Impacts of Mineral Resources and Fossil Fuels on Sovereign Credit Ratings and Sovereign Borrowing Costs: Evidence from Cross-Country Panel Data

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Contents

List of Tables

List of Appendices

List of Acronyms

GDP	Gross Domestic Product
OLS	Ordinary Least Squares
FE	Fixed Effects
RE	Random Effects

Abstract

This research aims to investigate the impacts of mineral resources and fossil fuels on sovereign credit ratings and sovereign borrowing costs. Each type of resource is separately investigated for comparison purposes. The government bond yield is the proxy for sovereign costs and 10 year bonds presents long-term debts while 1-year bonds are proxies for short-term debt. The panel data set consists of 110 countries from multiple sources over the period from 1998 to 2015. To achieve the objectives, the study applies panel data regression analysis such as Fixed Effects as the main methodology, Random Effects and Random-Effects ordered probit estimation as robustness checks. The empirical results imply that not every mineral resource and fossil fuel variables has a significant impact on sovereign ratings or government borrowing costs. Mineral rents per GDP is the only variable having positive impacts on credit ratings while gas rents, oil rents and total extractive activity have negative influences. In a sub-sample of high-income countries, none of the mineral resource or fossil fuels are significantly correlated to the ratings. The empirical regression on long-term government bond yields suggests that only oil rents and total extractive activity per GDP influenced 10-year bond yields negatively and significantly. While mineral rents per GDP and total extractive activity per GDP positively affect on 1-year bond yields for high-income countries. The findings imply that rich-mineral resource and high-income countries have to pay higher interest rates for their short-term loans. Countries with higher oil rents per GDP tend to pay lower bond yields in the long-term.

Keywords

Mineral resource, resource curse, sovereign credit rating, sovereign borrowing cost, bond yield

Chapter 1
Introduction

1.1 Research problem

For economic development activities, besides the aids, governments attract the international capital flow from the other governments or organizations by issuing bonds in the international markets. Sovereign credit rating be-comes one of the key determinants in assessing the government's ability and willingness to pay its debt obligations in principal and interests on time. Hence, sovereign ratings can determine the interest rates of government bonds and the ability of a nation to access international funds markets. The higher a credit rating is, the more flexible a nation can access the global capital markets. This is important for emerging countries to get ac-cess to sufficient funds with lower costs so they can achieve the required growth rate.

Many studies have intensively assessed mineral resources and fossil fuels (hereafter called mineral resources) impacts on economic growth and dis-covered their tendency to have adverse effects on economies. There is plenty of evidence that resource-rich countries generally grow at a slower pace compared to resource-scare counterparts (Sachs and Warner, 1999; Gylfason 2001). It is commonly known as the 'Natural resource curse'. Many examples for this 'Resource curse', such as resource-abundance countries in Africa, Latin America and the Middle East, have experienced growth of comparatively low rates. In contrast, countries that are endowed with few natural resources have achieved high levels of economic development.

It is essential for emerging countries to be able to access enough funds required for their economic activities and to achieve the desired growth rate. The research provided by this paper will help countries to understand how mineral resources impact their credit ratings. In addition, a sovereign rating is also a constraining rating to all corporations and banks in any given country. Hence, it not only affects a nation's access to international capital markets, but that of all the firms and banks in that country. The investors rely on sovereign ratings to acquire the minimum risk they may face when lending to a particular government to charge an equivalent interest rate. Be-sides the indirect effects on borrowing costs via sovereign ratings, it is important to know whether mineral resources have direct impacts on the borrowing costs of a government. Emerging countries, especially those with mineral resource wealth, could be able to understand their rating composition and how mineral resources could have an impact on borrowing costs. Policy makers could then act accordingly by amending fiscal policies and making plans to boost the sovereign ratings.

To the best of my knowledge, this is the first research that assesses the effects of mineral resources on ratings and the borrowing cost of governments. Using government bond yields as the proxy for sovereign borrowing costs, this paper assesses how the lenders and international credit rating agencies evaluate borrowing countries' ability to fulfil their debt obligations by their mineral resource flow. The lenders consider mineral re-sources as collateral for the loan or see exploiting activities are considered as a signal for a dependency on mineral resources that would harm economic performance. Therefore, they would charge a higher interest rate in return for the rising risk of default. In addition, the paper examines how much weight the international credit rating agencies put on mineral resources be-sides other macroeconomic and institutional factors. This study examines the different ways this can be measured in order to see which methods can significantly impact the outcome.

1.2 Research objectives

Despite the research literature about natural resources being extensive, it lacks the study about the impacts of mineral resources on sovereign credit ratings and government borrowing costs. This paper concentrates on the links of a country's mineral resources with its credit rating score and the government bond interest rates. It will examine how the mineral resource factor affects country borrowing costs in the international market and whether mineral resources influence sovereign credit ratings of a given country. Whether a country which is abundant in natural resources, specifically in oil and other types of minerals, would be considered to be dependent on exploiting activities and therefore making this abundance a negative indicator for governance by lenders and credit agencies.

Research questions

How do a country's mineral resources affect its sovereign credit rating and borrowing costs in the international market?

Sub-questions

i) How do mineral resources affect the sovereign credit rating scores in the international market?

ii) How do mineral resources affect the borrowing cost in the international market?

1.3 Scope and limitations of the study

This research assesses the impacts of mineral resources and fossil fuels on sovereign credit ratings and sovereign borrowing costs. The resources include oil, gas, minerals and total extractive activity defined as the sum of gas, oil and minerals. Instead of focusing on the side effects of resources such as 'Resource curse' or 'Dutch disease', I focus on the mineral resource impacts on sovereign credit rating score and on sovereign borrowing costs of a country. Besides this the research also investigates the difference in effects of oil resources compared to other types of mineral resources on sovereign ratings and government bond yields. Taking into account the units of measurement from the literature, in this research, mineral resource variables are measured in terms of percentage of GDP and per capita GDP. The four types of mineral resources and fossil fuels are oil, gas, minerals and total extractive activity (which is the sum of gas, oil and minerals) measured in terms of a share of GDP and GDP per capita. Hence, there are eight mineral variables examined: oil rents per GDP, gas rents per GDP, mineral rents per GDP, total extractive activity per GDP, oil rents per capita, gas rents per capita, mineral rents per capita and total extractive activity per capita.

This research uses panel data of 110 countries over the period 1998 – 2015. Dependent on the availability of variables (data on sovereign credit ratings and government bond yields), the number of countries and time period could vary with each regression. The study conducts empirical analysis through Fixed Effects methodology. The research also employs robustness checks such as Random-Effects ordered probit regression, Random Effects and controlling explanatory variables by incorporating related variables and replacing political stability index.

1.4 Organization of the research paper

The rest of this research paper is structured as followed. Chapter 2 provides the literature review on resource curse, sovereign credit ratings and sovereign borrowing costs. Chapter 3 presents the data and the empirical methodology to achieve the research objectives as well as the robustness checks. Chapter 4 provides the analysis of the regression results on sovereign ratings and the price of government borrowing. Chapter 5 provides the conclusion of the research paper.

Chapter 2
Literature Review

This chapter is divided into three sections providing literature related to resources curse, sovereign credit rating and sovereign borrowing costs. The first section reviews 'resource curse' literature regarding the link of mineral resource abundance with economic outcomes and other political or institutional variables. The second section describes empirical results relating to sovereign credit ratings. It comprises macroeconomic fundamental factor affecting sovereign ratings and methods used in rating literature. The final section presents researches related to sovereign borrowing costs. It includes three main groups having impacts on country borrowing costs. The first group consists of macroeconomic factors. The second group is sovereign credit rating impacts and the final one is about institutional dimension.

2.1. Literature on the resource curse

2.1.1. Mineral resources and economic outcomes

The correlation of mineral resources and economic development has been focused intensively since 1950s, especially over the past two decades; however, there are controversial findings about mineral-rich economy. Norway is an example of mineral resource blessing with impressive manufacturing growth of the economy since 1971 while accounted as the third largest petroleum exporter (Ploeg, 2011). Chile reached a remarkable annual growth rate of 8.5 percent in 2011 while the mining industry values almost half of total exports (Ploeg, 2011). In the nineteenth century, Germany and UK replied on their coal and iron ore deposits to push industrial development while in Asia, Japan and Korea managed to become crucial steel producers even though they had to import iron ore (Ploeg, 2011). Rostow (1960) suggested the positive influences of resources abundance could potentially expand the economy by alleviating credit constraints and improve standard of living. The empirical analysis of Brunnschweiler (2008) shows that natural resources are more likely a push to economic growth than a curse even when controlling institution factors.

Over the last decade, several studies highlight the conditionalities and complexities of 'resource curse' rather than dispute and focus on the universality of the phenomenon. Numerous papers distinguish the type of resource and find out the 'resource curse' is 'mineral course'. The 'point resources' are resources more concentrating geographically such as fuels, diamonds, ores and metals. Most studies agree that 'point resources' is the cause of the 'resource curse' rather than 'diffuse' resources (agriculture, for example) (Bulte et al., 2005; Lederman & Maloney, 2007; Williams, 2011). Studies find the strong negative correlation between economic growth and mineral wealth when the latter proxied in term of a share of GDP or total export rather than per capita. Brunnschweiler & Bulte (2008) also refer the former proxy as resource dependence and the latter as resource abundance. Brunnschweiler & Bulte (2008) also criticize resource dependence as the measurement influenced by natural resources and other growth factors. Van der Ploeg and Poelhekke (2010) use mineral reserves per capita as a proxy for resource abundance to replicate the analysis of Brunnschweiler & Bulte (2008).They find out there is no negative direct correlation of resource bonanza and economic growth. The finding suggests that the proxy of resource abundance matters and the resource curse depends on the relative value or size of the extractive sector rather than the absolute value/size compared to the whole economic activities.

The adverse impacts of mineral resource abundant are still dominant in the literature and called as 'resource curse'. Many researches have studied the influences of mineral resources on long-term economic growth through economic factors. Singer (1950) found that the resource –dependent economy deteriorates the terms of trade over time. Therefore, those countries would have to export more for any given amount of imported manufactured goods. The impacts of mineral abundance on marcoeconomic growth are studied in 'Dutch Disease' theory, the revenue generated by natural resources causes appreciation of exchange rate then the contraction of the traded sectors (Corden and Neary, 1982; Corden, 1984). Two effects of Dutch Disease are the Resource Movement Effect and the Spending Effect. The former effect describes the shift of labour and other productive factors from manufacturing to primary sector thus making their traded sectors more productive compared to resource-poor countries. The later which is inflationary pressures induced by income shocks from mineral resources, reduces the competitiveness of commodities except primary sectors. Harding and Venables (2010) analysis data of 135 countries from 1975 to 2007 and find that a resource windfall leads to a decrease of 35-70 percent in non-resource exports and an increase up to 35 percent of non-resource imports. These findings hold in cross-sections of countries, pooled panels and panel data including dynamics and country fixed effect. **Ismail (2010)** finds the correlation of 10 percent oil windfall and a 3.4 percent fall in value added in manufacturing sectors, but the impacts is less in countries restrict capital flows and in more capital-intensive sectors.

Many studies concentrated on the contraction of manufacturing sectors and then the consequent impacts on economic growth. The causes of Dutch Disease are learning-by-doing and spillover effects across sectors (Aizenman and Lee, 2010; Papyrakis, 2011; Torvik, 2001) with support from studies of Auty and Evia (2001) for Bolivia, Pegg (2010) for Botswana, Papyrakis and Raveh (2014) for Canada. Several studies showed the correlation of mineral resource abundance and a debt overhang, as a consequence of using mineral stock as collateral in international markets (Manzano & Rigobon, 2001).

Other macroeconomic variables

There are other resource curse theories focus on other macroeconomic variables. Papyrakis and Gerlagh (2006) found the negative correlation of resource bonanza with national savings and investment rates while Gylfason and Zoega (2006) support the hypothesis with evidence of resource abundance associated with lower level of national savings in GDP shares and less mature financial system. Several studies find that mineral rich countries are more likely related to a debt overhang due to mineral wealth as collateral for debt (Manzano and Rigobon, 2001). The volatile prices of mineral resources also create uncertainties for investors and cause government difficulties in imposing fiscal policies (van der Ploeg and Poelhekke, 2010). The adverse impacts even accentuated by the less diversified economies and short-sighted policies to develop industry sector (Auty and Pontara, 2008; Murshed and Serino, 2011). Dietz et al. (2007) assess the interaction effect of resource abundance with institutional quality on gross and genuine savings on panel data of 115 countries for the period 1984 to 2001. Genuine savings is measured as net investment of natural, produced and human capital. They find that resource-rich countries with weak institution tends to cause a lower level of genuine savings.

2.1.2. Mineral resources and political/institutional indicators

Besides economic outcomes, one of the main part of resource curse literature focuses on the correlation of extractive industries with political or institutional variables. Several papers suggest the mechanism of resource curse to the development of institutions and government by induce corruption and rent-seeking (Baggio and Papyrakis, 2010; Isham et al., 2005; Torvik,

2002) and lack of transparency (Williams, 2011). Corporates and firms have incentive to pay bribes to government officials in order to have access to mineral resources. The chosen process is not based on competence or benefits from extractive activities to the public (Baland and Francois, 2000; Boschini et al., 2007)

Overreliance on mineral rents can also induce bad governance, corruptive institution to stay longer in power since resource abundance raises the value of being in power. Corruptive politicians can use resources rents to bribe voters and supporters by offering inefficient subsidies and tax handouts, well paid but unproductive jobs (Brollo et al., 2013). Governments adopt short-sighted policies and have less incentive to build up transparent and efficient bureaucracy (Kolstad and Wiig, 2009; Stevens and Dietsche, 2008). Mineral rents could also provide the means to authoritarian regimes to stay longer in power by oppression or unequal redistribution (Andersen and Ross, 2015; Aslaksen, 2010; Tsui, 2011). For example, authoritarian rulers may decrease public demand for democratic accountability by relying much more on mineral rents than tax revenue (McFerson 2010). Political authorities may also suppress democratic aspirations by spending excessively on internal security (Tsui, 2010) or obstruct free information (Williams, 2011).

