



# How giant discoveries of natural resources impact sovereign debt ratings in developing and emerging countries ?

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### **How giant discoveries of natural resources impact sovereign debt ratings in developing and emerging countries?**

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## **Abstract**

This paper sheds light on the effects of giant discoveries of natural resources (oil natural gas, minerals) on sovereign debt ratings in the short and long run. To do so, it employs 28 developing and emerging countries over the period 1990-2014 and applies a random effect ordered Probit model on different sets of samples. It shows evidence of the differentiated effects (positive and negative) of giant discoveries on ratings. These differentiated effects are linked to the behavior of macroeconomic and political indicators resulting from the actions and policies taken in the aftermath of the discoveries. It also finds evidence of the learning effects of giant discoveries in countries with increasing sovereign debt ratings. What seems to matter is not only the resources but also how governments respond to the news of the discovery of those resources. Therefore, taking the right actions and policies will help countries to prevent a deterioration of their financial conditions.

## **Keywords**

Giant discoveries, Natural resources, Sovereign debt ratings, Developing countries, Random effect ordered response models

## **JEL Codes**

C 23, G15, Q32, Q33

## **Acknowledgments**

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# 1 Introduction

Giant natural resources discoveries worldwide have generally led first to jubilation, and more often turned into disappointments after that, in line with the so-called "Dutch Disease".<sup>1</sup> The exuberance duration is generally linked to the actions and policies that the country authorities will undertake in the aftermath of the discovery. Still, they may also depend on the country's structural and institutional characteristics. Although relevant for growth, institutional factors, exchange rate, and industrialization, giant discoveries also matter for the terms under which countries have access to international capital markets. Indeed, there are regularly giant discoveries of natural resources worldwide, and many of the resources-rich countries have encountered periods of access to international markets and periods of financial turmoil. However, the existing literature on giant discoveries has overlooked their effects on the financial conditions, especially on the long-term sovereign debt ratings. Should we expect an improvement or a deterioration in financial conditions in the years following the discoveries? This paper provides an answer to this question. It shows that while some countries could improve their financial conditions in the aftermath of giant discoveries, others could experience a deterioration. These differentiated effects depend on the behavior of many macroeconomic and political indicators resulting from the actions and policies taken in the discoveries' aftermath. What seems to matter is not only the resources but also how authorities respond to the news of the discovery of those resources.

Some case studies drive my assumptions. The case of Ghana illustrates the failures. Indeed, Ghana had two giant discoveries in 2007 and 2010, summing up to 2 billion barrels of oil equivalent (boe). At this time, governments and citizens alike were jubilant, anticipating the prosperity these discoveries herald, and the former Ghanaian President, John Kufuor, proclaimed in 2007, "Even without oil we are doing well ... With oil as a

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<sup>1</sup>The papers supporting the Dutch disease include, among others, [Sachs and Warner \(1995, 2001\)](#); [Kretzmann and Nooruddin \(2005\)](#); [Ross \(2004, 2006\)](#); [Van Der Ploeg \(2011\)](#); [Keen \(2012\)](#); [Van Der Ploeg and Poelhekke \(2017\)](#); [Corden and Neary \(1982\)](#); [Collier and Hoeffler \(2005\)](#). They show that natural resources are generally associated with the deterioration of economic and institutional conditions, the occurrence of conflicts, an appreciation of real exchange rate which induces a loss of competitiveness and a de-industrialization of the economy, as well as with weak fiscal policy stance and unsustainable debt accumulation.

shot in the arm, we are going to fly”. Unfortunately, fast-forward to today, Ghana is not flying. Growth dropped below 4% between 2014 and 2016, the lowest in 20 years; debt increased by 14 percentage points (pp.) of GDP in 2014 and remained above 70% of GDP since then, and financial conditions quickly deteriorated, as illustrated by the \$1 billion emergency loan as part of an IMF-supported program requested in 2015 by the Ghanaian’s authorities. The jubilation ends because of economic imprudence and bad luck: profligate spending, heavy borrowing (over this period, Ghana borrowed \$4.5 billion on international markets and saved \$484 million in oil revenues for a rainy day), and oil price bust of 2014 ([Bawumia and Halland, 2017](#)). Other countries like Mozambique, Sierra Leone, and Uganda experienced a deterioration of their financial conditions, and growth falls in the aftermath of the giant discoveries because of miscalculated anticipations and disastrous decisions related to off-budget government borrowing ([Khan et al., 2016](#)).

Fortunately, the picture also appears bifurcated. Some success stories give hope to countries in which giant discoveries are found. Botswana is one of the successful countries reliant on natural resources. Since the discoveries of diamond in the late 1960s and early 1980s, Botswana has rapidly improved its economic, social, and institutional environment and has become a middle-income country. Since then, Botswana has benefited from good financial conditions and permanent access to the international market. As an illustration, the sovereign rating on Botswana’s long-term debt has always been classified in the upper-medium investment grade by Standard and Poor since 2001. Despite consistent access to the international market, Botswana has developed a domestic capital market since 1989, becoming the Botswana Stock Exchange in 1995. Over the years, the domestic stock market has grown tremendously. As the regulatory environment has improved, new products have been introduced, and various outreach programs have been implemented to attract issuers and investors. Botswana overcame the resource curse’s threat mostly by government investment in public goods and infrastructures, by measures taken to boost productivity, by establishing savings funds to smooth the economy during financial turmoil, and because of the good governance pursued by the authorities. It has been able to reinvest in improving health and education through a lack of unnecessary public spending, low inflation, or an increase in foreign reserves while avoiding over-indebtedness issues ([Acemoglu et al., 2003](#); [Leith, 2005](#)). Taking stock of these case

studies, I assume that giant discoveries of natural resources may have a dual effect on countries' financial conditions, and their effects depend on how authorities respond to the news of the discovery of those resources.

Then, this paper is related to two strands of literature. The first strand of papers describes the effects of giant discoveries on several macroeconomic indicators and policies, institutions, and conflicts. They generally point out to negative impacts of giant discoveries, notably a deterioration of the fiscal policy and increase in debt level associated with the rising likelihood of crises ([Kretzmann and Nooruddin, 2005](#)), an overvaluation of exchange rate ([Harding et al., 2020](#)), an increase of the incidence of armed conflicts and change of institutional framework towards autocracy ([Lei and Michaels, 2014](#); [Tsui, 2011](#)), and an increase in both poverty and inequality ([Smith and Wills, 2018](#)). Few papers point out to positive or ambiguous effects of giant discoveries. They find that oil and gas giant discoveries favor an increase of more stable funds like foreign direct investments in non-resource sectors ([Toews and Vezina, 2017](#)). Also, after discoveries, the current account and saving rate decline for the first five years and then rise sharply during the ensuing years; investment rises robustly soon after the news arrives, while GDP does not increase until the fifth year; employment rates fall slightly for a sustained period ([Arezki et al., 2017](#)). This literature on giant discoveries does not directly analyze their effects on the financial conditions of countries.

The second strand of papers looks at the determinants of financial conditions proxied by either sovereign spreads of interest rates or sovereign debt ratings.<sup>2</sup> In this literature, [Hooper \(2015\)](#) is the paper closely related to my analysis; however, it studies how oil and gas reserves affect sovereign spreads instead of giant discoveries. It finds that oil reserves increase sovereign spreads while gas reserves lower them and that financial markets' reactions also depend on institutional quality. The paper sustains that oil and gas reserves may facilitate access to international financial markets since they can be used as collaterals. An argument that is also shared by [Manzano and Rigobon \(2001\)](#) and [Melina et al. \(2016\)](#).

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<sup>2</sup>According to [Cantor and Packer \(2011\)](#) and [Chen et al. \(2016\)](#), sovereign debt ratings are defined as an assessment of the relative likelihood that a borrower will default on its obligation. They incorporate a combination of economic, social, and political factors to assess a country's capacity and willingness to honor its current and future debt obligations in full and on time.

Three categories of determinants of sovereign debt ratings are identified in the existing literature. The first category includes the macroeconomic factors: higher income per capita, lower inflation, higher GDP growth, higher fiscal base, lower external debt and higher investment are positively associated with financial conditions (see, e.g. [Cantor and Packer, 2011](#); [Larraín et al., 1997](#); [Bissoondoyal-Bheenick, 2005](#); [Mellios and Paget-Blanc, 2006](#); [Depken et al., 2011](#); [Afonso et al., 2011](#); [Jaramillo and Tejada, 2011](#); [Erdem and Varli, 2014](#)). The second category includes institutional factors: greater political stability, lower corruption, absence of violence and terrorism and no default history are positively associated with financial conditions (see, e.g. [Cantor and Packer, 2011](#); [Afonso et al., 2011](#); [Mellios and Paget-Blanc, 2006](#); [Teixeira et al., 2018](#); [Depken et al., 2011](#); [Erdem and Varli, 2014](#); [Andreasen and Valenzuela, 2016](#)). The third category includes external factors: good terms of trade and sustained exports are positively associated with financial conditions (see, e.g. [Mellios and Paget-Blanc, 2006](#); [Hilscher and Nosbusch, 2010](#); [Erdem and Varli, 2014](#)).

My paper reconciles the two strands of literature by looking at the effects of giant discoveries on countries' sovereign debt ratings. Giant discoveries are included as a critical determinant of sovereign debt ratings. I assume that natural resources discoveries could favor access to international markets, on one side, and lead to excessive debt, borrowing, and off-budget activities on the other side. Consequently, the effects of giant discoveries on financial conditions may be ambiguous. I assume that the effects will depend on the country's authorities' actions and policies in the aftermath of discoveries. To answer these research questions, I use a sample of 28 developing and emerging countries from 1990 to 2014.<sup>3</sup> I divide these countries into two groups of countries in which sovereign ratings tend to improve or deteriorate in the aftermath of giant discoveries, based on the stylized facts.<sup>4</sup> I then estimate on the different samples, a random-effects ordered Probit model following [Afonso et al. \(2009\)](#) and [Teixeira et al. \(2018\)](#), where the dependent

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<sup>3</sup>The size of the sample is constrained by the availability of data on both sovereign debt ratings and giant discoveries.

<sup>4</sup>I further discuss more extensively the subdivision of the sample in the [Section 2](#). Countries with increasing sovereign ratings that I qualify as "up" sample include Bolivia, Brazil, China, Ecuador, India, Indonesia, Kazakhstan, Mongolia, Pakistan, Peru, Philippines, Romania, Turkey. Countries with decreasing sovereign ratings that I qualify as "down" sample include Argentina, Azerbaijan, Colombia, Egypt, Ghana, Guatemala, Mexico, Mozambique, Malaysia, Russia, South Africa, Thailand, Venezuela, Vietnam.



variable is the foreign currency long term sovereign debt rating (from [Kose et al., 2018](#)), the variable of interest is giant discoveries of natural resources (from [Horn, 2011](#), and [MinExConsultingDatasets \(2014\)](#)), and the control variables are some macroeconomic, institutional, and external determinants in line with the literature. Following [Arezki et al. \(2017\)](#), I consider different time horizons that allow me to differentiate the effects of giant discoveries in the short, medium, and long term.

After controlling for the variables on the determinants of sovereign debt ratings, I find that giant discoveries lead to differentiated effects. Some countries experience an improvement in their sovereign ratings while others experience a deterioration. This finding reveals that the outcome of giant discoveries on ratings is sensitive to the group of countries studied. My results show that, when considering the full sample, giant discoveries of natural resources deteriorate sovereign debt ratings over the medium and long term. In the set of countries with increasing ratings (Up sample) of 13 countries, I find that giant discoveries are associated with a deterioration of sovereign debt ratings in the short-term while they improve them in the medium and long term. In the set of decreasing ratings (Down sample) of 15 countries, I show that giant discoveries have no effect in the short term but have significant negative impacts in the medium and long term. These results point out to the differentiated effects of giant discoveries. These findings are robust to changing control variables and dropping the extreme values of ratings. Moreover, when including the history of past-giant discoveries, I find the evidence of possible learning effects of giant discoveries in countries with increasing sovereign debt ratings. Indeed, past-discoveries' history is positively associated with sovereign debt ratings, which is not the case for countries with decreasing ratings. This result suggests that while some countries have learned from the past, others have remained at least identical, taking the same actions and policies following discoveries.

More interestingly, I analyze why giant discoveries may have differentiated effects on countries. Then, I investigate the effects of giant discoveries on several macroeconomic and institutional variables in the two sets of countries. I show that in countries with improving sovereign debt ratings, on average, over ten years following giant discoveries, giant discoveries are also associated with an increase of tax revenues in percent of GDP, a decrease of public debt, an improvement of financial markets development and total

investments, and an enhancement of the government stability index. In contrast, in countries with decreasing ratings following giant discoveries, giant discoveries are associated with a reduction of total investments, and a deterioration of the institutional quality through a worsening of the corruption's level. My findings call for a careful assessment of the macroeconomic conditions and decisions that governments may undertake in the aftermath of giant discoveries. What seems to matter is not only the resources but also how governments respond to the news of the discovery of those resources. Many countries are about to find giant discoveries; then, if they want to enjoy the benefits of good luck for many years, they need to take the right actions and policies.

The rest of the paper is organized as follows. [Section 2](#) describes data and stylized facts. In [Section 3](#), I present the methodology. [Section 4](#) displays the benchmark results. In [Section 5](#), I describe whether my results are robust. [Section 6](#) discusses the main transmission channels, and [Section 7](#) concludes.

