The dependent variable is the sovereign CDS spread. Given that for some maturity, market data are not available, we opted for information on five-year sovereign CDS[4] in US dollars provided by Bloomberg. To obtain the probability of default on a sovereign bond, the data series was obtained from a conversion matrix based on multi-year cumulative default rates, calculated by Moody's and S&P[5] (Tables 2 and 3). Data on the VIX index was retrieved from Bloomberg.

Table 1: Descriptive Statistics of Data

	Mean	*Standard Dev.*	*Min.*	*Max.*
US CDS Spread	35.20	19.00	5.80	100.00
Greece CDS Spread	293.04	290.23	17.68	985.38
VIX Index	28.81	12.10	15.45	80.86

Notes: *Sovereign CDS spreads in US dollars.*
Source: Bloomberg, CMA.

[4] This data turn out to be among the most liquid credit default swaps.
[5] In the case of S&P's, for example, they are obtained by calculating marginal weighted average default rates conditional on survival for each possible time horizon, and accumulating marginal default rates

Table 2: Sovereign Foreign-Currency Cumulative Average Default Rate for the United States (2008-2010)

%	*Time Horizon (years)*		
Rating	***2008***	***2009***	***2010***
AAA	0.00	0.00	0.00
AA	0.00	0.00	0.00
A	0.00	0.00	0.00
BBB	0.50	1.57	3.97
BB	2.13	6.36	4.03
B	9.32	13.54	11.67
CCC/CC	16.13	25.77	21.50
Investment-grade	1.09	1.09	1.09
Speculative-grade	5.85	16.10	13.86
All rated	5.82	7.15	6.70
CMA Implied Rating	CMA_aaa		

Notes: *Default rates conditional on survival.*
Source: S&P, Moody's and CMA.

Table 3: Sovereign Foreign-Currency Cumulative Average Default Rate for Greece (2008-2010)

%	*Time Horizon (years)*		
Rating	***2008***	***2009***	***2010***
AAA	0.00	0.00	0.00
AA	0.00	0.00	0.00
A	0.02	0.15	0.09
BBB	0.95	3.18	4.20
BB	4.76	11.34	14.70
B	16.23	35.60	47.84
CCC/CC	37.56	49.81	65.55
Investment-grade	2.78	2.78	2.80
Speculative-grade	18.40	20.65	25.66
All rated	11.26	14.34	18.20
CMA Implied Rating	CMA_bb-		

Notes: *Default rates conditional on survival.*
Source: S&P, Moody's and CMA.

Empirical Framework. Following Varga (2009, 2010), we estimated separate regressions of CDS spreads for the United States and Greece as follows:

$$\log(CDS_{i,t}) = \alpha_0 + \alpha_1 PD_{i,t} + \alpha_2 VIX_t + \varepsilon_{i,t} \quad (7)$$

where $CDS_{i,t}$ is the sovereign CDS spread for country i at time t; $PD_{i,t}$ is the average rating agencies' probability of default for sovereign bonds of country i at time t; VIX_t is the VIX Index at time t; and $\varepsilon_{i,t}$ is the error term or the unobserved country-specific effect for our purposes.

RESULTS

We estimated equation 7 for both countries being examined, using OLS. The standard errors and covariance of the coefficients obtained are White heteroscedasticity-consistent. The results are shown in Table 4 and are coherent with Varga (2009, 2010) and Revoltella et al (2010). We found a statistically significant positive relationship between the CDS spreads and the probability of sovereign default in both cases. In the case of the United States, a 1% increase in the probability of default is estimated to increase the corresponding CDS spread on average by 43.5%. On the other hand, a 1 percent increase in the probability of Greek default would increase the CDS premium about 6.5%. One possible explanation for the difference between these effects could be the distress of bondholders. That is to say the following: since the economy is more stable in the US than in Greece, a marginal change in the probability of sovereign default would have a greater affect on investors' decisions – investors are more sensible to macroeconomic announcements – and such sensitivity could trigger an increase in CDS spreads.

Table 4: Estimated Relationship between Sovereign CDS Spreads, Sovereign Default Probabilities and Risk Aversion

	United States	*Greece*
Constant	2.05906	3.69210
	[0.0000]***	[0.0000]***
PD	43.51092	6.53105
	[0.0000]***	[0.0000]***
VIX	-0.00185	0.01005
	[0.0035]***	[0.0000]***
R2	0.90668	0.88575

Notes: *P-values in brackets.*
* Significance at 10%
** Significance at 5%
*** Significance at 1%
Source: Authors' calculations.

The coefficient related to risk aversion in the United States implies that an increase in market volatility of 1% translates into an average decrease in CDS spreads of about 0.002%. Contrarily, an increase of 1% of the same coefficient for Greece would increase the risk premia by 0.01%. This means that if world markets become volatile, savers

would demand bigger amounts of US bonds, which could once again be attributable to the US economic stability. Therefore, these estimated outcomes are consistent with our theoretical framework.

