Universitat Autònoma de Barcelona

THREE ESSAYS ON THE RELATIONSHIP BETWEEN NATURAL RESOURCES, ECONOMIC DEVELOPMENT AND POLITICAL INSTITUTIONS

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Ph.D. Programme in Applied Economics

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Ph.D. Dissertation

Barcelona, 2019

"...the planet is just too small for these developing countries to repeat the economic growth in the same way that the rich countries have done it in the past. We don't have enough natural resources, we don't have enough atmosphere. Clearly, something has to change."

Mario Molina (1943-...)

Acknowledgments

Firstly, I would like to express my sincere gratitude to my advisors Prof. Oriol Roca Sagales and David Castells-Quintana for their continuous support, scientific guidance, and encouragement. I am extremely grateful for the time and effort they have devoted to this thesis. Through countless hours of productive discussions, they have pushed me towards improving the research. They have made this learning experience both constructive and enjoyable, and I really thank them for this. I am also grateful with all members of the Department of Applied Economics of the Universitat Autonoma de Barcelona, especially to Emilio Padilla and Rosella Nicolini for having trusted in me to be part of the Ph.D. programme. Gratitude is extended to Francesc Trillas, Isabel Busom, Javier Asensio and Hector Sala for their supportive attitude and their constant feedback to my work in formal scenarios such as seminars and workshops. I would like also thank Xavier Vila in Department of Economics and Economic History of the Universitat Autònoma de Barcelona for his guidance during my master degree. I want to dedicate this work to my family, thank you for encouraging me in all of my pursuits and inspiring me to follow my dreams. I cannot thank them enough for their help, advice and supporting me emotionally and financially throughout writing this thesis.

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Chapter 1

Introduction

1.1 Background and motivation

Are natural resources a blessing or curse for economic development? This question is subject to considerable debate among economists and still remains controversial. According to the literature, it seems that natural resource abundance, in particular in poor countries, is more a curse rather than a blessing for economic development, but there is still little agreement on why this occurs. According to United Nation Development Report in 2014, resource-rich countries appeared to perform worse than resource-poor countries in terms of economic and social indicators; it is also referred to as "the paradox of plenty". Natural resources are regarded as one of the most important resources of national wealth and it might be considered in the first place that large revenues from natural resources can provide a boost to economic growth and development for nations, but it seems they rarely do so.

This dissertation examines natural resources and economic development considering the role of political institutions as a mediating factor. The term "political institutions" is understood here in terms of different indicators that have been used to measure the quality of government. Thoroughly, this dissertation is composed by three chapters. Its three chapters explore different aspects of the topic: Chapter 2 examines the relationship between oil and gas rents and the different indicators of education focusing on the role of political institutions and considering a threshold model. Chapter 3 analyses the effects of natural resources on both the quantity and quality of human capital. Chapter 4 studies how different types of commodity price shocks affect inequality via different channels. More specifically, Chapter 2 and 3 consider resource rents as a proxy for natural resources while Chapter 4 focuses on commodity prices. All chapters entailed the use of several recent data sources to address relevant and unresolved questions in the resource curse literature.

Natural resources may stand as an important factor in facilitating investment and economic growth, although, the empirical observations sometimes show the opposite of this claim. Resources have a large, robust, negative impact on institutions suggesting that resource-rich countries, with poorer quality of institutions, are more likely to be trapped in conditions that render such policy improvements ineffective (Bulte et al., 2005). The destructive effect of government dependency upon revenue of natural resources has been taken into account for years. Hence, understanding the intricate dynamics of the resource curse from a broader point of view, and in order to enable the population in resource-rich countries to benefit from their vast natural resource endowments is therefore of the utmost importance.

Through the different chapters of this dissertation, it is argued that the quality of political institutions is crucial for the accumulation of resources to have a strong influence on economic indicators. Considering political institutions can helps us to better think about the role of natural resources revenues on the process of economic development. Nevertheless, the role of institutions in determining how natural resources affect economic indicators has been a point of divergence in the resource curse literature. Some authors emphasize that resource rents have a corruptive impact on the quality of a country's institutions (Ross, 2001; Hodler, 2006; Iimi, 2007; Bhattacharyya and Hodler, 2010; Arezki and Gylfason, 2011; and Tsui, 2011). Others do not find a mediating role of institutions in the resource curse hypothesis (Sachs and Warner, 1995 and 1997; and Brunschweiler and Bulte, 2008). Finally, another group of economists emphasizes that quality of institutions determines whether resource rents pose a curse or blessing and they indicate that quality of institutions involves an important way in evading the resource curse (Mehlum et al., 2006; Robinson et al., 2006; and Brunnschweiler and Bulte, 2008). Therefore, it is fair to say that, there is currently no consensus regarding the relevant role of political institutions on the curse of natural resources.

The following chapters have in common the attention to the role of quality of political institutions in the relationship between natural resources and economic development. The analysis in Chapter 2 and 3 take into account political institutions as a mediating factor between natural resources rents and various indicators of human capital, while Chapter 4 considers commodity price shocks and inequality.