## 2 Data and Stylized facts

### 2.1 Data

This study covers 28 developing and emerging countries over the period 1990-2014.<sup>56</sup> This sample is obtained given the availability of data, including in the regression analysis. I use as dependent variable the foreign currency long-term sovereign debt ratings from [Kose et al. \(2018\)](#). This variable captures the market perception of a government's creditworthiness, as established by credit rating agencies, including Standard & Poor's, Moody's, and Fitch Ratings ([Afonso et al., 2011](#); [Reusens and Croux, 2017](#)). According to [Cantor and Packer \(2011\)](#) and [Chen et al. \(2016\)](#), sovereign debt ratings are defined as an assessment of the relative likelihood that a borrower will default on its obligation. They incorporate a combination of economic, social, and political factors to assess a country's capacity and willingness to honor its current and future debt obligations in full and on

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<sup>56</sup>I drop all developed countries from the analysis as they exhibit strong governments' ratings. Moreover, this allows me to increase the homogeneity of the sample. Giant discoveries data are used since 1970 to also account for their long-run effects.

<sup>6</sup>As we will see in the next section, this set of 28 countries can be divided into two groups: (i) countries with increasing ratings following giant discoveries, and (ii) countries with decreasing ratings following giant discoveries.

time. Its values range from 1, reflecting the worst financial conditions, to 21, reflecting the best financial conditions.<sup>7</sup>

The variable of interest is giant discoveries of oil, natural gas, and minerals. Giant discoveries of oil and gas are from [Horn \(2011\)](#). They define them as a discovery with a recoverable volume of at least 500 million barrels of ultimately recoverable oil equivalent (boe). Giant discoveries of minerals are from Minex Consulting Datasets and encompass the giant and super-giant discoveries, following their definition and criteria.<sup>8</sup> Besides, giant discoveries of natural resources exhibit three essential features worth noting: the relatively significant size, the production lag, and the plausible exogenous timing of discoveries. First, giant discoveries represent a substantial amount of natural resources revenues for a specific country; therefore, they can significantly impact countries' behavior and trajectory. Second, giant oil discoveries do not immediately translate into production. Indeed, there is a significant delay between the announcement of the discovery and the start of the production, four to six years after the discovery, which requires considerable investments. Third, the timing of giant oil discoveries is plausibly exogenous and unpredictable due to the uncertain nature of oil exploration (see, [Arezki et al., 2017](#); [Khan et al., 2016](#)). Given that, it is reliable to treat giant discoveries as quasi-natural experience. They can be considered as exogenous shocks with huge macroeconomic and political implications for countries, notably for sovereign debt ratings.

The set of control variables used include macroeconomic, external, and institutional variables critical for sovereign ratings, in line with the literature. All the data and their sources are reported in [table A.4](#), and [tables B.7](#) and [B.8](#) present the summary statistics.

## 2.2 Stylized facts

### 2.2.1 *Evolution of giant discoveries and distribution of sovereign debt ratings*

I present in [fig. 1](#) some statistics on giant discoveries and sovereign debt ratings in the set of 28 countries. First, [fig. 1](#) (A) shows the evolution over time of the number of countries in which giant discoveries were found. In all years, giant discoveries were found in at least two countries. The years where giant discoveries were found in many countries

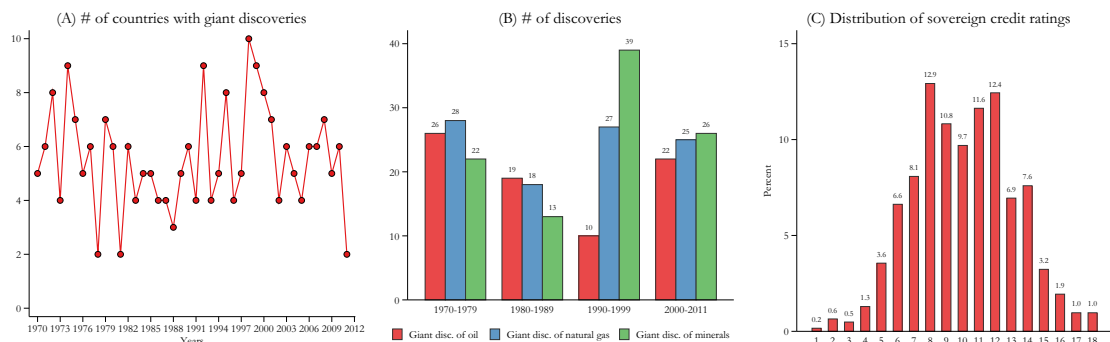
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<sup>7</sup>The different rating categories are reported in [table B.5](#).

<sup>8</sup>The different value of minerals discoveries are reported in [table B.6](#)

include 1998 (10 countries), 1974, 1992, 1999 (9 countries), and in few countries include 1978, 1981, 2011 (2 countries). Overall, the number of countries where giant discoveries were found follows a downward trend from 1970 to 1988 and 1998 to 2011, and an upward trend from 1988 to 1998. Second, [fig. 1 \(B\)](#) presents the number of giant discoveries by types of natural resources and by decades. It shows that giant discoveries of oil, natural gas, and minerals have been widespread over decades, concentrated in the 1970s, the 1990s (except for oil), and the 2000s. During the 1980s, they were relatively few discoveries of oil, natural gas, and minerals. Third, [fig. 1 \(C\)](#) presents the distribution of sovereign debt ratings over the period 1990-2016. It shows that few country-year observations had a rating located in the tails of the distribution, namely the categories of default (1-2), high default risk (3-5), strong payment capacity (15-17), and high credit quality (18). They were concentrated in the middle categories, namely high speculative (6-8), speculative (9-11), and adequate payment capacity (12-14).

Figure 1: Giant discoveries and sovereign debt ratings



Notes: Panel (A) shows the evolution of countries in which giant discoveries were found over time. Panel (B) presents the number of giant discoveries by types of natural resources and by decades. Panel (C) plots the distribution of sovereign debt ratings over the period 1990-2010.

### 2.2.2 Evolution of sovereign debt ratings following giant discoveries, and justification of sample's subdivision

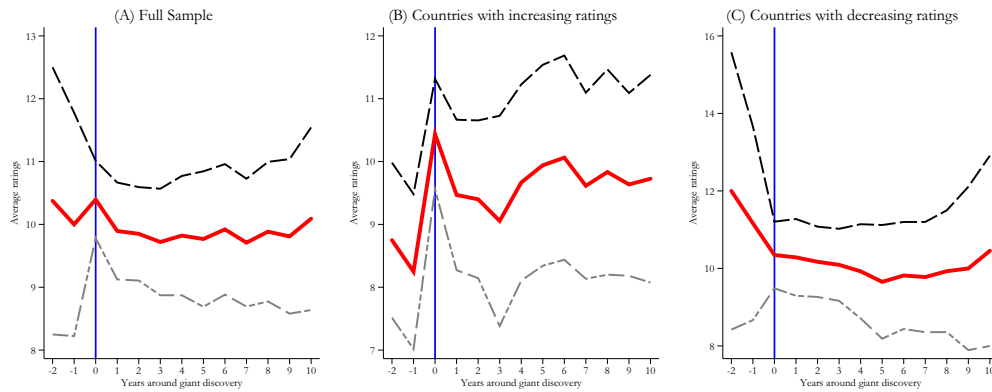
As noted in [section 1](#), giant discoveries can have both a positive and negative effect on sovereign debt ratings. Therefore, I look at the evolution of sovereign debt ratings following giant discoveries for each of the 28 countries. I report the findings for eight countries in [fig. B.4](#) as an illustration. One can notice that sovereign debt ratings increase in the aftermath of giant discoveries for India, Peru, the Philippines, and Romania (Panel

A) while they decrease for Egypt, Colombia, South Africa, and Venezuela (Panel B). This sustains that giant discoveries may have differentiated effects in different countries. Based on the graphical analysis, I identify two groups of countries: (i) 13 countries with increasing sovereign debt ratings following giant discoveries (Bolivia, Brazil, China, Ecuador, India, Indonesia, Kazakhstan, Mongolia, Pakistan, Peru, Philippines, Romania, Turkey), denominated hereafter as "Up sample"; and (ii) 15 countries with decreasing sovereign debt ratings following giant discoveries (Argentina, Azerbaijan, Colombia, Egypt, Ghana, Guatemala, Mexico, Mozambique, Malaysia, Russia, South Africa, Thailand, Turkmenistan, Venezuela, Vietnam), denominated hereafter as "Down sample".<sup>9</sup> In [fig. 2](#), I plot the average dynamics of sovereign debt ratings from 2 years before giant discoveries to up to 10 years after the discoveries for the full sample (Panel A), the Up sample (Panel B), and the Down sample (Panel C). In the full sample, sovereign debt ratings tend to moderately decrease in the aftermath of giant discoveries and remain around 10. In the up sample, sovereign debt ratings are around 8 the year before the giant discoveries, jump to more than 10 and remains close to this level in the aftermath of giant discoveries. In the Down sample, sovereign debt ratings are around 12 before giant discoveries, fall to approximately 10, and remain close to this level in the aftermath of giant discoveries. Given that, I employ in the next section a more comprehensive methodology to explain the effects of giant discoveries on sovereign debt ratings after controlling for other determinants. Throughout the paper, I will present the results for the full sample and the two sets of up and down samples.

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<sup>9</sup>This subdivision is also supported by empirical tests. First, I include a dummy Updown taking the value of one if the country belongs to the set of Up countries and zero if it belongs to the set of Down countries. This dummy is significant, which shows that the level of sovereign ratings is different across the two subsamples. Second and more importantly, I interact this dummy Updown with the dummy of giant discoveries. I also include these dummies in the regressions. Here also, the interactive term is significant, which supports the differentiated effects of giant discoveries across the two subsamples. The results are available upon request. In the rest of the paper, I apply my model on the two subsamples Up and Down to account for not only for the differentiated effects of giant discoveries, but also for the differentiated effects of covariates, between the two subsamples.

Figure 2: Evolution path of rating around the moment of giant discoveries



Notes: This figure shows the dynamics of sovereign debt ratings from 2 years before giant discoveries to 10 years after for the full sample (Panel A), the up sample (Panel B, countries with increasing ratings), and the Down sample (Panel C, countries with decreasing ratings).

### 2.3 Differences in characteristics between countries in up and down samples

In [table B.8](#), I report the difference in characteristics between countries in the up and down samples. First, it reveals that these two countries' groups have no significant differences in terms of giant discoveries, history of giant discoveries, history of default, reserves, current account balance, exchange rate, and financial openness. Second, sovereign debt ratings, natural resources rents, the volatility of growth, and quality of institutions (ICRG index, political rights index, internal conflicts index) are, on average lower in the up sample than in the down sample. Third, the level of development (real GDP), total investments, and public debt are higher in the up sample compared to the down sample. These findings suggest that while the two sets of countries have some common characteristics, they are also different for many other variables. Therefore, I control for all these characteristics in the regression analysis.

## 3 Methodology

My empirical strategy follows closely [Afonso et al. \(2009\)](#); [Depken et al. \(2011\)](#); [Erdem and Varli \(2014\)](#) and [Teixeira et al. \(2018\)](#). Given the nature of the sovereign debt ratings used as a dependent, I employ a random effects ordered probit model and assume that rating agencies make a continuous evaluation of a country's creditworthiness,

embodied in an unobserved latent variable  $R_{i,t}^*$ . Therefore, the model can be specified as follows

$$R_{i,t}^* = \alpha_0 + \beta^T D_i^T + X_{i,t-1}\theta + \sigma_t + \alpha_i + \varepsilon_{i,t} \quad (1)$$

where,  $R_{i,t}$  is sovereign debt ratings with different cut-off points  $\mu_i$ . Indeed, while random effects assume that the disturbances  $\mu_i$  are independent across time, and are not correlated with the explanatory variables, fixed-effects contrarily assume possible correlation with explanatory variables. However, the latter model presents some issues since it fails estimating time-invariant covariates coefficients, and also is limited by the incidental parameters problem. (Wooldridge, 2019). In this context, I apply the Hausman test to choose the more appropriate model between fixed effect and random effect models. I obtain a negative statistic,<sup>10</sup> and I follow Greene (2005) chap.9 to interpret this result. He shows that in the presence of a negative statistic, we cannot reject the random effects model. Consequently, I use in this paper the random effects ordered Probit model, which seems to be the most convenient way to make this analysis, and which is also the most widely used in the literature on the analysis of the determinants of sovereign debt ratings.

$D_i^T$  is a dummy that takes the value one over a specified horizon  $T$  following the giant discoveries and zero otherwise. I consider five different horizons to capture the effects in the short-, medium-, and long-run: (i) from the year of discovery to up to 2 years after, (ii) between 3 and 5 years after the discovery, (iii) from the year of discovery to up to 5 years after, (iv) between 6 and 10 years after the discovery, and (v) from the year of discovery to up to 10 years after. Therefore, the effects of giant discoveries on sovereign debt ratings over the different horizons  $T$  is captured by the coefficients  $\beta^T$ . I expect  $\beta^T$  to vary over the different horizons  $T$ , in line with Arezki et al. (2017); Khan et al. (2016), and across the different sets of samples (full, up, and down samples).  $X_{i,t-1}$  is a set of control variables comprising macroeconomic, external, and institutional determinants of sovereign debt ratings, included with a one-year lag to limit reverse causality issues.  $\sigma_t$  describes time fixed effects capturing the common shocks affecting countries like the global financial

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<sup>10</sup>which could be due to the small sample of our study, according to Mora (2006)

crisis of 2008-09.  $\alpha_i$  is the country-specific effect and  $\varepsilon_{i,t}$  is the idiosyncratic error term.<sup>11</sup>

<sup>12</sup>  $\alpha_0$  is an intercept. Given the specification, I assume that the probabilities for each level of sovereign debt ratings follow a normal distribution, which allows calculating the different cut-off points  $\mu_i$  of the latent variables  $R_{i,t}^*$  described as follows

$$R_{i,t} = \begin{cases} 1 & \text{if } R_{i,t}^* \leq \mu_1 \\ 2 & \text{if } \mu_1 < R_{i,t}^* \leq \mu_2 \\ 3 & \text{if } \mu_2 < R_{i,t}^* \leq \mu_3 \\ \vdots & \\ 18 & \text{if } \mu_{17} < R_{i,t}^* \end{cases} \quad (2)$$

I use log-likelihood maximization to estimate the parameters and cut-off points of the eq. (3). Following Cantor and Packer (2011); Bissoondoyal-Bheenick (2005); Mellios and Paget-Blanc (2006); Depken et al. (2011); Afonso et al. (2011); Hilscher and Nosbusch (2010) and Erdem and Varli (2014), I use a set of control variables  $X_{i,t-1}$ , macroeconomic variables: (i) natural resources rents, (ii) log of real GDP, (iii) volatility of growth, (iv) total investments, (v) public debt, and (vi) history of default; external variables: (vi) international reserves, (vii) current account balance, (viii) log. of exchange rate, and (ix) financial openness index; and an institutional variable: (xi) ICRG index.

