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The effects of the crisis on credit rating agencies: A panel data analysis

Master in Economics

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Abstract

This effort aims to observe the determinants that affect the decisions of CRAs. The dataset concerns 12 Eurozone countries for the period from 2005 to 2021 and contains nine variables from the macroeconomic sector, also it is characterized by cross-sectional-dependence. Highlight that it is important to follow three different paths. Firstly, our dataset contains cross sectional dependence, for this reason we have to adapt the regressions by means of the cross sectional average. Second, we cannot ignore the impact of the crisis of 2007-2009, for this reason we utilize dummies for some variables of the external sector which received a huge importance on the years of crisis. Lastly, we will analyze the cumulated current account and its significance. We applied the analysis for panel data via pooled OLS, fixed & random effects for every agency. To sum up, only government debt is significant for every regression and the current account seems to be significant in the case that we use the average of the CRAs as dependent variable and for the most of the CRAs regressions. On the other side, the external balance is not significant for any level of significance. Government debt affect stronger the CRAs after the crisis in comparison with some years earlier.

Keywords: Credit Rating Agencies; Sovereign rating; Fixed and Random Effects; Cross Sectional Dependence; Panel data

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1. Introduction

Nowadays, both investors and researchers agree that the role of credit rating agencies is extremely significant for the economic sector. The three biggest agencies come from the United States and they called Moody's, S&P and Fitch, nevertheless there are domestic agencies for each country as well. Their role is to examine a combination of financial conditions and after that they provide the appropriate rates concerning the creditworthiness. They are related to economic sector, for instance ratings for sovereign debt, bonds, companies etc. The last years, specifically after the economic crisis of 2007-2009 which had a huge impact on financial field, the judgment of credit rating agencies became a controversial issue with many doubts.

Utzig S. (2010) made an effort to explain the role and the conditions of ratings during the financial crisis. He concluded that the main problem of CRAs came from the underestimation of products with structured credit. As a consequence, they had to deal with another problem which was the adjustment of rating so as to follow the real market conditions. The roots of the problem were in methodology errors and in the unreliability of the results. After this damage, there were massive reports focused on the mistakes of CRAs which followed by a great number of new regulations. In addition, White J. (2018) argues that the results of the crisis made their appearance in the end of the summer of 2008 while the biggest financial institution seems to not have the power to absorb their losses due to their huge capitalization from the housing boom. After this, the global crisis will be appeared with huge impact on the CRAs. Sinclair, T. J. (2010) supports that the financial crisis reflects the lack in confidence on the capital markets and the recovery will take many years. CRAs had to pay attention on their initial steps in order to recover and gain their reliability again.

According to the bibliography, the most investigators utilize panel data for different periods but for countries with similar characteristics like Eurozone, Asian countries etc. Also, they add a variety of macro variables so as to examine the influence of sovereign debt. For instance, Boumparis et al (2015) chose 19 Eurozone countries for the period of 2002-2013 in combination with nine macroeconomic variables. They summarized that CA and the government debt play a significant role after the crisis. Afonso et al. (2011) decided to analyze the period from 1995 to 2005 for 78 countries. They observed that the GDP, gov. debt & balance caused the credit ratings in the short run, for the long run period the default history, external debt, gov. effectiveness and foreign reserves has the most significant influence. Mora (2005) focused on the East Asia crisis,

as a result there are 35 countries for 1989-1999. This paper summarized that the ratings were not procyclical and the predicted ratings were on the same line as real ratings. Also, this paper does not support that the agencies did not add negative factors on the crisis. This is in contrast with Ferri et al. (1999) which conclude that the rating agencies were not able to predict the crisis.

The study of the previous literature review, made us to focus on some particular vital parts. The main step was to decide the macroeconomic variables that should be added on our dataset. Panel data consists of both time series and cross sectional data and as a consequence we had to focus on some particular countries for a specific time horizon. In summary, we choose the period of 2005 to 2021 so as to include the economic crisis of 2007-2009 and the period after the crisis. The countries that are under our microscope are 12 Eurozone countries that have a strong economic field such as Luxemburg, Germany, Austria and some countries that were fully affected by the unstable economic field like Greece, Italy, Ireland, Portugal. The choice of the macroeconomic variables is in the line with Boumparis et al. (2015), GDP per capita/growth rate, Government debt, Accumulated CA, unemployment & inflation rate, external balance, reg. quality and reserves complete our dataset. Notice that there are sovereign ratings for every country from the three main agencies.

In other words, this particular research aims to observe the factors that affect the decisions of CRAs. Highlight that it is important to follow three different paths. Fisrtly, our dataset contains cross sectional dependence, for this reason we have to adapt the regressions by means of the cross sectional average. Second, we cannot ignore the impact of the crisis of 2007-2009, as a result based on the paper of Baghai et al. (2014), we have to utilize dummies for some variables of the external sector which received a huge importance on the years of crisis. Lastly, we will analyze the cumulated current account and its significance. The second and the third steps are also based to Gross (2011). In summary, in each case we have as dependent variable the ratings of the three CRAs. Next, we applied the analysis for panel data via pooled OLS, fixed & random effects for every agency. The methodology sector represents the final structural of the model.

This effort is based on the bibliography of the previous years and particularly on the paper of Boumparis et al. (2015) in combination with some methodology parts of Baghai et al. (2014) and Gros (2011). This study is separated in six parts. The second sector is referring to the general role of the Credit Rating Agencies and the effects of the economic crisis on their role. Section 3 is organized by the literature review with an extended analysis. The methodology part is discussed on the 4th Section where the analysis of panel data with fixed and random effects is the main

topic. Section 5 represents a detailed presentation of the empirical results by means of graphs and tables for each Credit Rating Agency. Last but not least, in Section 6 there are the results of this effort and the general summary of this progress. Let's note that the results and the figures are created with the help of the programming language of R.

2. Global Credit Rating Agencies

The global industry of credit rating agencies consists of three huge corporations, named as Moody's, Standard & Poor's, and Fitch. Besides those three, we have to bear in mind that a great number of countries have their domestic rating agencies as well. All of them have an important contribution to the financial field. Both S&P and Moody's have founded in the US while Fitch has its roots in New York and London.

2.1.Their Contribution on the financial sector

Based on the economic sector, both companies and countries are under the microscope of the CRAs which are responsible for the evaluation of the creditworthiness of debt. In other words, they try to explain how possible is for borrowers to lose their credibility and in the end to default a loan. As a consequence there is a direct and crucial relationship between lender and borrower. Their rates are depicted by particular scales that contain letters (eg. A,B,C) and numbers (eg. 1,2,3) according to the *Table 11* (Appendix).

Consequently, lenders have to know the conditions and the terms of the repayment for their loan, however due to asymmetry of information there are many obstacles. It is significant for them to figure out the probability of a default in order to adapt and apply their terms for each borrower. The contribution of the CRAs on this effort is extremely significant. Particularly, the agencies try to collect information for borrowers like governments, firms, corporations concerning their assets, bonds etc. and finally they assess the creditworthiness in each case. Their results are usually depicted by letters and numbers, ordered in a ranking scale, for instance SD, CC, Aa3, AAA etc. The investors that take part in lending-borrowing activities with main ingredient bonds are usually financial institutions.

There are some particular steps for this procedure. Initially, the agencies have to evaluate the creditworthiness and charge a fee. Next, the debt securities such as stocks, derivatives, bonds etc. plus debt issuers like companies, banks, governments etc. are under rating and finally the rates are provided by means of letters, numbers and symbols. Higher ratings mean lower risk and lower ratings mean higher risk.

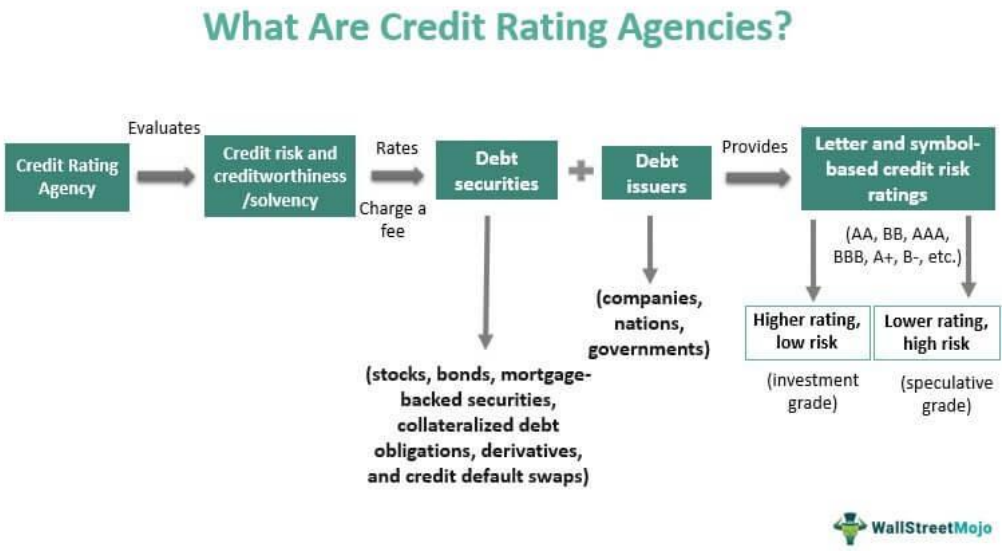

Figure 1: The role of the CRAs, source: WallStreetMojo .com

2.2. CRAs and the Financial crisis of 2008

During the global financial crisis, CRAs received a strong blow and their credibility was under dispute. Based on the survey of White L.J. (2018), the housing boom of the 90s had a huge impact on the CRAs. The agencies tended to be extremely optimistic on the RMBS ratings, as a result the interest rates were low while at the same time there was huge risk. Some years later, in the 2006, the prices of houses increased and after all they got decreased which means that the defaults levels started to be visible. As a consequence, the agencies were not as optimistic as they were before and they downgraded the RMBS that caused losses on the huge financial institutions. The results of this procedure became visible during the summer of 2006.

According to the effort of Utzig S. (2010), the volatility of the CRAs was increased to a great extend the following years of the crisis. This unstability had both procyclical effects and also influenced the future credibility of the CRAs. This was a good reason for further investigation of them. The next step was to create European reports that referred the reasons and the details of the CRAs contribution to the collapse of financial sector. On 7th April of 2008 the

first report appeared on the Financial Stability Forum (FSF). In summary, the risk was underestimated because of methodological obstacles and the CRAs were under criticism due to they did not bear in mind the lending standards. Moreover, there were a great number of reports by Jose Manuel Barroso – President of the European Commission in October 2008, the UK Financial Services Authority in March 2009 that highlighted the actions of the CRAs and their false estimations.

The global financial crisis forced the whole economic sector to take actions in order to reduce the possibilities of a future collapse. Both CPA of 2010 and Dodd-Frank Wall Street Reform strived to create new regulation in case of the USA for the previous reason. It was sure that the role of the CRAs would play a crucial role on their efforts. Firstly, the regulators of federal financial got forced to study the levels of their reliance on the relevant ratings and also to develop new methods that will focus on prudential regulatory targets and avoid the references based on the ratings. Secondly, the other target was to create transition matrices with yearly frequency that describes the ratings changes by means of NRSRO. This happened due to NRSRO had to clarify their role and be improved based on the SEC.

Some years later, Barroso expressed his thinking at Strasbourg while attending a press conference:

"Rating agencies are market players and as such they are not immune from market cycles, mistakes and exaggerations that come with them"

3. Literature review

According to the literature, it is undeniable that the Credit Rating Agencies play a vital role on the financial sector. In this particular field, CRAs had received extensive criticism based on their results and this fact cumulated during period of crises, for instance the 2007-2009 crisis, the Asian crisis etc. Both researchers and investors strive to find the factors that influence the quality

of ratings and the credibility of their results. In the most cases, the investigators focus their researches on particular groups of countries with common clues such as Eurozone, Asian Countries, and the USA. The truth is that there are ratings concerning the financial field and the banks, for instance corporate bonds etc. and ratings that focus on the economic field like sovereign ratings that relate to macroeconomic variables. This research belongs to the second field.