1.2 Three essays on the relationship between natural resources, economic development and political institutions

This section presents a summary of the three central chapters of the dissertation, including their main contributions.

Chapter 2. An empirical analysis on the relationship between oil and gas rents and education: The role of institutional quality thresholds

This chapter examines the relationship between oil and gas rents and education when the institutional quality threshold is taken into account using a split-sample of 54 developing and developed countries. Methodologically speaking, the Cabrales and Hauk (2010) empirical model is replicated. A threshold is estimated that allows us to classify countries in two different regimes according to their institutional quality. Extensions are as follows; first a cross-sectional analysis is considered for 2000 and the mean of 1996 through 2013, and second, a panel data analysis is considered covering the period from 1996 to 2013.

The results confirm that the level of institutional quality is crucial to determine the effects of oil and gas rents on education either in the cross-section or panel data analysis. Also, we find that the negative impact of resource rents on education gets moderated especially in countries with quality of institutions above the threshold level. The main results hold across different samples and data frequencies as well as considering period fixed effects, three-year averages of data and instrumental variable estimations.

The main contribution of this chapter would be testing more thoroughly the key findings of the paper by Cabrales and Hauk (2010) using panel data as well as alternative educational indices. Specifically, a threshold regression model has been applied in two different time periods (2000 and the mean of the 1996-2013 period) and verified the evidence for a threshold effect. Second, alternative educational indices have been employed in the analysis; specifically, we have considered average years of total schooling, gross enrollment rate (secondary) and highest level attained (secondary) - to capture various aspects of human capital development.

Chapter 3. Natural resources, institutions and the quality-adjusted human capital

This chapter empirically analyses the effects of natural resources on both the quantity and quality of human capital. A panel of 162 countries for the period 1996-2014 is employed and allows us to confirm the crucial role of institutions showing that the negative association between natural resources and human capital can be reversed if the quality of institutions is high enough. The analysis also considers different types of natural resources and emphasizes the importance of using an indicator that incorporates the quantity but also the quality of human capital.

In this chapter, we analyze the relationship between resource rents and human capital and to do it an indicator of human capital has been used which incorporates the quantity and quality of human capital simultaneously. Specifically, we use a variable that incorporates two components of human capital, education and health. Although previous attempts have had some success in estimating the adverse effect of natural resources on human capital they are not without problems. Over the last quarter-century, assessments of human development have focused primarily on quantitative achievements declining for the quality of human capital (Human Development Report, 2016). In fact, World Bank (2011) first identified the term "quality-adjusted human capital" addressed the limitation of measuring human capital ignoring the quality of human capital.

The results show that resources rents are negatively associated with quality-adjusted human capital while controlling for several factors, and importantly this negative effect can be mediated by the quality of institutions. Therefore, institutional quality seems to play a critical role in determining the impact of natural resources on human capital. Moreover, the obtained results demonstrate that this resource adverse effect depends on to the type of resource rents; in particular, high dependency on oil rents appears to harm human capital. Finally, the robustness of the estimations has been checked applying instrumental variables in Two-stage Least Squares (TSLS) approach.

This chapter aims at contributing the literature by obtaining additional insights on the impact of resource rents on human capital. Most of the earlier papers on the topic are largely reliant upon either the quantitative measure of human capital or cross-sectional evidence. In this chapter, we include a variable of human capital that consider quantitative and also qualitative aspects of human capital. In addition, this chapter departs from previous studies, in that considers the disaggregation of natural resources for almost all countries blessing from natural resources.

Chapter 4. Commodity price shocks and inequality: cross-country evidence

The fourth chapter analyzes the relationship between commodity price shocks and inequality considering a panel of 80 countries from 1990 to 2016. Surprisingly little is known about the impact of income shocks due to commodity price shocks on income distribution. Building on insights from the resource curse literature, this chapter analyzes whether different types of commodity price shocks (labor-intensive vs. capital-intensive commodities) affect inequality via different channels (opportunity cost vs. rapacity effects) following Dube and Vargas (2013). According to these authors, any shock that raises the return to appropriation of resources will increase conflict by increasing labor supplied to the conflict sector "(rapacity effect)". By contrast, any shock that raises wages will reduce conflict by decreasing labor supplied to appropriation activity "(opportunity cost effect)". The chapter argues that these channels can be considered to study not only conflict (as in Dube and Vargas, 2013) but also income distribution.

Results show that commodity price shocks tend to increase inequality. However, as expected, results provide evidence that price shocks affect inequality in different directions depending on the type of the commodity. Positive price shocks on non-agricultural (capital-intensive) commodities increase capital rents inequality, and this seems to happen due to an increase in capital tax revenues (signaling rapacity effects). Therefore, the existence of opportunity cost and rapacity effects, help us understand how different types of commodities may mitigate or exacerbate inequality. Furthermore, the main finding that positive commodity price shocks increase inequality when given in capital-intensive commodities seems stronger when the initial level of inequality is high and/or the quality of institutions is low. This is the case of many Sub-Saharan African and Latin-American countries.

