SPATIAL ANALYSIS OF THE SOVEREIGN CREDIT RATINGS: A CASE OF GIPSI COUNTRIES

Gül Huyugüzel KIŞLA[1]

Abstract

Sovereign credit ratings are monitored globally because they reflect the forward-looking estimate of the default probability. In addition, they are widely accepted as an indicator of sovereign risk. Many studies try to find the determinants of the credit ratings from economic, financial or political perspectives. While many different econometric methods (like ordinary least square, ordered response model or ordered probit models) are used in these studies, ignoring the interdependency between the countries can cause a major problem. This study aims to contribute to the related literature by applying spatial methods for credit ratings. In contrast to the conventional models, spatial models consider the spillover effects between the countries. For this reason, quarterly data for GIPSI (Greece, Ireland, Portugal, Spain and Italy) countries are used from 2003 to 2021. LM (Lagrange Multiplier) test and the LR (Likelihood Ratio) tests support that the spatial autoregressive model (SAR) is appropriate. According to estimations, the explanatory variables (GDP per capita, international reserves, GDP growth, primary balance, current account balance and government debt) are found to be statistically significant. In addition, the spatial autoregressive coefficient (ρ) is significant, which provides the existence of spatial interaction.

Keywords: Spatial Econometrics, Sovereign Credit Ratings, GIPSI Countries.

Jel codes: C82, C33, G24, G19

ÜLKE KREDİ DERECELENDİRMENİN MEKÂNSAL ANALİZİ: GIPSI ÜLKELERİ

Özet

Ülke kredi notları, temerrüt olasılığının ileriye dönük tahminini yansıttıkları için küresel olarak izlenmektedir. Ayrıca, ülke riskinin bir belirleyicisi olarak da kabul edilmektedir. Birçok çalışma, kredi notlarının belirleyicilerini ekonomik, finansal veya politik açıdan bulmaya çalışmaktadır. Bu çalışmalarda birçok farklı ekonometrik yöntem (en küçük kareler, sıralı tepki modeli veya sıralı probit modelleri gibi) kullanılırken, ülkeler arasındaki karşılıklı bağımlılığın göz ardı edilmesi büyük bir soruna neden olabilmektedir. Bu çalışma, kredi notları için mekânsal yöntemler uygulayarak ilgili literatüre katkı sağlamayı amaçlamaktadır. Geleneksel modellerin aksine, mekânsal modeller, ülkeler arasındaki yayılma etkilerini dikkate almaktadır. Bu nedenle bu çalışmada GIPSI (Yunanistan, İrlanda, Portekiz, İspanya ve İtalya) ülkeleri için 2003-2021 dönemi için üçer aylık veriler kullanılmıştır. LM(Lagrance Multiplier) ve LR(Likelihood Ratio) testleri mekânsal otoregresif modelin uygun olduğunu desteklemektedir. Yapılan tahminlemelere göre, açıklayıcı değişkenler (kişi başına GSYİH, uluslararası rezervler, GSYİH büyümesi, faiz dışı denge, cari işlemler dengesi ve devlet borcu) istatistiksel olarak anlamlı bulunmuştur. Ayrıca mekansal etkileşimin varlığını kanıtlayan mekansal otoregresif katsayısı (ρ) anlamlı bulunmuştur**.**

Anahtar Kelimeler: Mekânsal Ekonometri, Ülke Kredi Derecelendirme, GIPSI Ülkeleri.

Jel kodları: C82, C33, G24, G19

[1] **Corresponding author**, Assist. Prof. Dr., Ege University, Faculty of Economics and Administrative Sciences, Department of Economics, İzmir, TURKEY. gul.kisla@ege.edu.tr, Orcid No: 0000-0002-0901-2038.