## 4 Results

In this section, I discuss the benchmark results. I first discuss the effects of giant discoveries on sovereign debt ratings for the full sample (see, table 1) before turning to the differentiated effects in the up (see, table 2) and down (see, table 3) samples. For each sample of countries, I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: from the year of discovery to up to 2 years after (column 1), between 3 and 5 years after the discovery (column 2), from the year of

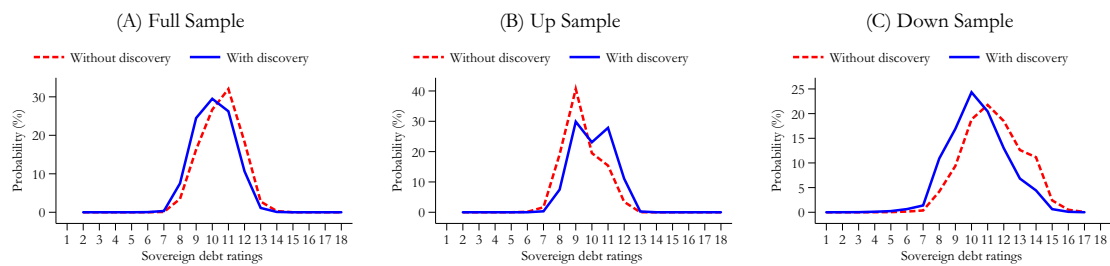
<sup>11</sup>  $\alpha_i$  and  $\varepsilon_{i,t}$  constitute the random effects.

<sup>12</sup> To capture the possible differences in terms of ratings across regions, I also include regional dummies (Africa, Asia, Latin America) in the analysis. These dummies are not significant; hence they are excluded from the analysis.



discovery to up to 5 years after (column 3), between 6 and 10 years after the discovery (column 4), and from the year of discovery to up to 10 years after (column 5). I also report for each sample, the predicted probabilities for each level of sovereign ratings over the 10 years following giant discoveries and periods with no giant discoveries in [table B.10](#), in order to quantify the results. The [fig. 3](#) displays them graphically.<sup>13 14</sup>

Figure 3: Predicted probabilities of sovereign debt ratings



Notes: This figures plots the predicted probabilities for each level of sovereign ratings in the 10 years following giant discoveries (blue and solid lines) and in periods with no giant discoveries (dashed and red lines), based on columns 5 of [table 1](#) (Panel A), [table 2](#) (Panel B) [table 3](#) (Panel C).

#### 4.1 Effects of giant discoveries in the full sample

In the full sample of 28 countries (see, [table 1](#)), I find that giant discoveries have no significant effect on sovereign debt ratings over the 2 years (column 1), from the year 3 to up to 5 years (column 2), and the year 6 to up to 10 years (column 4), following the discoveries. However, this effect is negative and significant over the 5 (column 3) and 10 (column 5) years following the discoveries. As found by [Arezki et al. \(2017\)](#) and [Khan et al. \(2016\)](#) for other variables, this finding suggests that it may take some time to have significant effects of giant discoveries on sovereign debt ratings, in line with the delay in the production of the resources. Moreover, this could reflect that the financial markets fail to anticipate the effects of giant discoveries on sovereign ratings in the short run.

<sup>13</sup>The following results show that the information criteria (AIC, BIC) are lower in the up and down samples compared to the full sample, and the log-likelihoods for regressions are higher in the up and down samples compared to the full sample. These findings show that the choice of splitting the results across the up and down samples instead of the full sample is improving the specifications and the results.

<sup>14</sup>In [table B.9](#), the results without control variables are reported. It generally leads to similar results than the results found when control are added.

Table 1: Benchmark results for Full sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.067 (0.112)	-0.122 (0.111)	-0.205* (0.116)	-0.040 (0.119)	-0.389*** (0.147)
<b>Natural ressources rents, one-year lag</b>	-0.038*** (0.014)	-0.037*** (0.014)	-0.038*** (0.014)	-0.037*** (0.014)	-0.036** (0.014)
<b>Log of real GDP, one-year lag</b>	0.571*** (0.200)	0.567*** (0.201)	0.585*** (0.202)	0.563*** (0.200)	0.582*** (0.202)
<b>Volatility of growth, one-year lag</b>	-0.105** (0.043)	-0.105** (0.043)	-0.099** (0.043)	-0.107** (0.043)	-0.093** (0.043)
<b>Total investments, one-year lag</b>	0.067*** (0.016)	0.067*** (0.016)	0.069*** (0.017)	0.067*** (0.016)	0.073*** (0.017)
<b>Public debt, one-year lag</b>	-0.025*** (0.004)	-0.025*** (0.004)	-0.025*** (0.004)	-0.026*** (0.004)	-0.025*** (0.004)
<b>History of default, one-year lag</b>	-0.794*** (0.205)	-0.769*** (0.205)	-0.796*** (0.205)	-0.783*** (0.204)	-0.811*** (0.205)
<b>Reserves, one-year lag</b>	0.055*** (0.009)	0.054*** (0.009)	0.055*** (0.009)	0.054*** (0.009)	0.054*** (0.009)
<b>Current account balance, one-year lag</b>	0.004 (0.010)	0.005 (0.010)	0.004 (0.010)	0.005 (0.010)	0.006 (0.010)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.216*** (0.042)	0.219*** (0.042)	0.222*** (0.043)	0.215*** (0.042)	0.223*** (0.043)
<b>Financial openness index, one-year lag</b>	1.979*** (0.270)	1.999*** (0.270)	2.014*** (0.271)	1.972*** (0.270)	1.979*** (0.270)
<b>ICRG index, one-year lag</b>	4.192*** (0.720)	4.233*** (0.722)	4.336*** (0.726)	4.174*** (0.719)	4.503*** (0.731)
<b>Constant</b>	2.793*** (0.862)	2.837*** (0.875)	2.853*** (0.878)	2.794*** (0.863)	2.870*** (0.883)
<b>Observations</b>	567	567	567	567	567
<b>AIC</b>	1900.4	1899.6	1897.6	1900.7	1893.7
<b>BIC</b>	2139.1	2138.3	2136.3	2139.4	2132.5
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-895.2	-894.8	-893.8	-895.3	-891.9

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

As the coefficients cannot be interpreted, I plot the probabilities associated with each level of sovereign debt ratings in the 10 years following discoveries and periods without discoveries in [fig. 3 \(A\)](#), based on column 5 of [table 1](#). It reveals that the probability of having a rating inferior or equal to 10 (bad ratings) is higher when countries have giant discoveries than do not. In contrast, the likelihood of having a rating superior or equal to 11 (good ratings) is lower when countries have giant discoveries than do not. For instance, the probability of having a rating of 9 (speculative) is 24.5% in countries with giant discoveries, while it is 16.3% in countries without giant discoveries. The probability

of having a rating of 12 (adequate payment capacity) is 10.7% in countries with giant discoveries, while it is 18.3% in countries without giant discoveries. This shows that having a giant discovery downgrades the probabilities of having relatively good ratings in the 10 years following the discoveries.

## 4.2 Effects of giant discoveries in the up sample

In the up sample of 13 countries (see, [table 2](#)), I find that giant discoveries are negatively associated with sovereign debt ratings the first two years following discoveries and have no significant effects from the year 3 to up to 5 years, and over the five years, following the discoveries. From year 6 to up to 10 years and over the 10 years following the discoveries, the effects are positive and significant, confirming the stylized facts in [section 2.2](#). This finding shows that after controlling for other determinants of sovereign ratings, giant discoveries significantly increase sovereign debt ratings in the long run for some countries.

The probabilities associated with each level of sovereign debt ratings in the 10 years following discoveries and periods without discoveries in [fig. 3 \(B\)](#), based on column 5 of [table 2](#). This chart shows that the probability of having a rating inferior or equal to 10 (bad ratings) is lower when countries have giant discoveries than do not. However, the likelihood of having a rating superior or equal to 11 (good ratings) is higher when countries have giant discoveries than do not. For instance, the probability of having a rating of 9 (speculative) is 29.9% in countries with giant discoveries, while it is 40.7% in countries without giant discoveries. The probability of having a rating of 12 (adequate payment capacity) is 11.1% in countries with giant discoveries, while it is 3.4% in countries without giant discoveries. This finding is opposite to what I found in the full sample, which falls short of capturing the differentiated effects. Next, I further investigate the effects of giant discoveries in the sample of down countries.

## 4.3 Effects of giant discoveries in the down sample

In the down sample of 15 countries (see, [table 3](#)), I find that giant discoveries have no significant effect on sovereign debt ratings over the 2 and 5 years following the discoveries. However, the effect is significant and negative for the horizons, from the year 3 to up to 5 years, from the year 6 to up to 10 years, and over the 10 years, following the

Table 2: Benchmark results for Up sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.447** (0.200)	0.264 (0.181)	-0.119 (0.196)	0.539*** (0.191)	0.609*** (0.228)
<b>Natural ressources rents, one-year lag</b>	-0.062*** (0.020)	-0.063*** (0.020)	-0.063*** (0.020)	-0.068*** (0.020)	-0.070*** (0.020)
<b>Log of real GDP, one-year lag</b>	1.131*** (0.353)	1.071*** (0.350)	1.084*** (0.355)	1.159*** (0.363)	1.089*** (0.358)
<b>Volatility of growth, one-year lag</b>	-0.276*** (0.074)	-0.317*** (0.071)	-0.309*** (0.073)	-0.298*** (0.072)	-0.349*** (0.072)
<b>Total investments, one-year lag</b>	0.066** (0.032)	0.060* (0.032)	0.066** (0.032)	0.051 (0.032)	0.038 (0.033)
<b>Public debt, one-year lag</b>	-0.025*** (0.008)	-0.025*** (0.008)	-0.024*** (0.008)	-0.023*** (0.008)	-0.024*** (0.008)
<b>History of default, one-year lag</b>	-0.571 (0.362)	-0.521 (0.361)	-0.457 (0.359)	-0.457 (0.363)	-0.450 (0.364)
<b>Reserves, one-year lag</b>	0.023 (0.015)	0.025* (0.015)	0.023 (0.015)	0.023 (0.015)	0.026* (0.015)
<b>Current account balance, one-year lag</b>	-0.012 (0.022)	-0.016 (0.022)	-0.013 (0.022)	-0.013 (0.022)	-0.020 (0.022)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.332*** (0.059)	0.318*** (0.059)	0.334*** (0.059)	0.341*** (0.059)	0.313*** (0.058)
<b>Financial openness index, one-year lag</b>	2.050*** (0.509)	2.005*** (0.508)	1.912*** (0.505)	2.174*** (0.516)	2.232*** (0.520)
<b>ICRG index, one-year lag</b>	5.707*** (0.921)	5.452*** (0.917)	5.613*** (0.925)	5.621*** (0.919)	5.213*** (0.924)
<b>Constant</b>	4.890** (2.155)	4.818** (2.127)	4.962** (2.188)	5.209** (2.296)	5.097** (2.249)
<b>Observations</b>	274	274	274	274	274
<b>AIC</b>	876.4	879.3	881.1	873.4	874.3
<b>BIC</b>	1071.6	1074.4	1076.2	1068.5	1069.4
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-384.2	-385.7	-386.5	-382.7	-383.1

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

discoveries. Therefore, the long-run results are like what is found in the full sample and contrary to what is found in the up sample, in line with the stylized facts in [section 2.2](#). This finding shows that after controlling for other determinants of sovereign ratings, giant discoveries significantly decrease sovereign debt ratings in the long run for some countries.