This chapter contributes to the literature by: i) considering two opposite effects highlighted in the literature, namely; opportunity cost and rapacity effects, in an international setting (whereas previous studies focused on subnational setting) and ii) applying them to the study of the relationship between commodity price shocks and income distribution (whereas previous studies focused on conflict).

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Chapter 2

An empirical analysis on the relationship between oil and gas rents and education: The role of institutional quality thresholds

2.1 Introduction

During the last two decades, resource curse has drawn the attention of economists and policy makers more than ever (Sachs and Warner, 1997, 1999 and 2001; Ross, 1999; Robinson, 2006; Sala-i-Martin and Subramanian, 2008). The idea that natural resource might be an economic curse more than a blessing appeared in the 1980s, while the term resource curse was first used in 1994 referring to countries with abundance of natural resources (specifically nonrenewable resources) that tend to have less economic growth than countries with fewer natural resources (Auty, 1994). Due to the potential negative effect of natural resources on economic objectives, economists have attempted to identify some factors that may drive this so-called resource curse (Ross, 1999; Papyrakis and Gerlagh, 2004). According to Gylfasson (2001), education can be one of the main channels of transmission from abundant natural resources to stunted economic development. In this sense, several authors point out the important role of human capital accumulation and argue that there is a negative and significant association between natural resources and different indicators of human capital (Gylfasson, 2001; Stijns, 2006).

Recently resource curse studies focus on the relationship between natural resources and the quality of political institutions indicating that institutions involved in an important way in evading the resource curse (Mehlum et al., 2006; Robinson et al., 2006; Brunnschweiler and Bulte, 2008). These studies try to link resource curse hypothesis to institutional quality in order to find the appropriate impact of the natural resources on economic indicators (Bulte et al., 2005 Bhattacharyya and Collier, 2013; Farhadi et al., 2015; Cockx and Francken, 2016). Interestingly, a study by Cabrales and Hauk (2010) found that the quality of institutions can be decisive whether natural resources are blessing or curse on human capital by presenting both theoretical and empirical evidences. They estimated a threshold based on quality of institutions using a cross-section analysis in 2000 and confirmed that oil and gas rents have a positive effect on education only in countries with higher quality of institutions.

This chapter empirically checks the relationship between natural resource rents specifically oil and gas rents and human capital determined by education following Cabrales and Hauk (2010) approach and expand the empirical analysis. Thus, comparing with Cabrales and Hauk (2010), this chapter estimates the relationship between oil and gas rents and education either in 2000 or 1996-2013; the possible endogeneity of the variables is taken into account, and the indicators of measuring education are adjusted using alternative educational indices. So, the main contribution of this chapter would be testing more thoroughly the key findings of the paper by Cabrales and Hauk (2010) using panel data as well as alternative educational indices. Specifically, this chapter explores whether there exists an institutional quality threshold in different periods of time. The relationship between educational indicators and resource rents might be contingent on institutional quality, where oil and gas rents promote education after institutions exceed a certain threshold level.

The objective of this chapter is to empirically check if the institutional quality threshold is decisive in determining the effects of oil and gas rents on education. Methodologically speaking, the Cabrales and Hauk (2010) empirical approach is replicated, and an econometric threshold is estimated to classify countries into different regimes according to their institutional quality. This study begins analyzing the relationship between oil and gas rents and education using the sample of 54 developing and developed countries applying both cross-sectional and panel data analyses. The results show that institutional quality threshold is crucial to determine the effects of oil and gas rents on education either in the cross-section or panel data analysis.

Moreover, this study extends the literature in some respects. First, a threshold regression model has been applied in two different time periods (2000 and the mean of the 1996-2013 period) and verified the evidence for a threshold effect. Second, alternative educational indices have been employed in the analysis; specifically we have considered average years of total schooling, gross enrollment rate (secondary) and highest level attained (secondary) - to capture various aspects of human capital development.

The article is organized as follows. Section 2.2 presents the empirical model; section 2.3 summarizes the data; section 2.4 provides the empirical results and findings, and Section 2.5 concludes.

2.2 The Empirical model

The empirical model is based on Cabrales and Hauk (2010), in which the empirical linkage between resource rents and human capital considers the following linear cross-country equation:

$$H_i = \alpha_i r_i + \beta_i Z_i + \varepsilon_i \qquad (2.1)$$

Where H_i is the human capital determined by education in country i, r_i represent resource rents (oil and gas rents) in country i, Z_i are additional controls (GDP per capita, fertility rate and Gini index) and ε is a noise term. Since some explanatory variables are in logarithmic forms, the effect of resource rents on human capital is expressed as elasticity.