Based on previous researches, we conclude that there is a wide range of surveys that try to explain the factors that influence the CRAs and how these agencies take into account the phenomena which are included in the economic sector. For instance, Afonso et al. (2011) figured out that there are both short run and long run factors that influence the countries ratings for the sovereign debt. Particularly, they studied the period of 1995 to 2005 for both European and other countries like Mexico, South Africa, Brazil etc. utilizing ordered response and linear methodologies. The interesting part of this paper is that the growth of Gross Domestic Product and GDP, government balance and debt can affect with short run way the ratings of the CRAs. On the other side, default history, the effectiveness level of government, debt and foreign reserves have a long run influence on the ratings. Boumparis et al. (2015) followed a similar procedure, their dataset consists of panel data for the Eurozone countries over the period of 2002-2013 including the 2007-2009 crisis so as to investigate its impact on the decisions of CRAs. They preferred this kind of dataset due to cross sectional dependence and they applied the methodology of Fixed and Random effects with dummy variables. Finally, the cumulative CA and the government debt were the most significant factors on the ratings.

Another approach is those of Han et al. (2012) that focused on the reputation of the CRAs and their reaction under the financial crisis. They figured out that their reputation decreased over the period of global financial crisis. For example, bond ratings were higher by the global CRAs in comparison with the domestic agencies in case of Japan, however during the crisis period, the yields of this particular bonds raised as a result the global CRAs suffered a severe reduction in their reputation. Almost for the same time period, from 1985 to 2009, the study of Baghai et al. (2014) aimed to explore the conservative of the debt ratings. Actually, the ratings decreased by 3 notches, but this action is not clarified due to the fact that defaults have been decreased during this period. The firms that were characterized with more conservatism did not have high levels of leverage and it was more possible to not obtain ratings of debt. Also, the debt spreads were not higher than firms which were not affected by conservatism.

A few years earlier, Ferri et al. (1999) represented that the CRAs played a disastrous role on the East Asia crisis. The East Asian countries received worst ratings than they deserved consequently, the borrowing abroad costs got worsen and this contributed negatively to the crisis. The authors proposed for the CRAs to become more conservative in order to repair their negative reputation. Moreover, they consider that it would be interesting to create a model that can detect the procyclical roots of sovereign ratings. On the other side, the paper of Mora (2006) tries to investigate the results of the previous work of Ferri et al. (1999). It comes to the conclusion that ratings is possible be affected by non macroeconomic metrics like default history, as a result it is not crystal clear if the cycle of boom & bust can be exacerbated by them.

Cavallo et al. (2012) argue that many European nations subjected to downgrades and this fact caused many questions if they had a real impact. Finally, the value of ratings is significant only if the spreads and the fundamentals contribute to the study of different variables of the market. In addition, Kraussl (2005) investigated if the emerging markets are affected by the changes of sovereign ratings. This is proven in case of lending in this group of countries with downgrades to play an important role compared to positive ratings. However, the changes in sovereign ratings do not have high impact on emerging markets.

The following table incorporates extensive results and methods based on the literature

Table 1: Overview of the literature

	Title of the paper/study	***(Authors names & year of publication)***	***Keywords***	***Data (Sources)***	***Conclusions***
1	Short and long run determinants of sovereign debt credit ratings	(Antonio Afonso, Pedro Gomes, Philipp Rother, 2011)	Credit ratings, sovereign debt, rating agencies, random effects ordered probit	The dataset contains the ratings of the 3 CRAs for 78 countries from 1995 to 2005 as well as government debt, fiscal balance, CA, external debt, foreign reserves, unemployment, inflation, GDP. The main sources were the databases of the three CRAs and the World Bank for the explanatory variables.	In this effort, the first model is the linear and the second is the ordered response model. The authors figured out that the ratings of the countries can be affected both in the short and in the long run period. For instance, the short run impact on ratings comes from changes in gov. debt & balance, GDP while long run impacts were created from default history, external debt, gov effectiveness and foreign reserves.

2	Has the crisis affected the behavior of the rating agencies? Panel evidence from the Euro zone	(Boumparis P., Milas C., Panagiotidis T., 2015)	Credit ratings, sovereign debt, panel data	There are 18 Euro Zone countries with 9 variables from 2002-2013 like GDP, Government gross debt, Unemployment rate, CPI, Aggregate Government Indicator, Current account balances. They came from the IMF WEO, World Bank and databases of the 3 credit rating agencies.	The paper includes cross-sectional dependence on the data. The authors concluded that the ratings of the CRAs received a significant impact from cumulative current account and government debt after the period of crisis. The analysis contains dummy variables which help in the comparison between before and after crisis.
3	Do credit rating agencies add to the dynamics of emerging market crises?	(Roman Kraussl, 2005)	Credit Ratings, Event study, Financial crises, Sovereign risk	There are 28 advanced and emerging economies from all over the world for the period of 1997 to 2000. The main variables are the ratings of foreign currency debt (long term) on a daily basis from Moody's and S&P. Stock market price indexes, nominal ER and short term IR build the dataset, too. They are obtained from DataStream and Bloomberg.	The author summarized that the lending of emerging economies affected by the changes of the CRAs. Also, the negative ratings' changes and the downgrades of the governments have an extremely strong impact in comparison with positive actions.
4	An analysis of the determinants of sovereign ratings	(Emawtee Bissoondoyal-Bheenick, 2005)	Sovereign rating, Ordered response model	The dataset contains the sovereign rating from 12:1995 to 12:1999 for 25 high rated & 70 low rated countries (Moody's & S&P data sources). World bank provided GNP per capita, real ER, foreign reserve and net exports/GDP came from IMF, OECD provided unit labor cost & unemployment rate, and inflation, gov debt & financial balance, foreign debt, CA came from Moody's.	This paper focused on the quantitative determinants concerning the sovereign ratings. The author observed that the macro variables do not play a vital role on the ratings when they are analyzed alone. Also, their role and their significance are different in countries with high grades that deal with a stable economic sector and low grades.
5	Have Rating Agencies Become More Conservative? Implications for Capital Structure and Dept Pricing	(Ramin P. Baghai, Henri Servaes, Ane Tamayo, 2014)		The debt ratings are obtained from Compustat Ratings File and they are on monthly frequency from 1985 to 2009. Next, convertible debt, rental payments, debt cash securities profitability and	This paper is the key in order to study the behavior of CRA in the crisis period. During this period, the conservative of debt rating increased. According to firms, if the predictions are better that

				it volatility, tangibility are some of the explanatory variables. Also, the domestic long term issuer and the analysis are repeated for the three agencies unsecured bond by Mergent FISD.	the real ratings, they face smaller leverage and the debt that they issue is less. Also, this conservatism influences with positive way the cash holdings while the investments and growth in acquisitions receive a negative influence.
6	Do Credit Rating Agencies add value? Evidence from the sovereign rating business	(Eduardo Cavallo, Andrew Rowell, Roberto Rigobon, 2012)	Ratings, Spreads, Information Economics, event studies	The dataset consists of 75000 daily obs. In particular, there are Stock market indices, sov. Spreads, ER, VIX for 32 emerging economies over the period of Jan 1998 to April 2007 from Bloomberg.	This paper describes weather the information that come from ratings is credible in comparison with the real info of bond spreads. Next, it represents the relation of ratings between macro variables by means of Hausman specification test. Finally, their value is significant when other variables are explained by them.
7	Sovereign credit determinants: a comparison before and after the European debt crisis	(Peter Reusens, Christophe Croux, 2017)	Composite marginal likelihood, Credit rating agencies, European debt crisis, multi-year ordered probit model, sovereign credit rating determinants	In this paper, the basic variables are GDP per capita, Gov debt, GDP growth, CA, inflation from IMF, Eurozone membership from ECB, Fin. Balance, external debr from moody's, economic development from OECD and default history from Beers and Nadeau (2015), also there are the sov. rating from the three main agencies (from their databases) for 90 emerging & advanced countries from 2002 to 2015.	The authors concluded from their determinants that the external debt, fin. Balance & the economic development increased their significance after the 2009, however the variable of eurozone membership gained negative effect. Moreover, the countries with low GDP growth had more significance on the gov. debt. As the authors observed, the crisis affected the grades on the sovereign ratings.
8	Variations in sovereign credit quality assessments across rating agencies	(Paula Hill, Robert Brooks, Robert Faff, 2010)	Credit rating, Rating transition, Prediction, Information content, Sovereign	In this survey there are the ratings of the three main CRAs for 129 countries from 04:1990 to 03:2006. Also, the ratings of issuer government, individual bond issue, country ceilings, and dominated debt are on sovereign levels.	The authors conclude that all of the variables play a different role on the credit quality so there is material heterogeneity. Their ordered probit model indicates that the strongest prediction (in-sample) is provided by S&P while the other two agencies have better watch data.

9	Sovereign credit ratings: Guilty beyond reasonable doubt?	(Nada Mora, 2006)	Credit rating agencies, Sovereign debt, International financial markets	The variables are the sovereign ratings by S&P and Moody's, PPP GDP, real GDP, CPI, CA, external debt, budget deficit from IMF & WDI. The period concerns the 90th decade and the early of 2000 for a group of Asian countries.	The paper suggests that before the crisis the predicted ratings did not exceed the real ratings and during the crisis they matched to a great extend but after the crisis the predictions increased more that the assigned ratings. It is important that the non macro factors like default histories of countries or lagged spreads influenced the ratings.
10	The Procyclical Role of Rating Agencies: Evidence from the East Asian Crisis	(G.Ferri, L-G. Liu, J.E. Stiglitz, 1999)		This paper contains yearly data from 17 Asian countries during 1989 to 1998 including the Asian crisis and the Moody's sovereign ratings. Authors apply random effects and use linear and nonlinear regressions. GDP, real GDP growth, inflation, Budget deficit, CAB external debt, development indicators are the main variables. IMF, World Bank and Moody's were the basic data sources.	The authors observed that the prediction of the CRAs during the Asian crisis were worst than the real results for the Asian countries. The conservation of the CRAs damaged the Asian economy and one reason for this was because they did not bear in mind the economic fundamentals but they focused on the qualitative judgment.
11	Sovereign ratings of advanced and emerging economies after the crisis	(Marlene Amstad, Frank Packer, 2015)		The dataset concerns the sovereign ratings based on the three basic CRAs and three other agencies out of the USA, Dagong, JCR and Fen. There are 54 emerging and 28 advanced countries in 2007 and 2015. GDP per capita, GDP growth, public/external debt, log inflation, foreign reserves default history helped the research. The Bank of Canada, IMF, World Economic Outlook, Bloomberg, BIS and IFS are the main databases.	The authors summarized that the crisis changed plenty of methodology frameworks of the CRAs. After the crisis the ratings were sensitive on some particular variables like GDP growth. Nevertheless, the other agencies provide ratings that are in favor of EMEs after the period of crisis.

12	Analysis of Moody's sovereign credit ratings: criticisms towards rating agencies are still valid?	(Haspolat Fatih Bahadir, 2015)	Sovereign credit ratings, credit rating agencies, Moody's, credit risk	The study period of this effort is from 1996 to 2012 for 69 economies. Default history, GDP, ER volatility, Gov Gross Debt and effectiveness, CA, inflation, control of Corruption, Voice & Accountability, Rule of law, Regulatory quality for 69 countries, are the main variables in this analysis. IMF, WGI, WDI, and Moody's are the basic sources.	The analysis of the panel dataset via RE, FE and OLS method indicated that the positive influences on sovereign ratings come from GDP, CA, gov quality and growth performance and expectations. Default occurrences, ER, debt stock, cause negatively the ratings. This fact confirms the low levels of forecasts of CRAs related to economic crises.
13	The euro area sovereign debt crisis: Identifying flight-to-liquidity and the spillover mechanisms	(De Santis, R. A, 2014)	Sovereign Spreads, Credit ratings, Spillovers	This survey contains data for 10 Euro zone countries during Jan 2006 to Dec 2012 with a daily frequency. In particular, there are 2Y, 3Y, 5Y, 7Y & 10Y bond yields regarding to government and they are gained from Thomson Reuters Datastream in case of Ireland and Bloomberg for the other countries.	The author concluded that the most euro zone countries faced raised sovereign spreads and this worsen due to fiscal problems of Greece. The yields are affected by a combination of factors like contagion risk, aggregate risk etc. After the appearance of crisis, countries like Spain, Portugal, Ireland, Greece seemed to be vulnerable and non reliable, affecting the whole European Zone. During this period the aim was to follow a policy which could increase the countries credibility reduces the contagion.