Several empirical studies are made with cross-country analyses proving the negative link of mineral resources and institutional variables such as corruption (Arezki and Bruckner, 2011; Leite and Weidmann, 2002), bureaucracy quality (Brunnschweiler and Bulte, 2008, Isham et al., 2005), or transparency (Williams, 2011). Dietz et al. (2007) study how the interaction effect of resource abundance with institutional quality effect resource-rich countries. They find evidence that the interaction of a weak governance with resource abundance could probably decrease genuine savings (measured as net investment, human capital and natural capital). Institutional indices usually used include corruption, rule of law and bureaucratic quality, taken from the International Country Risk Guide. Williams (2011) find that while "point" resource variables (ores, fuels and minerals) are negative significant linked to bad institution, **agriculture raw material** variable ("diffuse" resource) is positive correlated to government transparency.

Another strand on constitution literature treats institution as a mediating variable which does not dependent on mineral wealth. Instead of examining institution as a endogenous variable to explain its variability as a consequence of mineral abundance, it emphasizes institution role in prevent the resource curse activities including rent-seeking and corruption (Boschini et al., 2007; Kolstad, 2009; Mehlum et al., 2006; Sarmidi et al., 2014). Tornell and Lane (1999) discuss the interaction of weak institution with mineral boom can lead to 'voracity effect' with numerous interest groups. Boschini et al. (2007) show the correlation of the appropriability of mineral rents and institution quality by proxied the property rights protection. The finding from theoretical and empirical research by Mehlum et al. (2006) confirms that weak institutions interacts with mineral wealth constrain growth while El Ansashy and Katsaiti (2013) find that strong institution and low corruption can manage mineral windfall to higher growth rates. A strong governance and good institutional framework can turn 'mineral curse' into 'mineral blessing'. Sound governments can channel resource rents into investment in production sectors to promote economic growth, shield against volatile prices of primary commodities and encourage public spending on infrastructure and human capital, increase equitable distribution of mineral revenue, improve the local living standard and compensate for negative effect of extractive activities in the local.

2.2. Literature on the determinants of sovereign credit ratings

2.2.1. Sovereign credit ratings and macroeconomic fundamentals

Sovereign credit ratings are assessments of the likelihood that a country is able to repay its debt obligations. The rating agencies assess a wide range of elements from solvency factors to socio-political factors that may have impacts on the ability and willingness to pay of the borrower. Afonso et al. (2011) suggest a set of variables determines sovereign credit ratings from literature review incorporated in most studies. **GDP per capita** indicates how rich the country is. As the richer the country is, the more stable institution it has so it is less probability that government over borrows and be less vulnerable to exogenous shocks. Thus, GDP per capita is probably positively correlated to ratings (Afonso et al., 2011; Arefjevs and Brasliņš, 2013; Cantor and Packer, 1996; Haque et al., 1996). The higher growth economy has more capacity to repay its financial obligations. Similarly, the **GDP growth** indicates the capacity that government can use to pay its debt obligations, thus it also has positive impacts on ratings (Afonso et al., 2011; Arefjevs and Brasliņš, 2013). While **inflation rate** possibly decreases the real stock of sovereign debt in domestic currency, sparing more capacity to cover foreign-currency debt obligations, it also indicates the symptomatic issue of the macroeconomic policies (Afonso et al., 2011; Arefjevs and Brasliņš, 2013; Cantor and Packer, 1996; Haque et al., 1996). **Government debt** has negative impacts on ratings since a higher level of debt is equivalent to a higher interest burden and higher risk of default (Afonso et al., 2011; Cantor and Packer, 1996; Haque et al., 1996). Large **fiscal deficits** are detrimental to domestic savings and indicates macroeconomic disequilibria. Persistent deficits may be correlated to problems with the institutional environment (Afonso et al., 2011; Cantor and Packer, 1996; Haque et al., 1996). On the other hand, Afonso et al. (2011) argue that an account deficit represent an economic prospect and it seems to indicate for willingness of investors to cover the gap through loans and investment. Their empirical study finds that a higher **current account deficit** is correlated with a higher sovereign rating.

A large part of empirical literature find sovereign credit ratings strongly correlated to economic fundamentals. Afonso et al. (2011) study the short-run and long-run determinants of sovereign ratings, using data from three main rating agencies for the decade from 1995 to 2005. They use both linear and ordered estimation models to examine the impacts of macroeconomic and fiscal determinants. The estimation correctly predicts 40 percent of the rating sample and more than 75 percent of the predicted values are different less than one notch from the observed values. The study provides evidence that a set of variables have impacts on rating in short-run comprises of **government debt, budget deficit, GDP per capita and real GDP growth**. The long-run macroeconomic determinants are foreign reserves, external debt.

Subsequently, analysis of Juttner and McCarthy (1998) confirm the link with rating data in 1996 and 1997 but fails to explain when it comes to the Asian crisis in 1998. The interest rate differential, problematic bank assets as a share of GDP and external indicators such as foreign reserves, current account surplus, export growth and real effective exchange rate (Monfort and Mulder, 2000) are incorporated into the model in the crisis period to keep the correlation. Ferri et al. (1999) suggest the most significant variable is short-run debt as a share of international reserves.

2.2.2. Sovereign credit ratings and institutional factors

Several studies prove the significant impacts of institutional and political variables on sovereign credit ratings. Afonso et al. (2011) find that government effectiveness index has impacts on sovereign rating in long-term. They argue that the quality public service, low corruption and competent bureaucracy would improve the capacity to commit debt obligations. Butler

and Fauver (2006**)** examine the determinant of sovereign credit ratings on cross-sectional sample data of 86 countries. They argue that **legal and political institution** does not have direct effects on preventing a country defaulting on its financial debt although a sound institution may provide resources against a private firm expropriates wealth from community and minority investors. However, a strong legal and political institution can have relatively direct impacts on equity valuations and markets. They measure the development of legal institution by qualifying **the voice of the people, political stability, government effectiveness, rule of law, corruption and regulatory quality** from World Bank dataset. Their findings suggest that the legal and political institution have the most significant influences on a country's credit rating. The rule of law, government effectiveness and corruption control show the strongest effects when being examined individually. Mellios and Blanc (2006) also find that corruption index and the quality of government have a strong influence on credit rating of a country.

There is no consensus about the influence of political and institutional factors on sovereign credit rating of a country and its ability and willingness to repay its debt obligations. Several scholars argue that governments issue bonds with more than 1 year or more than 5 year to borrow from international investors, thus the sovereign credit rating is supposed to predict the capacity of committing its financial debts in future, not the present (Archer et al., 2007). The political literature attempts to measure the credibility of a government based on multiple political factors. Shultz and Weingast (2003) suggest that democratic advantage is much better than other forms of government in access to financial flows due to limited of government and the potential lost constituent support. Democracy provides the populace a means to discipline sovereigns harming the citizenry through electoral accountability. If expanding debt is damaging, people may exert their right and force governments to commit their debt obligations. The interviews conducted by Archer et al. (2007) with raters from three main international agencies suggest that the agencies take into account the political and institutional factors and two of them use World Bank Governor Indicators that includes six indices: political stability and absence of violence, control of corruption, rule of law, government effectiveness, voice and accountability, and regulatory quality. However, their regression results on panel data of fifty developing countries from 1987 to 2003 show that regime type and political factors have very limited impacts on sovereign credit ratings.

2.2.3. Sovereign credit ratings and mineral resources

Literature provides correlation of macroeconomic and institutional factors on sovereign credit ratings (Afonso et al., 2011) besides the impacts of mineral variables on both economic outcomes and institutional factors (Baggio and Papyrakis, 2010; Ploeg, 2011). Thus, there would be possible link of mineral resources on sovereign credit ratings. The omission of mineral resources would lead to biased empirical results when performing analyses on the attribution of ratings of the sovereign that influenced by mineral resource factors. In addition, mineral resources could promote or damage an economy as suggestion from literature, it can also have impacts on the ability to repay debt of that country. Hence, resources of a sovereign can possibly influence its credit ratings.

2.2.4. Sovereign credit ratings and methodologies used

There are two main strands in econometric approach literature on sovereign credit ratings. Firstly, most of the first studies apply linear regression methods changing credit ratings into numerical representation. This method is firstly used by Cantor and Packer (1995), running OLS regressions on linear numerical representation of ratings for 45 countries. Subsequent studies of Afonso (2003), Alexe et al. (2003) and Butler and Fauver (2006) also apply linear OLS regression with sovereign ratings. Using linear regression is one of the most simplest

and straightforward method allowing generalization to panel data and apply fixed effect and random effect methodology (Mora, 2006; Monfort and Mulder, 2000). Afonso et al. (2011) study the determinants of sovereign ratings applying both linear and ordered regressions and find that the models can predict correctly with quite high R-square values about 0.95. Similarly, the study of Mellios and Paget-Blanc (2006) also apply linear regression analysis, the model successfully predict approximately 55 percent of the ratings with a difference of one notch while the logistic model prediction is more successful with 74 percent.

Linear regression can be a good predictor for sovereign credit ratings and have relative good predictive power in most of the cases. Despite its popularity in assessing the determinants of credit ratings, linear regression method has its own drawbacks. As ratings is a qualitative ordinal system, applying traditional technique of linear representation of ratings is not adequate. It assumes that the difference between any two consecutive ratings are equal, which is not explicitly stated by rating agencies. Two rating scores at the top and bottom make the linear numeric presentation estimate biased. Afonso et al. (2007) confirm the linear estimation results by ordered probit analysis results. This study also provides evidence of different distance between categories across rating agencies. Given the existence of rating categories, Eliasson (2002) argues that the rating variables can be treated as continuous and different quantitative transformations can be used without biased estimation results. Reisen and Maltzan (1999) and Afonso (2003) use logistic transformation of the ratings. Given the distances between categories are not even, it is still applicable.

The other strand of literature uses ordered estimation models. This method overcome the drawback of linear rating presentation because it determine the gap differences between each two consecutive categories. Specifically, Bissoondoyal-Bheenick (2005) and Bissoondoyal-Bheenick et al. (2005) use the ordered regressions. Gartner et al. (2011) estimate the sovereign credit rating on the data of 26 OECD countries in the period of 1999-2010, probit ordered estimation model applied generates the estimations whose 80 percent of predicted ratings differ by less than one notch from their actual value.

In literature, studies use many methods to check the robustness of its regression results. Firstly, the robustness checks incorporate several additional variables suggested by previous papers. For example, countries issue debt in foreign currencies, currency related variables can be added such as real effective exchange rates, trade deficit, and other trade related variables. In case the countries issue debts in their own currency, other institution and governance variables can be relevant. While Afonso et al. (2009) use the government effectiveness index issued by World Bank and find significant impact on sovereign rating, Gartner et al. (2011) incorporate the corruption index the determinant on credit ratings of OECD countries and it has no significant explanatory power.

2.3. Literature on sovereign borrowing costs

2.3.1. Sovereign borrowing costs and macroeconomic fundamentals

Several studies suggest fiscal prudence has significant impacts on reducing the borrowing government costs. Faini (2006) finds that expansionary of fiscal policy in one of Eurozone country will increase the interest the governments have to pay for lenders from international markets, the effects is significantly stronger if the country is in high debt level. Attinasi et al. (2009) apply a dynamic panel approach to study the bond yield spreads between Germany and other European countries in the period from July 2007 to March 2009. The regression finds that government bond differentials between Germany and other Eurozone countries is positively correlated to expected **deficit and government debt ratio**, reflecting concerns

of investors regarding credit risk and liquidity risk of a country and international risk aversion. The findings are in line with existing literature and robust to the use of different estimation techniques and time frequencies as well as addition of more control variables. This model has highly predictive powder for both country-specific bond spreads and on average. The coefficient estimates indicate that on average, the explanatory variables in the model contributed up to 56 percent the international risk aversion; 14 percent the liquidity risk; 21 percent the fiscal position and 9 percent the bank rescue package announcement. There is evidence that the **debt of US government** is positive correlated to their bond interest rates, the impact is relatively stronger than in other countries. Laubach (2009) provides evidence of a significant impacts of debt and deficits on long-term interest rates while controlling for business cycles and monetary policy actions. Using fixed effect panel approach and focusing on the accuracy of fiscal data reported by government, Bernoth and Wolff (2008) have an additional finding that fiscal transparency significantly reduces the spreads.

The opinions regarding the correlation of fiscal regime and interest rates are divided among scholars. The US administration has questioned the significant correlation of fiscal policy and government borrowing costs (Council of Economic Advisers, 2003). Empirical studies of Bernoth et al., 2004; Codogno et al., 2003 provide evidences of significant link of government bond spreads and fiscal fundamental variables for European countries but the effect of fiscal policy is quantitatively small. Specifically, one percent increase in the ratio of deficit to GDP leads to a raise in interest rate of government bonds by less than 10 basis points. The magnitude of effect on US government bond yield is much higher. Gale and Orszag's (2002) find that every 1 percent increase in the deficit to GDP ratio will raise interest rate from 50 to 70 basis points. The 'credit punishment hypothesis' describe the negative relationship of fiscal variables and bond yields spreads (yield-at-issue difference between Euro and USD denominated bonds issued by US or Germany governments and other EU governments) of Goldstein and Woglom's (1991). Lemmen and Goodhart (1999) and Bernoth et al. (2004) provide supports against the hypothesis. Their results show that the European Monetary Union countries get fiscal supports by markets in financial distress as long as these countries have not misbehaved. Specifically, the results from Bernoth et al. (2004) show that the debt service has more explainable power on yield spread variation across EU members than debt or the deficit variable and that if a country's debt share in total EU debt is larger, the lower interest rates it has to pay.