As mentioned earlier, the aim of this chapter is to examine whether the impact of resource rents on education is conditional on institutional quality. So, it can be argued that Equation (2.2) is particularly well-suited to capture the presence of contingency effects and to offer a rich way of modeling the influence of institutional quality on the impact of resource rents on human capital. Consequently, the threshold regression approach suggested by Hansen (2000) is used to explore the nonlinear behavior of resource rents in relation to the human capital. The model based on the threshold regression takes the following form:

$$H_i = \begin{cases} \alpha_1 r_i + \beta_1 Z_i + \varepsilon_i & if \quad I_i \leq \xi \\ \alpha_2 r_i + \beta_2 Z_i + \varepsilon_i & if \quad I_i > \xi \end{cases} \qquad (2.2)$$

Where " I_i" (i.e., level of institutional quality in country i) is the threshold variables used to split the sample into two different regimes or groups, and ξ is the unknown threshold parameter. This type of modeling strategy allows the role of resource rents to differ depending on whether institutions are below or above some unknown level of ξ. In this equation, institutions act as sample-splitting (or threshold) variable. The impact of resource rents on human capital will be α_1 and α_2 for countries with a low and high regime, respectively. It is obvious that under the hypothesis α_1=α_2 and $\beta_1 = \beta_2$, the model becomes linear and reduces to Equation (2.1).

In order to write the sample-split or threshold regression model in a single Equation (2.3), a dummy variable $d_i(\xi)$ has been defined which takes the value of (0) when the quality of institution is below the threshold, and oppositely, takes the value of (1) when the quality of institution is above the threshold.

$$H_i = \alpha_1 r_i + \beta_1 Z_i + d_i(\xi) + [(\alpha_2 - \alpha_1) * d_i(\xi) * r_i] + [(\beta_2 - \beta_1) * d_i(\xi) * Z_i] + \varepsilon_i \quad (2.3)$$

The first step of the estimation is to test the null hypothesis of linearity H_0: $\alpha_1 = \alpha_2$ against the threshold model. Once the presence of the threshold effect is confirmed the next step is to estimate the model following Hansen (1996, 2000), who suggested a heteroscedasticity-consistent Lagrange Multiplier (LM) bootstrap procedure to test the null hypothesis of a linear formulation against the threshold regression alternative. Since the threshold parameter ξ is not identified under the null hypothesis of the no-threshold effect, inferences should be implemented through calculating a Wald or LM statistic for each possible value of ξ.

Hansen (2000) shows that this procedure yields asymptotically correct p-values. It is important to note that, if the hypothesis of $\alpha_1 = \alpha_2$ is rejected and a threshold level is identified, the threshold regression model against a linear specification is tested again after dividing the original sample according to the threshold identified. This procedure is carried out until the null of $\alpha_1 = \alpha_2$ can no longer be rejected.

Once an estimation of ξ is obtained, then the estimates for $\hat{\alpha}(i)$ and $\hat{\beta}(i)$ are the OLS estimates corresponding to the chosen $\hat{\xi}$ according to Equation (2.3).

2.3 Data

Data is collected from different sources with the purpose of investigating the relationship between resource rents and education and exploring the impact of institutional quality.[1] This study employs cross-country estimations in order to test Equation (2.3). Then, comparing the data used by Cabrales and Hauk (2010), the variables, countries and time period are similar in terms of cross-sectional analysis. Specifically, 54 countries are included in the analysis and two different time periods (2000 and the mean of the 1996-2013 period) have been considered.[2]

The institutional dataset is obtained from Kaufmann et al. (2009) from World Governance Indicators (WGIs).[3] And the indicators were constructed based on information gathered through a

[1] The long definition and sources of the variables can be found in Table A.2.1.

[2] The list of countries is presented in Table A.2.2. The sample contains 5 less countries than Cabrales and Hauk (2010) due to lack of country available data for gross enrolment rate.

[3] These institutional indicators were measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes.

wide variety of cross-country surveys. Specifically, three indicators are employed representing the quality of institutions: (I) control of corruption, (II) government effectiveness, (III) regulatory quality, and finally, an average of these three indicators has also been considered.

On the other hand, three different sources are used to measure human capital accumulation. First, the stock of human capital is measured by the average years of total schooling among the people over 25 years old (similar to Cabrales and Hauk, 2010). This data is obtained from the original revised version of the Barro-Lee Educational Attainment Dataset and is available from 1970-2010 with 5 years of intervals. Second, the gross enrolment rate taken from the World Bank dataset measured using the total enrollment rate in secondary education, regardless of age, expressed as a percentage of the population of official secondary education age. This variable that is available annually can exceed 100% due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition (UNESCO Institute for Statistics). Finally, the highest level attained in secondary schooling or percentage of population age 25+ with secondary schooling (completed) is considered and is taken from Barro-Lee dataset (ver. 2.1), which is also available in 5 years intervals.

With respect to resource rents, the sum of oil and gas rents is extracted as a percentage of GDP and is provided by World Bank dataset.[4] Specifically, oil and gas rents (%GDP) variable is measured as a difference between the price of a commodity and the average cost of producing the resources.[5] Then, the obtained GDP percentage is multiplied by the GDP in constant 2005 US dollar in order to convert to dollar term.[6] Finally, the values are converted into logarithmic form hence the effect of resource rents on human capital is expressed as elasticity. In some countries earnings from natural resources, especially from fossil fuels and minerals, account for a sizable share of GDP, and much of these earnings come in the form of economic rents above the cost of extracting the resources. Rents from nonrenewable resources - fossil fuels and minerals - indicate the liquidation of a country's capital stock (World Bank, 2011). This measure of natural resources has been used to explain

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[4] Following de Soysa and Neumayer (2007), rents from production are a more comprehensive measure of natural resources than exports. It is the rents generated by natural resources which might be stolen by politicians and weaken the quality of institutions.