4. Methodology and Data

The methodology sector is an applied approach of the extended book of Hsiao C. (2022) which analyzes with details the panel data as well as their benefits. We combined the main ingredients of this book so as to create and interpret the regressions of OLS, Fixed and Random Effects. According to Frees E. W. (2004) the definition of panel data is very simple and extremely interesting and this group of data tends to be broadening mainly in the labor economic field. Their two dimensions make them different in comparison with simple time series. For instance they are a combination of time series and cross sectional dimensions, such as a group of countries that are the cross sectional dimension and their macroeconomic variables like GDP, GDP growth that are the casual time series. Another example from our everyday life is to examine a group of households from a particular area and their income. Berrington A. et al. (2006) represent various examples of panel data for social sciences and they highlight the significance of this group of variables. Also they applied fixed and random effects, change score models, graphical illustration and latent growth curve models, nevertheless they reached out that there are not wrong models and results. It depends on the availability of the data and the questions that are raised.

4.1. Panel Methodology

As mentioned above, this survey analyzes the use of panel data. This kind of data contains some particular and unique characteristics and it is analyzed by means of a group of methodologies because of they are affected by two different factors, the cross-sectional dimensions and time series as well. The simplest model of this methodology is the following:

$$y_{it} = a + \beta x_{it} + u_{it} \qquad (1)$$

Where *i* is referring on the time series, *t* is the cross sectional dimension (for instance countries, households etc.), the dependent variable is the y_{it}, α is a constant β is a vector (kx1) and x_{it} with *t*=1,…,*T*, *i*=1,...,*N*.

4.2. Pooled OLS

The pooled regression is the simplest way to analyze and estimate the previous equation. However, it is worth mentioning that this way assumes that the variables are all together in the same "pool". For this reason there is no heterogeneity in this framework. The next paragraphs represent two methodology techniques of panel data that are more complex and add more interesting on the econometric analyses. The simplest example is a common regression:

$$y_{it} = x_{it}\beta + c_i + e_{it} \quad where\ c_i + e_{it} = u_{it} \qquad (2)$$

$$\begin{bmatrix} y_{11} \\ \vdots \\ y_{1T} \\ \vdots \\ y_{i1} \\ \vdots \\ y_{iT} \\ \vdots \\ y_{N1} \\ \vdots \\ y_{NT} \end{bmatrix} = \begin{bmatrix} 1 \ldots x_{11k} \ldots x_{11K} \\ \ddots \\ 1 \ldots x_{1Tk} \ldots x_{1TK} \\ \vdots \\ 1 \ldots x_{i1k} \ldots x_{i1K} \\ \ddots \\ 1 \ldots x_{iTk} \ldots x_{iTK} \\ \vdots \\ 1 \ldots x_{N1k} \ldots x_{N1K} \\ \ddots \\ 1 \ldots x_{NTk} \ldots x_{NTK} \end{bmatrix}$$

As it seems y_{it} is the dependent variable, x_{it} is the independent variable and c_i is the unobserved effect which is stable across time. We can see it in practice on the sector of empirical results. The performance of OLS method is correct in case that the x_{it} variable is exogenous.

$$E[\acute{x}_{it} u_{it}] = 0 \text{ or } E[\acute{x}_{it} e_{it}] = 0 \ \& \ E[\acute{x}_{it} c_i] = 0 \qquad (3)$$

In the case that we observe unstable errors on cross section units we can use robust standard errors. This model has a good performance but the researchers utilize a range of complicated methodologies.

4.3. Fixed Effects Models

The following equation indicates the philosophy of the Fixed Effects Models.

$$y_{it} = a + \beta x_{it} + \mu_i + \nu_{it} \quad (4)$$

We observe that the previous equation is almost the same as *equation 2* but there is the term of μ_i. This term reflects the heterogeneity and every cross sectional unit has different intercepts. Moreover, this model can be extended by dummies variables to LSDV model:

$$y_{it} = a + \beta x_{it} + \mu_1 D1_i + \mu_2 D2_i + \mu_3 D3_i + \cdots + \mu_N DN_i + \nu_{it} \quad (5)$$

Where dummies $D1_i$, $D2_i$, DN_i take the value 1 for the observations on the specific entities. In addition, in order to avoid the huge number of dummies, there is the time mean of the obs. concerning the cross sectional unit i, $\overline{y_i} = \sum_{t=1}^{T} y_{it}$.

This progress is called within transformation. In other words the demeaned variables are represented by $y_{it} - \overline{y_i} = \beta(x_{it} - \overline{x_i}) + u_{it} - \overline{u_i}$ and can be written as $\ddot{y}_{it} = \beta\ddot{x}_{it} + \ddot{u}_{it}$ (6)

4.4. Random Effects

Furthermore, the random effect (or error component model) is a different approach. This model contains different constants for every entity like the previous method. Nevertheless, the following equation indicates that there is a variable ε_i that is random and constant.

$$y_{it} = \alpha + \beta x_{it} + \omega_{it,} \quad , \omega_{it} = \varepsilon_i + v_{it} \qquad (7)$$

The ε_i is the random term with zero mean, constant variance, independent of v_{it} and replace the Dummies of the previous model. The OLS method estimates the α and β. We have to highlight that the standard errors are fixed and the error term contains the unobserved heterogeneity throughout this method.

4.4.1. Hausman test

As mentioned above, Fixed and Random effects are the basic components in the analysis of panel data. Both of them follow a specific formula however it is significant to choose which of

them is the most appropriate model for our survey. For this reason this test focuses on the explanatory variables and specifically on their endogeneity and its presence. The next table (*Table 2*) compares the null and the alternative hypothesis of the two previous effects.

$$H = \left(\hat{\beta}^{RE} - \hat{\beta}^{FE}\right)' \left[Var\left(\hat{\beta}^{RE}\right) - Var\left(\hat{\beta}^{FE}\right)\right]^{-1} \left(\hat{\beta}^{RE} - \hat{\beta}^{FE}\right) \quad (8)$$

In the previous equation the term β^{RE} refers to the Random Effect estimation and the term β^{FE} refers on the Fixed Effects estimation. This equation helps us to estimate the Hausman statistic.

Table 2: Hausman Test

	Fixed Effects	***Random effects***
H_0: $Cov(\alpha_i, x_{it}) = 0$	Consistent Inefficient	Consistent Efficient
H_1: $Cov(\alpha_i, x_{it}) \neq 0$	Consistent Possibly Efficient	Inconsistent

In summary, the null hypothesis (H_0) means that the random effect formula is preferable due to the fact that the independent variables and the error term are characterized with no correlation. One characteristic of the correct RE model is the best linear unbiased estimates known as BLUE. On the other side, the alternative hypothesis (H_1) indicates that we prefer the fixed effect model which means that there is statistically significance on the correlation of the independent variable and the error term. Note that the term α is the individual specific component.

4.5. Cross Sectional Dependence Test

If we observe in some previous papers, we will understand that the Cross Sectional Dependence is a common obstacle for the researchers that analyze panel data. De Hoyos et al. (2006) represent a detailed work that refers to the different tests so as to detect the cross sectional dependence. More specifically, there is a great range of factors that can influence this kind of dependence, the most simple is the nature of the data. Another common factor is the correlation that comes from the cross sectional dimension of the data and its size as well. Moreover, we can characterize it as strong or weak according to the factors that affect the dependence. For fixed & random effects, the estimators would be not efficient and the errors would be characterized as

biased if the factors that were mentioned above were uncorrelated and unobserved. Consequently, if we have to deal with such a problem, we have to choose the appropriate statistical technique to correct it. The next chapters describes our decision to utilize the averages of the cross sectional dimensions.

4.5.1. Pesaran Cross Sectional Dependence

The cross sectional dependence can be detected via a number of tests. Some of them are the Pesaran Scaled Lagrange Multiplier test (LM), Breusch-Pagan Lagrange Multiplier (LM) and the Pesaran CD test. The test of Pesaran for cross-sectional-dependence, Pesaran (2004) is based on the following equation:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widehat{\rho_{ij}}\right) \quad (9)$$

The statistic of CD, for fixed T and N suggests that the mean is zero. The null hypothesis supports that N (0,1) when N $\rightarrow\infty$ and means that there is not cross-sectional dependence. The *equation 9*, tend to follow some assumptions. But firstly, we have to be based on the *equation 1*.

1st assumption: The u_{it}, is not dependent and the means are equals to zero, also the variance σ^2_i is: $0<\sigma_i<\infty$ (for each i).

2nd assumption: The null hypothesis means that the distribution of the ε_{it} is around zero and symmetrically.

$$H_0: u_{it} = \sigma_i\varepsilon_{it} \text{ , where } \varepsilon_{it} \sim \text{II D } (0,1)$$

3rd assumption: The x_{it} are characterized as strictly exogenous:

$$E(u_{it} \mid X_i, X_j) = 0$$

X_{it} equals to $(\tau T, x_{i1}, x_{i2}, \ldots, x_{iT})'$,
τT is a vector *Tx1* & $T^{-1}X_i'X_i$ is a matrix with positive define for T > k and T$\rightarrow\infty$.

4th assumption: There are residuals from OLS method that are not zero & T > k+1.

4.6. Main model

The main body of this effort is based on the survey of Boumparis et al. (2015) who built their analysis on the *equation 10*. Moreover, this particular equation includes the idea of Baghai et al. (2014) that observed how the rating agencies behaved during and after the appearance of the global economic crisis.

$$CRA_{it} = \alpha_0 + \mu_i + \sum_{i=1}^{9} \alpha_i x_{it} + \sum_{i=1}^{9} b_i \bar{x}_i + \sum_{j=i}^{3} c_j D_{crisis} x_{jt} + error_{it} \quad (10)$$

As it seems, there are nine macroeconomics variables in the x_i that are represented on the *Table 3*, D_{crisis} variable represents the Dummy that is 1 in the years after 2009. It is significant to notice that only three variables interact with the previous dummy variable that reflects the period of crisis. Gros (2011) highlighted that the external field played an extremely role on the crisis, for this reason CA, external balance and government debt are the three variables that are combined with the dummy variable. Lastly, there is an extra regressor $\bar{x}$ for the cross-sectional average in combination with the dependent variables.

4.7. Data

Panel data play a vital role on this research, the dataset concerns the period of 2005 to 2021 including the global financial crisis. We focused on the Eurozone group countries with 12 countries of the Euro area and nine macroeconomic variables. In particular the countries of the dataset are: Germany, Luxemburg, France, Ireland, Greece, Italy, the Netherlands, Spain, Belgium, Austria, Portugal and Finland. The next table describes CRAs ratings, the macroeconomic variables and their sources as well. Notice that the data are on annually frequency and they are analyzed based on the methodology sector by means of panel data methods. We observe that there are both development and advanced economies in order to study the differences and their reactions on the macroeconomic variables.

Table 3: Description of the variables

Variables	***Data Description***	***Sources***
Ratings Moody's	Sovereign rating of each year	*Moody's*
Ratings S&P	Sovereign rating of each year	*S&P*
Ratings Fitch	Sovereign rating of each year	*Fitch*
GDP per capita	GDP per capita (log), $ constant	*World Bank*
GDP growth rate	% change of GDP	*IMF WEO*
Gov. Debt	General government gross debt, % of GDP	*IMF WEO*
Accumulated CA	Sum of current account balances, % of GDP	*IMF WEO*
Unemployment Rate	Unemployment rate, % of total labor force	*IMF WEO*
Inflation Rate	Growth rate of CPI	*IMF WEO*
External Balance	External balance on goods and services, % of GDP	*World Bank*
Reserves	Total reserves (log, includes gold, constant)	*World Bank*
Regulatory Quality	Aggregate Government Indicator	*World Bank*

The following graphs illustrate the ratings of each CRA per country and per year. We observe that almost all countries received lower ratings during the crisis period except from advanced economies like Germany, Luxembourg and Austria that continued to receive the highest degree of ratings. Greece received the lowest grades during the crisis from the three agencies. It is clear that after 2009 the most countries received lower ratings than before 2008. This fact is visible on the following three graphs.