There is anticipated positive correlation of inflation and government bond interest rates, the impacts channeled through credit ratings (Gartner et al., 2011). It is suggested that in the short run, a higher expected inflation would have a negative impact on long-term interest rate (Faini, 2006). The possible explanation would be that tax considerations are not the paramount determinant of the expected inflation impact on real interest rate and high inflation probably boost precautionary saving thus decrease interest rates. In contrast, empirical studies emphasize the important role of economic fundamentals. The level of economic development and other economic variables are highly correlated to the cost of government borrowing. Sy (2002), Afonso et al. (2012) and Attinasi et al. (2009) find that the level of GDP per capita and economic growth rate tend to negatively correlate to the cost of sovereign borrowing. From the empirical findings, it can be said that rich countries are probably access to funds from international market more easily than poorer countries.

2.3.2. Sovereign borrowing costs and sovereign credit ratings

Sovereign credit ratings express the rating agencies' views of a country's economic and political risk. It also reflexes a country's ability and willingness to pay its debt obligations to international borrowers on time and in full of interests and principle over the life of a rated

instrument. Credit ratings are monitored closely by traders, institutional investors and portfolio managers on international bond market to make strategies and anticipate the rating cycle. Several studies suggest that sovereign ratings are the key determinant of the price of sovereign bond (Erb et al., 2000).

Literature commonly agree that a country credit ratings is significantly correlated to its government borrowing costs by the papers of Kamin and von Klieist (1999); Eichengreen and Mody (2000). Gomez-Puig (2006) and Manganelli and Wolswijk (2009) both find the negative link between ratings and bond spreads for EMU countries from 1996 to 2001 and from 1999 to 2008, respectively. More recent studies such as Attinasi et al. (2009) or Sgherri and Zoli (2009) assess the link in time of crisis and find out that the relationship also hold. The study of Gartner et al. (2011) contribute to the literature explaining the sovereign credit ratings' impacts on government bond spread and applying Granger causality tests on the causal relationship.

Erb et al. (2000) provide strong evidence of significant impacts of country credit ratings on the cross-section of real interest rates for developing countries. The study assess the link of Institutional Investor's sovereign credit ratings and the spreads over US Treasuries. Unlike the previous studies using secondary data and cross-sectional estimations, a time series of spreads for emerging market bond in primary markets is used in the studies of Eichengreen and Mody (1998) and Kamin and Kleist (1999). Karmin and Kleist (1999) use data of sovereign credit ratings and industrial country interest rates and find that for a comparable credit rating, Asian spreads are on average 39 percent lower than Latin American spreads. Latter, the study of Eichengreen and Mody improve the estimations by incorporating several different classes such as private, public, sovereign and region to control for the likelihood of new issues.

2.3.3. Sovereign borrowing costs and institutional variables

Institution factor is probably correlated with government borrowing costs. Literature on institution dimension suggest that good institutions probably decrease the risk premia proxied by government bond interest rates. Poterba and Rueben (1999, 2001) study the impacts of state fiscal institutions on interest rates of the US municipal bonds. They find out that institutions would have not only direct impacts but also indirect impacts on the actual fiscal outcomes, for example the debt level. They argue that fiscal institutions make rules prevent raising taxes and increasing budget deficit which may lead to a default on interest payments. Anti-deficit rules restrict the legislature to issue more debts then affect the bond market's perception of borrowing countries' ability to pay debt and bond prices charged. The empirical results show that state's anti-deficit rules affect significantly on borrowing costs. The regression results of fiscal institution bond interest rate from Lowry and Alt (2010) are similar. Johnson and Kriz (2005) find that stricter rules on expenditure limits and balanced budget lower credit risk, thus lower interest cost as well.

Hallerberg and Wolff (2006) study the impacts of a sound constitution on risk premia captured by government bond yields in European sovereign bond markets. They argue that a strong institution could improve the fiscal outcomes in long-term and the positive impacts on the fiscal performance could go beyond the direct effects within a given year. Better institution also mitigate the adverse impacts of budget deficits of a particular country since international investors would consider the deficits as a temporary effects, and it would be addressed in long-term. Their regression results show that better institutions are correlated to lower risk premia or lower government bond yields and neglecting institution roles causes omitted variable bias of fiscal policy effect on risk premia under European Economic and Monetary Union.

2.3.4. Sovereign borrowing costs and mineral resources

Literature suggests that borrowing costs of a country is linked to macroeconomic, institutional factors and its sovereign credit ratings (Gartner et al., 2011); Lowry and Alt, 2010). Similarly to credit ratings, since mineral resources affect economic growth and institutional then ratings could possibly influence the costs that a sovereign has to pay when borrowing in international markets. By not incorporating mineral resource factors, the specification seems to lack of important variable contributing on the effects on the price of government borrowing.

Chapter 3
Data and Methodology

This chapter describes the analytical framework, data and the empirical model used in the research paper. The first part introduces the analytical framework, the second part describes the data definition, data source and their unit of measurement, variable description and statistical description. The third part empirical model applied in this paper.

3.1. Analytical framework

Government bond yields

Government bond yield is the proxy for sovereign borrowing costs in this research. This is the common proxy used in several papers (Bernoth et al., 2004; and Faini, 2006). 1-year government bond yields and 10-year government bond yields are the proxy for short-term and long-term sovereign borrowing costs, respectively.

Macroeconomic variables

The explanatory variables in this paper can be clustered into macroeconomic and political group. A set of macroeconomic variables that have significant impacts on the ability and willingness of a sovereign to repay its debt obligations and reflects the economy health tends to be highly correlated to sovereign credit ratings and government bond yields. From literature, macroeconomic variables set comprises of **per capita GDP, GDP growth**, **inflation rate**, **government debt** and **budget deficit** (Afonso et al., 2011; Cantor and Packer, 1996; Haque et al., 1996). Besides, the level of the economic performance matters since it indicates how well the economy is. Therefore, logarithm of GDP per capita is incorporated in sovereign credit rating model but not in government borrowing costs due to high correlation with credit ratings (see Table 4).

Political variables

Political factor plays important role in determining sovereign ratings (Archer et al., 2007; Mellios and Blacnc, 2006) and government borrowing costs (Hallerberg and Wolff, 2006). **Political stability Index** is the proxy for political factor. This index has been taken from World Bank (2017) and captures the probability of government being overthrown or destabilized by either violent or unconstitutional reasons.

Mineral resources and unit of measurement

Besides the types of mineral resources and fossil fuels, their units also matter. Evidences from resource literature suggest that proxy of resource bonanza makes difference on whether or not it has significant impacts on the economy and the government's ability of repaying debt. Brunnschweiler and Bulte (2008), and Van der Ploeg and Poelhekke (2010) find out that mineral resources measured as a share of GDP or total export have negative impacts on economic growth while the effect disappear when replacing by per capita GDP. This paper chooses both two types of measurement unit of resources variables (**percentage of GDP** and **per capita GDP**) to assess the impact on sovereign credit ratings and borrowing costs.

Methodologies

Being dominant in credit rating literature is applying linear estimation and ordered regressions. Ordered probit model is used since the rating is discrete variable and reflects the order of default probability in many studies (Afonso et al., 2007; Afonso et al., 2011; Mellios and Blanc, 2006). However, this research uses fixed-effects panel data regression, the ordered probit reveals its drawback as there are not one but two error terms. The other options could be fixed effect, random effect and pool OLS. Afonso et al. (2011) suggest random-effects ordered probit estimation in this case. This method assumes that both error terms are normally distributed, and maximizes the log-likelihood accordingly. If the country specific error term is uncorrelated with the independent variables, then a random effect estimation is the most preferable, next preferable option is fixed effect. In this research, that normal condition does not hold so the results of both pooled OLS and random effects estimation are inconsistent, thus fixed effects estimation is the more preferable approach in this research.

Robustness test

Several additional variables are added to check the robustness of this research results. Gartner et al. (2011) suggest adding trade related variables and other political or institutional variables such as corruption index and government effectiveness. Since there are highly correlated between political variables, the political index will be added separately in model.

In sum, this paper applies fixed effect estimation on sovereign credit rating and government borrowing cost estimation models and use random-effects ordered probit model and random-effect estimation as a robustness check for sovereign rating regression results.

3.1.1 Sovereign credit ratings transformation process

Data of sovereign credit ratings come from three most popular international credit rating agencies: Fitch Ratings (referred as Fitch hereafter), Moody's Investor Services (Moody's) and Standard & Poor's (S&P). The rating agencies assess the capacity and willingness to pay of sovereign debtors to commit its financial obligations to the private creditors within the maturity dates as conditions agreed between the parties (Canuto et al., 2012). The assessing outcomes then synthesized in rating ranking which fundamentally estimates the probability of a given sovereign government defaulting. The ratings are essential estimation of sovereign risk provided to international creditors.

The ratings are variations of the scale with A as the best to D as the worst. Both Fitch and S&P rank AAA as the highest grade while Moody's set Aaa as the best credit grade. The rating scales are slightly different cross the rating agencies. Moody's ratings reflect expected loss as a consequence of default probability and the expectation of monetary loss caused by the defaulting government (Bhatia, 2002). While Fitch only evaluates the default probability prior to the default occurrence and differentiates assessments of the agency (Bhatia, 2002), S&P ratings refers only to the probability of default regardless to its magnitude (Bhatia, 2002).

As the ratings are in form of alphabet letters, econometric analysis is unable to apply ratings in estimating regressions. Most researchers apply numeric transformation for the rating categories before putting them in econometric regressions. Both linear and non-linear transformation are adequate to use and there seems no difference in the results from the two systems (Ferr et al, 1999; Afonso et al., 2007). The linear transposition assumes that there are equal distances between ratings categories while a non-linear transformation assess them different depending on which raking they move from. In this research, I apply linear numeric transformation procedure in which the highest grade equivalent to the biggest value and the lowest value corresponded to the default risk following Badr et al. (2016). Table 1 illustrates whole ratings transformation results.

Table 1
Sovereign credit ratings from Fitch, Moody's, and S&P

Numerical transformation scale	Fitch	Moody's	S&P	Interpretation	
23	AAA		AAA	Highest grade	Investment grade ratings
22	AA+	Aaa	AA+		
21	AA	Aa1	AA	High grade	
20	AA-	Aa2	AA-		
19	A+	Aa3	A+	Strong payment capacity	
18	A	A1	A		
17	A-	A2	A-		
16	BBB+	A3	BBB+	Adequate payment capacity	
15	BBB	Baa1	BBB		
14	BBB-	Baa2	BBB-		
13	BB+	Baa3	BB+	Speculative, have capacity to meet obligations	Speculation grade ratings
12	BB	Ba1	BB		
11	BB-	Ba2	BB-		
10	B+	Ba3	B+	Highly credit risk, high speculative	
9	B	B1	B		
8	B-	B2	B-		
7	CCC+	B3	CCC+	Very high credit risk, highly speculative, near default	
6	CCC	Caa1	CCC		
5	CCC-	Caa2	CCC-		
4	CC	Caa3	CC		
3	C	Ca	C	In default	
2	D	C	D		
1	RD	WR	SD		

Source: self-elaboration from Badr et al. (2016)

3.2. Econometric models

3.2.1. Sovereign credit rating specification

This research paper applies panel dataset analysis for the period from 1998 to 2015 to examine how mineral resources have impacts on sovereign credit rates and on sovereign borrowing costs.

Mineral resource variables in this paper including oil, gas, and mineral resource and total extractive activities data come from World Bank (2017a). In this paper, I assess the impacts of resource variables in form of a share of GDP and per capita.

Multiple macroeconomic factors (inflation rate, GDP per capita growth, logarithm of GDP per capita in 2010, and government debt or budget deficit) and political variables (political stability) are incorporated in the model to assess the dependence level of sovereign credit ratings and sovereign borrowing costs of countries.

$$CRS_{it} = \alpha_0 + \alpha_1 M_{it} + \alpha_2 Inflationrate_{it} + \alpha_3 GDPpercapitaGrowth_{it} + \alpha_4 lnGDPpercapita_{it} + \alpha_5 GovernmentDebt_{it} + \alpha_6 Politicalstability_{it} + u_i + \nu_{it} \quad (1)$$

Where

CRS_{it}: credit rating score by international credit rating agencies of country i in year t. Credit ratings have been taken from three main international credit agencies Fitch, Moody's Investor Services, and Standard & Poor and the ratings are transferred into the numeric scale from 1 to 23 for Fitch and S&P and from 1 to 22 for Moody's. Unit of measurement of credit ratings is point.

M_{it}: mineral resource variable of country i in year t. This research examines three types of resources that are mineral, gas and oil in form of percentage of GDP and per capita. Total extractive activity is the sum of three resource rents. Specifically, there are eight mineral resource variables: oil rents/GDP (measurement unit is percentage), gas rents/ GDP (measurement unit is percentage), mineral rents/ GDP (measurement unit is percentage), total extractive activity/ GDP (measurement unit is percentage), oil rents per capita (measurement unit is 2010 U.S. dollar),), gas rents per capita (measurement unit is 2010 U.S. dollar), mineral rents per capita (measurement unit is 2010 U.S. dollar),), total extractive activity per capita (measurement unit is 2010 U.S. dollar).

$Inflationrate_{it}$ is the inflation rate of country i in year t, measurement unit is percentage.

$GDPpercapitaGrowth_{it}$ is the per capita GDP growth rate of country i in year t, measurement unit is percentage.

$lnGDPpercapita_{it}$ is logarithm of GDP per capita of country i in year t, measurement unit is constant U.S. dollar in 2010.

$GovernmentDebt_{it}$ is general government gross debt as a share of GDP of country i in year t, measurement unit is percentage.