[5] Total costs of production and estimation is based on sources and methods described in "The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium" (World Bank, 2011).

[6] According to Harford and Klein (2005), using the dollar value of oil and gas production is more direct measure of oil and gas rents through it leaves aside production costs.

corruption and conflict effects by Arezki and Gylfasson (2013) and also measure the impact of resource rents on political stability by Bjorvatn and Farzanegan (2015).

The set of further controls in the baseline specification includes three variables. Specifically, the effect of income per capita is taken into account by including the logarithmic of real GDP per capita expressed in US dollar at constant 2005 prices obtained from World Bank data. To capture the effect of population growth, fertility rate is included as the average number of children born per woman, from the World Development Indicators (WDI) database. Finally, the Gini index obtained from the Standardized World Income Inequality Database (SWIID) is also included to account for the effect of inequality by the distribution of income among individuals or household within the economy.

2.4 Empirical results

The empirical results are structured as follows; section 2.41 test the presence of a threshold effect in the relationship between oil and gas rents and education in two time periods (2000 and the mean of the 1996-2013 period). Then, section 2.42 reports the cross-sectional results using different indicators of education. Finally, section 2.4.3 considers a panel-data analysis and some robustness checks.

2.4.1 Threshold estimation

The empirical analysis begins by testing the presence of a threshold effect in terms of institutional quality (measured through control of corruption, government effectiveness, regulatory quality and average of these three indices) by using the Hansen threshold testing procedure. The null hypothesis here is that there is no threshold effect. The LM-test statistic for testing the null of no threshold effect and the corresponding *p*-values are reported in Table 2.1. In addition, Table 2.1 reports the results of estimating Equation (2.3) using the average years of total schooling as the human capital variable and taken into account two periods of time; 2000 and the mean of 1996-2013 period. The statistical significance of the threshold estimate was evaluated by the *p*-value calculated using the bootstrap method with 5000 replications and 15% trimming percentage. As shown in Table 2.1, the bootstrap *p*-values indicate that the test of no threshold effect can be rejected and this suggests that there might be a sample split based on institutions.

Table 2.1 First sample split: threshold estimates of institutions

year	2000			
	CC	GE	RQ	AVE
LM test for no threshold	12.28	13.27	14.14	14.55
Bootstrap *p*-value	0.067	0.034	0.014	0.012
Threshold estimates of institutions	0.612	0.622	0.651	0.625
95% Confidence interval	[0.612/0.687]	[0.523/1.194]	[0.515/0.728]	[0.568/0.625]
year	1996-2013			
	CC	GE	RQ	AVE
LM test for no threshold	14.77	14.76	14.63	14.76
Bootstrap *p*-value	0.012	0.009	0.01	0.01
Threshold estimates of institutions	0.3	0.84	0.8	0.624
95% Confidence interval	[-0.62/1.85]	[-0.56/0.84]	[-0.06/0.94]	[-0.50/1.37]

Note: H_0: no threshold effect. : CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. Dependent Variable: Average years of total schooling, +25 years, version 1.1.

Moreover, the 95% confidence intervals estimated for the mean of 1996 through 2013 are wider compared with the ones in 2000 (Table 2.1).[7] In addition, as Hansen (2000) recommends, further split of these two subsamples can be tested in order to make the 95% confidence interval results relatively narrow. In this regards, the high and low-institutions groups can be split further into sub-regimes. The bootstrap p-values are not significant for the second sample split, which suggests that only the single threshold in equation (2.3) is adequate for all models.[8]

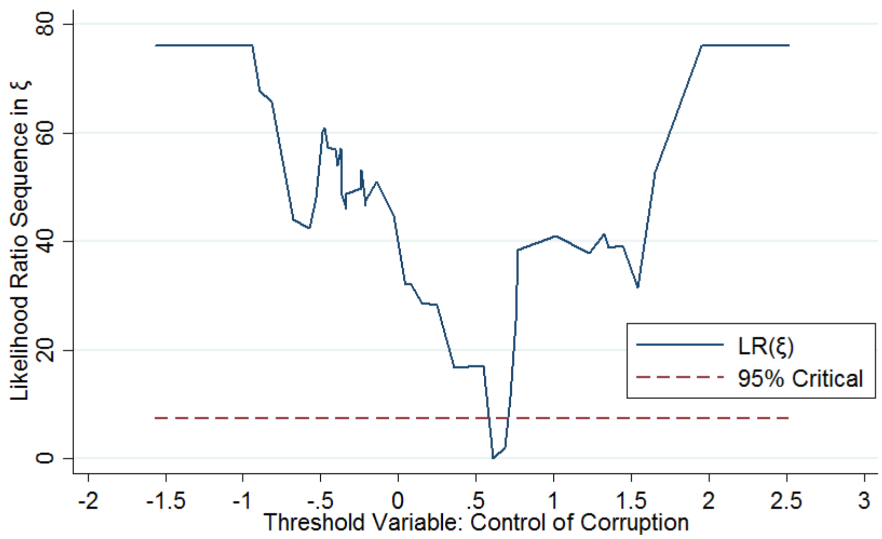
For example, referring to control of corruption in 2000, the threshold value of control of corruption is 0.612 with a corresponding 95% confidence interval (0.612, 0.687). This implies that countries with values of less than 0.612 are classified into the low institutional quality, while those with greater values are classified into the high institutional quality. These threshold values in 2000 are almost consistent with Cabrales and Hauk (2010) findings. The threshold values that they

[7] Similarly, Law et al., (2012) confront with a wider interval problem with WGI indicators when they employed WGI institutions corresponding to institutions dataset in order to check the threshold effect in the finance-growth relationship.