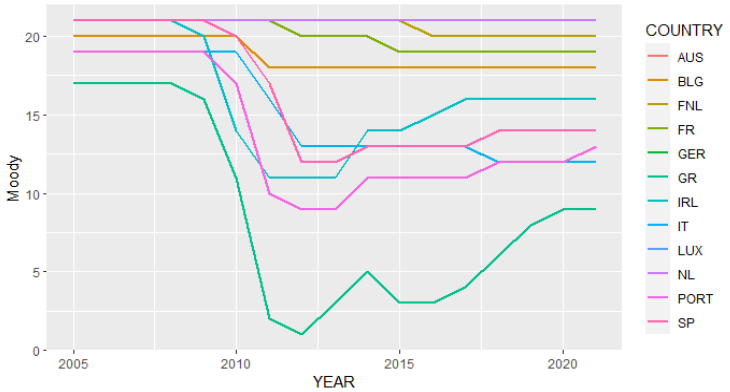

Figure 2: Moody's Ratings

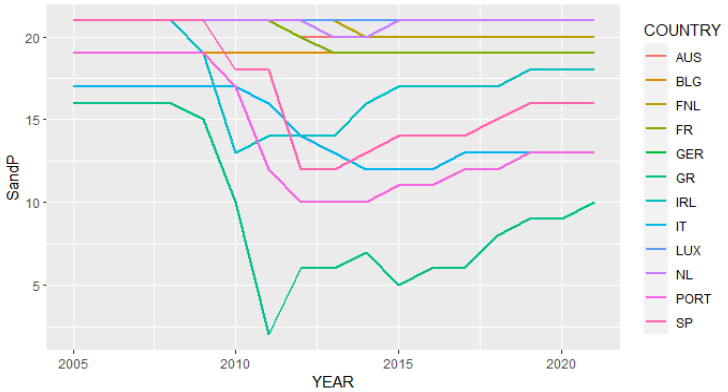

Figure 3: S&P Ratings

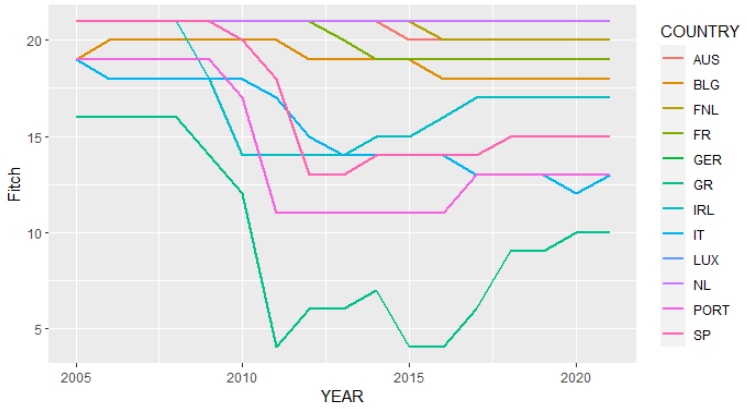

Figure 4: Fitch Ratings

As mentioned above, the main methodology line is based on the paper of Boumparis et al. (2015). Fixed and Random Effect estimations will play a vital role on the following analysis. Initially, after the graphical illustration of the data, we have to represent the descriptive statistics of the dataset. The *Table 4* represents our variables as well as their descriptive statistics.

Table 4: Descriptive Statistics

Descriptive Statistics									
	Log GDP per capita	GDP growth	Gov. debt	Current Account	Inflation rate	External rate	Log Reserves	Unempl. Rate	Regul. Quality
Mean	4.5843	1.2642	84.4967	0.7596	1.5607	5.1286	10.3208	9.2234	1.3228
Median	4.6044	1.6590	80.8780	1.0140	1.6075	2.7948	10.3780	7.9125	1.4019
Max	5.0508	24.371	212.449	14.2300	4.7040	40.2854	11.4709	27.4750	2.0454
Std. Dev.	0.0195	3.8592	40.6437	5.2821	1.2664	10.4695	8.3122	4.9768	0.4268
Skewness	0.4833	0.4807	0.5626	(0.6959)	(0.0403)	1.5030	(0.5580)	1.7387	(0.5171)
Kurtosis	3.3552	9.8713	3.3941	4.0732	2.5807	4.8583	2.7617	5.8008	2.3261
Jar. Bera	9.0161	409.18	12.0842	26.2597	1.5496	106.164	11.071	196.468	12.9542
Sum	935.19	257.90	17237.3	154.97	318.40	1046.2	2105.4	1881.5	269.86
Obs.	204	204	204	204	204	204	204	204	204

According to the literature, we are expecting that the unemployment and the government debt to have a negative correlation with ratings. It makes sense due to the fact that the labor market of the countries that have small amounts of unemployment is working more efficient than economies with high levels of unemployment. Furthermore, in the case of government debt we realize that the economies with high levels of debt have to face more risk, consequently risk of default. Also, this kind of countries deals with high interest rate. On the other side, inflation rate and external balance is not feasible to be predicted because they can interact with other macroeconomic variables. The other five variables have positive correlation with ratings because

of they reflect the economic growth and the reliability of the counties. All of our expectations can be confirmed by the below correlation graphs.

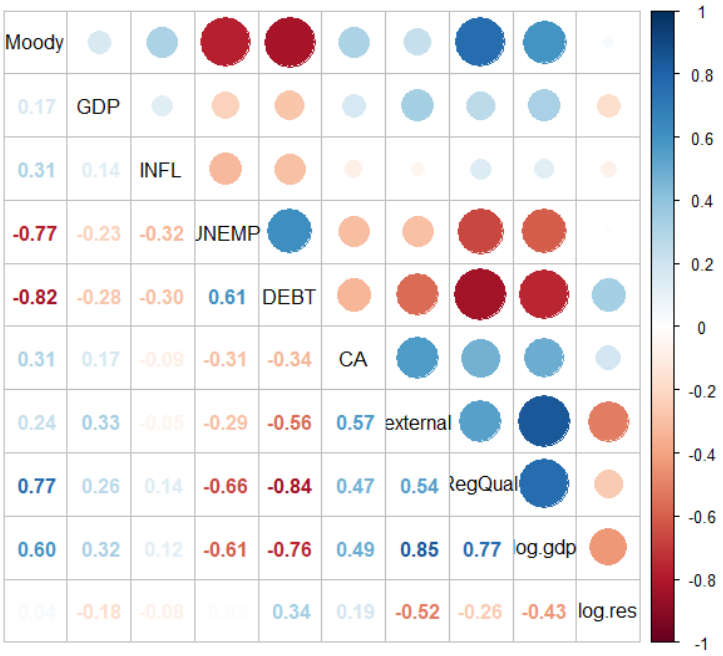

Figure 5: MOODY'S correlation figure

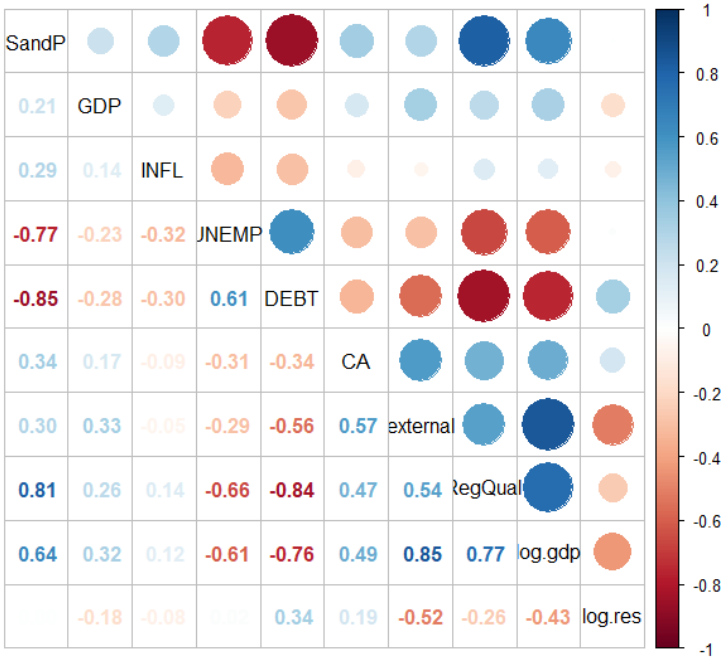

Figure 6: S&P correlation figure

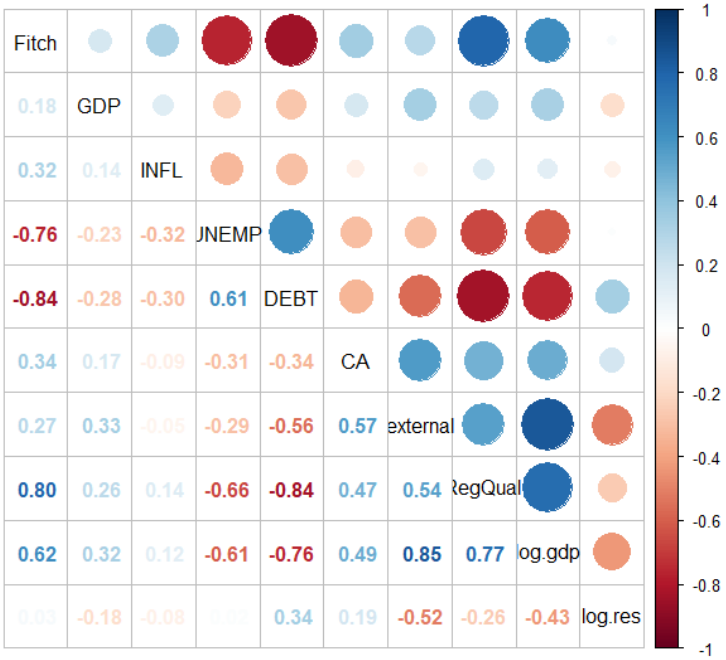

Figure 7: FITCH correlation figure

5. Preface of Empirical Results

The first step before our econometrical analysis, is to depict the graphical analysis by means of a variety of figures. The following three graphs (*Figure 8*, *Figure 9* & *Figure* 10) are called violin charts. In the horizontal axis we have the grades of rating (1-21) and on the vertical axis the dataset is grouped by years. As we can see, the thinner the line is on the right, the lower the rating of the countries is. Highlight that in all three cases the range of the ratings from 2005 to 2008 is common, as we observe that many countries received the highest rate. However, after 2009 the ratings were rapidly changed. The year of 2011 had the same characteristics for the three CRAs. After 2009 there were not a lot of countries with high scores and as we can see the range of grades was bigger in comparison with other years. In the ratings of S&P we observe less break points after 2011. Nevertheless, the Fitch agency continued to be more restricted on its rating.