The probabilities associated with each level of sovereign debt ratings in the 10 years following discoveries and periods without discoveries in [fig. 3 \(C\)](#), based on column 5 of [table 3](#). This figure shows that the probability of having a rating inferior or equal to 10

Table 3: Benchmark results for Down sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	0.231 (0.154)	-0.458*** (0.155)	-0.259 (0.166)	-0.292* (0.174)	-1.037*** (0.236)
<b>Natural ressources rents, one-year lag</b>	-0.002 (0.023)	0.001 (0.023)	-0.004 (0.023)	-0.006 (0.023)	-0.004 (0.024)
<b>Log of real GDP, one-year lag</b>	0.320 (0.309)	0.330 (0.318)	0.341 (0.310)	0.310 (0.309)	0.287 (0.336)
<b>Volatility of growth, one-year lag</b>	0.056 (0.059)	0.069 (0.059)	0.052 (0.059)	0.055 (0.058)	0.084 (0.060)
<b>Total investments, one-year lag</b>	0.121*** (0.023)	0.126*** (0.023)	0.126*** (0.023)	0.121*** (0.023)	0.132*** (0.024)
<b>Public debt, one-year lag</b>	-0.025*** (0.005)	-0.024*** (0.005)	-0.025*** (0.005)	-0.026*** (0.005)	-0.026*** (0.005)
<b>History of default, one-year lag</b>	-1.064*** (0.301)	-1.054*** (0.304)	-1.085*** (0.302)	-1.091*** (0.300)	-1.135*** (0.308)
<b>Reserves, one-year lag</b>	0.093*** (0.014)	0.097*** (0.014)	0.097*** (0.014)	0.091*** (0.014)	0.097*** (0.014)
<b>Current account balance, one-year lag</b>	0.025* (0.013)	0.024* (0.013)	0.023* (0.013)	0.026* (0.013)	0.027** (0.014)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.125 (0.121)	0.127 (0.124)	0.108 (0.122)	0.122 (0.121)	0.126 (0.129)
<b>Financial openness index, one-year lag</b>	1.967*** (0.363)	2.128*** (0.370)	2.052*** (0.368)	1.959*** (0.363)	2.306*** (0.375)
<b>ICRG index, one-year lag</b>	2.816* (1.654)	3.017* (1.659)	2.592 (1.644)	2.704 (1.647)	2.931* (1.664)
<b>Constant</b>	2.113** (0.989)	2.291** (1.067)	2.168** (1.010)	2.082** (0.980)	2.491** (1.183)
<b>Observations</b>	293	293	293	293	293
<b>AIC</b>	982.6	976.2	982.4	982.1	965.3
<b>BIC</b>	1181.4	1174.9	1181.2	1180.8	1164.0
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-437.3	-434.1	-437.2	-437.0	-428.6

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

(bad ratings) is higher when countries have giant discoveries than do not. However, the likelihood of having a rating superior or equal to 11 (good ratings) is lower when countries have giant discoveries than do not. For instance, the probability of having a rating of 9 (speculative) is 16.9% in countries with giant discoveries, while it is 9.4% in countries without giant discoveries. The probability of having a rating of 12 (adequate payment capacity) is 13% in countries with giant discoveries, while it is 18.5% in countries without giant discoveries.

#### 4.4 Effects of control variables

Besides, I provide some interpretations of the control variables. I find that total investments, international reserves, financial openness, and ICRG are consistently positively associated with sovereign debt ratings across all samples. Also, the log. of real GDP and the log. of the exchange rate (+ means depreciation) are positively associated with ratings in the full and up samples. The current account has a positive effect on the down sample. However, public debt has a significant and negative effect on ratings, which is consistent across samples, natural resource rents and volatility of growth are negatively associated with ratings in the full and up samples, and history of default has a significant and negative effect on ratings in the full and down sample. In sum, these findings confirm the results found in the literature ([Cantor and Packer, 2011](#); [Bissoondoyal-Bheenick, 2005](#); [Mellios and Paget-Blanc, 2006](#); [Depken et al., 2011](#); [Afonso et al., 2011](#); [Hilscher and Nosbusch, 2010](#); [Erdem and Varli, 2014](#)).

Overall, our benchmark findings reveal that the effects of giant discoveries on sovereign debt ratings are neither systemically positive nor negative. They show that many countries will experience a deterioration of their financial conditions in the years following giant discoveries while others will enjoy an improvement. As we will see in [section 6](#), what matters for the effects of giant discoveries is the responses of governments to the news of giant discoveries.

### 5 Robustness checks

In this section, I check the robustness of my benchmark findings. First, I use an alternative methodology, the correlated random effects, which is a model that unifies the traditional random and fixed effects estimators and overcome each of their limits. Second, I include as regressors the history of giant discoveries. It is the sum of past discoveries since 1970 at a time of a new discovery. This variable will capture the learning effects. I assume that countries with a past history of giant discoveries have learned how to use and manage them better. Then, it will also explain the differentiated effects of giant discoveries on sovereign debt ratings. Third, I use other institutional and conflict variables, including political rights and internal conflicts, instead of the ICRG index, to capture the effects

of institutions' quality and, more importantly, of conflicts. Indeed, as pointed out by [Lei and Michaels \(2014\)](#) and [Tsui \(2011\)](#), giant discoveries are associated with an increase of armed conflicts and a change of institutional framework towards autocracy. Fourth, I check the sensitivity of my results by dropping extreme values in sovereign debt ratings.

## 5.1 Alternative methodology: Correlated Random Effects

As we described in the methodology section, both random effects and fixed-effects models present some limits, including respectively the strong assumption of the independence between error terms and regressors for the former, and the incidental parameters problem, and the failing in estimating time-invariant covariates coefficients for the latter. In order to solve this issue, we follow [Mundlak \(1978\)](#), [Allison \(2009\)](#), and [Wooldridge \(2010\)](#) who propose the Correlated Random Effects (CRE). CRE unifies the traditional random and fixed effect models, and consists firstly to add time-average of the independent variable as additional time-invariant regressors, in order to deal with possible problem of correlation between errors terms and regressors; and secondly to add the average of the explanatory or control variables as supplementary variables.

$$R_{i,t}^* = \alpha_0 + \beta^T D_i^T + \overline{D_i} + X_{i,t-1}\theta + \overline{X_{i,t-1}} + \sigma_t + \alpha_i + \varepsilon_{i,t} \quad (3)$$

By using this alternative methodology, the results reported in [table B.11](#) are still qualitatively and quantitatively robust <sup>15</sup>.

## 5.2 History of giant discoveries

The results when the history of giant discoveries is included as additional covariate in the model in [tables B.12 to B.14](#), for the full, up, and down samples, respectively. They show that the history of giant discoveries has a positive and significant effect on sovereign debt ratings in full and up samples. In contrast, it has no significant impact on the down sample. This finding sustains the presence of learning effects in the full and up samples. Giant natural resources discoveries worldwide have generally led first to jubilation, and more often turned into disappointments. The jubilation ends because of

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<sup>15</sup>For the Correlated Random Effects' methodology, only results for the full sample are reported. The results for the "Up" and "Down" samples are available upon request.

economic imprudence and bad luck: profligate spending, heavy borrowing, oil price bust. Countries that have gone through this process often have learned how to manage their resources well to prevent them from losing access to capital markets. Nevertheless, the learning effects are not a panacea since I find that in countries with decreasing ratings, the history of giant discoveries has no significant impact on sovereign debt ratings. Moreover, our benchmark findings on the effects of new giant discoveries remain valid. They have negative and significant effects on sovereign debt ratings in the full and down samples, and a positive effect in the up sample.

### **5.3 Controlling for political rights and internal conflicts**

The results where the ICRG index is substituted by the political rights index and internal conflicts index are reported in [tables B.15 to B.17](#), for the full, up, and down samples, respectively. They indicate the robustness of the benchmark findings. Giant discoveries induce a decrease of sovereign debt ratings in the full and down samples over the long run, sometimes over the medium-term. In contrast, they have a positive effect on the up sample over the long run. Besides, I find that internal conflicts are positively associated with sovereign ratings in the full and up samples, showing that the absence of internal conflicts favors an increase of sovereign debt ratings. However, political rights have no significant effects on ratings.

### **5.4 Dropping country-year observations in the top 5% and bottom 5% of sovereign debt ratings**

The results where country-year observations in the top 5% and bottom 5% of sovereign debt ratings are dropped out in the analysis are reported in [tables B.18 to B.20](#), for the full, up, and down samples, respectively. I do so to reduce the influence of outliers with very high and low sovereign ratings. Extreme values of sovereign debt ratings do not drive the results; they are quite robust both qualitatively and quantitatively.

## **6 Transmission channels**

I have shown that giant discoveries have a differentiated effect on sovereign debt ratings in different sets of countries. While some countries may experience an improve-



ment in their financial conditions in the aftermath of giant discoveries, others may experience a deterioration. These differentiated effects depend on the behavior of many macroeconomic and political indicators resulting from the actions and policies taken in the discoveries' aftermath. What seems to matter is not only the resources but also how authorities respond to the news of the discovery of those resources. Therefore, I employ several intermediary variables, also known as critical for sovereign debt ratings.

The differentiated effects could come from differences in the reaction of tax resources, public debt, development of financial markets, total investment (private and public), and quality of institutions including high government stability and low level of corruption. These variables will allow me to capture the indirect effects of giant discoveries going through other determinants of sovereign debt ratings, consequently, highlighting possible transmissions channels. To shed light on the transmission channels, I estimate for each sample (full, up, and down), a panel fixed-effects model described as follows.<sup>16</sup>

$$X_{i,t} = \alpha_0 + \beta^T D_i^T + Z_{i,t}\theta + \alpha_i + \sigma_t + time_i + \varepsilon_{i,t} \quad (4)$$

where  $X_{i,t}$  represents the dependent variable used as a channel, including tax resources, public debt, development of financial markets index, the total investment (private and public), and quality of institutions including high government stability and low level of corruption.  $D_i^T$  is a dummy that takes the value one over a specified horizon  $T$  following the giant discoveries and zero otherwise. As the effect of giant discoveries on sovereign debt ratings is consistently obtained over the long-run, I focus on the effects of giant discoveries on intermediary variables over the 10 years following discoveries.<sup>17</sup>  $Z_{i,t}$  is the set of control variables including the history of default and output gap calculated using an HP filter on the log. of real GDP. I also use country-fixed effects  $\alpha_i$  to control for time-invariants factors and unobserved heterogeneity, time-fixed effects  $\sigma_t$  to capture common shocks affecting countries, and country-specific time trend  $time_i$  to capture the specific trend evolution of each intermediary variable.  $\alpha_0$  is an intercept and  $\varepsilon_{i,t}$  is the idiosyncratic error term. By estimating these models on the full, up, and down samples,

<sup>16</sup>Driscoll and Kraay (1998) robust standard errors are used to correct for the heteroskedasticity, the serial correlation, and the contemporaneous correlation of error terms.

<sup>17</sup>The results for the other horizons can be obtained upon request

separately, I can capture the different responses of intermediary variables in each sample. The results are reported in [table B.21](#).

## 6.1 Tax resources

According to the Government Financial Statistics Manual (IMF), tax resources is the dominant share of revenue for many governments. It is composed of compulsory transfers including penalties, fines, and excludes social security contributions. This variable is critical since it has been found by [Cantor and Packer \(2011\)](#) and [Mellios and Paget-Blanc \(2006\)](#) that the greater the potential tax base of the borrowing country, the greater the ability of a government to repay debt. In addition, according to [Akitoby and Stratmann \(2008\)](#), tax-financed spending tend to lower spreads of interest rate and then improves sovereign debt ratings. In this study, we find that giant discoveries increase the tax resources in Up sample ten years after the discoveries while the effect is non significant in the Down sample. This result is in line with [Abdelwahed \(2020\)](#) who find, using 46 developed and developing countries, that giant discoveries lead to higher tax collection, which effect is attributed to increased effort on income taxes and international trade especially in developing countries. Then, the positive effect of giant discoveries on sovereign debt rating in Up sample could translate through the increasing level of tax resources in the years following the discoveries.

## 6.2 Public debt

The results in [table B.21](#) show that giant discoveries are associated with a decrease of public debt in the up sample over 10 years while they have no significant effect in the full and down samples. In the down sample, the effect while non-significant, is positive, showing that some countries could have increased public debt the years following discoveries. Recalling that in the benchmark findings I found that an increase of public debt is strongly and negatively associated with sovereign debt ratings in each sample (in line with [Cantor and Packer, 2011](#); [Mellios and Paget-Blanc, 2006](#); [Afonso et al., 2009](#); [Teixeira et al., 2018](#)), this finding suggests that giant discoveries lead to differentiated effects in the up and down samples of countries because of its differentiated effects on public debt. In some countries, debt is reduced following discoveries, and they have a positive effect on sovereign debt ratings (up sample); in others, debt increases even if it is non-significant,

and discoveries have a negative effect (down sample). This result shows that the reaction of countries *vis-à-vis* debt and borrowing following the discoveries matter for the effects of discoveries on ratings, the years following this shock.

### 6.3 Development of financial markets

Financial markets is a sub-index of the aggregated financial development index developed by the IMF ([Svirydzenka, 2016](#)). The financial markets index includes stock and bond markets, and aims at capturing the key features of financial systems, for instance how deep, accessible and efficient are the financial markets.<sup>18</sup> Since it has been found by [Andreasen and Valenzuela \(2016\)](#) that financially integrated countries with the rest of the world are positively evaluated by credit rating agencies, it appears important to analyze whether the development of financial markets could be a channel in this study. Then, we find that giant discoveries increase the development of financial market index in Up sample, but the effect is non significant in Down sample. Therefore, we can confirm that the high level of financial markets in Up sample compared to the Down sample, in the ten years following giant discoveries, is a potential channel transmission of the improvement of rating in these countries as described by [Andreasen and Valenzuela \(2016\)](#).

### 6.4 Total investments

The findings in [table B.21](#) suggest that giant discoveries induce an increase of total investments in the up sample over 10 years while they have a negative and significant effect in the down sample. Recalling that I find that total investments are positively associated with sovereign debt ratings across all samples in the benchmark results (see, [Afonso et al., 2011](#); [Arezki et al., 2017](#); [Mellios and Paget-Blanc, 2006](#); [Teixeira et al., 2018](#)), these findings show that giant discoveries, when associated with an increase of investments, induce an improvement of financial conditions, however, when associated with a decrease of investments induce a deterioration of financial conditions. Therefore, investments are a possible channel through which giant discoveries affect sovereign debt ratings.

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<sup>18</sup>For more details on the components of the financial markets index, see [Svirydzenka \(2016\)](#).