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1. Introduction

The policymakers and investors in the financial markets always observe Sovereign credit ratings. According to Reinhart (2002), sovereign credit ratings can be accepted as a measure of the likelihood of the default and they in fact reflect the ability of a country's access to international capital markets. On the other hand, sovereign credit ratings are important because they give necessary information about a country's borrowing costs. They may help the investors select their portfolio compositions efficiently (Afonso, 2007). Actually, there are 3 main credit rating agencies (CRAs), namely Fitch Ratings, Moody's and Standard&Poor's (S&P), making announcements about the credit rating scores of the countries in particular periods[2]. Countries are monitored according to their risk parameters like political, economic, and fiscal risks (Chodnicka-Jaworska, 2014). The ratio scale combines the investment-grade (starting from AAA) and the speculative grade (including the default level). In many studies, researchers use the credit rating scores with the linear transformation, logistic transformation or exponential transformation[3]. Apart from the studies that used these transformed credit rating scores, we used the credit ratings which are obtained from Refinitiv Datastream. These credit ratings take the value from lowest (or noninvest) to highest (most invest) as 1 (default) to 20 (AAA) and they are all compatible with Fitch Ratings, Mood's and S&P's credit rating scores, respectively.

In the literature, along with the CDS spreads or bond yield spreads[4], sovereign credit ratings are also used as a good proxy of the sovereign risk. However, as one of the main indicators of sovereign risks, sovereign credit ratings have taken much more attention from governors, investors, and policymakers in recent years. The financial risks have deepened concerning the latest financial crises and it has become crucial to understand the possible determinants of the sovereign credit ratings. Many studies examine the sovereign credit ratings of developed countries, developing countries, or both. In addition, the related literature generally focus on the linear regression models, ordered response models or combination of different methodologies[5] (*Cantor & Packer, 1996b; Haque et al 1996; Hu et al. 2002; Afonso, 2003; Rowland & Torres, 2004; Bissoondoyal-Bheenick, 2005; Mellios & Paget-Blanc, 2006; Mora, 2006; Afonso, 2007; Gültekin Karakaş et al, 2011; Canuto, 2012; Bozic & Magazzino, 2013; Erdem & Varlı, 2014; Chodnicka-Jaworska, 2014; Fourie & Both, 2015; Kabadayı & Çelik, 2015; Öztürk et al., 2016;Kırkıl, 2020*; *Stawasz-Grabowska, 2020; Proença et al, 2021*). Here, some of these studies examining the sovereign credit ratings can be summarized as follows.

Cantor & Packer (1996b) was the first study to use Moody's and Standard and Poor's ratings of sovereigns. In this respect, they included per capita income, GDP growth, inflation, fiscal balance, external balance, external debt, economic development and default history. The authors covered a sample of 49 countries between 1987 and 1994 and used ratings to measure sovereign credit risk. According to their Ordinary Least Square (OLS) estimations, 6 factors (per capita income, GDP growth, inflation, external debt, level of economic development, and default history) played an essential role in determining the countries' credit rating.

Afonso (2003) analyzed the possible determinants of the sovereign credit ratings (S&P's and Moody's) with linear, logistic and exponential transformations for 81 developed and developing countries. According to the estimation results, GDP per capita, external debt, economic development, default history, GDP growth rate and inflation rate are relevant in determining a country's credit rating. While GDP per capita is appropriate for developed countries, external debt gains much more important

[2] A comprehensive information about the credit ratings and the history of the sovereign rating business can be found in the study of Cantor and Packer (1996a), Micu et al. (2004) and Binici and Hutchison (2018). For the sake of simplicity, we do not include additional information about the credit rating process at this point.

[3] Erdem and Varlı (2014) present the schema of linear scales of the credit ratings for S&P and Afonso (2003) mentions the linear, logistic and exponential transformation of the credit rating scores.

[4] For the further research on the CDS spreads and bond yield spreads, interested readers can look at the studies of Aizenman et al (2013), Beirne and Fratzcher (2013), Hilscher and Nosbusch (2010), Caceres et al (2010), Dieckmann et al. (2012).

[5] A comprehensive literature review of credit ratings can be evaluated in the study of Afonso et al. (2007), Bozic and Magazzino, 2013.

for developing countries. He also concluded that logistic transformation was better for the overall sample.