Additionally, equation 6 was estimated. The main purpose of doing this was to decompose CDS spread into the country-specific risk and the global risk. In the case of the United States, the particular uncertainty component of sovereign CDS premium is 64% while the global risk component is 36%, on average (Chart 1). On the other hand, the Greek-specific risk is 68% and the global risk component is 32%, on average (Chart 2).

Chart 1: Decomposition of CDS Spreads: United States (2008-2010)

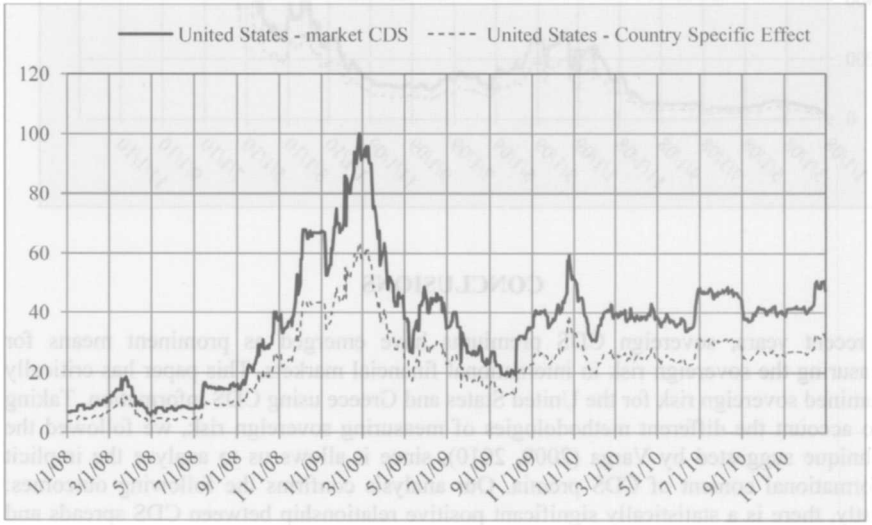
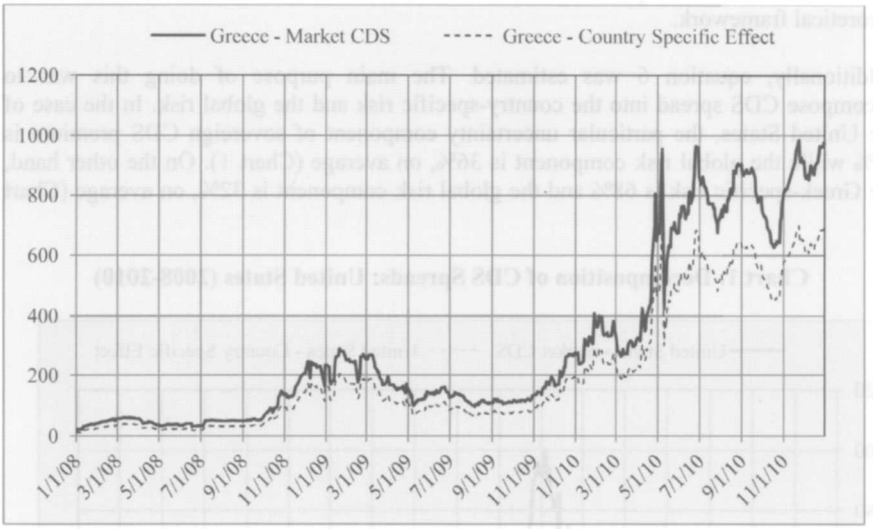


Chart 2: Decomposition of CDS Spreads: Greece (2008-2010)



CONCLUSIONS

In recent years, sovereign CDS premiums have emerged as prominent means for measuring the sovereign risk in international financial markets. This paper has critically examined sovereign risk for the United States and Greece using CDS information. Taking into account the different methodologies of measuring sovereign risk, we followed the technique suggested by Varga (2009, 2010), since it allows us to analyze the implicit informational content of CDS premia. Our analysis confirms the following outcomes: Firstly, there is a statistically significant positive relationship between CDS spreads and the probability of sovereign default for both the United States and Greece. However, two important factors should be taken into account regarding this idea: (1) CDS spreads tend to fluctuate dramatically over time and in some cases there is little obvious relationship to movements in default risk (Revoltella et al, 2010); and (2) since the econometric specification described in equation 7 also depends on average credit ratings' probability of default, the informational outcome of this article could carry the same problems when talking about adjustment of investor's expectations.