$Politicalstability_{it}$ is the index of Political Stability, measurement unit is point.

u_i: country-specific time-invariant component of error term

ε_{it}: time variable component of error term

3.3.2. Sovereign borrowing cost specifications

3.3.2.1. Direct model

The direct effect of mineral resources on sovereign borrowing costs in long-term is examined in the model below

$$BC_{it} = \beta_0 + \beta_1 CRS_{it} + \beta_2 M_{it} + \beta_3 Inflationrate_{it} + \beta_4 GDPpercapitaGrowth_{it} + \beta_5 GovernmentDebt_{it} + \beta_6 Politicalstability_{it} + w_i + \varepsilon_{it} \quad (2a)$$

BC_{it} is the sovereign borrowing cost of country i in year t, unit of measurement is percentage. In this paper, 10-year government bond yield is the proxy for long-term sovereign borrowing cost.

w_i is the country-specific time-invariant componant of error term

ε_{it} is the time variable componant of error term

In long-term, the government debt matters as it affects the ability of a government to repay its financial debts. The too high level of government debt to GDP indicates a risk that government may be unable to commit its debt obligations. While in short-term, budget deficit matters more. Therefore, the model for sovereign borrowing costs in short-run illustrated as below

$$BC_{it} = \beta_0 + \beta_1 CRS_{it} + \beta_2 M_{it} + \beta_3 Inflationrate_{it} + \beta_4 GDPpercapitaGrowth_{it} + \beta_5 BudgetDeficit_{it} + \beta_6 Politicalstability_{it} + w_i + \varepsilon_{it} \quad (2b)$$

BC_{it} denoted 1-year government bond yield of country i in year t, unit of measurement is percentage. This is the proxy for short-term sovereign borrowing cost.

BudgetDeficit$_{it}$ is the proxy for budget deficit of country i in year t and measured as a share of GDP.

This paper applies fixed effect analysis to examine the impacts of mineral resources along with several macroeconomic and institutional factors on sovereign credit rating and country borrowing costs. The results from the Hausman tests show that the fixed effect approach is the most suitable method in this case. Another widely applied method in credit rating literature is the random-effect ordered probit regression; it will be used as a robustness check for sovereign rating estimation results.

3.3.2.2. Indirect impact model

Following the methodology of calculating indirect effect in the papers of Pellegrini and Gerlagh (2004), Papyrakis and Gerlagh (2007), the indirect effect of mineral resources on sovereign borrowing costs measured by the effect of mineral resources on borrowing costs through credit ratings. In this case, ratings is the transmission channels and the magnitude of the indirect effect equals to the effect of mineral resources on rating (α_1) multiply with the effect of sovereign ratings on borrowing costs (β_1). The magnitude of indirect effect of mineral resources on government borrowing costs equals $\alpha_1\beta_1$

Expected regression results

In term of expected regression results, there is not always consensus on every independent variables in sovereign credit rating regression and government borrowing cost regression. The direct and indirect impacts of mineral as well as other macroeconomic and institutional variables may be different in specific circumstances. My expectation on the effects of each explanatory variable are as follow. In the sovereign rating regression, GDP per capita growth, logarithm of GDP per capita and political stability have positive impacts on ratings because they indicate a higher level of economic development while inflation rate and government debt may be harmful to an economy. Thus, the latter two are negatively correlated to sovereign ratings.

Government bond yields are utilized as proxies for sovereign borrowing costs. Specifically, the 1-year bond yield and 10-year bond yield represents the borrowing cost of short-term and long-term loan, respectively. As the lower risk the loan is, the lower interest the lenders charge the debtors; therefore, all explanatory variables have opposite impacts on government bond yields compared to their impacts on credit rating regressions. Sovereign ratings, GDP per capita growth, logarithm of GDP per capita and political stability are probably negatively correlated with government bond yields while inflation rate, government debt and budget deficit have positive effects on borrowing costs.

3.3. Data

3.3.2. Data and variable explanation

Data required for regressions in this paper has been compile from several sources for the period from 1998 to 2015. Data on GDP per capita growth (annual growth rate of per capita GDP, calculated based on 2010 U.S. dollar), inflation rate and GDP per capita (measured in constant 2010 U.S. dollar), lnGDPpercapita (logarithm of per capita GDP in 2010) are taken from World Development Indicators of World Bank (2017a). The government gross debt (comprise all liability in the future, as a share of GDP) and budget deficit (total spending minus total revenue, as percentage of GDP) have been taken from International Monetary Fund (2017). The 1-year government bond yield and 10-year government bond yield data are acquired from the website Investing.com (2017). Data on mineral resources consist of 4 types

of mineral resources (oil rents, gas rents, mineral rents and total extractive activity) measured as a share of GDP or per capita. The source of mineral data is World Development Indicator (WorldBank, 2017a). The overall panel dataset used in this research covers 110 countries over the period 1998 – 2015. The source of institutional and political variable (including political stability, government effectiveness). There are six indices measuring governance from Worldwide Governance Indicators (World Bank, 2017b) including Voice and Accountability, Political Stability and Absence of Violence/Terrorism (called Political stability hereafter), Government effectiveness, Regulatory Quality, Rule of Law and Control for Corruption. Given that six indices are highly correlated, one variable chosen as a main and exclusive political variables in sovereign credit rating model and sovereign borrowing cost model is political stability. The other governance indicators would be introduced into the model to robust the regression results.

Sovereign credit rating of three rating agencies as dependent variables are S&P, Fitch and Moody's ratings. There are 2082 observations of S&P ratings, the average rating value is 15.195. The standard deviation of S&P ratings is 4.995 while Fitch and Moody's are 5.087 and 4.936, respectively. There are 1823 Fitch rating observations and 2117 Moody's rating observations. The average rating score of Fitch and Moody's is 15.696 and 13.798, respectively. All ratings are transferred to the numerical scale where 1 is the lowest value and 23 is the highest value for S&P and Fitch and 22 is the maximum value for Moody's rating.

The two main regressions in sovereign credit ratings and sovereign borrowing costs. The explanatory variables can be clustered into macroeconomic variables and political variables. Table 2 provides definition and data sources of all variables used in this research paper. Table 3 presents the descriptive statistic (number of observations, means, standard deviation, minimum value and maximum value) of all variables in Tables 2. Tables 4 computes the matrix of correlation between explanatory variables. The credit ratings of all three rating agencies exhibit strong correlation (more than 0.979). Besides, the sovereign ratings are highly correlated to political stability index (0.715) and logarithm of GDP per capita variable (0.829) and the correlation between the latter two variables are relatively high (0.746).

Table 2
Definition and unit of measurement of variables

Variable	Description	Unir of measurement	Source
Ratings variables			
Fitch rating	Credit rating agency's opinion about credit risk, whether the issuer is willing and able to commit its financial obligations on time and in full. Its value ranges from 23 (stable, minimal risk) to 1 (default)	unit point	S&P (2016)
Moody's rating	Credit rating agency's opinion about credit risk, whether the issuer is willing and able to commit its financial obligations on time and in full. Its value ranges from 22 (stable, minimal risk) to 1 (default)		Fitch (2016)
S&P rating	Credit rating agency's opinion about credit risk, whether the issuer is willing and able to commit its financial obligations on time and in full. Its value ranges from 23 (stable, minimal risk) to 1 (default)		Moody's (2016)
Macro-economic variables			
GDP per capita growth	Annual growth rate of GDP per capita with GDP per capita is measured in constant 2010 U.S. dollars	per cent	World Bank's World Development Indicators (2017)
Inflation rate	Measured by the change of the consumer price index, reflexing the annual change rate of the price in the economy	per cent	
GDP per capita	Gross domestic product by all resident producers in the economy in constant 2010 U.S. dollars, divided by population	2010 U.S. dollars	
General government gross debt	comprise of all liabilities that require payment or payments by in the future, measured as a percent of GDP	per cent	International Monetary Fund (2017)

Budget deficit	Total spending minus total revenue, measured as a percent of GDP	per cent	
Government bond yields			
Government bond yield 1 year	Return on investment of 1-year-government bonds, measured as a percentage	per cent	Global financial portal Investing.com (2017)
Government bond yield 10 year	Return on investment of 10-year-government bonds, measured as a percentage		
Political variables			
Political stability index	Captures the probability of government being overthrown or destabilized by either violent or unconstitutional reasons.	point	World Bank's Worldwide Governance Indicators (2017)
Government effectiveness index	Captures the quality of public services, the civil service and its independence degree from political pressures, the quality of formulating and implementing policy and the credibility of government in committing the policies		
Control for corruption	Captures pretty and grand forms of corruption, the extent where public power is used for private gain		
Mineral resources variables			
Oil rents/GDP	are the difference between crude oil production value at regional prices with total production costs, as a share of GDP	percentage	World Bank's World Development Indicators (2017)
Gas rents/GDP	are the difference between natural gas production value at regional prices with total production costs, as a share of GDP		
Mineral rents/GDP	Mineral resource here consists of tin, silver, gold, lead, nickel, iron, copper, zinc, photsphate and bauxite. Mineral rents are the difference between the value of a stock of mineral production at world prices and the total production costs, as a share of GDP		

Total extractive activities/GDP	self-calculated by sum of oil rents/GDP, gas rents/GDP and mineral rents/GDP		self-calculation based on data from World Bank's World Development Indicators (2017)
Oil rents per capita	self-calculated by oil rents/GDP multiply with GDP per capita	2010 U.S. dollars	
Gas rents per capita	self-calculated by natural gas rents/GDP multiply with GDP per capita		
Mineral rents per capita	self-calculated by mineral rents/GDP multiply with GDP per capita		
Total extractive activities per capita	self-calculated by sum of Oil rents per capita, gas rents per capita and mineral rents per capita		

Table 3
Descriptive statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
S&P rating	2083	15.195	4.995	1	23
Fitch rating	1823	15.696	5.087	1	23
Moody's rating	2117	13.798	4.936	1	22
Bond yields 1 year	607	6.829	14.705	-0.834	104.031
Bond yields 10 years	751	6.591	10.413	-0.382	104.483
Inflation rate	3690	35.411	470.012	-18.109	23773.13
GDP per capita growth	3906	2.192	5.846	-64.997	92.361
Political stability	2616	0.002	0.953	-3.324	1.663
ln GDP per capita	8417	8.202	1.521	4.749	11.886
Government debt	3175	54.954	46.258	0.1	789.8
Oil rents/GDP	5259	4.832	10.860	0	90.906
Mineral rents/GDP	7804	1.070	3.593	0	46.906
Gas rents/GDP	5237	0.543	3.534	0	100.824
Total extractive activity/GDP	5176	6.141	11.897	0	123.059
Oil rents per capita	5126	5.403	4.673	0	15.493

Mineral rents per capita	7302	3.585	3.740	0	12.842
Gas rents per capita	5098	0.0002	0.001	0	0.029
Total extractive activity rents per capita	5043	9.591	6.176	0	23.508

Table 4
Correlation between variables

	S&P rating	Fitch rating	Moody's rating	Bond yields 1 year	Bond yields 10 years	Inflation rate	GDP percapita growth	Political stability	ln GDP per capita	Government debt
S&P rating	1									
Fitch rating	0.986	1								
Moody's rating	0.979	0.978	1							
Bond yields 1 year	-0.279	-0.275	-0.255	1						
Bond yields 10 years	-0.188	-0.201	-0.188	0.547	1					
Inflation rate	-0.531	-0.528	-0.534	0.309	0.2498	1				
GDP percapita growth	-0.198	-0.225	-0.212	0.060	0.0290	0.167	1			
Political stability	0.715	0.719	0.705	-0.156	-0.0819	-0.497	-0.265	1		
ln GDP per capita	0.829	0.846	0.818	-0.294	-0.1682	-0.547	-0.378	0.746	1	
Government debt	0.095	0.111	0.109	-0.103	-0.0120	-0.299	-0.203	0.203	0.224	1
Oil rents/GDP	-0.180	-0.175	-0.200	0.077	0.0500	0.453	0.112	-0.259	-0.155	-0.284
Mineral rents/GDP	0.062	0.031	0.052	0.011	-0.0092	0.094	0.066	-0.003	-0.075	-0.296
Gas rents/GDP	-0.059	-0.047	-0.059	0.033	0.0197	0.372	-0.0002	-0.125	-0.003	-0.234

Total extractive activity/GDP	-0.090	-0.103	-0.109	0.064	0.0308	0.428	0.113	-0.196	-0.148	-0.415
Oil rents per capita	-0.087	-0.091	-0.081	0.090	0.0586	0.247	0.013	-0.128	-0.122	-0.282
Mineral rents per capita	-0.116	-0.147	-0.134	0.036	-0.0401	0.276	0.195	-0.268	-0.245	-0.345
Gas rents per capita	-0.489	-0.476	-0.497	0.173	0.1222	0.593	0.111	-0.466	-0.471	-0.146
Total extractive activity rents per capita	-0.119	-0.140	-0.126	0.075	0.0121	0.308	0.121	-0.232	-0.215	-0.369

	Oil rents/GDP	Mineral rents/GDP	Gas rents/GDP	Total extractive activity/GDP	Oil rents per capita	Mineral rents per capita	Gas rents per capita	Total extractive activity rents per capita
Oil rents/GDP	1							
Mineral rents/GDP	-0.0457	1						
Gas rents/GDP	0.7929	-0.0602	1					
Total extractive activity/GDP	0.7813	0.5755	0.6798	1				
Oil rents per capita	0.5952	0.0861	0.5140	0.5435	1			
Mineral rents per capita	0.2563	0.5042	0.2380	0.5258	0.4368	1		
Gas rents per capita	0.6655	-0.0350	0.6458	0.5410	0.3153	0.1696	1	
Total extractive activity rents per capita	0.5063	0.3432	0.4469	0.6309	0.8542	0.8408	0.2878	1

Chapter 4
Research Results and Discussion

This section aims at identifying which mineral variables have the most significant impacts on credit ratings and government bond yields. The models opt for a panel data regression analysis with fixed effect method followed the literature on sovereign ratings and government borrowing cost determinants. This approach seems to yield good quality results. Besides, I check the robustness of the estimation by random effects and ordered probit models. The first section presents regression results of rating determinant estimates over the period from 1998 to 2015. The next section provides discoveries regarding the mineral resource effect along with the macroeconomic and institutional factors on government bond yields in short-term as well as in long-term.

4.1. Sovereign credit rating

A particular country's sovereign rating seems to remain stable over years. The panel data includes country-specific error term which is correlated with the macroeconomic and institutional factors. Hence, Fixed effects is preferred than Random Effects and pooled OLS. The result from the Hausman test also confirms that the Fixed Effects approach is more consistent and efficient. Thus, this section focuses on the Fixed Effects estimation results. The coefficients of the variables obtained from the Fixed Effects regression equation (1) listed in the Table 5.