Rowland and Torres (2004) used annual panel data for 1998-2002, considering two dependent variables: creditworthiness index[6] and EMBI global country index. Using 19 emerging countries, they found that GDP growth, debt/GDP, reserves/GDP, inflation, debt/exports and default variables are statistically significant.

Mellios and Paget-Blanc (2006) examined the determinants of the 86 countries' sovereign credit ratings via principal component analysis and an ordered logistic model. According to their estimation results, per capita income, government income, real exchange rate changes, inflation rate, and default history most influenced the sovereign credit ratings.

Afonso et al. (2007) examined the sovereign credit ratings (with 3 CRAs ratings) based on the linear regression models and also they used the ordered probit model considering the period of 1970-2005 (with subsamples). According to their estimation results, the level of GDP per capita, real GDP growth, the public debt level, government effectiveness, external debt and external reserves are all statistically significant. On the other hand, they stated that the estimation results are not stable across different credit rating agencies. Also, the current account balance was found to be more important in the 1996-2000 period, whereas external reserves were found to be more critical in the later period, 2001-2005.

Canuto et al. (2012) use a large panel sample of 66 countries from 1998 through 2002. This study took the average of the 3 CRAs rating levels as the dependent variable. Their estimations used a pooled cross-section, fixed-effect, and first difference models. In line with the other studies, they include inflation, per capita GDP, real GDP growth, gross debt of the central government, level of openness, total net external debt, development level and default dummy.

De Vries and Haan (2015) examined the relationship between the spreads and the credit ratings of the Euro area (Austria, Belgium, Finland, France, Germany, Greece, Italy, Ireland, the Netherlands, Portugal, Slovakia, Slovenia and Spain). They also included the estimations considering the credit ratings. Herein, GDP growth, GDP per capita, investment/GDP, inflation, unemployment, debt/GDP, and current account balance/GDP are all significant, whereas government balance/GDP is found to be insignificant.

Beyond these studies, which emphasize the determinants of sovereign credit ratings, there are also limited studies that focus on the contagion based on the connection between sovereign ratings. For example, Fourie and Both (2015) test the contagion between the selected EU countries (France, Greece, Hungary, Ireland, Italy, Poland, Portugal and Spain) regarding the S&P spovereign ratings monthly from 2004 through 2013. They used a three-step process including cointegration, Granger causality and variance decomposition tests. According to their analysis, contagion exists during the Lehman and the sovereign debt crises. Granger causality tests also support the idea of short-run relations between the Euro countries. Lastly, they asserted that the connection between Portugal, Italy, Greece, and Spain was very strong during the sovereign debt crisis. Abad et al. (2018) focus on the contagion effect of the rating actions on the stock market. They found that downgrades of high-rated countries lead to contagion to both high and low-rated countries, while downgrades of low-rated countries incline competitive effects.

Apart from these studies mentioned above, our study focuses on the determinants of the sovereign credit ratings for the GIPSI (Greece, Ireland, Portugal, Spain and Italy) countries for 2003-2021. This is the first study to examine the sovereign credit ratings from a spatial perspective to the best of our knowledge. We employ a spatial panel model for the GIPSI countries. For this purpose, related or well-known determinants of the credit ratings will be used as the explanatory variables and for the weight matrix, we construct a geographical distance between the countries. Using spatial methods, we will examine whether there is a spillover effect or contagion effect between the sovereign credit ratings of the GIPSI countries or not. The remainder of the paper is organized as follows. Section 2 describes

[6] The authors use Institutional Investor's Creditwortiness Index as a proxy of the credit ratings.

the data and the methodology. Section 3 gives the estimation results. In Section 4, the study will be concluded with the overall discussion and the policy implications.