## 6.5 Quality of institutions: high governmental stability and low level of corruption

The quality of institutions is one of the most important determinants of the access to international financial markets, and is critical for sovereign debt ratings ([Mellios and Paget-Blanc, 2006](#); [Depken et al., 2011](#); [Erdem and Varli, 2014](#); [Teixeira et al., 2018](#)). In order to test whether the results could translate through the institutions, I use two institutional variables including the government stability index and the corruption index from ICRG. Government stability index assesses both the government's ability to carry out its declared programs, and its ability to stay in office. Corruption index assesses the corruption level within the political system. The highest level of each of the index reveals lowest risk in the country. In [table B.21](#), I find firstly that giant discoveries increase the government stability in Up sample while the effect is non significant in the Down sample. Secondly, giant discoveries deteriorate significantly the level of corruption in the aftermath of discoveries in the Down sample while the effect is non significant in Up sample. These results in line with the literature of [Tsui \(2011\)](#) explaining the negative impacts on institutions in poor countries, reveal well how the quality of institutions could be an important transmission channel.

To sum up, this section shows that beyond the differentiated direct effects of giant discoveries found in the benchmark results, giant discoveries also may have differentiated effects through several channels including tax resources, public debt, development of financial markets, total investment, and quality of institutions. Consequently, the differentiated effects of giant discoveries on sovereign debt ratings also depend on the behavior of some macroeconomic and institutional indicators resulting from the actions and policies taken in the discoveries' aftermath. What seems to matter is not only the resources but also how authorities respond to the news of the discovery of those resources.

## 7 Conclusion

In this paper, I shed light on the effects of giant discoveries of natural resources (oil, natural gas, minerals) on sovereign debt ratings in the short- and long-run, which have been overlooked by the literature. Specifically, I show evidence of the differen-

tiated effects of giant discoveries in different countries. To do so, I use a sample of 28 developing and emerging countries, divided into two sets of countries: countries with increasing ratings in the aftermath of giant discoveries (up sample) and decreasing ratings in the aftermath of giant discoveries (down sample), over the period 1990-2014. I further apply a random effect ordered probit models on the full, up, and down samples to check the assumptions that countries may experience a differentiated effect of giant discoveries on their sovereign debt ratings. After controlling for several determinants of sovereign debt ratings, I find that giant discoveries generate differentiated effects, in which some countries experience an improvement of their sovereign ratings while others experience a deterioration of financial conditions. This result shows that the outcome of giant discoveries on ratings is sensitive to the group of countries studied. I also find the evidence of possible learning effects of giant discoveries in countries with increasing sovereign debt ratings, as the history of past discoveries is positively associated with sovereign debt ratings, which is not the case for countries with decreasing ratings. This suggests that while some countries have learned from the past, others have remained at least identical or worse, taking on more often irrelevant actions and policies, the years following discoveries.

More importantly, I show that these differentiated effects depend on the behavior of several macroeconomic and political indicators resulting from the actions and policies taken in the aftermath of the discoveries. I find that giant discoveries also have differentiated effects through some channels, including tax resources, public debt, development of financial markets, total investment, and quality of institutions.

Overall, this paper reveals that giant discoveries are good predictors of sovereign debt ratings and that ratings' agencies and governments should pay attention to them. Also, what seems to matter is not only the resources but also how governments respond to the news of the discovery of those resources. Therefore, taking the right actions and policies, having better management of natural resources, will help countries prevent a deterioration of their financial conditions and increase their access to international capital markets.

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## Appendix A Data and sample

### Appendix A.1 Data description and sources

Table A.4: Variables and their sources

Variables	Nature	Sources
<b>Dependent variable</b>		
Foreign currency long term sovereign debt ratings	Ordinal	<a href="#">Kose et al. (2018)</a>
<b>Giant discoveries data</b>		
Giant discovery of natural resources	Binary	<a href="#">Horn (2011)</a> , Minex Consulting Database
History past giant discoveries	Categorical	Author's calculations based on Horn and Minex Consulting Databases
<b>Control variables</b>		
<b>Macroeconomic variables</b>		
Natural resources rents (% of GDP)	Continuous	WDI
Log. of real GDP	Continuous	WDI
Volatility of growth (standard deviation of past-10 years growth)	Continuous	Author's calculations based WDI database
Total investments (% of GDP)	Continuous	IMF Investment and Capital Stock dataset 1960-2015
Public debt (% of GDP)	Continuous	<a href="#">Mbaye et al. (2018)</a> - IMF
History of default crisis	Categorical	Author's calculations based on <a href="#">Reinhart and Rogoff (2014)</a>
<b>External variables</b>		
International reserves (% of GDP)	Continuous	WDI
Current account balance (% of GDP)	Continuous	WDI
Log of exchange rate (LCU/ US\$)	Continuous	IFS , 2018 (IMF)
Financial openness index	Continuous	<a href="#">Chinn and Ito (2008)</a>
<b>Institutional variables</b>		
ICRG index score between 0 and 1	Continuous	ICRG
Political rights index	Ordinal	Freedom House dataset
Internal conflicts index	Continuous	ICRG

### Appendix A.2 List of countries

#### Countries with increasing ratings (Up sample)

Bolivia, Brazil, China, Ecuador, India, Indonesia, Kazakhstan, Mongolia, Pakistan, Peru, Philippines, Romania, Turkey.

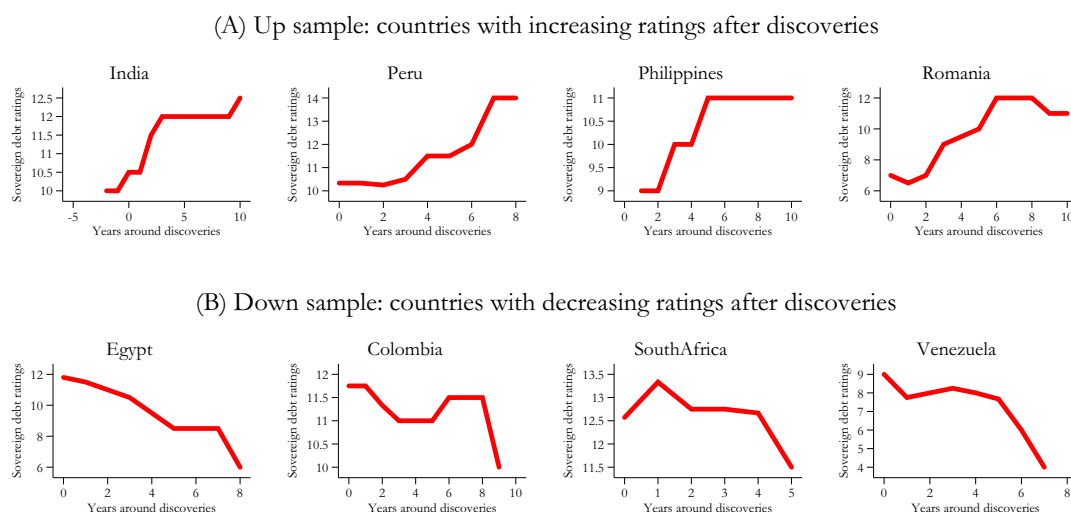
#### Countries with decreasing ratings (Down sample)

Argentina, Azerbaijan, Colombia, Egypt, Ghana, Guatemala, Mexico, Mozambique, Malaysia, Russia, South Africa, Thailand, Turkmenistan, Venezuela, Vietnam.

## Appendix B Supplementary tables and graphs

### Appendix B.1 Illustration of the differentiated effects of giant discoveries on sovereign debt ratings

Figure B.4: Trend evolution of rating around the time of giant discoveries



### Appendix B.2 Numerical conversion of sovereign debt ratings

Table B.5: Numerical conversion of sovereign debt ratings

Ratings	Moody's	Fitch	Standard & Poor's	Interpretation
21	Aaa	AAA	AAA	Highest credit quality
20	Aa1	AA+	AA+	High credit quality
19	Aa2	AA	AA	
18	Aa3	AA-	AA-	
17	A1	A+	A+	Strong payment capacity
16	A2	A	A	
15	A3	A-	A-	
14	Baa1	BBB+	BBB+	Adequate payment capacity
13	Baa2	BBB	BBB	
12	Baa3	BBB-	BBB-	
11	Ba1	BB+	BB+	Speculative, Credit risk developing due to economic changes
10	Ba2	BB	BB	
9	Ba3	BB-	BB-	
8	B1	B+	B+	High speculative, credit risk present, with limited margin safety
7	B2	B	B	
6	B3	B-	B-	
5	Caa1	CCC	CCC+	High default risk, capacity depending on sustained favourable conditions
4	Caa2	CC	CCC	
3	Caa3	C	CCC-	
2	Ca	RD	CC	Default
1	C	D	C/D	

Sources: Rating agencies Moody's, Fitch, S&P, [Elkhoury \(2009\)](#), [Teixeira et al. \(2018\)](#)

### Appendix B.3 Size and value of discoveries of minerals from Minex Consulting Datasets

Table B.6: Size and value of mineral's discoveries from Minex Consulting Datasets

	<i>Size Range</i>			
	<b>Moderate</b>	<b>Major</b>	<b>Giant</b>	<b>Super Giant</b>
<b>Gold</b>	> 100 koz Au-eq	> 1 Moz Au-eq	> 6 Moz Au-eq	> 60 Moz Au-eq
<b>Silver</b>	> 5 Moz Ag	> 50 Moz Ag	> 300 Moz Ag	> 3000 Moz Ag
<b>PGE</b>	> 100 koz Au-eq	> 1 Moz Au-eq	> 6 Moz Au-eq	> 60 Moz Au-eq
<b>Copper</b>	> 100 kt Cu-eq	> 1 Mt Cu-eq	> 5 Mt Cu-eq	> 25 Mt Cu-eq
<b>Nickel</b>	> 10 kt Ni	> 100 kt Ni	> 1 mt Ni	> 10 Mt Ni
<b>Zinc</b>	> 250 kt Zn+Pb	> 2.5 Mt Zn+Pb	> 12 Mt Zn+Pb	> 60 Mt Zn+Pb
<b>Lead</b>	> 250 kt Zn+Pb	> 2.5 Mt Zn+Pb	> 12 Mt Zn+Pb	> 60 Mt Zn+Pb
<b>Cobalt</b>	> 100 kt Cu-eq	> 1 Mt Cu-eq	> 5 Mt Cu-eq	> 25 Mt Cu-eq
<b>Molybdenum</b>	> 100 kt Cu-eq	> 1 Mt Cu-eq	> 5 Mt Cu-eq	> 25 Mt Cu-eq
<b>Tungsten</b>	> 100 kt Cu-eq	> 1 Mt Cu-eq	> 5 Mt Cu-eq	> 25 Mt Cu-eq
<b>Uranium Oxide</b>	> 5 kt U3O8	> 25 kt U3O8	> 125 kt U3O8	> 1 Mt U3O8

### Appendix B.4 Summary statistics and differences in means between the up and down samples

Table B.7: Summary statistics for the full sample

	<b>Variable</b>	<b>Obs</b>	<b>Mean</b>	<b>Sdev</b>	<b>Min</b>	<b>Max</b>
	<b>Sovereign debt ratings</b>	567	10.110	3.059	1.000	18.000
	<b>Giant discoveries dummy at start</b>	567	0.178	0.383	0.000	1.000
	<b>History of past giant discoveries</b>	567	7.051	5.753	0.000	27.000
	<b>Natural resources rents (% of GDP)</b>	567	8.225	8.229	0.123	45.570
	<b>Log of real GDP</b>	567	12.190	1.494	8.211	15.940
	<b>Volatility of growth</b>	567	3.303	2.177	0.454	13.720
	<b>Total investments (% of GDP)</b>	567	18.190	7.339	5.634	45.410
	<b>Public debt (% of GDP)</b>	567	42.700	22.210	3.673	152.200
	<b>History of default</b>	567	0.949	0.832	0.000	3.000
	<b>Reserves (% of GDP)</b>	567	15.950	10.690	1.220	53.220
	<b>Current account balance (% of GDP)</b>	567	-0.849	7.275	-44.740	33.590
	<b>Log of exchange rate (LCU / \$US)</b>	567	2.691	3.050	-13.610	9.959
	<b>Financial openness index</b>	567	0.428	0.299	0.000	1.000
	<b>ICRG index</b>	567	0.615	0.094	0.000	0.801
	<b>Political rights index</b>	567	3.550	1.771	1.000	7.000
	<b>Internal conflicts index</b>	564	0.729	0.139	0.181	1.000

Table B.8: Summary statistics and differences in means between Up and Down samples

	Variable	(1) Up sample					(2) Down sample					Mean difference (1) - (2)	
		Obs	Mean	Sdev	Min	Max	Obs	Mean	Sdev	Min	Max	Diff	SE Diff
	Sovereign debt ratings	274	9.661	2.989	2.000	18.000	293	10.530	3.068	1.000	17.000	-0.87***	(0.255)
	Giant discoveries dummy at start	274	0.197	0.399	0.000	1.000	293	0.160	0.368	0.000	1.000	0.04	(0.032)
	History of past giant discoveries	274	7.164	5.785	0.000	22.000	293	6.945	5.731	0.000	27.000	0.22	(0.484)
	Natural resources rents (% of GDP)	274	6.752	7.974	0.123	45.570	293	9.603	8.237	0.562	41.950	-2.85***	(0.682)
	Log of real GDP	274	12.320	1.705	8.211	15.940	293	12.070	1.257	8.645	14.350	0.25*	(0.125)
	Volatility of growth	274	2.995	1.612	0.526	8.338	293	3.592	2.566	0.454	13.720	-0.60**	(0.181)
	Total investments (% of GDP)	274	19.600	7.167	7.212	41.980	293	16.870	7.264	5.634	45.410	2.73***	(0.607)
	Public debt (% of GDP)	274	45.710	21.340	5.874	98.450	293	39.890	22.670	3.673	152.200	5.81**	(1.852)
	History of default	274	0.985	0.877	0.000	3.000	293	0.915	0.787	0.000	3.000	0.07	(0.070)
	Reserves (% of GDP)	274	15.480	10.600	1.558	51.410	293	16.390	10.770	1.220	53.220	-0.91	(0.898)
	Current account balance (% of GDP)	274	-1.365	4.820	-27.390	11.860	293	-0.365	8.966	-44.740	33.590	-1.00	(0.611)
	Log of exchange rate (LCU / \$US)	274	2.847	3.307	-13.610	9.381	293	2.546	2.787	-3.361	9.959	0.30	(0.256)
	Financial openness index	274	0.437	0.308	0.000	1.000	293	0.421	0.290	0.000	1.000	0.02	(0.025)
	ICRG index	274	0.595	0.105	0.000	0.765	293	0.633	0.078	0.409	0.801	-0.04***	(0.008)
	Political rights index	274	3.347	1.752	1.000	7.000	293	3.741	1.769	1.000	7.000	-0.39**	(0.148)
	Internal conflicts index	271	0.711	0.145	0.181	1.000	293	0.746	0.132	0.285	1.000	-0.03**	(0.012)

Notes: Differences in means: \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. These summary statistics use the similar samples as in the benchmark findings.