The model estimation uses the dataset consists of 110 countries (see Appendix 12) over the period from 1998 to 2015. I find that not all macroeconomic variables could explain the sovereign ratings over the period. This estimate shows that a higher **political stability** index is associated with higher expected credit rating. Its effect has the largest magnitude on sovereign ratings. An increase of 1 point of political stability index improves the ratings from 0.5 to 0.8 rating points depending on the rating used in the regression. Moody's puts more emphasis on political factor with 5 percent significance level and political stability variable has the stronger magnitude of effects on Moody's ratings.

Logarithm of GDP per capita variable and **government debt** variable are found to play significant roles in determining the ratings with the level of significance of 1 percent. With 1 percentage point increase of government debt per GDP, there is be a drop of around 0.06 points in ratings of three agencies. When the logarithm of GDP per capita increase 1 unit, the S&P rating moves up 5.866 points, and Fitch rating increases the least of 4.016 points. The estimation results show that the **inflation rate** does have significant impacts on Fitch and Moody's ratings but not on S&P ratings at 10 % of significance level. Although the magnitude effect is small, an increase of 1 percentage point of inflation rate decreases the rating by about 0.02 points for all three agencies when the estimation includes either oil rents or total extractive activity rents as a share of GDP. Turning to the **growth rate of GDP per capita**, the estimates show that economic growth rate could have positive or negative effects on sovereign ratings although the impact is not significant.

Table 5
Fixed Effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Inflation rate	-0.021	-0.023*	-0.022*	-0.025	-0.022*	-0.022*
	(0.014)	(0.012)	(0.012)	(0.016)	(0.013)	(0.013)
GDP per capita Growth	0.923	0.587	-0.586	1.06	0.772	-0.636
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Political stability	0.553*	0.658*	0.888***	0.549*	0.651*	0.881**
	(0.281)	(0.335)	(0.337)	(0.282)	(0.335)	(0.337)
ln GDP per capita	5.866***	4.016***	4.811***	5.880***	4.006***	4.820***
	(0.896)	(0.952)	-1.270	(0.890)	(0.945)	-1.266
Government Debt	-0.064***	-0.055***	-0.063***	-0.064***	-0.055***	-0.063***
	(0.008)	(0.008)	(0.01)	(0.008)	(0.008)	(0.011)
Oil rents/GDP	-0.007	-0.026**	-0.005			
	(0.02	(0.011)	(0.029)			
Total extract activity/GDP				0.005	-0.022**	-0.001
				(0.015)	(0.011)	(0.023)
Constant	-33.94***	-18.43**	-26.34**	-34.04***	-18.27**	-26.38**
	-7.920	-8.627	(11.28)	-7.865	-8.567	(11.25)
Observations	1,387	1,316	1,409	1,371	1,304	1,395
R-squared	0.532	0.473	0.471	0.533	0.475	0.472
Number of CountryCode	107	98	110	105	97	108

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Most mineral resource variables have insignificant impacts on sovereign ratings. The variables oil rents/GDP and total extractive activity/GDP only have significant and negative effects only on Fitch ratings, the level of significance is 5 percent and the magnitude is 0.026 rating points for oil rents/GDP and 0.022 ratings points for total extractive activity/GDP. These coefficients indicate that 1 percentage point increase of oil rent/GDP decreases the Fitch rating by 0.026 points. The oil rents/GDP also have a negative but not significant effect on S&P and Moody's ratings.

Each mineral variable is incorporated separately into the equation (1) and the estimates of coefficients and robust standard errors are summarized in Table 6. The influence of gas rents/GDP on S&P rating is positive but on Fitch rating is negative at 10 percent of significance level while the impact on Moody's rating is positive but insignificant. These results indicate that each rating agency has different point of view regarding the effects on gas rents/GDP when scoring sovereign ratings. Mineral rents per GDP variable exhibits positive and significant impacts on Fitch rating but the impact is not significant on the other two. One percent increase of mineral rents per GDP improves the Fitch rating by 0.042 point. This positive coefficient implies that mineral rents/GDP is beneficial for increase ability to repay government debt obligation and therefore, it contributes to improve the sovereign credit rating. Interestingly, with 1 dollar increase in gas rents per capita, the Fitch rating drops 457.8 notches. The extremely large magnitude is due to the so low mean (the mean is 0.0002) of the variable gas rents per capita. Other mineral resource variables measured in term of per capita do not have effects on credit ratings. The regression result reveals that not only the type of mineral but the unit of measurement matters.

The regression result of the impacts of resource variables on credit ratings shows that the mineral resources can significantly influence sovereign ratings when they are measured as percentage of total national income. Most resource variables lose the significant impacts when measured in term of per capita except gas rents. The unit measurement in term of a share of GDP captures the resource dependence of an economy while resource rents per capita indicates the average rents made for everyone in the country. The regression results suggest that the efficiency of resource used could probably increase the credit rating and the level of average resource production for each individual in the country does not have a significant impact on credit ratings. Furthermore, oil rents identified as the production cost of crude oil subtracted from production value at regional prices; hence, it also implies the dependence of resource while mineral rents measured by the production cost of a stock of minerals subtracted from their production value at world price. The definition of mineral rents imply the mineral abundance of an economy. The results are in line with the study of Brunnschweiler & Bulte (2008).

An essential issue is to assess the accuracy of estimated model by its predictive power. The R-square value is a measurement of the accuracy of the model. The average R square of estimate regressions is about 0.5. It indicates that the model successfully predict about 50 percent compared to the actual values. The accuracy level is relatively high. The differences between estimated values and observed values can be attributed to factors correlated with political issues and qualitative factors which the model is unable to capture. Sovereign credit ratings also comprises of the agencies' projection regarding the ability and willingness to meet the debt obligations of a given sovereign in the future thus it attributes to the inaccuracy of the estimate model.

Table 6
Fixed Effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	S&P	Fitch	Moody's

Total extract activities/capita	-0.004	-0.043	-0.043
	(0.046)	(0.046)	(0.053)
Oil rents per capita	0.0377	-0.120	0.105
	(0.088)	(0.081)	(0.115)
Mineral rents per capita	-0.025	-0.046	-0.077
	(0.045)	(0.046)	(0.059)
Gas rents per capita	184.0	-457.8*	-180.9
	(469.4)	(251.8)	(343.5)
Gas rents/GDP	0.177*	-0.281*	0.179
	(0.097)	(0.160)	(0.173)
Mineral rents/GDP	0.028	0.042**	0.004
	(0.022)	(0.019)	(0.03)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sovereign credit ratings for high-income countries and low and middle-income countries

When separating the countries into high-income and low and middle-income groups, the effect of mineral resources on sovereign ratings changes. According to World Bank's country classification by income level, high-income economies have GNI per capita equals or more than $12,056. Since this research works on data of GDP per capita, high-income countries are those with GDP per capita of $12,001 or more, the others are low and middle-income countries.

Table 7 reports empirical results on sovereign ratings for low and middle-income and high-income countries. The model incorporates each mineral variable separately in the equation (1) and the coefficients and error terms are presented. Low and middle-income country group still has significant impacts of oil rents/GDP and total extractive activity/GDP on Fitch ratings while in high-income countries, mineral resource variables do not have any effects on their sovereign ratings. Compared to the general group, low and middle-income group has several more variables which have significant impacts such as mineral rents/GDP and oil rents per capita while gas rents/GDP variable loses its impact on S&P ratings. Only mineral rents/GDP has significant and positive effects on the ratings of Fitch and Moody's. The results imply that credit agencies put more weight on mineral resources when calculating ratings of low and middle income countries but not high-income countries. Only mineral rents/GDP is positively correlated with sovereign ratings.

Table 7
Fixed Effects regression on sovereign credit ratings – Low and middle-income and high-income countries

	Low and Middle-income countries			High-income countries		
Dependent variable: Sovereign ratings	**S&P**	**Fitch**	**Moody's**	**S&P**	**Fitch**	**Moody's**
Oil rents/GDP	-0.00492	-0.0328*	0.000452	0.000728	-0.00596	-0.0480
	(0.0229)	(0.0174)	(0.0296)	(0.0243)	(0.0164)	(0.0317)
Total extract activity/GDP	-0.00132	-0.0284*	0.00635	0.0123	-0.00216	-0.0355
	(0.0161)	(0.0157)	(0.0214)	(0.0218)	(0.0183)	(0.0266)
Mineral rents/GDP	0.033	0.057***	0.029*	0.0760	0.0459	-0.142
	(0.023)	(0.019)	(0.016)	(0.108)	(0.0876)	(0.132)
Gas rents/GDP	-0.062	-0.499***	-0.121	0.198	0.0361	0.400
	(0.149)	(0.177)	(0.122)	(0.164)	(0.285)	(0.247)
Total extract activities/capita	-0.028	-0.09	-0.049	0.0493	-0.00659	0.0528
	(0.05)	(0.058)	(0.039)	(0.0511)	(0.0473)	(0.0725)
Oil rents per capita	0.016	-0.146*	0.154	0.00661	-0.0550	0.0956
	(0.105)	(0.079)	(0.135)	(0.133)	(0.122)	(0.198)
Mineral rents per capita	-0.031	-0.044	-0.021	-0.0166	-0.0746	-0.0847
	(0.053)	(0.054)	(0.053)	(0.0528)	(0.0517)	(0.0769)
Gas rents per capita	21.19	-578.3***	-113.0	3,419	9,471	8,814
	(392.5)	(165.0)	(330.7)	-4,411	-9,299	-7,568

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.1.1 Robustness checks of Sovereign credit rating results

In this section, I perform several robustness tests for the empirical results of sovereign rating above. First, the robustness is investigated by random-effects ordered probit estimation. Second, random effects estimation techniques is applied to check the robustness of the results obtained from fixed effects estimation. Third, the other macroeconomic and institutional variables are added or substituted for comparison and completeness purposes.

Random-effects ordered probit regression

A random-effects ordered probit estimate is utilized to compare the results with those obtained by the fixed effect regression above (table 8). In general, the logistic estimated coefficients for variables in equation (1) have the same sign as the fixed-effects estimate results. The significance level in logistic model slightly differs. Political stability index loses its significance level in Fitch rating regression while inflation rate variable (with S&P rating), oil rents per GDP (with S&P rating, Moody's rating) and total extractive activity/GDP (with Moody's rating) become statistically significant.

Table 8
Random-effects ordered probit regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	S&P rating	Fitch rating	Moody's rating
Inflation rate	-0.032**	-0.021*	-0.018*
	(0.014)	(0.012)	(0.01)
GDP per capita Growth	0.008	-0.001	0.006
	(0.014)	(0.015)	(0.010)
Political stability	0.519**	0.485	0.777***
	(0.260)	(0.31)	(0.234)
ln GDP per capita	3.802***	3271***	2192***
	(0.445)	(0.351)	(0.268)
Government Debt	-0.061***	-0.054***	-0.046***
	(0.008)	(0.009)	(0.008)
Oil rents/GDP	-0.029*	-0.035***	-0.024*
	(0.017)	(0.009)	(0.014)
Total extractive activity/GDP	-0.016	-0.031***	-0.025*
	(0.014)	(0.010)	(0.013)

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Random-effects regression

Table 9 reports the regression results on sovereign credit ratings applied random-effects methodology to compare with those obtained by fixed effects regression. The sample consists of 110 countries over the period from 1998 to 2015. In general, the sign and level of significance of most variables hold but the magnitude in random-effects estimates is slightly higher than those in the fixed-effects regression (table 9).

Table 9
Random-effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Inflation rate	-0.0274*	-0.0286**	-0.0303**	-0.0302*	-0.0278**	-0.0302**
	(0.0145)	(0.0124)	(0.0124)	(0.0165)	(0.0125)	(0.0126)
GDP per capita Growth	0.0201	0.0106	0.00384	0.0225	0.0127	0.00342
	(0.0195)	(0.0180)	(0.0188)	(0.0196)	(0.0182)	(0.0187)
Political stability	0.612**	0.679**	0.858***	0.628**	0.678**	0.868***
	(0.262)	(0.290)	(0.293)	(0.263)	(0.288)	(0.293)
ln GDP per capita	3.528***	3.270***	3.149***	3.543***	3.258***	3.175***
	(0.299)	(0.297)	(0.302)	(0.304)	(0.292)	(0.308)
Government Debt	-0.0635***	-0.0529***	-0.0595***	-0.0632***	-0.0532***	-0.0598***
	(0.00919)	(0.00859)	(0.0107)	(0.00920)	(0.00860)	(0.0108)
Oil rents/GDP	-0.0386**	-0.0425***	-0.0353			
	(0.0172)	(0.0114)	(0.0225)			
Total extract activity/GDP				-0.0233*	-0.0377***	-0.0261
				(0.0141)	(0.0106)	(0.0184)
Constant	-12.86***	-11.71***	-11.35***	-13.00***	-11.53***	-11.55***
	-2.555	-2.672	-2.655	-2.615	-2.630	-2.733
Observations	1,387	1,316	1,409	1,371	1,304	1,395
Number of CountryCode	107	98	110	105	97	108

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Controlling for other explanatory variables

Several variables are added to the regression to examine the robustness of the model obtained from equation (1) and its results presented in table 5. First, agriculture value per GDP variable is incorporated into the specification (Appendix 5). Agriculture variable includes fishing, forestry, hunting, and cultivation of crops and livestock and measured as percentage of GDP. Agriculture variable data is provided by World Bank (2017a). The sign and significance level of the main macroeconomic factors in equation (1) remain while the magnitude changes slightly. The newly added variable agriculture value per GDP is positively correlated to S&P and Fitch ratings. Oil rents per GDP holds its negative significant effect on Fitch rating, the total extractive activity per GDP loses the significant impacts compared to the results in table 5

The specification in Appendix 6 substitutes Government effectiveness index for Political Stability index. The estimate results show that the effects of both oil rents/GDP and total extractive activity/GDP lose when the government effectiveness index is incorporated into the model. It implies that when the government manages the economy well, the mineral resources do not have impacts on sovereign ratings. In other words, the governance can cancel out the negative impacts of mineral resource on the sovereign rating.