[8] The results of the second sample split can be found in Table A.2.3.

estimated are: control of corruption: 0.6, government effectiveness: 0.6, regulatory quality: 0.7 and average: 0.65. Figure 2.1 displays a graph of the normalized likelihood ratio sequence LR* (ξ) as a function of the threshold in control of corruption. The least square (LS) estimate of ξ is the value that minimizes this graph, which occurs at $\hat{\xi}$=0.612. The 95% critical value at of 12.02 is also plotted (the dash line). Hence, we can read off the asymptotic 95% confidence set (0.612, 0.687) from the graph from where LR*(ξ) crosses the dashed line. These results show that there is reasonable evidence for a two-regime specification. Next, the obtained thresholds values are applied in the upcoming estimations of Equation (2.3).

Figure 2.1: First sample split: confidence interval construction for threshold variable: control of corruption in 2000.[9]



The remaining empirical strategy is organized as follows. First, the results of Cabrales and Hauk (2010) in 2000 are replicated and also the estimation for an alternative period is considered (the mean of 1996-2013 period). Second, the last updated version of the dependent variable (average years of total schooling, age 25+) measured from Barro and Lee Dataset version 2.1 (02/2016) is used because the values of the original version 1.1 have been modified comparing to the updated version (2.1). Third, the framework is extended considering alternative educational indices as the

[9] List of confidence interval construction for remaining threshold variables can be found in Figures A.2.1a and A.2.1.b.

dependent variable. And finally, an annual unbalanced panel data is applied covering the period from 1996 to 2013 based on WGI institutional quality thresholds.

2.4.2 Cross-sectional threshold regressions

Having established the existence of an institutional quality threshold, the next question to pose is how institutions impact on the resource rents-education relationship. Now, $\hat{\alpha}(i)$ and $\hat{\beta}(i)$ are estimated with the OLS estimations corresponding to the chosen $\hat{\xi}$. The classification of countries into countries with "good" institutions and "bad" institutions varies slightly depending on the index of institutional quality that has been used. Table 2.2 presents the empirical results of Equation (2.3), where Cabrales and Hauk (2010) estimation is replicated in 2000 applying the original version of the dependent variable extracted from the Barro and Lee Dataset version 1.1 (07/2010). The differences with respect to their estimation are the number of countries, and the threshold values that Cabrales and Hauk (2010) estimated.[10] Hence, the results obtained in the four scenarios considered corresponding to the threshold obtained using the different indicators of institutional quality show that the log of oil and gas rents are negatively (positively) associated with average years of total schooling in countries with lower (higher) institutional quality. Results are highly significant at 1 % level of significance. This analysis is also developed testing a different period of time (the mean of 1996 through 2013) and the results are maintained.

Then, Table 2.3 presents the results of the analysis, using the updated version of average years of total schooling as a proxy for human capital regarding two periods of time; 2000 and the mean of 1996 through 2013. The results are broadly similar to those obtained using the original version taken from the Barro and Lee dataset, reported in Table 2.2.

Later, Table 2.4 reports the results using gross enrolment rate in secondary schooling as another indicators of human capital to check if the model is consistent considering alternative educational indices. The results are similar to the findings in the previous tables even though they are not always statistically significant in the case of the 1996-2013 period. However, this result can lead us to apply an annual panel data analysis considering gross enrolment rate as a dependent variable in the upcoming section.

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[10] The original results of Cabrales and Hauk (2010) is provided in Table A.2.4.

Finally, Table 2.5 presents the results using the highest level attained in secondary schooling as another indicator for human capital in 2000 and the mean of 1996-2013 period confirming that human capital does not respond differently to different human capital indicators.

Moreover, in all cases (see Table 2.2 to 2.5) the estimated coefficients on GDP per capita, fertility rate, and Gini index are consistent with the literature. To summarize, the coefficients of GDP per capita are positive below than threshold levels, pointing out that countries with lower quality of institutions are more reliant on individual income to promote human capital. Fertility rate is positive and statistically significant only above the threshold levels, it may be that the higher human capital accumulation in these countries allows them to handle population growth. And inequality is negative in countries with higher quality of institutions; it may be that the higher educational level in these countries allows them to construct a more equal society.

To conclude, the effects of resource rents on human capital accumulation significantly depend on the quality of institutions in the cross-sections analysis. In countries with bad quality of institutions, increasing resource rents have a negative effect on education. However, in countries with good quality of institutions, resource rents do increase educational level.