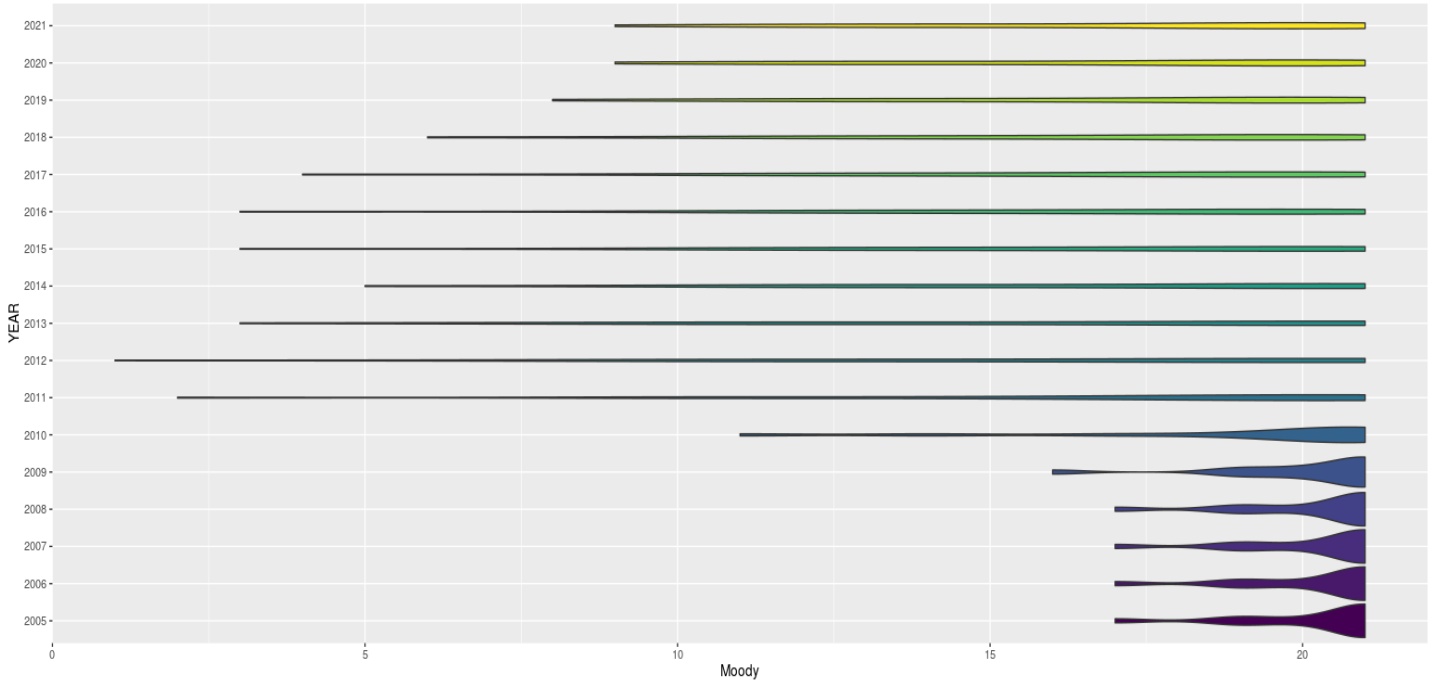

Figure 8: Violin graph for Moody's ratings

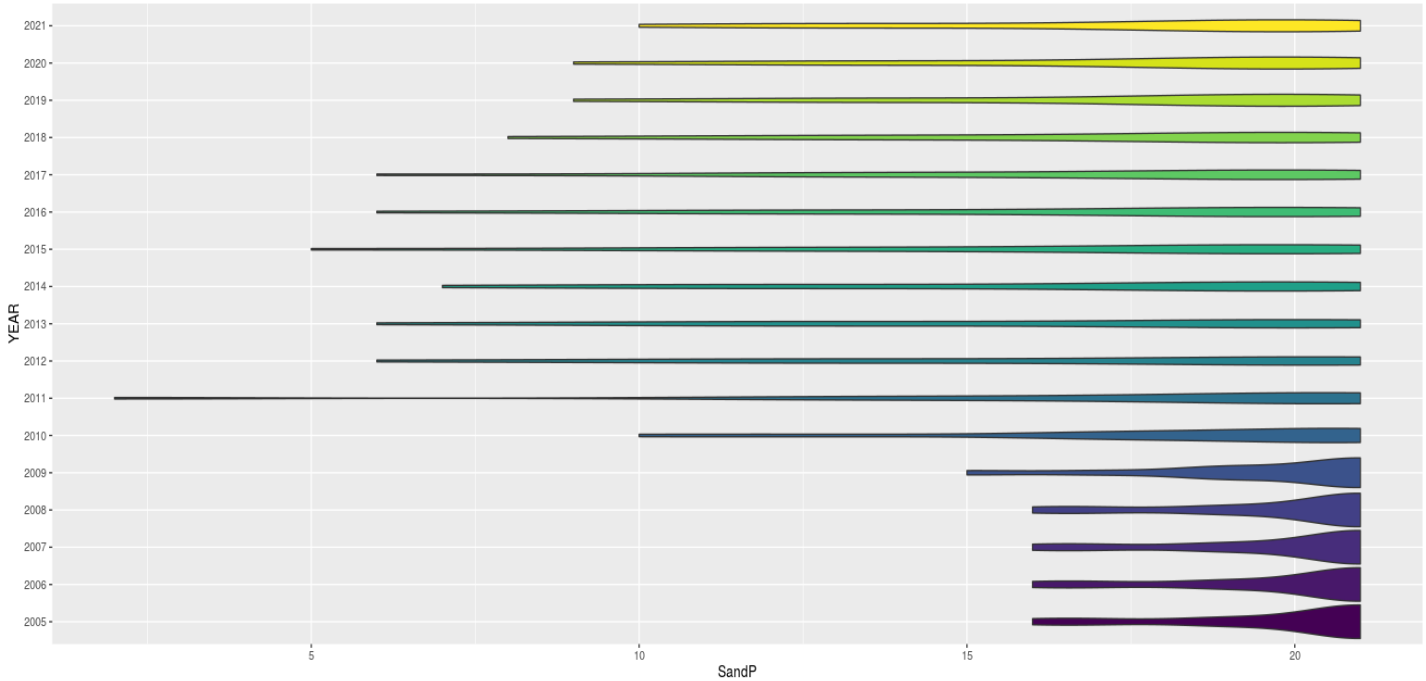

Figure 9: Violin graph for S&P ratings

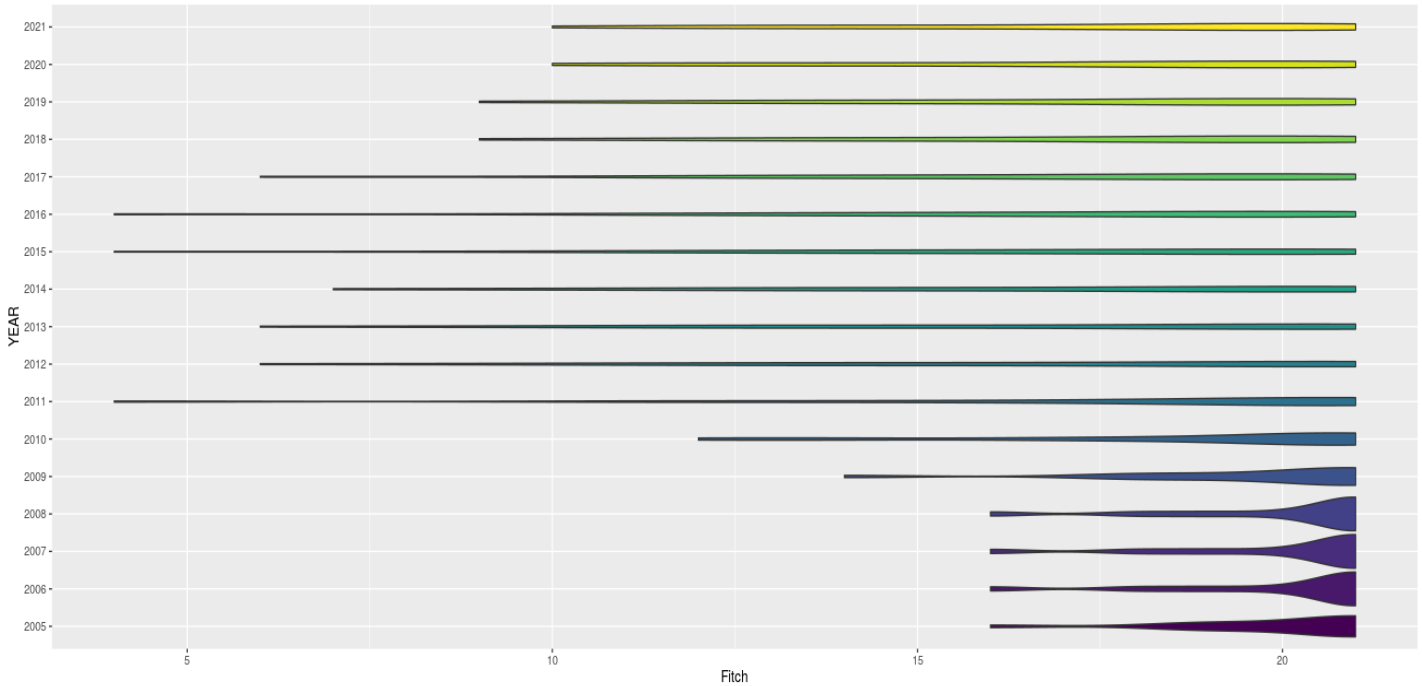

Figure 10: Violin graph for Fitch ratings

Another important graphical illustration is provided by the following time trend graph *Figure 11*. In this graph, the years are represented by the horizontal axis and the ratings of the three CRAs by the vertical axis. Panel data gives us the opportunity to analyze the dataset with a plethora of methodologies. In this case, the main variable is the mean of ratings per year. We conclude that the ratings follow a specific trend until 2009 with high grades and small range. After this period, S&P and Fitch follow a downgrade trend until 2013. The ratings of Moody's follow an abrupt downgrading trend until 2012. On 2014 all of the agencies provided higher grades, however they started to follow a stable trend after 2015 while they seem to be more conservative in comparison with the previous years. In addition, it is clear that after 2010 we have greater range on the ratings, for instance during 2010-2014 the agencies had the tendency to provide lower grades.

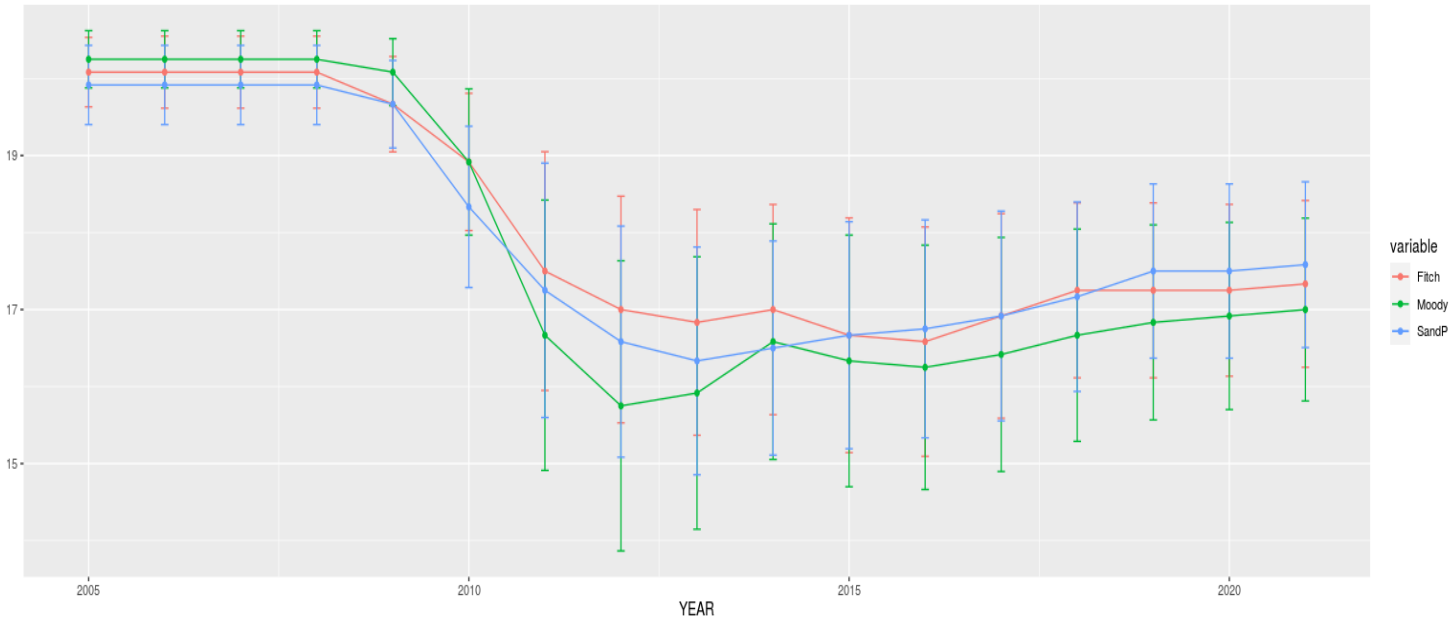

Figure 11: Trend graph

5.1. Heterogeneity

Next, we decided to study the heterogeneity of the data. The following six graphs illustrate the heterogeneity across years and countries. The first three graphs indicate the heterogeneity across years. It is clear that after 2009 all of the agencies followed a downgraded flow on their rates. What is more, the crisis of 2007-2009 appeared its effects after 2009, where the agencies started to rate with lower rates many European countries.

The other three figures refer to heterogeneity across countries. It is clear that in this graphs we can understand the range of each agency for every country. We have to highlight that countries that were vulnerable during the crisis, such as Greece, Ireland, Italy, Portugal and Spain had greater range on their ratings as it seems on the *Figures 15, 16 & 17*.