The trade value per GDP variable is added into the specification in Appendix 7. Trade value per GDP (measured by percentage of GDP) is the sum of imports and exports of goods and services as a share of GDP. The regression result remains the same as the finding from Appendix 6, which is the sign and significance level of the variables remain unchanged. While the trade per GDP does not affect the sovereign ratings.

Conclusion

Not every mineral resource variable has significant impacts on the credit rating of a country. The effects depend on the measurement unit of the variable, the type of mineral resource and the income level of countries. Mineral resources do not have any effects on high-income countries. In low and middle-income countries, only mineral rents/GDP has positive impacts on sovereign ratings. While other variables such as oil rents/GDP, gas rents/GDP, total extractive activities/GDP, oil rents per capita and gas rents per capita have negative impacts on credit ratings. The Gas rents /GDP impact magnitude is larger than the average with 1 percent increase damages almost half a notch of Fitch rating. I find that Fitch rating tends to put more weight on most mineral resources as negative factors such as oi rents/GDP, total extractive activity rents/GDP, gas rents/GDP, gas rents per capita, oil rents per capita except mineral rents per GDP. These findings corroborate the idea that mineral resources do not influence on the rating of developed countries while low and middle-income countries depend on mineral revenue thus the economy suffers from mineral wealth in general. However, mineral rents per GDP has significant positive effects on sovereign rating while the rest either do not have significant impacts or have negative impacts on ratings. The conclusion drawn from results suggests that the effective usage of resources (measured in term of per unit GDP) probably increases the sovereign ratings while the average amount of resource rents for each individual in a country does not influence. The effect is significantly shown in low and middle-income countries while it loses the significance with high-income countries. This results possibly indicate that the high-income countries do not suffer the 'resource curse' while resource rents have significant influences on the sovereign ratings of low and middle-income countries.

4.2. Sovereign borrowing costs

4.2.1 Long-term sovereign borrowing costs

This section assesses the impacts of mineral resources on sovereign borrowing costs. This research uses 1-year and 10-year government bond yields as proxies for country borrowing costs in short-term and long-term, respectively.

Table 10
Fixed-effects regression on 10-year bond yields – All countries

Dependent variable: 10-year bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Rating score	-0.448**	-0.421*	-0.352*	-0.447**	-0.423*	-0.357*
	(0.198)	(0.225)	(0.184)	(0.198)	(0.225)	(0.183)
Oil rents/GDP	-0.200**	-0.254**	-0.233***			
	(0.092)	(0.099)	(0.086)			
Total extractive activ-ity/GDP				-0.153*	-0.191**	-0.217***
				(0.083)	(0.089)	(0.073)
Inflation rate	0.135**	0.120**	0.167***	0.137**	0.122**	0.169***
	(0.059)	(0.053)	(0.040)	(0.059)	(0.053)	(0.04)
GDP per capita Growth	-0.156***	-0.166***	-0.183***	-0.154***	-0.164***	-0.179***
	(0.046)	(0.052)	(0.055)	(0.045)	(0.051)	(0.054)
Political stability	-0.816**	-0.960***	-0.967***	-0.870**	-1.025***	-1.031***
	(0.363)	(0.346)	(0.331)	(0.361)	(0.345)	(0.328)
Government Debt	0.005	0.007	0.008	0.004	0.006	0.006
	(0.017)	(0.015)	(0.016)	(0.017)	(0.014)	(0.016)
Constant	17.26***	16.76***	14.20***	17.30***	16.91***	14.60***
	-4.356	-4.767	-3.948	-4.352	-4.755	-3.895
Observations	549	580	520	549	580	520
R-squared	0.587	0.569	0.577	0.588	0.570	0.582
Number of Country Code	46	46	46	46	46	46

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10 reports the estimation results for the 10-year government bond yields with fixed effects regressions. The sample data covers 46 countries over the period 1998 - 2015. The differential between the number of country in this sample and the sample in sovereign credit rating regression is due to the availability of government bond yield data.

The first three regressions include the mineral variables oil rents per GDP and the last three regressions incorporate total extractive activity per GDP variable. Contrary to the sovereign credit ratings, the higher yields capture the higher risk. Hence, the impacts of inflation rate and government debt are positive while credit ratings, GDP per capita growth, logarithm of GDP per capita and political stability have negative effects on bond yields. As expected, all ratings have significantly negative impacts on bond yields. The higher the rating of a sovereign indicates the better ability of repayment debt so the governments have to pay international lenders lower interest rates. With 1 point increase of rating, the 10-year government bond yield decreases by 0.448 percent for S&P, 0.421 percent for Fitch and 0.352 for Moody's. These findings provide evidences confirming previous results by Gomez-Puig (2006) and Manganelli and Wolswijk (2009) with different data.

Mineral resource variables also have some impacts on bond yields. Results indicate that a negative relation between long-term government bond yields and oil rents per GDP and total extractive activity per GDP and that the impacts of these mineral variables are statistically significant. The magnitude of the impacts of these two variables are relatively close. An increase of 1 percentage point of oil rents per GDP is correlated with a drop of around 0.2 to 0.254 percentage points of bond yields depending on the sovereign rating used in the regressions. The estimated coefficients of total extractive activity per GDP varies across three ratings**.** The effects with Moody's rating is the strongest at 1 percent of significance level while the magnitude of the effect with S&P rating is the lowest impacts at 0.35 percent of the yield. The negative coefficients of mineral variables indicate that in long-term, oil rents could be considered as a collateral for the loan which contributes to decrease the interest rate the borrowing government have to pay. The negative coefficients of resource variables imply that in long term, bond buyers see oil rents and total extractive activity rents as a good sign of the economy. Hence, they are willing to accept lower interest rates for those government bonds yields.

The estimate results suggest that a mutual correlation of the four standard macroeconomic and political country statistics with mineral resource variables contribute to explain from 56 percent to 58 percent differential between actual values and predicted values of 10-year government bond yields in the regression with oil rents and total rents per GDP. The predict power of the model is relatively high taken into account the qualitative factors and liquidity condition of the current markets that cannot be incorporated in the model.

Table 11 summarizes the regression results (coefficients and error terms) of each independent variables with sovereign rating from one of three agencies on 10-year bond yields. Each mineral resource variable is incorporated into the estimation regression separately to avoid multicorrelation issue. A 1 percent increase of total extractive activity rents per GDP causes 10-year bond yields drop 0.217 percent in the regression incorporating Moody's rating. The estimation results suggest that mineral rents/GDP and gas rents/GDP and the mineral variables measured in term of per capita do not have impacts on borrowing costs in long term. The results imply that only oil rents per GDP and total extractive activity per GDP are considered by international bond buyers. The other mineral variables do not affect the price of government bonds in long-term. Furthermore, the average amount of resource rents for each individual is not considered by lenders and do not significant influence the price of borrowing.

Table 11
Fixed-effects regression on 10-year bond yields – All countries

Dependent variable: 10-year bond yields	S&P	Fitch	Moody's
Mineral rents/GDP	-0.133	-0.148	-0.269
	(0.179)	(0.181)	(0.177)
Gas rents/GDP	-0.083	-0.111	-0.081
	(0.111)	(0.115)	(0.102)
Total extract activities/GDP	-0.153*	-0.191**	-0.217***
	(0.083)	(0.089)	(0.073)
Oil rents per capita	-0.055	-0.096	-0.047
	(0.108)	(0.101)	(0.125)
Mineral rents per capita	-0.017	-0.031	-0.046
	(0.049)	(0.049)	(0.048)
Gas rents per capita	-1,96	-2,816	-2,214
	-1,634	-2,254	-1,546
Total extract activities/capita	-0.024	-0.045	-0.047
	(0.041)	(0.039)	(0.038)

4.2.1.1 Indirect effects of mineral resources on long -term sovereign borrowing costs

Table 12 displays the indirect effects of mineral resource variables on 10-year government bond yields. The impact magnitude is calculated as the value of $\alpha_1\beta_1$ from equation (1) and the values are presented as below.

Compared to the direct effects of mineral resource variables, the indirect effects are negligible except the impact of gas rents per capita.

Table 12
Indirect effects of mineral resources on 10-year government bond yields

Indirect effects on 10-yearr bond yields	S&P	Fitch	Moody's
Oil rents /GDP	0.003	0.011	0.002
Mineral rents/GDP	-0.004	-0.006	-0.001
Gas rents/GDP	-0.015	0.031	-0.014
Total extract activities/GDP	-0.002	0.009	0.0003
Oil rents per capita	-0.002	0.012	-0.005
Mineral rents per capita	0.0004	0.001	0.004
Gas rents per capita	-360.64	1289164.8	400512.6
Total extract activities/capita	0.0001	0.002	0.002

4.2.1.2 Robustness checks for long-term sovereign borrowing costs

In this section, several macroeconomic variables are added and government effectiveness index is substituted for political stability index to check the robustness of my regression results.

Appendix 8 presents the estimate results of specification incorporated government effectiveness index instead of political stability index. The result implies that political stability has

significant impacts while government effectiveness does not significantly influence on long-tern government borrowing. The sign and effect other variables remain unchanged**.** The impacts of oil rents/GDP and total extractive activity/GDP on 10-year bond yields remain negative and significant. The result reveals that international lenders pay attention to political stability when giving loans in long-term and do not put much emphasis on government effectiveness. Besides, oil rents and total extractive activity measured as a share of GDP have negatively significant influence on the price the governments have to pay when borrowing in international markets.

Appendix 9 presents the regression results when adding agriculture value into the specification. Both oil rents and total extractive activity per GDP variables remain negative significant across three agencies' ratings while the agriculture variable only has negative impacts on 10-year bond yields in the specification incorporated Moody's rating. The results prove that the effects of mineral resources remain and robust across multiple specifications.

4.2.2 Short-term sovereign borrowing costs

This section examines the effects of mineral resources on short-term sovereign borrowing costs. I use 1-year government bond yields as the proxy for short-term government borrowing costs. As in short-term, budget deficit matters more, I replace government debt in equation (2a) by budget deficit (equation 2b). The sample includes 43 countries over the period 1998 – 2015. The number of observations in the regression different from the sovereign credit rating regressions due to the availability of 1-year bond yields and budget deficit variable. The estimation result from the fixed-effect panel estimation suggests that in short-term, international lenders pay less attention to sovereign credit ratings. Table 13 presents the regression results on 1-year government bond yields. Only Moody's rating is still significantly correlated to borrowing costs. Differently from long-term borrowing, lenders now pay only attention to inflation and budget deficit. When inflation rate increase 1 percent, the yields of 1-year government bond increase correspondently about 0.27 to 0.29 percent when oil rents/GDP variable along with S&P rating or Moody's rating is incorporated in the estimation, respectively. An increase of 1 percent in budget deficit is linked to a drop of 1-year government bond interest rate by 0.265 percent (with S&P rating), 0.181 percent (Fitch rating) and 0.212 percent (with Moody's rating) in the regression including oil rents/GDP variable. It indicates that to bond buyers or international lenders, deficits in short-term has positive meaning and that it does not have negatively systematic effects in long-term, the economy will recover later. In short-term, neither political factor nor any mineral resource variables have impacts on sovereign borrowing costs. The specification successfully predict about 50 percent in variation of 1-year government bond yields.

Table 14 reports the coefficients obtained by incorporating each mineral resource variable separately into equation (2b). The results from the regressions in table 13 and table 14 suggest that all resource variables (measured in term of share of GDP and per capita) do not influence on sovereign borrowing costs in short-term. The significant coefficients provide evidences that in short-term, lenders do not pay attention on mineral resource of a country and then resource variables have insignificant impacts of short-term government bond yields.

In the high-income country group (table 15), mineral rents/GDP has positive impacts on bond yields when the regression incorporates S&P and Fitch ratings. It means that the higher the mineral rents/GDP is, the higher costs the government of high-income countries have to pay for its debt obligations. Specifically, an increase of 1 percent on mineral rents/GDP rises the bond yields by 0.152 and 0.158 for S&P and Fitch rating, respectively while it have insignificantly effect when there is Moody's rating in thee regression. Total extractive activity per GDP variable interacting with S&P rating influence bond yields with 10 percent of significance level. Other resource variables do not affect bond yields of high-income countries.

In the low and middle-income countries, mineral resources do not have significant impacts on government bond yields. The regression result imply that in short-term, the 'resource curse' happen only to high-income countries. The results emphasis that the measurement unit per capita of resources negates all significant impacts of mineral resources on the price of short-term borrowing.