Table 2.2 OLS regression results. Dependent variable: average years of total schooling, age +25, original version 1.1

year	2000							1996-2013							
	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2		log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.612	-0.34*** (t: -3.89)	1.34*** (t: 3.68)	-0.51 (t: -1.93)	0.008 (t: 0.30)	4.66 (t: 1.33)	54	0.78	CC < 0.3	-0.24* (t: -2.05)	1.13*** (t: 3.71)	-0.41 (t: -1.93)	0.00 (t: 0.02)	4.18 (t: 1.08)	54	0.78
CC > 0.612	0.14*** (t: 3.58)	-2.44 (t: -1.22)	1.86** (t: 3.40)	-0.13 (t: -1.75)				CC > 0.3	0.20** (t: 2.76)	-2.64* (t: -2.31)	1.51*** (t: 3.54)	-0.13** (t: -2.07)			
GE < 0.622	-0.33*** (t: -3.78)	1.17*** (t: 3.09)	-0.56* (t: -2.12)	0.016 (t: 0.57)	5.54 (t: 1.52)	54	0.77	GE < 0.84	-0.28** (t: -2.85)	0.98** (t: 3.27)	-0.52* (t: -2.38)	-0.009 (t: -0.31)	7.00 (t: 1.86)	54	0.77
GE > 0.622	0.07** (t: 2.98)	-1.98 (t: -1.06)	1.32* (t: 2.48)	-0.12 (t: -1.90)				GE > 0.84	0.08* (t: 2.43)	-1.35 (t: -0.36)	0.95* (t: 2.30)	-0.033 (t: -0.41)			
RQ < 0.651	-0.30** (t: -3.32)	1.20** (t: 2.98)	-0.51 (t: -1.97)	0.013 (t: 0.48)	4.63 (t: 1.24)	54	0.79	RQ < 0.8	-0.24* (t: -2.10)	1.17*** (t: 3.58)	-0.39 (t: -1.80)	0.006 (t: 0.21)	3.47 (t: 0.86)	54	0.78
RQ > 0.651	0.15*** (t: 3.60)	-2.72* (t: -2.36)	2.39*** (t: 5.18)	-0.13* (t: -2.65)				RQ > 0.8	0.12* (t: 2.34)	-2.66* (t:-2.28)	1.61*** (t: 3.97)	-0.12* (t: -2.08)			
AVE< 0.625	-0.33*** (t: -3.77)	1.31*** (t: 3.53)	-0.49 (t: -1.89)	0.004 (t: 0.16)	4.72 (t: 1.31)	54	0.8	AVE< 0.624	-0.28** (t: -2.77)	0.95** (t: 3.29)	-0.5* (t: -2.31)	0.00 (t: -0.01)	6.65 (t: 1.75)	54	0.78
AVE > 0.625	0.19*** (t: 4.37)	-2.93** (t: -2.76)	2.49*** (t: 5.28)	-0.08 (t: -1.79)				AVE > 0.624	0.1* (t: 2.55)	-1.67 (t: -0.88)	0.79 (t: 1.87)	-0.06 (t: -1.00)			

Note: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average.* Significant at 10%, ** significant at 5% and *** significant at 1%. t-values shown in parenthesis. “n” is the number of countries (observations). See Table A.2.5 for grouping of countries.

Table 2.3 OLS regression results. Dependent variable: average years of total schooling, age +25, updated version 2.1.

year	2000							1996-2013							
	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2		log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.612	-0.39***	1.41***	-0.53	-0.009	6.14*	54	0.81	CC < 0.3	-0.32**	1.25***	-0.52**	-0.01	5.88*	54	0.81
	(t: -4.89)	(t: 3.77)	(t: -1.87)	(t: -0.28)	(t: 1.84)				(t: -2.74)	(t: 3.96)	(t: -2.39)	(t: -0.29)	(t: 1.8)		
CC > 0.612	0.07***	2.86*	1.77***	-0.14*				CC > 0.3	0.05**	-2.57**	1.09**	-0.1**			
	(t: 4.00)	(t: -2.14)	(t: 3.62)	(t: -2.36)					(t: 2.42)	(t: -2.04)	(t: 2.67)	(t: -1.91)			
GE < 0.622	-0.38***	1.21**	-0.58*	0.00	7.09**	54	0.8	GE < 0.84	-0.30***	0.99***	-0.63**	-0.01	7.88**	54	0.79
	(t: -5.32)	(t: 3.21)	(t: -2.12)	(t: 0.02)	(t: 2.22)				(t: -2.80)	(t: 3.11)	(t: -2.73)	(t: -0.45)	(t: 2.07)		
GE > 0.622	0.01**	-2.37	1.18*	-0.15*				GE > 0.84	0.01**	-1.81	0.95**	-0.07			
	(t: 3.41)	(t: -1.60)	(t: 2.44)	(t: -2.21)					(t: 2.11)	(t: -0.81)	(t: 2.44)	(t: -1.06)			
RQ < 0.651	-0.34***	1.17**	-0.54*	0.001	6.49*	54	0.82	RQ < 0.8	-0.20*	1.12***	-0.47**	0.00	3.61	54	0.82
	(t: -4.73)	(t: 2.94)	(t: -2.03)	(t: 0.05)	(t: 1.97)				(t: -1.76)	(t: 3.70)	(t: -2.08)	(t: 0.09)	(t: 0.88)		
RQ > 0.651	0.10***	-3.06**	2.27***	-0.16**				RQ > 0.8	0.12**	-3.18**	-2.53***	-0.13**			
	(t: 4.02)	(t: -3.22)	(t: 5.18)	(t: -3.20)					(t: 2.15)	(t:-3.70)	(t: 3.89)	(t: -2.45)			
AVE< 0.625	-0.38***	1.37***	-0.51	-0.01	6.20*	54	0.82	AVE< 0.624	-0.29**	0.97**	-0.61*	-0.009	7.64	54	0.8
	(t: -4.92)	(t: 3.58)	(t: -1.85)	(t: -0.37)	(t: 1.86)				(t: -2.71)	(t: 3.11)	(t: -2.67)	(t: -0.32)	(t: 1.99)		
AVE > 0.625	0.12***	-3.34***	2.35***	-0.13*				AVE > 0.624	0.02*	-1.79	0.65	-0.06			
	(t: 4.22)	(t: -4.30)	(t: 5.28)	(t: -2.46)					(t: 2.16)	(t: -1.07)	(t: 1.75)	(t: -1.18)			