Heterogeneity across years

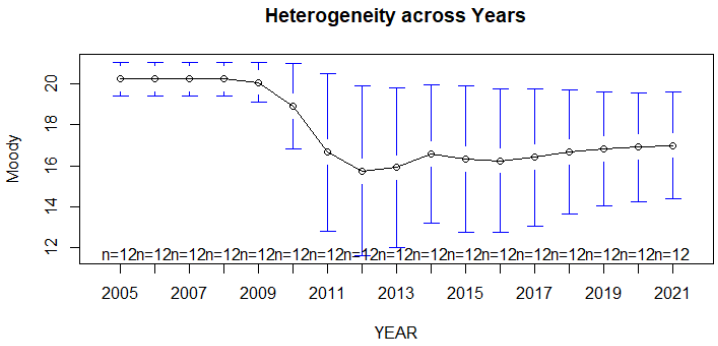

Figure 12: Moody's heterogeneity across years

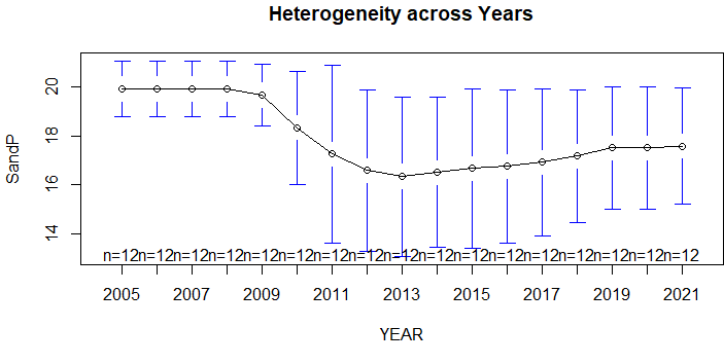

Figure 13: S&P heterogeneity across years

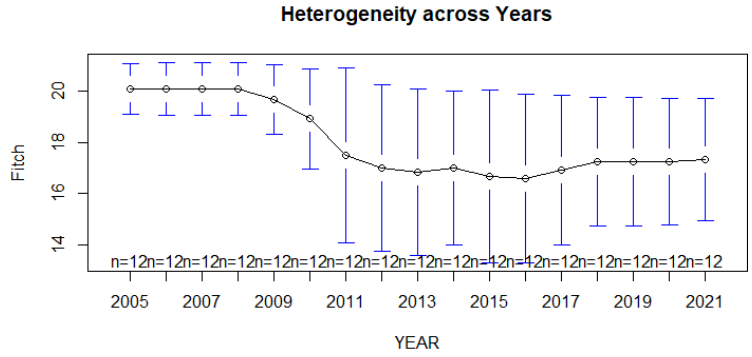

Figure 14: Fitch heterogeneity across years

Heterogeneity across Countries

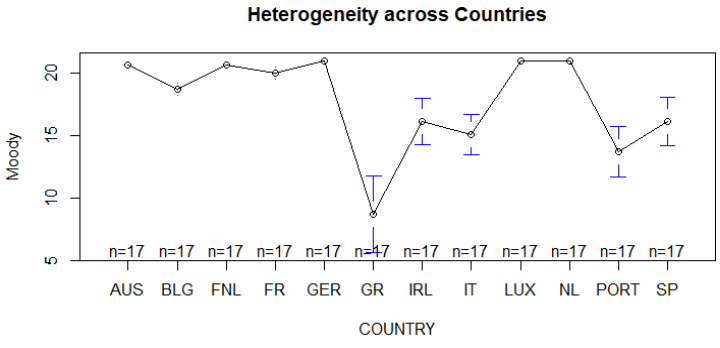

Figure 15: Moody's heterogeneity across countries

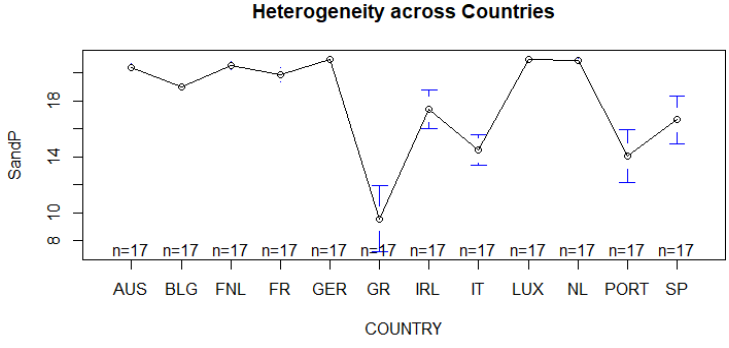

Figure 16: S&P heterogeneity across countries

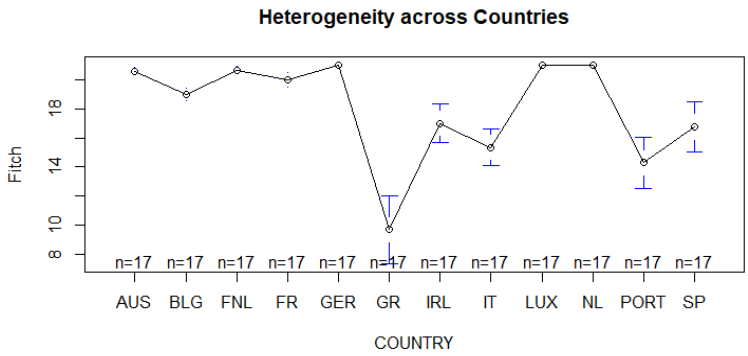

Figure 17: Fitch heterogeneity across countries

5.2. Cross Sectional Dependence & Fixed effects method

It is extremely significant to highlight that the first step, based on the methodology, is to estimate the Fixed effect method in order to decide the next steps of the procedure. Nevertheless, this particular dataset is characterized by cross sectional dependence, and as a result we have to overcome this obstacle. Perasan test for cross sectional dependence is going to detect this phenomenon. There are many statistical techniques that can resolve the cross sectional dependence, at this point we will utilize the cross sectional averages that will be added on the initial regression. As we can observe, the next table (*Table 5*) provides the results of the fixed effect method.

Table 5: Fixed Effects with cross sectional dependence

Fixed Effects

	Moody's		***S&P***		***Fitch***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	(19.436)	0.0002	(17.089)	0.0000	(17.499)	0.0000
GDP growth rate	0.0460	0.1101	0.0579	0.0124	0.0446	0.0522
Government debt	(0.0839)	0.0000	(0.0704)	0.0000	(0.0668)	0.0000
Inflation rate	(0.2543)	0.0030	(0.1766)	0.0097	(0.1207)	0.0747
Unemployment rate	(0.3536)	0.0000	(0.2987)	0.0000	(0.2777)	0.0000
Current Account	(0.1864)	0.0025	(0.1545)	0.0018	(0.1766)	0.0004
External Balance	0.0584	0.3646	0.0440	0.3920	0.0746	0.1464
Log reserves	1.1783	0.1461	1.6324	0.0123	0.9783	0.1299
Regulatory quality	2.9917	0.0002	1.9023	0.0032	2.5894	0.0001
CA*dcrisis	0.0166	0.7195	0.0354	0.3395	0.0439	0.2347
GovDebt*dcrisis	0.0010	0.6520	0.0009	0.6026	0.0041	0.0287
ExtBal*dcrisis	0.0137	0.5206	0.0002	0.9874	(0.0022)	0.8946
Constant	101.19	0.0000	85.661	0.0000	92.714	0.0000
R-squared	0.94		0.95		0.95	
PerasanCross sectional independence test	4.93	**Pr=0.00**	2.39	**Pr=0.00**	3.77	**Pr=0.00**

The most significant elements of this table are the results of the Perasan Cross Sectional independence test. The probability for all CRAs is Pr=0.00 which means that we can confirm that there is cross sectional dependence in our dataset, due to the previous fact we cannot interpret the results of the previous table . In this case, it is necessary to add the cross sectional averages on the regressions in order to explain the meaning of the coefficients. Moreover, the Appendix section contains a graph for each agency that illustrates the high correlation among the macroeconomic variables.

5.2.1. Fixed & Random Effects

After the detailed graphical illustration, we can represent the econometrical results which come from the empirical analysis. The first table (*Table 6*) represents the analysis with dependent variable the ratings of Moody's.

Table 6: Moody's FE & RE

Moody's						
	Pooled OLS		***Fixed Effects***		***Random Effects***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	10.188	0.0000	(10.075)	0.0415	(4.8210)	0.5244
Log GDP per capita cavg	(145.98)	0.0000	(125.94)	0.0000	(131.67)	0.0000
GDP growth rate	0.0114	0.7232	0.0674	0.1037	0.0509	0.6067
GDP growth rate cavg	0.1143	0.1834	0.0612	0.4168	0.0776	0.3017
Government debt	(0.0564)	0.0000	(0.0604)	0.0000	(0.0577)	0.0002
Government debt cavg	(0.0867)	0.0956	(0.0838)	0.0590	(0.0869)	0.0020
Inflation rate	0.1581	0.2689	(0.1266)	0.3631	(0.1498)	0.2903
Inflation rate cavg	(0.1250)	0.5571	0.1577	0.4149	0.1838	0.3744
Unemployment rate	(0.1977)	0.0000	(0.3141)	0.0000	(0.2919)	0.0083
Unemployment rate cavg	(0.0984)	0.6693	0.0198	0.9201	0.0012	0.9936
Current Account	0.0154	0.6633	(0.1268)	0.0318	(0.1057)	0.2768
Current Account cavg	(0.6604)	0.0329	(0.5210)	0.0476	(0.5440)	0.0231
External Balance	(0.1864)	0.0000	(0.0197)	0.7623	(0.0425)	0.6393
External Balance cavg	0.8845	0.0161	0.7212	0.0211	0.7450	0.0059
Log reserves	1.5628	0.0000	1.3641	0.2239	1.1069	0.0172
Log reserves cavg	11.7346	0.0002	12.002	0.0001	12.348	0.0020
Regulatory quality	1.2212	0.0229	3.7301	0.0000	3.8427	0.0000
Regulatory quality cavg	17.496	0.0400	15.003	0.0369	15.005	0.0352
CA*dcrisis	(0.0421)	0.4108	(0.0274)	0.5422	(0.0273)	0.6517
GovDebt*dcrisis	(0.0197)	0.0001	(0.0186)	0.0000	(0.0190)	0.0151
ExtBal*dcrisis	(0.0020)	0.9329	(0.0251)	0.2231	(0.0228)	0.4607
Constant	490.29	0.0000	490.67	0.0000	491.77	0.0000
R-squared	0.93		0.95		0.95	
PerasanCross sectional independence test	0.62	Pr=0.53	0.74	Pr=0.45	0.75	Pr=0.45
Hausman Specification test					46.16	Pr=0.00

The previous table is referring on the Moody's agency. The Perasan CD test shows that the problem of the cross dependence is solved. In addition, the Hausman test provides that the fixed effect is preferable in comparison with random effects. We can conclude that during the pre crisis period the coefficient of government debt is -0.060 while we have -0.060-0.018=-0.078 afterwards, in other words the impact of the government debt got increased. The results are similar to random effects where the impact increased -0.057-0.019=-0.076. The second (*Table 7*), is for the S&P agency and the last one (*Table 8*) represents the Fitch.

Table 7: S&P FE & RE

S&P

	Pooled OLS		***Fixed Effects***		***Random Effects***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	9.1785	0.0000	(10.932)	0.0074	(6.5600)	0.0494
Log GDP per capita cavg	(95.981)	0.0004	(79.077)	0.0003	(83.992)	0.0000
GDP growth rate	0.1032	0.0044	0.1359	0.0001	0.1190	0.1373
GDP growth rate cavg	(0.0560)	0.4563	(0.0900)	0.1474	(0.0731)	0.4034
Government debt	(0.0524)	0.0000	(0.0579)	0.0000	(0.0559)	0.0000
Government debt cavg	(0.0549)	0.2286	(0.0510)	0.1612	(0.0541)	0.0258
Inflation rate	0.0711	0.5702	(0.1060)	0.3544	(0.1437)	0.2264
Inflation rate cavg	0.0064	0.9724	0.2022	0.2045	0.2422	0.0062
Unemployment rate	(0.1165)	0.0001	(0.2390)	0.0000	(0.2234)	0.0001
Unemployment rate cavg	(0.1997)	0.3240	(0.0601)	0.7110	(0.0703)	0.6545
Current Account	0.0206	0.5071	(0.0975)	0.0445	(0.0920)	0.2292
Current Account cavg	(0.3489)	0.1973	(0.2302)	0.2852	(0.2407)	0.2842
External Balance	(0.1715)	0.0000	(0.0346)	0.5191	(0.0367)	0.6552
External Balance cavg	0.5950	0.0642	0.4621	0.0716	0.4668	0.0046
Log reserves	1.2577	0.0000	1.3212	0.1523	0.7323	0.1716
Log reserves cavg	7.5683	0.0055	7.9886	0.0010	8.7084	0.0024
Regulatory quality	1.6674	0.0005	2.3302	0.0002	2.4741	0.0000
Regulatory quality cavg	9.6828	0.1938	9.9990	0.0902	9.9408	0.0685
CA*dcrisis	(0.0086)	0.8472	(0.0063)	0.8633	(0.0015)	0.9718
GovDebt*dcrisis	(0.0118)	0.0079	(0.0118)	0.0009	(0.0122)	0.0404
ExtBal*dcrisis	(0.0001)	0.9944	(0.2156)	0.2106	(0.0202)	0.2448
Constant	319.92	0.0023	328.29	0.0100	329.35	0.0000
R-squared	0.93		0.94		0.94	
PerasanCross sectional independence test	(0.61)	Pr=0.53	(0.49)	Pr=0.63	(0.45)	Pr=0.64
Hausman Specification test					40.89	Pr=0.00

The *Table 7* focuses on the S&P agency. At first glance, we observe that the government debt impact before crisis is -0.057 while it increases after crisis based on the fixed effect method is -0.057-0.011= -0.068. If we compare the previous two fixed effect we summarize that Moody's impact is stronger than S&P. At this point we can refer the ratio of debt-to-GDP which is a metric that help us to compare the debt to Gross Domestic Product for a particular country. To put it differently, this ratio is a comparison of the products that are produced, with the debt for a country, consequently a higher ratio can be characterized as a red flag for this country because it reflects the low credibility to repay its debt. According to World Bank, the economic growth can be affected if the ratio is higher that 77% for a period. Statistically, the Japan is the first country with a percentage of 237% while Greece is the second country worldwide with a ratio of 177%. In the case of Moody's, this means that if the ratio increased almost 15%, we would have (~15*0.078) notch downgrade.