Table 13
Fixed-effects regression on 1-year government bond yields – All countries

Dependent variable: 1-year bond yields	**S&P**	**Fitch**	**Moody's**	**S&P**	**Fitch**	**Moody's**
Rating score	-0.130	-0.357	-0.219*	-0.128	-0.354	-0.218*
	(0.152)	(0.216)	(0.127)	(0.151)	(0.216)	(0.127)
Inflation rate	0.270**	0.270**	0.290**	0.272**	0.271**	0.291**
	(0.114)	(0.104)	(0.123)	(0.113)	(0.104)	(0.122)
GDP per capita Growth	-3.08	-4.51	-5.70	-3.28	-4.49	-5.64
	(0.065)	(0.055)	(0.058)	(0.064)	(0.055)	(0.057)
Political stability	0.066	0.684	0.523	0.0830	0.700	0.536
	-1.201	-1.139	-1.138	-1.198	-1.142	-1.136
Budget deficit	-0.265**	-0.181*	-0.212*	-0.272**	-0.195*	-0.221*
	(0.128)	(0.106)	(0.118)	(0.126)	(0.105)	(0.117)
Oil rents/GDP	0.017	-0.113	-0.091			
	(0.205)	(0.196)	(0.177)			
Total extractive activ-ity/GDP				0.068	-0.005	-0.023
				(0.111)	(0.111)	(0.096)
Constant	7.614***	11.85***	9.753***	7.401***	11.60***	9.612***
	-1.776	-3.022	-1.843	-1.784	-3.012	-1.842
Observations	422	461	409	422	461	409
R-squared	0.476	0.529	0.495	0.477	0.528	0.495
Number of Country Code	42	42	43	42	42	43

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14
Fixed-effects regression on 1-year government bond yields – All countries

Dependent variable: 1-year bond yields	S&P	Fitch	Moody's
Mineral rents/GDP	0.08	0.117	-0.008
	(0.140)	(0.113)	(0.146)
Gas rents/GDP	0.299	0.204	0.256
	(0.187)	(0.164)	(0.202)
Oil rents per capita	0.017	-0.011	-0.015
	(0.134)	(0.138)	(0.125)
Mineral rents per capita	-0.018	-0.02	-0.047
	(0.102)	(0.089)	(0.101)
Gas rents per capita	-1,335	-123.2	-1,577
	-1,537	-2,692	-1,554
Total extract activities/capita	-0.014	-0.0004	-0.036
	(0.092)	(0.085)	(0.084)

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 15
Fixed-effects regression on 1-year government bond yields

	High-income			**Low and Middle-income**		
Dependent variable: 1-year government bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Oil rents/GDP	0.105	-0.009	0.0813	0.0860	0.0811	-0.0217
	(0.120)	(0.127)	(0.105)	(0.249)	(0.264)	(0.190)
Mineral rents/GDP	0.152*	0.158***	0.101	0.349	0.318	0.0564
	(0.079)	(0.049)	(0.093)	(0.435)	(0.450)	(0.405)

Gas rents/GDP	0.039	-0.045	0.006	0.476	0.332	0.526
	(0.146)	(0.120)	(0.153)	(0.452)	(0.504)	(0.464)
Total extract activities/GDP	0.125*	0.0716	0.084	0.152	0.113	0.0474
	(0.065)	(0.059)	(0.068)	(0.180)	(0.202)	(0.146)
Oil rents per capita	-0.046	-0.051	0.008	0.796	0.762	-0.0804
	(0.111)	(0.107)	(0.11)	-1028	-1085	-1019
Mineral rents per capita	-0.061	-0.026	-0.022	0.237	0.000568	-0.276
	(0.094)	(0.079)	(0.096)	(0.409)	(0.319)	(0.682)
Gas rents per capita	8,745	4,303	8,034	-819.8	-227.1	-517.3
	-7,358	-6,694	-7,583	-1,607	-3,445	-1,633
Total extract activities per capita	-0.065	-0.029	-0.023	0.263	0.194	-0.407
	(0.083)	(0.068)	(0.081)	(0.557)	(0.601)	(0.618)

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

4.2.2.1 Indirect effects of mineral resources on short-term sovereign borrowing costs

The indirect effects of mineral resource variables on short-term sovereign borrowing costs is very small. Only the variable gas rents per capita has large impacts on bond yields due to the mean and value is very low and the coefficient is very large. However, the impact of this resource variable on government bond yields is not statistically significant.

Table 16
Indirect effects of mineral resources on 1-year government bond yields

Indirect effects on 1-year bond yields	S&P	Fitch	Moody's
Oil rents /GDP	0.001	0.009	0.001
Mineral rents/GDP	0.002	0.005	-0.00003
Gas rents/GDP	0.053	-0.057	0.046
Total extract activities/GDP	-0.001	0.008	0.0002
Oil rents per capita	0.001	0.001	-0.002
Mineral rents per capita	0.0004	0.001	0.004
Gas rents per capita	-245640	56400.96	285279.3
Total extract activities/capita	0.00005	0.00001	0.002

4.2.2.2 Robustness checks for short-term sovereign borrowing costs

This section presents robustness checks for previous estimation results on short-term sovereign borrowing costs. I proceed the checks by replacing the political stability index by government effectiveness index as well as adding several variables suggested by the literature such as agriculture value per GDP and trade value per GDP.

Appendix 10 displays the estimation results for fixed effects regression on panel data of 23 high-income countries over the period 1998 – 2015. This specification substitutes the political stability index for government effectiveness index following the papers of Afonso et al. (2009) and Gartner et al. (2011). The result indicates that government effectiveness index is positive significant while political stability is negatively but not significant correlated with short-term government bond yields. The variable growth rate of GDP per capita has negative impacts on bond yields. This implies the economic growth rate reduces the costs of borrowing. The sign and significance level of mineral rents per GDP and total extractive activity per GDP remain positive significant while the magnitude is slight different from the previous estimates reported in **table 15.**

Conclusion

The fixed-effects regression on the panel data on 42 countries over the period 1998-2015 implies that in long-term, oil rents per GDP and total extractive activity per GDP are negatively and significantly correlated to government bond yields while other mineral variables do not significantly influence the bond yields. The results imply that lenders in the international markets consider oil revenue measured in term of a share of GDP as a source of income for the loan repayment and it indicates a good sign for economic growth so they are willing to accept a lower interest rate. In contrast, resources measured in term of per capita do not have influences on 10-year bond yields. The average resource rents used by an individual do not matter while the effectiveness of oil rents and total extractive activity rents used are considered as a good sign by international lenders. The influence of mineral resources on government bonds in short-term is more complicating. Using the same sample, all mineral variables are insignificantly correlated to one-year bond yields. In the sub-sample

of 24 high-income countries over the same period, the effects of mineral variables measured in term of per capita remain insignificant while mineral rents per GDP have positive and significant impacts on the yields (in regressions with S&P rating and Fitch rating) and total extractive activity rents per GDP has positive impacts on bond yields. The results imply that the economy becomes dependent on revenue from mineral resources then it raises the risk of default in short-term. The lenders increase the price of the loans to governments in this situation.

Chapter 5
Conclusions

The impacts of mineral resources on the economy as well as on the sovereign borrowing costs is disputed in literature. This research aims to assess the effects of mineral resources on sovereign credit ratings and sovereign borrowing costs from three main international agencies (S&P, Fitch and Moody's). The paper also assesses the differentials of each type of mineral resources' effects. This study takes into account the unit of measurement and measured mineral resources in terms of a share of GDP and GDP per capita. Government bond yields in 10 years and 1 year tenor are proxies for the price of sovereign borrowing in long-term and short-term, respectively. The models examine the influences of a set of macroeconomic variables, political variables along with mineral resources on both long-term and short-term bond yields separately to distinguish the statistically significant core set of determinants of each type of borrowing costs.

To investigate the effect of mineral resources on sovereign ratings and borrowing costs, this research applies fixed effects panel data regression analysis on a sample of 157 countries over the period 1998-2015. Data used in this research comes from varied sources such as sovereign ratings from international agencies, macroeconomics, politics and mineral resource data come from the World Development Indicator (World Bank, 2017) and the Worldwide Governance Indicators (World Bank, 2017) and the International Monetary Fund (2017) and government bond yield data come from investing.com (2017). Due to variable data availability, the sample size used for each estimate regression varies. Besides the main methodology of fixed effects, I also apply random-effects ordered probit regression, random effects, including additional variables and replacing political variables to robust he regression results obtained from fixed effects estimations. Furthermore, this study also calculates the indirect impacts of mineral resources on government borrowing costs in both short-term and long-term through sovereign ratings.

The panel regression analysis implies that different types of mineral resources have different effects on sovereign ratings and sovereign borrowing costs. In sovereign rating regressions, mineral resources do not have effects on the ratings of high-income countries. The impacts on low and middle-income countries vary depending on the types and measurement units of mineral resource variables. Only mineral rents measured in terms of per GDP is positively correlated with Fitch ratings, other variables (oil and gas) have negative effects. In other words, only mineral used per unit production (measured in term of per unit of GDP) has significant impacts on credit ratings. It suggests that the effectiveness of mineral used influences the ratings of low and middle-income countries rather than high-income countries. The resources measured as per capita have insignificant impacts on ratings. Findings shed a light on the conditionalities of resource curse. The 'resource curse' only happens with gas and oil resources but not with mineral rents and only low and middle-income countries suffer. In addition, the effectiveness of mineral resource used influence ratings while mineral rents per capita show insignificant effects.

The sample used in sovereign borrowing costs consists of 42 countries over the period 1998-2015. The estimate results suggest that oil rents and total extractive activity per GDP influenced negatively and significantly on long-term government borrowing. The negative coefficients imply that in long term, oil rents and total extractive activity are considered as a positive factors which possibly contribute to the ability to repay the financial obligations of a government. Regarding short-term borrowing costs, only mineral rents per GDP and total extractive activity per GDP have positive significant influence on the government bond

yields of high-income countries in the regression with S&P rating and Fitch rating. The results imply that in short-term, the 'resource curse' occurs with high-income countries; the higher the rents of mineral resources are, the higher the interest rate they have to pay to international lenders. International lenders see mineral resource as a threat to the ability and willingness to pay of a government in short-term. The effects disappear when resources measured in term of per capita.

It is indisputable that the analysis on rating and borrowing cost often suffers from a data limitation problem. Due to the availability of government bond yields, the sample sizes decrease from about 100 countries in empirical regression on ratings to about 50 countries in analysis on borrowing costs. Hence, the actual number of observations that can be used in the empirical analysis is relatively small compared to the potentially full sample size. The study suffers from the issue of data availability, and that, to some extent, hinders the accuracy of empirical results. I expect that the data issue will be addressed in further research. In addition, the extension of this paper could be examining a different period of time. A period of crisis might especially be of interest and have different factors influencing the outcome.

Appendices

Appendix 1

Hausman test result (Sovereign Credit rating)

```
. quietly xtreg  rating1 Inflationrate GDPpercapitaGrowth  Politicalstability lny GovernmentDebt, fe

.
. est store fixed

.
. quietly xtreg  rating1  Inflationrate GDPpercapitaGrowth Politicalstability lny GovernmentDebt, re

.
. est store random

.
. hausman fixed random
```

	——— Coefficients ———			
	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
Inflationr~e	-.0163533	-.0222235	.0058701	.
GDPpercapi~h	.0240407	.0263388	-.002298	.
Politicals~y	.7926639	.7742419	.0184221	.0446647
lny	3.51502	3.154518	.3605018	.1813959
Government~t	-.0666863	-.0620114	-.0046748	.0006696

```
                b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =       95.63
              Prob>chi2 =      0.0000
              (V_b-V_B is not positive definite)

.
```

Appendix 2

Hausman test result (Sovereign Borrowing costs in long-term)

```
. quietly xtreg Bondyields rating1 Inflationrate GDPpercapitaGrowth  Politicalstability GovernmentDebt , fe

.
. est store fixed

.
. quietly xtreg Bondyields rating1 Inflationrate GDPpercapitaGrowth  Politicalstability GovernmentDebt , re

.
. est store random

.
. hausman fixed random
```

	——— Coefficients ———			
	(b) fixed	(B) random	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
rating1	-.0312866	-.477811	.4465244	.2740939
Inflationr~e	.2711479	.5638611	-.2927132	.0960921
GDPpercapi~h	-.0804724	-.0441193	-.0363531	.0530221
Politicals~y	7.796971	1.436047	6.360924	1.984399
Government~t	-.0010032	.0035213	-.0045245	.0346204

```
                b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =       29.47
              Prob>chi2 =      0.0000
```

Appendix 3

Hausman test result (Sovereign Borrowing costs in short-term)

```
. est store fixed

.
. quietly xtreg Bondyields1 rating1 Inflationrate GDPpercapitaGrowth  Politicalstability GovernmentDebt , re

.
. est store random

.
. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |    fixed        random       Difference          S.E.
-------------+------------------------------------------------------------
     rating1 |  -.0191337    -.6539313        .6347976        .4310676
Inflationr~e |   .6085356     .6819156         -.07338        .0580162
GDPpercapi~h |   .0906894     .1409733       -.0502839        .0611053
Politicals~y |   4.825238     2.142741        2.682497        1.734368
Government~t |  -.0696912    -.0147536       -.0549376        .0427432
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       15.72
                Prob>chi2 =      0.0077

.
```

Appendix 4

Correlations between political and institutional variables

.

	-1	-2	-3	-4	-5	-6
(1) Political stability	10.000					
(2) Government effectivenes	0.7274	10.000				
(3) Voice and accountability	0.6572	0.7958	10.000			
(4) Regulatory quality	0.6705	0.9275	0.8202	10.000		
(5) Rule of Law	0.7727	0.9559	0.8072	0.9138	10.000	
(6) Control of corruption	0.7588	0.9368	0.7813	0.8632	0.9495	10.000

Appendix 5

Fixed Effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	S&P	Fitch	Moody	S&P	Fitch	Moody
Inflation rate	-0.028*	-0.031**	-0.031**	-0.034*	-0.030**	-0.032**
	(0.015)	(0.012)	(0.012)	(0.017)	(0.012)	(0.012)
GDP per capita Growth	0.009	0.004	-0.001	0.011	0.006	-0.002
	(0.018)	(0.018)	(0.017)	(0.019)	(0.018)	(0.016)
Political stability	0.652**	0.752**	0.925***	0.644**	0.744**	0.921***
	(0.285)	(0.346)	(0.334)	(0.285)	(0.346)	(0.331)
ln GDP per capita	6.968***	5.105***	6.351***	6.965***	5.092***	6.397***
	(0.991)	-1.085	-1.399	(0.999)	-1.081	-1.399
Government Debt	-0.0621***	-0.053***	-0.060***	-0.062***	-0.053***	-0.060***
	(0.008)	(0.008)	(0.011)	(0.008)	(0.008)	(0.011)
Agriculture/GDP	0.099**	0.090*	0.074	0.096**	0.089*	0.08
	(0.045)	(0.046)	(0.072)	(0.048)	(0.048)	(0.074)
Oil rents/GDP	-0.015	-0.028**	-0.013			
	(0.025)	(0.014)	(0.031)			
Total extract activity/GDP				0.005	-0.020	-0.002
				(0.020)	(0.013)	(0.025)
Constant	-44.76***	-29.09***	-40.52***	-44.66***	-28.90***	-40.95***
	-8.953	-9.920	(12.72)	-9.038	-9.891	(12.73)
Observations	1,312	1,253	1,335	1,296	1,241	1,321
R-squared	0.548	0.488	0.498	0.549	0.490	0.499
Number of Country Code	104	95	108	102	94	106