2. Data and Methodology

2.1. Data

In this study, sovereign credit rating scores which are obtained from Refinitiv Datastream, are used as the dependent variable. The credit rating scores take the values from 1 (default) to 20(AAA), which show the country's highest risk to the lowest risk. Oxford Economics provides comprehensive data for sovereign credit ratings to reflect the default probabilities in the Datastream database. Likewise, the factors that might affect the credit ratings are selected according to the related literature. According to Rowland & Torres (2004), solvency variables show the countries' long-term ability to pay their debts and the liquidity variables indicate the short-term ability to pay their debts. In this respect, GDP growth rate, government debt to GDP, current account balance (CAB) to GDP, international reserves to GDP, primary balance/GDP, and GDP per capita are used in this study[7]. Data for 5 European Union countries (GIPSI-Greece, Ireland, Portugal, Spain and Italy) is used in the estimations for the period of 2003Q4-2021Q3. Most of the macroeconomic variables are in the quarterly frequency. Therefore, we choose the quarterly data for our estimation. This data selection focuses on the rising risks that culminated in the 2008 mortgage crisis and the 2010-2012 European debt crisis. In these periods, it is expected that GIPSI countries affect each other more than the other EU countries. The data information is presented in the Table 1.

Table 1: Data information for the explanatory variables

Variables (with abbreviations and definitions)	Economic explanation	Expected sign	Data source
Growth- GDP growth rate, year on year	GDP growth helps to decrease the relative debt burden.	(+)	Oxford Economics
Govdebt/GDP- General government debt, Maastricht definition, as of GDP	Government debt cause to the higher interest burden.	(-)	Oxford Economics
Cab/GDP- Current account balance as of GDP	The current account deficit or balance shows the dependency of a country to its foreign creditors.	(-) (+)	Oxford Economics
Res/GDP- Total reserves excluding gold as of GDP	Reserves may protect the government from default risk. A government with higher reserves may fulfill its obligations.	(+)	IMF - International Financial Statistics
Primary balance/GDP- General Government - Primary Balance (%GDP)	Primary balance shows the fiscal position of a government, whether there is a surplus or deficit. (net borrowing requirement)	(+)	Oxford Economics
GDP per capita (GDPPC) Gross Domestic Product Per Capita, Constant Prices	GDP per capita provides the stability of the institutions. Countries with higher GDP per capita will be less vulnerable to shocks.	(+)	Oxford Economics

Main Datasource: Refinitiv Datastream.

In order to construct the weight matrix, CEPII database, which gives the latitude and the longitude values, is used. The weight matrix (inverse distance matrix-w_{ij}) can be calculated as follows;

[7] The other factors (like unemployment rate, inflation rate, investment/GDP, external debt) that might affect the sovereign credit ratings are also used in the alternative estimations but they are found to be statistically insignificant. Therefore, we do not consider the other factors.

$wij = {}^{1}/_{d_{ij}}$; where dij shows the Euclid distance between the countries of i and j. The element of the first row and first column of the weight matrix shows the distance between Greece and Greece, the element of the first row and the second column shows the distance between Greece and Ireland and so on. The interaction between the GIPSI countries can be observed in table 2. In this table, the correlation between the credit ratings are quite high, which provides evidence of the spatial interaction between the GIPSI countries.

Table 2: Correlation matrix of the credit ratings for GIPSI countries

	Greece	Ireland	Italy	Portugal	Spain
Greece	1				
Ireland	0.942958	1			
Italy	0.777153	0.672269	1		
Portugal	0.973421	0.927511	0.87307	1	
Spain	0.886448	0.814885	0.93912	0.954376	1

Descriptive statistics of the variables are presented in Table 3. The median rating for the GIPSI countries amounted to 14, which shows the adequate payment capacity. The minimum rating amount is observed in Greece with 1.33 at the third and fourth quarter of 2011 and Ireland and Portugal reached the maximum rating at the period of 2004-2008 with an amount of 20. There is also heterogeneity in some of the explanatory variables. The minimum value of the government debt is observed in Ireland, while the maximum value of the government debt is observed in Greece.