## Appendix B.5 Benchmark results without control variables

Table B.9: Benchmark results for all the samples, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Panel A: Full sample</b>					
Giant discoveries dummy (1 in the horizon T)	0.135 (0.108)	-0.111 (0.107)	0.022 (0.110)	-0.052 (0.116)	-0.040 (0.138)
Observations	567	567	567	567	567
AIC	2219.2	2219.7	2220.7	2220.6	2220.7
BIC	2410.2	2410.7	2411.7	2411.5	2411.7
Time fixed-effects	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-1065.6	-1065.8	-1066.4	-1066.3	-1066.3
<b>Panel B: Up sample</b>					
Giant discoveries dummy (1 in the horizon T)	-0.355* (0.183)	0.265 (0.170)	-0.042 (0.178)	0.577*** (0.175)	0.675*** (0.196)
Observations	274	274	274	274	274
AIC	1027.4	1028.7	1031.1	1020.2	1019.3
BIC	1182.8	1184.1	1186.5	1175.6	1174.6
Time FE	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-470.7	-471.4	-472.6	-467.1	-466.6
<b>Panel B: Down sample</b>					
Giant discoveries dummy (1 in the horizon T)	0.425*** (0.147)	-0.250* (0.146)	0.195 (0.157)	-0.464*** (0.167)	-0.419* (0.218)
Observations	293	293	293	293	293
AIC	1159.6	1165.0	1166.4	1160.2	1164.3
BIC	1317.9	1323.3	1324.7	1318.5	1322.5
Time fixed-effects	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-536.8	-539.5	-540.2	-537.1	-539.1

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after for the Full sample (Panel A), the Up sample (Panel B), the Down (Panel C).

## Appendix B.6 Conditional probabilities of marginal effects

Table B.10: Predicted probabilities for each level of sovereign debt ratings

Ratings	(1) Full sample					(2) Up sample					(3) Down sample				
	Without discoveries		With discoveries			Without discoveries		With discoveries			Without discoveries		With discoveries		
	Prob	P-Value	Prob	P-Value		Prob	P-Value	Prob	P-Value		Prob	P-Value	Prob	P-Value	
2	0.00	0.77	0.00	0.75		0.00	0.87	0.00	0.88		0.00	0.78	0.01	0.73	
3	0.00	0.73	0.00	0.70		0.00	0.86	0.00	0.87		0.00	0.74	0.02	0.67	
4	0.00	0.69	0.00	0.65		0.00	0.85	0.00	0.86		0.02	0.68	0.10	0.57	
5	0.00	0.62	0.00	0.57		0.00	0.78	0.00	0.80		0.04	0.61	0.23	0.48	
6	0.01	0.52	0.04	0.44		0.15	0.65	0.02	0.70		0.14	0.53	0.64	0.36	
7	0.10	0.42	0.33	0.34		1.65	0.54	0.32	0.61		0.37	0.44	1.38	0.23	
8	3.47	0.21	7.52	0.11		19.14	0.25	7.48	0.40		4.20	0.17	10.91	0.02	
9	16.30	0.03	24.49	0.00		40.67	0.00	29.88	0.06		9.40	0.01	16.93	0.00	
10	26.67	0.00	29.50	0.00		19.52	0.02	23.10	0.00		18.82	0.00	24.33	0.00	
11	32.05	0.00	26.25	0.00		15.41	0.24	27.85	0.03		21.76	0.00	20.45	0.00	
12	18.28	0.03	10.66	0.07		3.43	0.51	11.10	0.36		18.50	0.00	12.99	0.00	
13	2.80	0.22	1.13	0.26		0.03	0.70	0.25	0.63		12.62	0.00	6.84	0.01	
14	0.31	0.38	0.09	0.42		0.00	0.80	0.00	0.77		11.16	0.02	4.42	0.11	
15	0.00	0.58	0.00	0.60		0.00	0.90	0.00	0.89		2.41	0.23	0.64	0.41	
16	0.00	0.69	0.00	0.70		0.00	1.00	0.00	0.96		0.51	0.46	0.09	0.58	
17	0.00	0.76	0.00	0.77		0.00	-	0.00	1.00		0.05	0.65	0.01	0.72	
18	0.00	0.82	0.00	0.85		0.00	-	0.00	-		-	-	-	-	

Notes: The predicted probabilities are based on column 5 of [table 1](#) for the Full sample, [table 2](#) for the Up sample, and [table 3](#) for the Down sample. They show the predicted probabilities of marginal effects of giant discoveries over the 10 years following discoveries, for each level of sovereign debt ratings, in countries with discoveries compared to countries without discoveries.

## Appendix B.7 Robustness checks

### Appendix B.7.1 Alternative methodology: Correlated Random Effect

Table B.11: Robustness, Correlated Random Effects, full sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
Giant discoveries (1 in the horizon T)	-0.036 (0.112)	-0.138 (0.110)	-0.194* (0.116)	-0.047 (0.119)	-0.381*** (0.147)
<i>Giant discoveries (1 in the horizon T) avg.</i>	<i>-1.418 (1.334)</i>	<i>10.058*** (3.797)</i>	<i>-0.143 (1.151)</i>	<i>3.768 (2.813)</i>	<i>0.594 (1.241)</i>
Natural ressources rents, one-year lag	-0.046*** (0.014)	-0.044*** (0.014)	-0.046*** (0.014)	-0.046*** (0.014)	-0.044*** (0.014)
<i>Natural ressources rents, one-year lag, avg.</i>	<i>0.096* (0.052)</i>	<i>0.025 (0.047)</i>	<i>0.082 (0.054)</i>	<i>0.074 (0.047)</i>	<i>0.068 (0.054)</i>
Log of real GDP, one-year lag	0.185 (0.439)	0.084 (0.432)	0.238 (0.441)	0.226 (0.441)	0.258 (0.440)
<i>Log of real GDP, one-year lag, avg.</i>	<i>0.821 (0.510)</i>	<i>0.907* (0.487)</i>	<i>0.641 (0.502)</i>	<i>0.698 (0.490)</i>	<i>0.564 (0.502)</i>
Volatility of growth, one-year lag	-0.167*** (0.043)	-0.162*** (0.043)	-0.159*** (0.043)	-0.166*** (0.043)	-0.152*** (0.043)
<i>Volatility of growth, one-year lag, avg.</i>	<i>-0.076 (0.191)</i>	<i>-0.153 (0.179)</i>	<i>-0.065 (0.193)</i>	<i>-0.120 (0.196)</i>	<i>-0.079 (0.191)</i>
Total investments, one-year lag	0.064*** (0.017)	0.066*** (0.017)	0.066*** (0.017)	0.065*** (0.017)	0.070*** (0.017)
<i>Total investments, one-year lag, avg.</i>	<i>-0.149*** (0.051)</i>	<i>-0.147*** (0.047)</i>	<i>-0.159*** (0.052)</i>	<i>-0.144*** (0.051)</i>	<i>-0.164*** (0.051)</i>
Public debt, one-year lag	-0.023*** (0.004)	-0.023*** (0.004)	-0.022*** (0.004)	-0.023*** (0.004)	-0.023*** (0.004)
<i>Public debt, one-year lag, avg.</i>	<i>-0.033** (0.013)</i>	<i>-0.027** (0.013)</i>	<i>-0.034** (0.014)</i>	<i>-0.034** (0.013)</i>	<i>-0.033** (0.014)</i>
History of default, one-year lag	-0.108 (0.081)	-0.107 (0.081)	-0.103 (0.081)	-0.111 (0.082)	-0.118 (0.081)
<i>History of default, one-year lag, avg.</i>	<i>-1.909*** (0.436)</i>	<i>-1.827*** (0.403)</i>	<i>-1.931*** (0.442)</i>	<i>-1.633*** (0.484)</i>	<i>-1.882*** (0.448)</i>
Reserves, one-year lag	0.064*** (0.009)	0.063*** (0.009)	0.064*** (0.009)	0.063*** (0.009)	0.063*** (0.009)
<i>Reserves, one-year lag, avg.</i>	<i>0.117*** (0.041)</i>	<i>0.146*** (0.039)</i>	<i>0.118*** (0.042)</i>	<i>0.134*** (0.041)</i>	<i>0.123*** (0.042)</i>
Current account balance, one-year lag	0.003 (0.011)	0.005 (0.011)	0.003 (0.011)	0.003 (0.011)	0.005 (0.011)
<i>Current account balance, one-year lag, avg.</i>	<i>0.030 (0.073)</i>	<i>-0.044 (0.073)</i>	<i>0.039 (0.074)</i>	<i>0.016 (0.073)</i>	<i>0.035 (0.074)</i>
Log of exchange rate (LCU/US), one-year lag	0.199*** (0.043)	0.192*** (0.044)	0.204*** (0.044)	0.194*** (0.044)	0.202*** (0.044)
<i>Log of exchange rate (LCU/US), one-year lag, avg.</i>	<i>-0.091 (0.072)</i>	<i>-0.080 (0.064)</i>	<i>-0.080 (0.072)</i>	<i>-0.097 (0.072)</i>	<i>-0.077 (0.070)</i>
Financial openness index, one-year lag	2.248*** (0.267)	2.204*** (0.268)	2.280*** (0.268)	2.218*** (0.268)	2.244*** (0.267)
<i>Financial openness index, one-year lag, avg.</i>	<i>-2.060* (1.158)</i>	<i>-2.144** (1.067)</i>	<i>-2.139* (1.177)</i>	<i>-2.590** (1.210)</i>	<i>-2.188* (1.186)</i>
ICRG index, one-year lag	5.024*** (0.720)	5.144*** (0.718)	5.134*** (0.725)	4.981*** (0.719)	5.300*** (0.730)
<i>ICRG index, one-year lag, avg.</i>	<i>0.863 (3.059)</i>	<i>-3.384 (3.268)</i>	<i>1.022 (3.130)</i>	<i>0.113 (3.096)</i>	<i>0.662 (3.167)</i>
Constant	0.743*** (0.232)	0.613*** (0.194)	0.770*** (0.240)	0.722*** (0.228)	0.758*** (0.238)
Observations	567	567	567	567	567
AIC	1895.8	1889.2	1894.2	1895.2	1890.2
BIC	2186.6	2180.0	2185.0	2186.0	2181.0
Time FE	Yes	Yes	Yes	Yes	Yes
Log-likelihood	-880.9	-877.6	-880.1	-880.6	-878.1

Note: Correlated Random Effect model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. Time-average variables are reported in italic. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after

**Appendix B.7.2 Adding history of giant discoveries**

Table B.12: Robustness, adding history of giant discoveries, full sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.075 (0.112)	-0.198* (0.112)	-0.300** (0.117)	-0.018 (0.120)	-0.508*** (0.149)
<b>History of past-giant discoveries</b>	0.171*** (0.035)	0.180*** (0.036)	0.185*** (0.036)	0.171*** (0.036)	0.189*** (0.036)
<b>Natural resources rents, one-year lag</b>	-0.044*** (0.014)	-0.043*** (0.014)	-0.044*** (0.014)	-0.044*** (0.014)	-0.042*** (0.014)
<b>Log of real GDP, one-year lag</b>	0.207 (0.223)	0.185 (0.226)	0.204 (0.224)	0.200 (0.223)	0.187 (0.226)
<b>Volatility of growth, one-year lag</b>	-0.113*** (0.043)	-0.112*** (0.043)	-0.104** (0.043)	-0.115*** (0.043)	-0.097** (0.043)
<b>Total investments, one-year lag</b>	0.063*** (0.017)	0.064*** (0.017)	0.066*** (0.017)	0.063*** (0.017)	0.072*** (0.017)
<b>Public debt, one-year lag</b>	-0.027*** (0.004)	-0.027*** (0.004)	-0.026*** (0.004)	-0.027*** (0.004)	-0.027*** (0.004)
<b>History of default, one-year lag</b>	-0.927*** (0.211)	-0.897*** (0.211)	-0.945*** (0.211)	-0.913*** (0.210)	-0.968*** (0.211)
<b>Reserves, one-year lag</b>	0.054*** (0.009)	0.053*** (0.009)	0.054*** (0.009)	0.053*** (0.009)	0.053*** (0.009)
<b>Current account balance, one-year lag</b>	0.009 (0.010)	0.010 (0.010)	0.009 (0.010)	0.009 (0.010)	0.012 (0.010)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.161*** (0.044)	0.163*** (0.044)	0.165*** (0.044)	0.161*** (0.044)	0.164*** (0.044)
<b>Financial openness index, one-year lag</b>	1.850*** (0.273)	1.878*** (0.273)	1.890*** (0.274)	1.847*** (0.273)	1.836*** (0.273)
<b>ICRG index, one-year lag</b>	4.318*** (0.724)	4.406*** (0.727)	4.545*** (0.731)	4.298*** (0.724)	4.740*** (0.737)
<b>Constant</b>	3.216*** (0.972)	3.343*** (1.010)	3.323*** (1.000)	3.234*** (0.978)	3.362*** (1.012)
<b>Observations</b>	567	567	567	567	567
<b>AIC</b>	1878.2	1875.5	1872.1	1878.6	1866.9
<b>BIC</b>	2121.2	2118.5	2115.1	2121.6	2110.0
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-883.1	-881.7	-880.0	-883.3	-877.5

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.