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 6

Fixed Effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	**S&P**	**Fitch**	**Moody's**	**S&P**	**Fitch**	**Moody's**
Inflation rate	-0.032**	-0.03**	-0.035***	-0.038**	-0.029**	-0.036***
	(0.015)	(0.012)	(0.013)	(0.017)	(0.013)	(0.014)
GDP per capita Growth	0.014	0.006	0.001	0.015	0.007	-0.002
	(0.019)	(0.019)	(0.017)	(0.019)	(0.019)	(0.017)
Government effectiveness	1.317***	1.909***	1.775***	1.362***	1.944***	1.870***
	(0.473)	(0.481)	(0.593)	(0.478)	(0.483)	(0.592)
ln GDP per capita	6.555***	4.318***	5.869***	6.522***	4.272***	5.860***
	-1.026	-1.024	-1.394	-1.038	-1.020	-1.396
Government Debt	-0.064***	-0.056***	-0.062***	-0.064***	-0.056***	-0.062***
	(0.008)	(0.008)	(0.010)	(0.008)	(0.008)	(0.010)
Oil rents/GDP	-0.010	-0.016	-0.012			
	(0.022)	(0.013)	(0.026)			
Agriculture	0.113**	0.081*	0.089	0.109**	0.080*	0.094
	(0.0443)	(0.045)	(0.071)	(0.047)	(0.047)	(0.073)
Total extract activity/GDP				0.009	-0.010	0.003
				(0.018)	(0.013)	(0.023)
Constant	-41.43***	-22.52**	-36.57***	-41.09***	-22.07**	-36.55***
	-9.203	-9.377	(12.62)	-9.313	-9.344	(12.65)
Observations	1,272	1,225	1,304	1,256	1,213	1,29
R-squared	0.571	0.505	0.507	0.573	0.508	0.510
Number of Country Code	101	93	105	99	92	103

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 7

Fixed Effects regression on sovereign credit ratings – All countries

Dependent variable: Sovereign ratings	**S&P**	**Fitch**	**Moody's**	**S&P**	**Fitch**	**Moody's**
Inflation rate	-0.0317**	-0.0301**	-0.0349***	-0.0380**	-0.0296**	-0.0364***
	(0.0154)	(0.0124)	(0.0133)	(0.0174)	(0.0126)	(0.0136)
GDP per capita Growth	0.0118	0.00493	0.000826	0.0123	0.00615	-0.00168
	(0.0196)	(0.0194)	(0.0171)	(0.0199)	(0.0196)	(0.0168)
Government effectiveness	1.324***	1.915***	1.775***	1.369***	1.951***	1.870***
	(0.477)	(0.482)	(0.593)	(0.482)	(0.484)	(0.592)
ln GDP per capita	6.542***	4.322***	5.890***	6.521***	4.277***	5.882***
	-1.007	-1.013	-1.406	-1.021	-1.009	-1.409
Government Debt	-0.0652***	-0.0560***	-0.0624***	-0.0653***	-0.0563***	-0.0624***
	(0.00797)	(0.00782)	(0.0105)	(0.00799)	(0.00782)	(0.0105)
Oil rents/GDP	-0.0131	-0.0173	-0.0117			
	(0.0212)	(0.0135)	(0.0262)			
Agriculture	0.107**	0.0783*	0.0895	0.105**	0.0767	0.0939
	(0.0429)	(0.0446)	(0.0699)	(0.0464)	(0.0466)	(0.0724)
Trade	0.00557	0.00262	0.000144	0.00561	0.00263	5.62e-05
	(0.00531)	(0.00540)	(0.00629)	(0.00545)	(0.00547)	(0.00638)
Total extract activity/GDP				0.00767	-0.0104	0.00300
				(0.0180)	(0.0137)	(0.0236)
Constant	-41.59***	-22.68**	-36.76***	-41.37***	-22.23**	-36.75***
	-9.078	-9.332	(12.71)	-9.212	-9.304	(12.74)
Observations	1,269	1,223	1,301	1,253	1,211	1,287
R-squared	0.574	0.504	0.506	0.575	0.508	0.509
Number of Country Code	101	93	105	99	92	103

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 8

Fixed Effects regression on 10-year bond yields – All countries

Dependent variable: 10-year bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Rating	-0.488**	-0.471*	-0.375*	-0.490**	-0.477*	-0.384*
	(0.201)	(0.238)	(0.195)	(0.201)	(0.237)	(0.193)
Inflation rate	0.137**	0.123**	0.172***	0.140**	0.125**	0.173***
	(0.0600)	(0.0535)	(0.0423)	(0.0600)	(0.0537)	(0.0423)
GDP per capita Growth	-0.162***	-0.173***	-0.190***	-0.161***	-0.172***	-0.187***
	(0.0464)	(0.0534)	(0.0569)	(0.0458)	(0.0528)	(0.0559)
Government effectiveness	0.192	0.0213	-0.301	0.223	0.0681	-0.239
	(0.762)	(0.717)	(0.781)	(0.738)	(0.699)	(0.754)
Government Debt	0.00446	0.00622	0.00903	0.00386	0.00500	0.00767
	(0.0179)	(0.0161)	(0.0174)	(0.0177)	(0.0158)	(0.0169)
Oil rents/GDP	-0.194**	-0.246**	-0.231***			
	(0.0888)	(0.0928)	(0.0825)			
Total extract activity/GDP				-0.141*	-0.174*	-0.205***
				(0.0823)	(0.0887)	(0.0697)
Constant	17.38***	17.12***	14.34***	17.42***	17.26***	14.71***
	-4.166	-4.786	-3.940	-4.164	-4.785	-3.896
Observations	549	580	520	549	580	520
R-squared	0.582	0.562	0.570	0.582	0.562	0.574
Number of Country Code	46	46	46	46	46	46

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix 9

Fixed Effects regression on 10-year bond yields – All countries

Dependent variable: 10-year bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Rating	-0.493**	-0.484*	-0.395*	-0.494**	-0.489**	-0.403**
	(0.206)	(0.241)	(0.197)	(0.205)	(0.241)	(0.194)
Inflation rate	0.133**	0.119**	0.188***	0.136**	0.122**	0.191***
	(0.0631)	(0.0573)	(0.0395)	(0.0631)	(0.0579)	(0.0396)
GDP per capita Growth	-0.160***	-0.171***	-0.178***	-0.157***	-0.169***	-0.173***
	(0.0476)	(0.0546)	(0.0535)	(0.0468)	(0.0538)	(0.0518)
Government effectiveness	0.235	0.152	-0.323	0.257	0.187	-0.286
	(0.812)	(0.797)	(0.818)	(0.789)	(0.781)	(0.785)
Government Debt	0.00302	0.00431	0.00892	0.00244	0.00314	0.00780
	(0.0189)	(0.0170)	(0.0188)	(0.0186)	(0.0167)	(0.0181)
Oil rents/GDP	-0.194**	-0.248**	-0.215**			
	(0.0925)	(0.0968)	(0.0857)			
Agriculture	0.0234	0.0296	-0.279*	0.0168	0.0184	-0.301**
	(0.199)	(0.224)	(0.140)	(0.202)	(0.229)	(0.140)
Total extract activity/GDP				-0.150*	-0.184*	-0.221***
				(0.0847)	(0.0925)	(0.0737)
Constant	17.41***	17.22***	15.98***	17.47***	17.42***	16.55***
	-4.660	-5.086	-4.442	-4.652	-5.087	-4.370
Observations	521	552	492	521	552	492
R-squared	0.564	0.545	0.560	0.565	0.546	0.566
Number of Country Code	45	45	45	45	45	45

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix 5

Fixed Effects regression on 1-year bond yields – High-income countries

Dependent variable: 1-year bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Rating	-0.0566	-0.107	-0.107	-0.0580	-0.0987	-0.105
	(0.128)	(0.134)	(0.0947)	(0.122)	(0.132)	(0.0909)
Inflation rate	0.282***	0.242**	0.311***	0.297***	0.246**	0.320***
	(0.0873)	(0.0993)	(0.0848)	(0.0829)	(0.0998)	(0.0812)
GDP per capita Growth	-0.0508**	-0.0555*	-0.0534**	-0.0464*	-0.0512*	-0.0498*
	(0.0241)	(0.0274)	(0.0243)	(0.0235)	(0.0277)	(0.0248)
Government effectiveness	1.579*	2.044**	1.856**	1.537*	2.052**	1.837**
	(0.780)	(0.808)	(0.766)	(0.764)	(0.806)	(0.766)
Budget deficit	-0.0836	-0.0535	-0.0829	-0.105	-0.0674	-0.0991
	(0.0645)	(0.0570)	(0.0553)	(0.0652)	(0.0622)	(0.0579)
Mineral rents/GDP	0.157**	0.163***	0.108			
	(0.0655)	(0.0472)	(0.0773)			
Total extract activity/GDP				0.137**	0.0899	0.0962
				(0.0595)	(0.0574)	(0.0615)
Constant	3.499	3.860	4.307	3.382	3.618	4.110
	-2.645	-2.996	-2.646	-2.489	-2.884	-2.551
Observations	231	277	219	231	277	219
R-squared	0.678	0.717	0.679	0.680	0.716	0.680
Number of Country Code	23	23	23	23	23	23

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Appendix 6
Fixed Effects regression on 1-year bond yields – High-income countries

Dependent variable: 1-year bond yields	S&P	Fitch	Moody's	S&P	Fitch	Moody's
Rating	-0.0746	-0.130	-0.126	-0.0759	-0.123	-0.123
	(0.133)	(0.146)	(0.103)	(0.127)	(0.143)	(0.0987)
Inflation rate	0.281***	0.241**	0.308***	0.295***	0.244**	0.316***
	(0.0855)	(0.0959)	(0.0818)	(0.0811)	(0.0965)	(0.0783)
GDP per capita Growth	-0.0466	-0.0510	-0.0481	-0.0424	-0.0468	-0.0449
	(0.0338)	(0.0312)	(0.0327)	(0.0324)	(0.0308)	(0.0322)
Government effectiveness	1.678*	2.114**	1.961**	1.639*	2.122**	1.942**
	(0.904)	(0.845)	(0.840)	(0.890)	(0.844)	(0.841)
Budget deficit	-0.0806	-0.0479	-0.0772	-0.101	-0.0607	-0.0922
	(0.0667)	(0.0592)	(0.0582)	(0.0681)	(0.0647)	(0.0611)
Mineral rents/GDP	0.149**	0.155***	0.0979			
	(0.0666)	(0.0480)	(0.0796)			
Trade	-0.00554	-0.00847	-0.00808	-0.00554	-0.00862	-0.00789
	(0.0191)	(0.0180)	(0.0199)	(0.0187)	(0.0177)	(0.0196)
Total extract activity/GDP				0.132**	0.0828	0.0882
				(0.0560)	(0.0540)	(0.0556)
Constant	4.155	4.863	5.172	4.039	4.658	4.968
	-3.018	-3.530	-3.266	-2.849	-3.397	-3.140
Observations	231	277	219	231	277	219
R-squared	0.679	0.719	0.681	0.681	0.718	0.682
Number of Country Code	23	23	23	23	23	23

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 7

Sample of Countries in regression on sovereign credit ratings (table 5)

Albania	Dominican Republic	Latvia	Serbia
Angola	Ecuador	Lebanon	Singapore
Argentina	Egypt, Arab Rep.	Lithuania	Slovak Republic
Armenia	El Salvador	Luxembourg	Slovenia
Australia	Estonia	Malaysia	South Africa
Austria	Ethiopia	Malta	Spain
Azerbaijan	Finland	Mauritius	Sri Lanka
Bahrain	France	Mexico	Suriname
Bangladesh	Gabon	Morocco	Sweden
Barbados	Georgia	Mozambique	Switzerland
Belarus	Germany	Namibia	Thailand
Belgium	Ghana	Netherlands	Trinidad and Tobago
Belize	Greece	New Zealand	Tunisia
Bolivia	Guatemala	Nicaragua	Turkey
Botswana	Honduras	Nigeria	Ukraine
Brazil	Hungary	Norway	United Kingdom
Bulgaria	Iceland	Oman	United States
Cambodia	India	Pakistan	Uruguay
Canada	Indonesia	Panama	Venezuela, RB
Chile	Ireland	Papua New Guinea	Vietnam
China	Israel	Paraguay	
Colombia	Italy	Peru	
Congo, Dem. Rep.	Jamaica	Philippines	
Congo, Rep.	Japan	Poland	
Costa Rica	Jordan	Portugal	
Cote d'Ivoire	Kazakhstan	Qatar	
Croatia	Kenya	Romania	
Cyprus	Korea, Rep.	Russian Federation	
Czech Republic	Kuwait	Saudi Arabia	
Denmark	Kyrgyz Republic	Senegal	

Appendix 8

Sample of Countries in regression on 10-year government bond yields (table 10)

Argentina	Egypt, Arab Rep.	Japan	Russian Federation
Australia	Finland	Kenya	Singapore
Austria	France	Korea, Rep.	Slovenia
Brazil	Germany	Malaysia	South Africa
Bulgaria	Greece	Netherlands	Spain
Canada	Hungary	Norway	Sweden
Chile	Iceland	Pakistan	Switzerland
China	India	Philippines	Thailand
Colombia	Indonesia	Poland	Turkey
Croatia	Ireland	Portugal	Vietnam
Czech Republic	Israel	Qatar	
Denmark	Italy	Romania	

Appendix 9

Sample of Countries in regression on 1-year government bond yields (table 13)

Australia	Egypt, Arab Rep.	Korea, Rep.	Singapore
Austria	France	Malaysia	Spain
Belgium	Germany	Malta	Sri Lanka
Brazil	Hungary	Mauritius	Switzerland
Bulgaria	India	Mexico	Thailand
Canada	Indonesia	Norway	Turkey
Chile	Ireland	Pakistan	Ukraine
China	Israel	Philippines	United Kingdom
Colombia	Italy	Poland	United States
Croatia	Japan	Romania	Vietnam
Denmark	Kenya	Russian Federation	

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