Table 3: Descriptive statistics of the variables

	Rating	Primarybalance/ GDP	Govdebt/GDP	Growth	CAB/GDP	Res/GDP	GDPPC
Mean	13.78	-1.69	104.78	2.50	-2.80	6.96	7735.00
Median	14	-0.50	104.24	2.53	-1.80	5.40	6457.08
Standard Deviation	4.53	5.01	41.77	6.39	7.77	5.01	3769.62
Kurtosis	0.02	7.25	-0.36	7.26	16.67	0.37	3.02738
Skewness	-0.65	-1.96	0.084	1.13	-2.35	0.99	1.80
Minimum	1.33	-29.31	23.6	-20.68	-64.25	0.33	4028.21
Maximum	20	9.52	209.23	37.56	21.29	24.65	23045.3
No. of observation	360	360	360	360	360	360	360

2.1. Methodology

In the related literature, many studies focus on the determinants of credit ratings using different estimation methods (like linear regression models or order response models). However, we aim to employ spatial regression model. For this purpose, we benefit from the study of Lesage and Page (2010) and Elhorst (2014) for spatial analysis. The well-known spatial models are the spatial autoregressive model (SAR), spatial error model (SEM) and spatial Durbin model (SDM). This methodology may help us to consider the dependency among the observations. In particular, it is defined as the SAR model if the values of the dependent variable at a specific location depending on the values of the other location's dependent variable (Asgharian et al., 2013).

$$y_{it} = \alpha_i + \rho \sum_{i=1}^{N} w_{ij} y_{it} + x_{it}\beta + \varepsilon_{it} \quad (1)$$

Here, y_{it} shows the sovereign credit rating of a specific country,"α_i"shows the country fixed effect, 'ρ' shows the spatial autoregressive coefficient, 'w_{ij}' shows the neighborhood between county i and country j, x_{it} shows the explanatory variables and lastly, "ε_{it}" gives the error term.

The spatial effect can be observed in the error term (SEM). The equation is presented as;

$$y_{it} = \alpha_i + x_{it}\beta + u_{it} \quad (2)$$

$$u_{it} = \lambda \sum_{j=1}^{N} w_{ij} u_{it} + \varepsilon_{it} \quad (3)$$

In this model, dependent variable are explained by the other factors and the error terms are correlated. "λ" is the spatial autocorrelation coefficient.

In the SDM model, the explanatory variables of the neighbouring countries may affect the dependent variable with the other factors.

$$y_{it} = \alpha_i + \rho \sum_{i=1}^{N} w_{ij} y_{jt} + x_{it}\beta + \sum_{j=1}^{N} w_{ij}\ x_{jt}\ \gamma + \varepsilon_{it}$$

The Ordinary Least Square method can not be used in the spatial interaction between the countries. Therefore, maximum likelihood estimation is used in this study. There are two steps to be taken in the analysis. At the first step, we decide whether there is a spatial effect between the GIPSI countries or not. Using the Lagrance Multier (LM) test based on the residual of the fixed-effect model, we decide that there is a spatial effect among the GIPSI countries. LM tests also canalize the models to the SAR model or SEM model. At this stage, LR test is used to decide between the pool regression and the fixed effects. In the second step, we run the spatial autoregressive models (SAR) and spatial Durbin models (SDM). We reduce our model to SAR or SEM model by looking at the LR tests. According to LM tests and the LR tests, the SAR model is found to be appropriate for our dataset. While SAR and SDM models provide direct and indirect of explanatory variables, the SEM model can not.

3. Estimation Results

This section analyzes the sovereign credit ratings of the GIPSI countries for the period of 2003Q4-2021Q3. The estimation results are presented in the Table 4. In the first column, the OLS estimation with fixed effects is given. LR test provides that a fixed effect is appropriate for our data. All of the explanatory variables except GDP per capita are statistically significant. According to the LM tests, there is a spatial effect between the countries. Therefore, we run the spatial panel models. The LR tests also confirm that the SAR model is appropriate for our dataset.