Table 8: Fitch FE & RE

Fitch

	Pooled OLS		***Fixed Effects***		***Random Effects***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	9.1712	0.0000	(11.046)	0.0076	(6.6961)	0.1548
Log GDP per capita cavg	(95.4462)	0.0004	(76.341)	0.0006	(81.030)	0.0005
GDP growth rate	0.0275	0.4368	0.0653	0.0590	0.0513	0.5123
GDP growth rate cavg	0.0300	0.6868	(0.0080)	0.8984	0.0059	0.9389
Government debt	(0.0511)	0.0000	(0.0524)	0.0000	(0.0506)	0.0000
Government debt cavg	(0.0573)	0.2041	(0.0580)	0.1166	(0.0603)	0.0020
Inflation rate	0.0823	0.5066	(0.1369)	0.2387	(0.1636)	0.1254
Inflation rate cavg	0.0462	0.8024	0.2681	0.0979	0.2965	0.0207
Unemployment rate	(0.1350)	0.0000	(0.2596)	0.0000	(0.2410)	0.0007
Unemployment rate cavg	(0.0973)	0.6266	0.0358	0.8275	0.0201	0.8531
Current Account	0.0156	0.6130	(0.1354)	0.0062	(0.1175)	0.0678
Current Account cavg	(0.3230)	0.2273	(0.1789)	0.4125	(0.1989)	0.4630
External Balance	(0.1582)	0.0000	0.0198	0.7152	0.0022	0.9729
External Balance cavg	(0.5168)	0.1037	0.3447	0.1842	0.3633	0.1129
Log reserves	1.4413	0.0000	1.0634	0.2556	0.8202	0.0940
Log reserves cavg	6.7150	0.0126	7.3349	0.0028	7.6482	0.0088
Regulatory quality	1.4956	0.0014	3.1403	0.0000	3.3079	0.0000
Regulatory quality cavg	8.6861	0.2383	7.2608	0.2242	7.1647	0.1421
CA*dcrisis	(0.0126)	0.7755	0.0060	0.8725	0.0069	0.8566
GovDebt*dcrisis	(0.0099)	0.0244	(0.0091)	0.0112	(0.0093)	0.1053
ExtBal*dcrisis	(0.0024)	0.9088	(0.0272)	0.1197	(0.0250)	0.1605
Constant	325.57	0.0017	327.97	0.0001	328.71	0.0000
R-squared	0.93		0.96		0.94	
PerasanCross sectional independence test	(0.65)	Pr=0.51	(0.66)	Pr=0.50	(0.67)	Pr=0.49
Hausman Specification test					35.79	Pr=0.00

The same analysis for Fitch agency provides that the government debt impact is -0.0524 before crisis, also we deal with the same case as previously. After crisis this impact is -0.0524-0.0091=-0.0615, the impact of Moody's continue to be stronger. For random effects, the probability of Hausman test is 0.00 which means that the fixed effect model is more preferable. After crisis the impact of the debt is -0.0506-0.0093=-0.0599.

Furthermore, we applied again the same methodology, but this time we take into consideration the average of CRAs as the dependent variable. The next table (*Table 9*) summarizes that the debt is significant before and after crisis. As we can see, the impact of debt is -0.056 and -0.0569-0.0132=0.0701 afterwards. In addition, we observe that Current Account is not significant after the economic crisis. As previously, the external balance is not significant for any level of significance. Notice that the results from fixed effects model are more preferable based on the Hausman test.

Table 9: Average Ratings FE & RE

Average Ratings

	Pooled OLS		***Fixed Effects***		***Random Effects***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	9.5129	0.0000	(10.685)	0.0086	(6.3446)	0.0544
Log GDP per capita cavg	(112.470)	0.0000	(93.789)	0.0000	(98.565)	0.0000
GDP growth rate	0.0484	0.1718	0.0895	0.0087	0.0744	0.0183
GDP growth rate cavg	0.0294	0.6920	(0.0122)	0.8423	0.0028	0.9624
Government debt	(0.0533)	0.0000	(0.0569)	0.0000	(0.0549)	0.0000
Government debt cavg	(0.0663)	0.1409	(0.0642)	0.0770	(0.0669)	0.0596
Inflation rate	0.1038	0.4012	(0.1232)	0.2804	(0.1530)	0.1603
Inflation rate cavg	(0.0241)	0.8959	0.2093	0.1875	0.2413	0.1159
Unemployment rate	(0.1497)	0.0000	(0.2709)	0.0000	(0.2538)	0.0000
Unemployment rate cavg	(0.1318)	0.5091	(0.0014)	0.9926	(0.0146)	0.9266
Current Account	0.0172	0.5750	(0.1199)	0.0134	(0.1075)	0.0133
Current Account cavg	(0.4441)	0.0968	(0.3101)	0.1491	(0.3257)	0.1221
External Balance	(0.1720)	0.0000	(0.0114)	0.8298	(0.0225)	0.6339
External Balance cavg	0.6654	0.0362	0.5093	0.0465	0.5221	0.0366
Log reserves	1.4206	0.0000	1.2497	0.1741	0.8646	0.1478
Log reserves cavg	8.6726	0.0013	9.1086	0.0002	9.5903	0.0000
Regulatory quality	1.4614	0.0018	3.0669	0.0000	3.2088	0.0000
Regulatory quality cavg	11.955	0.1044	10.754	0.0676	10.694	0.0636
CA*dcrisis	(0.0211)	0.6332	(0.0092)	0.8017	(0.0068)	0.8477
GovDebt*dcrisis	(0.0138)	0.0017	(0.0132)	0.0002	(0.0135)	0.0000
ExtBal*dcrisis	(0.0015)	0.9418	(0.0247)	0.1493	(0.0229)	0.1727
constant	387.59	0.0003	382.31	0.0000	383.22	0.0000
R-squared	0.94		0.96		0.95	
PerasanCross sectional independence test	0.24	Pr=0.80	0.20	Pr=0.8	0.23	Pr=0.81
Hausman Specification test					34.4	Pr=0.00

Moreover, we re-estimated the previous regressions with one more dummy variable which interacted with the government debt variable. In particular, we compared the debt-to-GDP ratio to the 90% threshold percentage, in case that the ratio was higher than 90%, we added the 1 value, otherwise the value was zero. Notice that the ratio was under the 90% except than the case of Greece. The results are represented in the Appendix (*Table 10*), nevertheless, the new variable is not significant and it is extremely difficult to conclude whether the CRAs have to be aggressive if they rate countries with high debt-to-GDP ratio.

6. Conclusion

As we can see throughout the years the reliability of credit rating agencies was shaken, especially during crisis, for instance economic crises (crisis of 2007-2009, the East Asian crisis) and pandemic flus. In the financial sector, the analysis of the factors that influence the rating agencies has an extremely significance for investors, economists and governments not only because they can examine the economic sector, but also they can make the correct forecasts. For this reason, the initial purpose of this study is to observe and explain the sovereign ratings during the period of crisis. In the sample there are nine macroeconomic variables that affect the ratings with different way. The period of this research is from 2005 to 2022 for 12 Eurozone countries.

In particular, in the first sector we analyze the general role of the CRAs and their problems during the crisis. We mentioned in the previous sectors that the methodology is a combination of techniques, since we were studying panel data that is an interesting combination of time series and cross sectional data. This gives us the opportunity to adapt the sample based on our questions. We decided to utilize a cross sectional dependent dataset in order to examine the sample under the existence of cross sectional dependence. The part that describes the literature review can show us some special techniques that are represented in this paper. Moreover, the graphical analysis is equally significant because we can observe the ratings and the impact of the crisis on them.

To sum up, this survey represents that only government debt is significant for every regression and the current account seems to be significant in the most cases. We focused on the determinants that may played a vital role on the CRAs, for these reason we analyzed nine macroeconomic variables in combination with a dataset from 2005 to 2021 which was characterized by cross-sectional-dependence. On the other side, the external balance is not

significant for any level of significance. In particular, government debt affect stronger the CRAs after the crisis in comparison with some years earlier. Our research can be used for further analysis with more variables and a wide group of countries, so as to detect and observe the factors that are significant for the reliability of the credit rating agencies.

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8. Appendix

Table 10: Re-estimation used Debt-To-GDP

DEBT-TO-GDP						
	Moody's		***S&P***		***Fitch***	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Log GDP per capita	(10.256)	0.0499	(11.894)	0.0059	(10.945)	0.0124
Log GDP per capita cavg	(125.78)	0.0000	(78.205)	0.0004	(76.433)	0.0006
GDP growth rate	0.0677	0.1040	0.1380	0.0001	0.0651	0.0616
GDP growth rate cavg	0.0610	0.4198	(0.0911)	0.1434	(0.0079)	0.9001
Government debt	(0.0603)	0.0000	(0.0574)	0.0000	(0.0525)	0.0000
Government debt cavg	(0.0835)	0.0608	(0.0497)	0.1730	(0.0581)	0.1173
Inflation rate	(0.1285)	0.3611	(0.1162)	0.3148	(0.1359)	0.2475
Inflation rate cavg	0.1598	0.4125	0.2130	0.1841	0.2669	0.1018
Unemployment rate	(0.3141)	0.0000	(0.2394)	0.0000	(0.2596)	0.0000
Unemployment rate cavg	0.0197	0.9205	(0.0605)	0.7100	0.0359	0.8279
Current Account	(0.1281)	0.0341	(0.1045)	0.0353	(0.1347)	0.0078
Current Account cavg	(0.5209)	0.0483	0.2294	0.2876	(0.1790)	0.4136
External Balance	(0.0184)	0.7812	(0.0278)	0.6100	0.0191	0.7299
External Balance cavg	0.7204	0.0217	0.4579	0.0747	0.3451	0.1851
Log reserves	1.3767	0.2234	1.3887	0.1353	1.0563	0.2627
Log reserves cavg	11.986	0.0001	7.9049	0.0012	7.3437	0.0029
Regulatory quality	3.7202	0.0000	2.2779	0.0003	3.1459	0.0000
Regulatory quality cavg	15.028	0.0373	10.130	0.0867	7.2469	0.2266
CA*dcrisis	(0.0269)	0.5545	(0.0033)	0.9289	0.0057	0.8804
GovDebt*dcrisis	(0.0186)	0.0000	(0.0120)	0.0008	(0.0090)	0.0118
ExtBal*dcrisis	(0.0257)	0.2228	(0.0229)	0.1867	(0.0270)	0.1251
Debt-to-GDP_dummy	**(0.0040)**	**0.9135**	**(0.0021)**	**0.4818**	**0.0020**	**0.9416**
constant	490.74	0.0000	328.63	0.0001	327.93	0.0001
R-squared	0.95		0.96		0.96	
PerasanCross sectional independence test	9.19	Pr=0.44	(0.33)	Pr=0.73	(0.67)	Pr=0.50

The previous table indicates the results of the regression based on fixed effect model including the dummy variable which concerns the debt-to-GDP ratio. As it seems, this particular variable is not significant, as a consequence it is difficult for us to explain how this ratio affect the decisions of CRAs.