Secondly, we found that the relationship between sovereign CDS premium and global volatility of financial markets in the US is statistically significant and negative, but quite small. As for Greece, this relationship is statistically significant and positive. At this point it is important to note two additional concepts: (1) from the macroeconomic point of view, if world markets become more volatile, it is reasonable to expect savers to substitute risky assets for bigger amounts of US bonds, because of the stability of this economy; (2) moreover, according to Zhu (2004) some institutional factors may also

cause CDS premia to differ from bond spreads – the CDS and bond markets operate differently.

Finally, our decomposition of CDS spreads into idiosyncratic and systematic risk provided the following result: the country-specific risk is 64% for the US and 68% for Greece. Intuitively, we expected a larger difference between these two proportions because of various macroeconomic factors: (1) the US economy is the financial benchmark worldwide, thus we would expect it to have a larger systematic risk in its CDS composition; (2) it is reasonable for the Greek economy to have a large proportion of idiosyncratic risk due to political, fiscal and financial instability in addition to a high amount of speculation activity.

Because of the previous results, it is essential to underline two significant features. First, CDS instruments are triggered by credit events, which not only include the default. Since there is no exact definition of the term "credit event", a general simplification made by the literature is to limit the value of CDS to default, as this research does. Second, until October 2012 the CDS acquisition could be made without having the secured public bond. The possibility to purchase naked CDS was argued to increases price volatility without involving changes in the probability of default. Perhaps this had some contribution over the results of Greek CDS of this research. In November 2011, the ECB banned the use of uncovered CDS and the legal decree took effect in November 2012.

To conclude, using CDS information, our statistical and econometric findings confirm that sovereign risk in Greece is substantially higher than in the United States. CDS spreads represent, under normal conditions, a useful source of information on country risk as they capture changes in the available information much earlier than the rating changes, the bond markets, or other methodologies [Zhu (2004) and Remolona et al. (2008)].

REFERENCIAS

Bayoumi, T., Goldstein, M. and Woglom, G. (1995). Do credit markets discipline sovereign borrowers? Evidence from US states. *Journal of Money, Credit, and Banking* 27(4), 1046-1059.

Colin-Drufesne, P. and Goldstein, R. (2001). Do credit spreads reflect stationary leverage ratios? *Journal of Finance* 56(5), 1929-1957.

Duffie, D. and Singleton, K. (2003). *Credit risk: Pricing, measurement and management.* USA: Princeton University Press.

Gilbert, J. (2010). Sovereign credit: The return of the deutschmark and credit default swaps, GRNEAM *Reflections*.

Goldstein, M. and Woglom, G. (1992). Market based fiscal discipline in monetary unions: Evidence from the US municipal bond market", in M. Canzoneri, V. Grilli, and P. Masson (eds.) "Establishing a central bank", USA: Cambridge University Press.

Hull, J. and White, A. (2000). Valuing credit default swaps I: No counterparty default risk. *The Journal of Derivatives,* 8(1), 29-40.

Lipman, H. and Wood, M. (2005). Valuing basket default swaps. *Bloomberg market.*

Mcguire, P. and Schrijvers, M. (2003). Common factors in emerging market spreads. *BIS Quaterly Review.* December.

Packer, F. and Suthiphongchai, C. (2003). Sovereign credit default swaps. *BIS Quaterly Review,* December.

Poterba, J. and Rueben, K. (1999). State fiscal institutions and the US municipal bond market, in J. Poterba and J. von Hagen (eds.) "Fiscal institutions and fiscal performance", Chicago, USA: University of Chicago Press.

Remolona, E., Scatigna, M. and Wu, E. (2008). The dynamic pricing of sovereign risk in emerging markets: Fundamentals and risk aversion. *The Journal of Fixed Income,* 17(4), 57-71.

Revoltella, D., Mucci, D. and Mihaljek, D. (2010). Properly pricing country risk: A model for pricing long-term fundamental risk applied to central and eastern european countries. *Financial Theory and Practice,* 34(3), 219-245.

Sarandi, A. (2010). What is sovereign risk and how to measure it?. Technical note: May, fixed interest and credit research department, colonial first state global asset management.

Shino, J. and Tahahashi, K. (2010). Sovereign credit default swaps: Market developments and factors behind price changes. *Bank of Japan Review* Working Paper No. E-2, Financial Markets Department, Bank of Japan.

Varga, L. (2009). The information content of Hungarian sovereign CDS spreads. *MNB Occasional Paper* No. 78, Magyar Nemzeti Bank.

Varga, L. (2009). Hungarian sovereign credit risk premium in international comparison during the financial crisis. *MNB Bulletin* July, Magyar Nemzeti Bank.

Varga, L. (2010). An indicator of sovereign risk. CDS supplement, Magyar Nemzeti Bank, 21-24.

Zhu, H. (2004). An empirical comparison of credit spreads between the bond market and the credit default swap market. *BIS Working Paper* No. 160, Monetary and Economic Department, Bank of International Settlements.