In the second column, the estimation results of the SAR model are presented. According to these results, all of the variables are found to be significant. The spatial autoregressive coefficient (ρ) is nearly 0.40 and statistically significant. While primary balance/GDP, government debt/GDP and Cab/GDP negatively affect the sovereign credit ratings, growth of GDP, reserves/GDP and GDP per capita are all increasing the sovereign credit rating. The estimation results are compatible with the studies of Afonso, 2007, Bissoondoyal-Bheenick, 2005 and Proenca et al. 2021. In contrast to expectations, the coefficient of the primary balance is found to be negative. This situation can be explained whether fiscal austerity plans may not be succeeded in increasing the credit rating scores (Yuan & Pongsiri, 2015).

The direct effect shows the effect of an explanatory variable in country i to itself and the indirect effect shows the effect of an explanatory variable in country i to other countries. The coefficients in the second and third columns are slightly different because of the feedback effect that arises from impacts going through the other countries (neighbour countries) and back to the country itself (Seldadyo et al, 2010). While all direct effects are statistically significant and have the expected sign except the primary balance/GDP, the indirect effects of the preliminary balance/GDP, government debt/GDP and the growth rate are all statistically significant. The significant indirect effects provide the fact that the other GIPSI countries may affect the sovereign credit ratings of a particular GIPSI country. In other words, sovereign credit ratings of a specific GIPSI country are affected by the other countries' primary balance/GDP, government debt/GDP, and GDP growth rates.

Table 4: Estimation results

	Fixed effect	SAR	SAR direct effects	SAR indirect effects
Primarybalance/GDP	-0.147***	-0.102***	-0.109***	-0.061***
Govdebt/GDP	-0.113***	-0.072***	-0.077***	-0.043***
Growth	0.054***	0.050***	0.053**	0.030**
CAB/GDP	-0.045***	-0.034***	-0.036**	-0.020
Res/GDP	0.044*	0.045**	0.048*	0.027
GDPPC	-0.936	1.527*	1.634[8]	0.941
ρ	-	0.399***		
R^2	0.80	0.90		
Loglikelihood	-	-633.82342		
LMspatial lag	94.92***			
LM spatial error	13.74***			
Robust LM spatial lag	96.50***			
Robust LM spatial error	15.33***			

Note: This table gives the estimation results for the sovereign credit ratings of the GIPSI countries. In the first column, OLS estimation with fixed effects is given. The second column shows results for the Spatial Autoregressive (SAR) model. In the third and fourth columns, direct and indirect effects of the SAR model are presented, respectively. The ***, **, and * indicate the significance level for 1%, 5%, and 10%.

4. Conclusion

The importance of globalization and financial integration has brought the idea of examining the sovereign risks more intensively. The latest financial crisis in 2008 and the European debt crisis also support this tendency. In this context, the related literature has concentrated on the sovereign risks with different applications, whether considering the sovereign spreads (CDS spreads or bond yield spreads) or sovereign credit ratings. At this point, we aim to examine the spillover effects between the GIPSI countries by using the sovereign credit ratings. For this purpose, we employ the spatial panel model for the sovereign credit ratings of the GIPSI countries with the quarterly data of 2003-2021. The LM tests show that there is a spatial interaction between the GIPSI countries in terms of sovereign credit ratings. The empirical findings provide that sovereign risks are transmitted from one to another. In addition, sovereign credit ratings are negatively affected by the government debt, current account balance, and the primary balance, whereas positively affected by the growth of GDP, GDP per capita, and the international reserves.

The study provides that GDP growth, international reserves and GDP per capita are all important for higher credit ratings. Still, the high government debt may weaken the countries' financial position in the global markets. In addition, significant indirect effects provide the idea of the contagion effects. Therefore, it will be good to monitor the other countries' solvency and liquidity power after all. The improvement would itself will result in higher credit ratings and affect the neighbouring countries. Considering the different sample groups like high rate countries and low rate countries may be worthwhile for further studies. Also, different time periods for those countries can also be examined in the context of sovereign credit ratings.

[8] t probability of the coefficient for the GDP per capita is nearly 10%. Therefore we do not consider this variable as statistically significant.

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