Table B.13: Robustness, adding history of giant discoveries, up sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.428** (0.204)	0.059 (0.187)	-0.347* (0.201)	0.628*** (0.195)	0.439* (0.234)
<b>History of past-giant discoveries</b>	0.335*** (0.051)	0.334*** (0.051)	0.351*** (0.052)	0.346*** (0.051)	0.325*** (0.051)
<b>Natural resources rents, one-year lag</b>	-0.076*** (0.021)	-0.077*** (0.021)	-0.077*** (0.021)	-0.083*** (0.021)	-0.081*** (0.021)
<b>Log of real GDP, one-year lag</b>	0.841* (0.435)	0.782* (0.434)	0.834* (0.448)	0.890** (0.449)	0.794* (0.433)
<b>Volatility of growth, one-year lag</b>	-0.340*** (0.077)	-0.381*** (0.074)	-0.354*** (0.076)	-0.359*** (0.074)	-0.401*** (0.075)
<b>Total investments, one-year lag</b>	0.055 (0.033)	0.052 (0.033)	0.058* (0.034)	0.034 (0.034)	0.033 (0.035)
<b>Public debt, one-year lag</b>	-0.029*** (0.008)	-0.028*** (0.008)	-0.028*** (0.008)	-0.027*** (0.008)	-0.028*** (0.008)
<b>History of default, one-year lag</b>	-0.774** (0.378)	-0.666* (0.375)	-0.671* (0.374)	-0.663* (0.375)	-0.637* (0.373)
<b>Reserves, one-year lag</b>	0.033** (0.015)	0.035** (0.015)	0.033** (0.016)	0.034** (0.015)	0.036** (0.015)
<b>Current account balance, one-year lag</b>	-0.030 (0.023)	-0.033 (0.023)	-0.029 (0.023)	-0.032 (0.023)	-0.036 (0.023)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.222*** (0.061)	0.215*** (0.061)	0.229*** (0.062)	0.228*** (0.061)	0.209*** (0.061)
<b>Financial openness index, one-year lag</b>	1.870*** (0.527)	1.758*** (0.526)	1.724*** (0.524)	2.053*** (0.536)	1.975*** (0.538)
<b>ICRG index, one-year lag</b>	6.308*** (0.950)	6.119*** (0.946)	6.407*** (0.959)	6.289*** (0.950)	5.905*** (0.952)
<b>Constant</b>	7.537** (3.319)	7.558** (3.320)	7.885** (3.499)	7.970** (3.519)	7.560** (3.296)
<b>Observations</b>	274	274	274	274	274
<b>AIC</b>	830.8	835.1	832.2	824.8	831.7
<b>BIC</b>	1029.5	1033.8	1031.0	1023.5	1030.4
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-360.4	-362.6	-361.1	-357.4	-360.8

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

Table B.14: Robustness, adding history of giant discoveries, down sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	0.228 (0.155)	-0.459*** (0.155)	-0.266 (0.167)	-0.294* (0.174)	-1.073*** (0.238)
<b>History of past-giant discoveries</b>	0.020 (0.066)	0.031 (0.067)	0.035 (0.067)	0.028 (0.066)	0.073 (0.067)
<b>Natural resources rents, one-year lag</b>	-0.004 (0.023)	-0.000 (0.024)	-0.007 (0.023)	-0.007 (0.023)	-0.008 (0.024)
<b>Log of real GDP, one-year lag</b>	0.277 (0.337)	0.263 (0.343)	0.266 (0.333)	0.248 (0.334)	0.136 (0.346)
<b>Volatility of growth, one-year lag</b>	0.054 (0.059)	0.067 (0.059)	0.049 (0.058)	0.053 (0.058)	0.080 (0.059)
<b>Total investments, one-year lag</b>	0.120*** (0.023)	0.125*** (0.023)	0.125*** (0.023)	0.120*** (0.023)	0.130*** (0.023)
<b>Public debt, one-year lag</b>	-0.025*** (0.005)	-0.024*** (0.005)	-0.025*** (0.005)	-0.025*** (0.005)	-0.026*** (0.005)
<b>History of default, one-year lag</b>	-1.093*** (0.315)	-1.098*** (0.317)	-1.135*** (0.314)	-1.132*** (0.313)	-1.237*** (0.317)
<b>Reserves, one-year lag</b>	0.092*** (0.014)	0.096*** (0.015)	0.096*** (0.015)	0.090*** (0.014)	0.095*** (0.015)
<b>Current account balance, one-year lag</b>	0.026* (0.014)	0.026* (0.014)	0.025* (0.014)	0.027** (0.014)	0.031** (0.014)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.125 (0.120)	0.127 (0.122)	0.108 (0.119)	0.122 (0.118)	0.125 (0.122)
<b>Financial openness index, one-year lag</b>	1.950*** (0.367)	2.102*** (0.373)	2.024*** (0.371)	1.935*** (0.366)	2.253*** (0.376)
<b>ICRG index, one-year lag</b>	2.803* (1.653)	3.005* (1.658)	2.573 (1.641)	2.689 (1.646)	2.913* (1.659)
<b>Constant</b>	2.028** (0.980)	2.154** (1.030)	2.007** (0.964)	1.961** (0.950)	2.140** (1.021)
<b>Observations</b>	293	293	293	293	293
<b>AIC</b>	984.5	977.9	984.2	983.9	966.2
<b>BIC</b>	1187.0	1180.4	1186.6	1186.3	1168.6
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-437.3	-434.0	-437.1	-436.9	-428.1

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

**Appendix B.7.3 Including political rights and internal conflicts**

Table B.15: Robustness, adding political rights and internal conflicts, full sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.028 (0.113)	-0.155 (0.112)	-0.196* (0.116)	-0.046 (0.119)	-0.385*** (0.147)
<b>Natural resources rents, one-year lag</b>	-0.039*** (0.014)	-0.038*** (0.014)	-0.039*** (0.014)	-0.038*** (0.014)	-0.037*** (0.014)
<b>Log of real GDP, one-year lag</b>	0.658*** (0.199)	0.663*** (0.200)	0.678*** (0.200)	0.653*** (0.199)	0.678*** (0.201)
<b>Volatility of growth, one-year lag</b>	-0.125*** (0.043)	-0.123*** (0.043)	-0.118*** (0.043)	-0.125*** (0.043)	-0.113*** (0.043)
<b>Total investments, one-year lag</b>	0.066*** (0.017)	0.067*** (0.017)	0.068*** (0.017)	0.066*** (0.017)	0.073*** (0.017)
<b>Public debt, one-year lag</b>	-0.027*** (0.004)	-0.027*** (0.004)	-0.027*** (0.004)	-0.027*** (0.004)	-0.027*** (0.004)
<b>History of default, one-year lag</b>	-0.919*** (0.203)	-0.895*** (0.202)	-0.932*** (0.202)	-0.913*** (0.201)	-0.952*** (0.203)
<b>Reserves, one-year lag</b>	0.056*** (0.009)	0.056*** (0.009)	0.056*** (0.009)	0.055*** (0.009)	0.055*** (0.009)
<b>Current account balance, one-year lag</b>	0.002 (0.010)	0.002 (0.010)	0.002 (0.010)	0.002 (0.010)	0.004 (0.010)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.196*** (0.042)	0.200*** (0.042)	0.201*** (0.042)	0.195*** (0.042)	0.201*** (0.042)
<b>Financial openness index, one-year lag</b>	2.009*** (0.270)	2.037*** (0.271)	2.045*** (0.271)	2.002*** (0.271)	2.015*** (0.270)
<b>Political rights index</b>	-0.061 (0.055)	-0.064 (0.055)	-0.060 (0.055)	-0.063 (0.055)	-0.067 (0.055)
<b>Internal conflicts index</b>	2.101*** (0.590)	2.232*** (0.596)	2.197*** (0.592)	2.108*** (0.589)	2.262*** (0.593)
<b>Constant</b>	2.839*** (0.869)	2.895*** (0.885)	2.896*** (0.884)	2.839*** (0.869)	2.936*** (0.896)
<b>Observations</b>	564	564	564	564	564
<b>AIC</b>	1901.6	1899.7	1898.8	1901.5	1894.8
<b>BIC</b>	2144.4	2142.5	2141.5	2144.3	2137.6
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-894.8	-893.9	-893.4	-894.8	-891.4

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

Table B.16: Robustness, adding political rights and internal conflicts, up sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.367* (0.202)	0.194 (0.183)	-0.121 (0.196)	0.482** (0.191)	0.534** (0.230)
<b>Natural resources rents, one-year lag</b>	-0.062*** (0.021)	-0.063*** (0.021)	-0.062*** (0.021)	-0.066*** (0.021)	-0.067*** (0.021)
<b>Log of real GDP, one-year lag</b>	1.293*** (0.382)	1.243*** (0.378)	1.273*** (0.386)	1.338*** (0.392)	1.259*** (0.382)
<b>Volatility of growth, one-year lag</b>	-0.333*** (0.076)	-0.366*** (0.074)	-0.358*** (0.076)	-0.350*** (0.074)	-0.392*** (0.075)
<b>Total investments, one-year lag</b>	0.072** (0.032)	0.067** (0.032)	0.073** (0.032)	0.058* (0.032)	0.047 (0.033)
<b>Public debt, one-year lag</b>	-0.025*** (0.008)	-0.025*** (0.008)	-0.025*** (0.008)	-0.024*** (0.008)	-0.025*** (0.008)
<b>History of default, one-year lag</b>	-0.777** (0.366)	-0.719** (0.364)	-0.681* (0.363)	-0.687* (0.365)	-0.662* (0.364)
<b>Reserves, one-year lag</b>	0.015 (0.015)	0.017 (0.015)	0.016 (0.015)	0.016 (0.015)	0.020 (0.015)
<b>Current account balance, one-year lag</b>	-0.007 (0.023)	-0.010 (0.023)	-0.007 (0.023)	-0.007 (0.023)	-0.014 (0.023)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.313*** (0.060)	0.304*** (0.060)	0.318*** (0.060)	0.321*** (0.060)	0.298*** (0.060)
<b>Financial openness index, one-year lag</b>	2.107*** (0.518)	2.072*** (0.516)	2.014*** (0.515)	2.243*** (0.525)	2.287*** (0.529)
<b>Political rights index</b>	-0.112 (0.089)	-0.116 (0.089)	-0.123 (0.089)	-0.126 (0.089)	-0.125 (0.089)
<b>Internal conflicts index</b>	3.782*** (0.852)	3.725*** (0.856)	3.865*** (0.854)	3.733*** (0.853)	3.520*** (0.862)
<b>Constant</b>	5.643** (2.470)	5.546** (2.427)	5.730** (2.510)	5.933** (2.601)	5.708** (2.495)
<b>Observations</b>	271	271	271	271	271
<b>AIC</b>	867.1	869.3	870.1	864.1	865.0
<b>BIC</b>	1065.3	1067.4	1068.2	1062.2	1063.2
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-378.6	-379.7	-380.0	-377.0	-377.5

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

Table B.17: Robustness, adding political rights and internal conflicts, up sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	0.235 (0.155)	-0.485*** (0.158)	-0.272 (0.167)	-0.257 (0.176)	-1.012*** (0.239)
<b>Natural resources rents, one-year lag</b>	-0.008 (0.023)	-0.004 (0.024)	-0.010 (0.023)	-0.010 (0.023)	-0.007 (0.024)
<b>Log of real GDP, one-year lag</b>	0.387 (0.299)	0.398 (0.314)	0.399 (0.303)	0.376 (0.295)	0.356 (0.321)
<b>Volatility of growth, one-year lag</b>	0.046 (0.059)	0.058 (0.060)	0.043 (0.059)	0.046 (0.059)	0.077 (0.060)
<b>Total investments, one-year lag</b>	0.123*** (0.023)	0.128*** (0.024)	0.129*** (0.024)	0.124*** (0.023)	0.134*** (0.024)
<b>Public debt, one-year lag</b>	-0.026*** (0.005)	-0.026*** (0.005)	-0.026*** (0.005)	-0.027*** (0.005)	-0.027*** (0.005)
<b>History of default, one-year lag</b>	-1.193*** (0.296)	-1.182*** (0.302)	-1.211*** (0.298)	-1.213*** (0.294)	-1.241*** (0.304)
<b>Reserves, one-year lag</b>	0.094*** (0.014)	0.099*** (0.015)	0.098*** (0.015)	0.092*** (0.014)	0.099*** (0.015)
<b>Current account balance, one-year lag</b>	0.025* (0.013)	0.024* (0.014)	0.024* (0.013)	0.026* (0.013)	0.027** (0.014)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.069 (0.120)	0.072 (0.125)	0.053 (0.122)	0.068 (0.119)	0.081 (0.127)
<b>Financial openness index, one-year lag</b>	2.018*** (0.361)	2.189*** (0.368)	2.105*** (0.366)	2.012*** (0.360)	2.357*** (0.373)
<b>Political rights index</b>	0.077 (0.088)	0.080 (0.089)	0.080 (0.088)	0.061 (0.088)	0.022 (0.090)
<b>Internal conflicts index</b>	1.410 (0.993)	1.808* (1.011)	1.300 (0.986)	1.074 (0.984)	1.049 (0.990)
<b>Constant</b>	2.038** (0.942)	2.304** (1.065)	2.131** (0.987)	1.968** (0.911)	2.371** (1.100)
<b>Observations</b>	293	293	293	293	293
<b>AIC</b>	985.3	978.1	984.9	985.4	969.3
<b>BIC</b>	1187.7	1180.5	1187.3	1187.8	1171.7
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-437.6	-434.0	-437.4	-437.7	-429.6