The *Figures 18, 19 & 20* depict the correlation of the CRAs. The dataset contains high levels of correlation for all of the variables. This is a reason why we cannot estimate the equations without the help of cross sectional averages. Also, the *Table 11* shows us the rates of the CRAs and the way that they are interpreted.

Table 11: RATINGS

	Rating Agency			*Rating Grades*
	Moody's	**S&P**	**Fitch**	**(1-21)**
Highest quality	Aaa	AAA	AAA	21
High quality	Aa1 Aa2 Aa3	AA+ AA AA-	AA+ AA AA-	20 19 18
Strong payment Capacity	A1 A2 A3	A+ A A-	A+ A A-	17 16 15
Adequate payment Capacity	Baa1 Baa2 Baa3	BBB+ BBB BBB-	BBB+ BBB BBB-	14 13 12
Likely to fulfill obligations, ongoing Uncertainty	Ba1 Ba2 Ba3	BB+ BB BB-	BB+ BB BB-	11 10 9
High credit risk	B1 B2 B3	B+ B B-	B+ B B-	8 7 6
Very high credit Risk	Caa1 Caa2 Caa3	CCC+ CCC CCC-	CCC+ CCC CCC-	5 4 3
Non default with possibility of recovery	Ca	CC	CC C	2
Default	C	SD D	DDD DD D	1

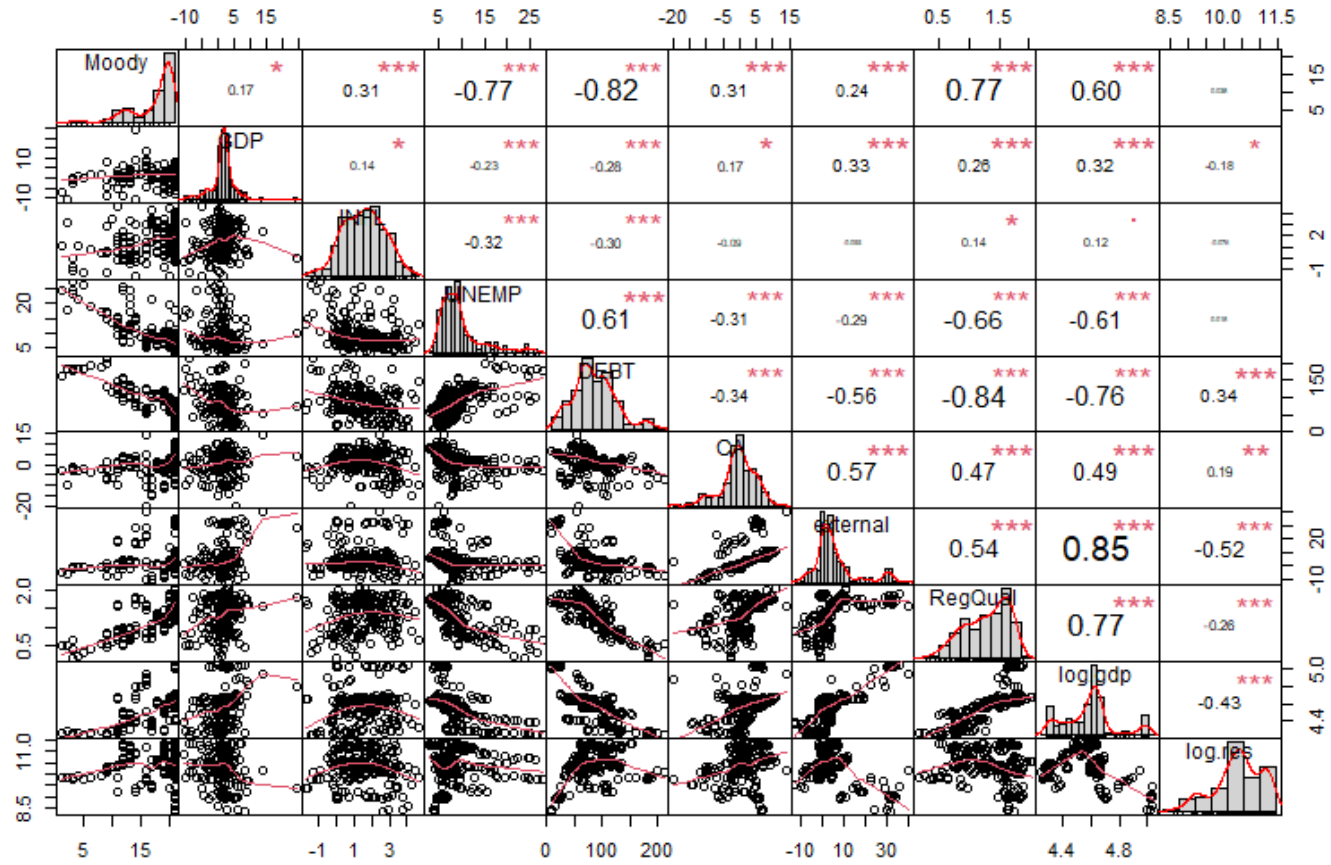

Figure 18: Correlation Chart for Moodys

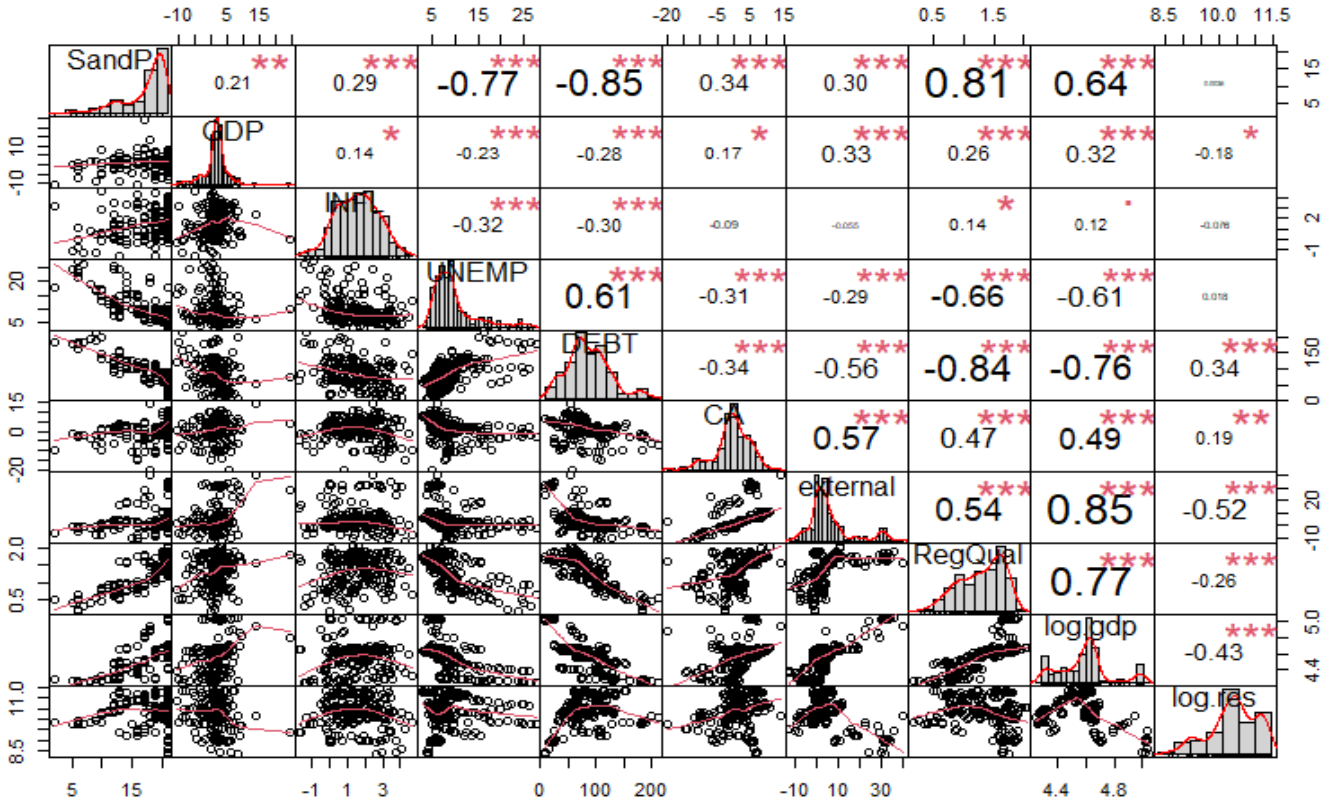

Figure 19: Correlation Chart for S&P

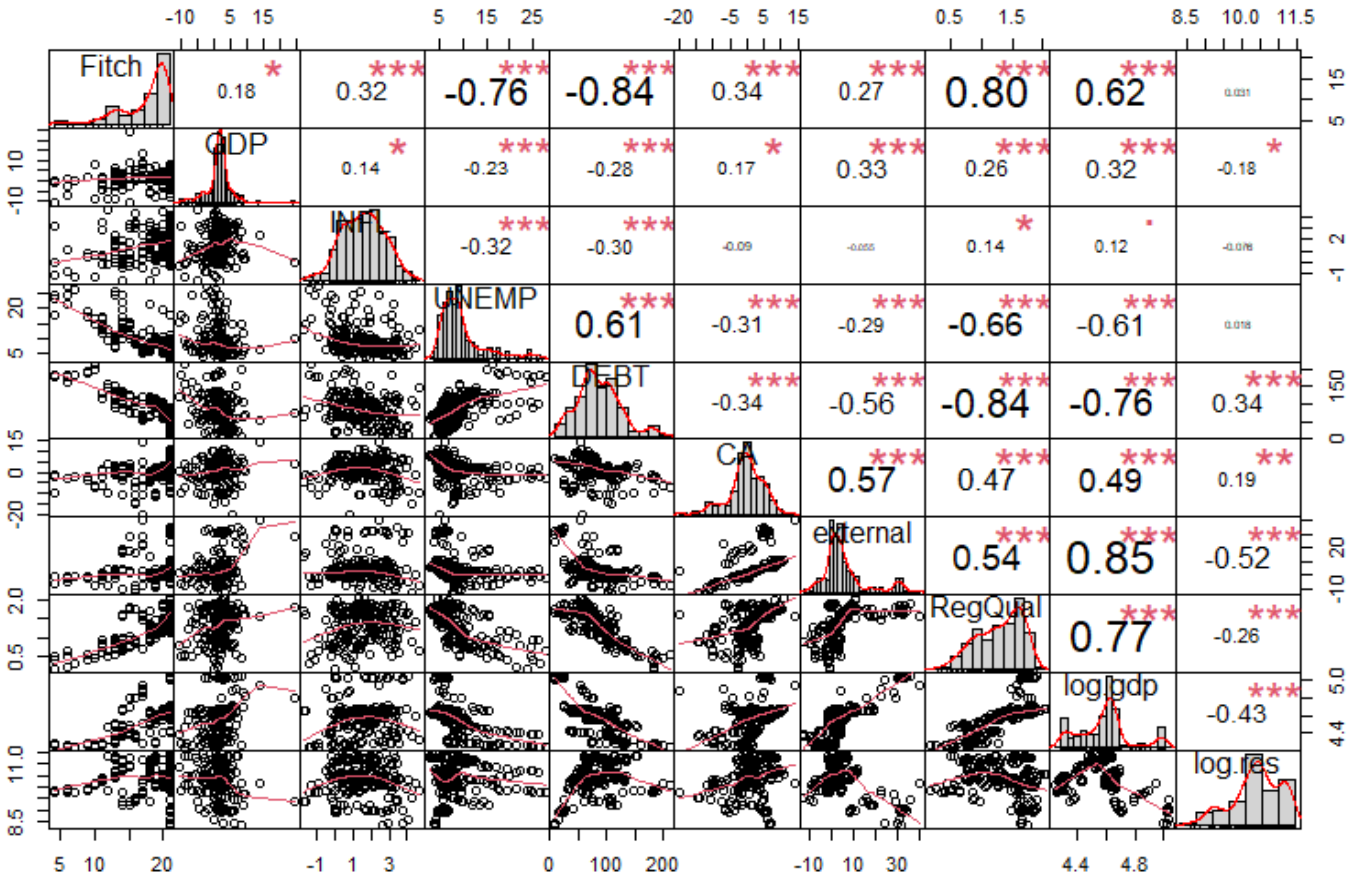

Figure 20: Correlation Chart for Fitch