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

**Appendix B.7.4 Drop top 5% and bottom 5% of sovereign debt ratings**

Table B.18: Robustness, drop top 5% and bottom 5% of sovereign debt ratings, full sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.095 (0.124)	-0.118 (0.123)	-0.220* (0.126)	-0.064 (0.131)	-0.421*** (0.155)
<b>Natural ressources rents, one-year lag</b>	-0.043*** (0.015)	-0.041*** (0.015)	-0.043*** (0.015)	-0.041*** (0.015)	-0.040*** (0.015)
<b>Log of real GDP, one-year lag</b>	0.665*** (0.171)	0.655*** (0.173)	0.672*** (0.173)	0.656*** (0.172)	0.675*** (0.173)
<b>Volatility of growth, one-year lag</b>	-0.127*** (0.045)	-0.128*** (0.045)	-0.123*** (0.045)	-0.129*** (0.045)	-0.116** (0.045)
<b>Total investments, one-year lag</b>	0.006 (0.020)	0.008 (0.020)	0.009 (0.021)	0.007 (0.020)	0.014 (0.021)
<b>Public debt, one-year lag</b>	-0.028*** (0.005)	-0.028*** (0.005)	-0.028*** (0.005)	-0.028*** (0.005)	-0.028*** (0.005)
<b>History of default, one-year lag</b>	-0.796*** (0.234)	-0.766*** (0.235)	-0.796*** (0.234)	-0.777*** (0.234)	-0.802*** (0.233)
<b>Reserves, one-year lag</b>	0.055*** (0.010)	0.054*** (0.010)	0.055*** (0.010)	0.055*** (0.010)	0.055*** (0.010)
<b>Current account balance, one-year lag</b>	-0.005 (0.011)	-0.005 (0.011)	-0.005 (0.011)	-0.005 (0.011)	-0.003 (0.011)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.121** (0.050)	0.123** (0.050)	0.126** (0.050)	0.119** (0.050)	0.127** (0.051)
<b>Financial openness index, one-year lag</b>	1.588*** (0.310)	1.612*** (0.310)	1.595*** (0.309)	1.599*** (0.309)	1.588*** (0.310)
<b>ICRG index, one-year lag</b>	4.191*** (0.770)	4.181*** (0.769)	4.320*** (0.775)	4.149*** (0.768)	4.506*** (0.780)
<b>Constant</b>	1.716*** (0.619)	1.759*** (0.636)	1.762*** (0.634)	1.723*** (0.622)	1.767*** (0.632)
<b>Observations</b>	494	494	494	494	494
<b>AIC</b>	1561.2	1560.9	1558.8	1561.6	1554.4
<b>BIC</b>	1754.6	1754.2	1752.1	1754.9	1747.7
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-734.6	-734.5	-733.4	-734.8	-731.2

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

Table B.19: Robustness, drop top 5% and bottom 5% of sovereign debt ratings, up sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	-0.374* (0.220)	0.433** (0.197)	0.169 (0.222)	0.409** (0.207)	0.721*** (0.237)
<b>Natural ressources rents, one-year lag</b>	-0.064*** (0.021)	-0.066*** (0.021)	-0.066*** (0.021)	-0.067*** (0.021)	-0.072*** (0.021)
<b>Log of real GDP, one-year lag</b>	1.108*** (0.341)	1.093*** (0.351)	1.047*** (0.353)	1.091*** (0.344)	1.076*** (0.366)
<b>Volatility of growth, one-year lag</b>	-0.245*** (0.078)	-0.275*** (0.076)	-0.296*** (0.078)	-0.264*** (0.076)	-0.314*** (0.077)
<b>Total investments, one-year lag</b>	0.035 (0.036)	0.033 (0.036)	0.035 (0.036)	0.019 (0.037)	0.004 (0.037)
<b>Public debt, one-year lag</b>	-0.036*** (0.009)	-0.039*** (0.009)	-0.037*** (0.009)	-0.034*** (0.009)	-0.037*** (0.009)
<b>History of default, one-year lag</b>	-0.409 (0.461)	-0.290 (0.465)	-0.224 (0.474)	-0.373 (0.467)	-0.185 (0.488)
<b>Reserves, one-year lag</b>	0.020 (0.016)	0.022 (0.016)	0.021 (0.016)	0.020 (0.016)	0.022 (0.016)
<b>Current account balance, one-year lag</b>	-0.014 (0.023)	-0.015 (0.023)	-0.016 (0.023)	-0.018 (0.023)	-0.021 (0.023)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	0.333*** (0.073)	0.329*** (0.072)	0.334*** (0.072)	0.331*** (0.072)	0.323*** (0.072)
<b>Financial openness index, one-year lag</b>	2.900*** (0.566)	3.091*** (0.581)	2.902*** (0.575)	2.924*** (0.567)	3.306*** (0.594)
<b>ICRG index, one-year lag</b>	5.675*** (0.977)	5.511*** (0.981)	5.552*** (0.982)	5.611*** (0.978)	5.332*** (0.989)
<b>Constant</b>	4.169** (2.100)	4.499** (2.251)	4.559** (2.296)	4.281** (2.172)	4.990** (2.539)
<b>Observations</b>	244	244	244	244	244
<b>AIC</b>	757.1	755.1	759.4	756.0	750.6
<b>BIC</b>	917.9	916.0	920.2	916.9	911.5
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-332.5	-331.6	-333.7	-332.0	-329.3

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.

Table B.20: Robustness, drop top 5% and bottom 5% of sovereign debt ratings, down sample, coefficients

	(1)	(2)	(3)	(4)	(5)
Horizon T	[0,2]	[3,5]	[0,5]	[6,10]	[0,10]
<b>Giant discoveries dummy (1 in the horizon T)</b>	0.268 (0.186)	-0.343* (0.183)	-0.100 (0.199)	-0.567*** (0.212)	-1.244*** (0.294)
<b>Natural ressources rents, one-year lag</b>	-0.060** (0.030)	-0.060** (0.030)	-0.066** (0.030)	-0.062** (0.030)	-0.063** (0.031)
<b>Log of real GDP, one-year lag</b>	0.806** (0.331)	0.797** (0.339)	0.806** (0.334)	0.818** (0.323)	0.812** (0.343)
<b>Volatility of growth, one-year lag</b>	-0.038 (0.067)	-0.039 (0.068)	-0.045 (0.067)	-0.029 (0.067)	-0.023 (0.068)
<b>Total investments, one-year lag</b>	0.033 (0.036)	0.039 (0.036)	0.035 (0.036)	0.022 (0.036)	0.031 (0.036)
<b>Public debt, one-year lag</b>	-0.017** (0.008)	-0.018** (0.008)	-0.020** (0.008)	-0.019** (0.008)	-0.022*** (0.008)
<b>History of default, one-year lag</b>	-0.771* (0.398)	-0.746* (0.401)	-0.792** (0.395)	-0.824** (0.395)	-0.790** (0.403)
<b>Reserves, one-year lag</b>	0.156*** (0.020)	0.159*** (0.020)	0.159*** (0.020)	0.155*** (0.020)	0.167*** (0.020)
<b>Current account balance, one-year lag</b>	0.023 (0.016)	0.023 (0.016)	0.022 (0.016)	0.022 (0.016)	0.021 (0.017)
<b>Log of exchange rate (LCU / \$US), one-year lag</b>	-0.166 (0.154)	-0.179 (0.158)	-0.187 (0.156)	-0.160 (0.150)	-0.203 (0.161)
<b>Financial openness index, one-year lag</b>	-0.414 (0.491)	-0.295 (0.499)	-0.438 (0.493)	-0.472 (0.490)	-0.115 (0.500)
<b>ICRG index, one-year lag</b>	9.744*** (2.136)	9.507*** (2.140)	9.541*** (2.138)	10.049*** (2.156)	9.445*** (2.198)
<b>Constant</b>	2.791** (1.350)	2.941** (1.428)	2.845** (1.384)	2.607** (1.266)	2.963** (1.452)
<b>Observations</b>	250	250	250	250	250
<b>AIC</b>	723.2	721.8	725.1	718.1	706.7
<b>BIC</b>	885.2	883.8	887.0	880.1	868.7
<b>Time fixed-effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Log-likelihood</b>	-315.6	-314.9	-316.5	-313.1	-307.4

Notes: Random effect ordered probit model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variable is sovereign debt ratings ranging from 2 to 18 (given the availability of data). The table reports the coefficient associated with each variable included as determinants of sovereign debt ratings. For simplicity of presentation, I do not report the estimated cut-off points. The control variables are included with one-year lag to limit reverse causality bias. I capture the effect of giant discoveries on sovereign debt ratings over several horizons following discoveries: (column 1) from the year of discovery to up to 2 years after, (column 2) between 3 and 5 years after the discovery, (column 3) from the year of discovery to up to 5 years after, (column 4) between 6 and 10 years after the discovery, and (column 5) from the year of discovery to up to 10 years after.



## Appendix B.8 Channels

Table B.21: Channels

	(1)	(2)	(3)
	Full	Up	Down
<b>Panel A: Tax revenue as a % of GDP, IMF</b>			
Giant discoveries dummy (1 in the horizon T)	1.241*** (0.413)	2.001*** (0.245)	-0.146 (0.568)
History of default, one-year lag	0.069 (0.054)	-0.121 (0.073)	0.308** (0.111)
Output gap (hp filter on log. of real GDP)	6.673*** (2.015)	8.166* (4.114)	6.513*** (2.084)
Observations	750	354	396
R-squared	0.688	0.728	0.688
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes
<b>Panel B: Public debt</b>			
Giant discoveries dummy (1 in the horizon T)	-0.872 (2.813)	-7.352** (3.549)	1.990 (2.622)
History of default, one-year lag	0.411 (0.783)	0.466 (0.578)	0.624 (0.915)
Output gap (hp filter on log. of real GDP)	-100.003*** (23.752)	-109.554*** (20.602)	-84.674** (34.667)
Observations	1071	478	593
R-squared	0.504	0.640	0.493
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes
<b>Panel C: Financial Markets Index</b>			
Giant discoveries dummy (1 in the horizon T)	0.020** (0.009)	0.044*** (0.012)	0.005 (0.008)
History of default, one-year lag	-0.007 (0.006)	-0.000 (0.004)	-0.009 (0.008)
Output gap (hp filter on log. of real GDP)	0.020 (0.054)	-0.021 (0.145)	0.002 (0.026)
Observations	1010	473	537
R-squared	0.650	0.724	0.598
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes
<b>Panel D: Total Investments</b>			
Giant discoveries dummy (1 in the horizon T)	0.496 (0.329)	1.892*** (0.325)	-1.210** (0.507)
History of default, one-year lag	0.225*** (0.060)	0.015 (0.072)	0.444** (0.188)
Output gap (hp filter on log. of real GDP)	27.659*** (1.632)	31.175*** (6.020)	26.672*** (3.512)
Observations	1126	547	579
R-squared	0.601	0.750	0.469
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes
<b>Panel E: Government stability index, ICRG</b>			
Giant discoveries dummy (1 in the horizon T)	0.010 (0.017)	0.037* (0.018)	0.012 (0.029)
History of default, one-year lag	0.013** (0.005)	0.018*** (0.005)	0.006 (0.007)
Output gap (hp filter on log. of real GDP)	0.449*** (0.082)	0.333*** (0.081)	0.477*** (0.105)
Observations	789	380	409
R-squared	0.642	0.699	0.667
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes
<b>Panel F: Corruption index, ICRG</b>			
Giant discoveries dummy (1 in the horizon T)	-0.004 (0.007)	0.004 (0.005)	-0.027** (0.013)
History of default, one-year lag	-0.012** (0.005)	-0.012** (0.005)	-0.014* (0.007)
Output gap (hp filter on log. of real GDP)	0.111** (0.045)	0.335*** (0.046)	0.026 (0.055)
Observations	789	380	409
R-squared	0.626	0.595	0.674
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Specific-trend	Yes	Yes	Yes

Notes: Panel-fixed effects model. \*\*\*, \*\*, and \* denote statistical significance at the 1%, the 5%, and the 10% level, respectively. Dependent variables are intermediary variables used as control variables in the benchmark model, also known as being critical for sovereign debt ratings (see text). Country-fixed effects included to control for time-invariant factors and unobserved heterogeneity, time-fixed effects included to capture common shocks affecting countries, and country-specific time trend included to capture the specific trend evolution of each intermediary variable. R-squared is relatively high for all specifications. The giant discoveries dummy takes the values of 1 in the 10 years following the discoveries, and 0 otherwise, capturing the long-term effect on intermediary variables. Control variables include history of default and output gap.