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. * Significant at 10%, ** significant at 5% and *** significant at 1%. t-values shown in parenthesis. “n” is the number of countries (observations).

Table 2.4 OLS regression results. Dependent variable: gross enrolment ratio (%), secondary schooling

year	2000						
	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.612	-2.79**	5.71*	-9.23***	0.25	97.95***	54	0.78
	(t: -3.01)	(t: 2.06)	(t: -3.95)	(t: 0.75)	(t: 3.80)		
CC > 0.612	1.51**	-10.55	13.15**	-1.76*			
	(t: 2.71)	(t: -0.61)	(t: 3.52)	(t: -2.08)			
GE < 0.622	-2.90**	6.32*	-9.11***	0.2	97.46***	54	0.76
	(t: -3.07)	(t: 2.06)	(t: -3.83)	(t: 0.58)	(t: 3.31)		
GE > 0.622	0.31*	0.63	5.44*	-0.53			
	(t: 2.20)	(t: 0.94)	(t: 2.23)	(t: -1.25)			
RQ < 0.651	-2.93**	5.89	-9.2***	0.29	97.72***	54	0.77
	(t: -3.28)	(t: 1.9)	(t: -3.97)	(t: 0.92)	(t: 3.80)		
RQ > 0.651	1.2**	-6.43	13**	-1.03*			
	(t: 2.83)	(t: -0.11)	(t: 3.27)	(t: -2.37)			
AVE< 0.625	-2.83**	5.42*	-9.28***	0.33	97.63***	54	0.78
	(t: -3.22)	(t: 2.02)	(t: -4.06)	(t: 1.12)	(t: 3.89)		
AVE > 0.625	1.5**	-9.79	13.67**	-1.2*			
	(t: 2.87)	(t: -0.76)	(t: 3.30)	(t: -2.66)			

year	1996-2013						
	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.3	-1.50	6.83**	-7.83***	0.13	66.65	54	0.78
	(t: -1.32)	(t: 2.69)	(t: -3.85)	(t: 0.35)	(t: 2.13)		
CC > 0.3	0.09	-6.25	6.06**	-0.72			
	(t: 1.11)	(t: 0.13)	(t: 2.06)	(t: -1.06)			
GE < 0.84	-1.54	7.43**	-7.9***	0.19	61.51*	54	0.79
	(t: -1.53)	(t: 3.39)	(t: -3.87)	(t: 0.67)	(t: 2.16)		
GE > 0.84	-01.11	-3.58***	0.86	-0.34			
	(t: 0.30)	(t: 2.01)	(t: 1.14)	(t: -0.28)			
RQ < 0.8	-1.85*	7.29***	-7.98***	0.18	69.91**	54	0.78
	(t: -1.77)	(t: 2.88)	(t: -3.98)	(t: 0.58)	(t: 2.23)		
RQ > 0.8	0.15	-5.91	5.97**	-0.73			
	(t: 1.47)	(t: 0.30)	(t: 2.03)	(t: -1.04)			
AVE< 0.624	-1.53	7.38**	-7.87***	0.21	60.81*	54	0.79
	(t: -1.53)	(t: 3.38)	(t: -3.86)	(t: 0.72)	(t: 2.14)		
AVE > 0.624	-0.92	1.68	-0.27	-0.09			
	(t: 0.46)	(t: 1.66)	(t: 1.48)	(t: -0.53)			

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. * Significant at 10%, ** significant at 5% and *** significant at 1%. t-values shown in parenthesis. "n" is the number of countries (observations).

Table 2.5 OLS regression results. Dependent variable: highest level attained (%), secondary, age +25, updated version 2.1

year: 2000	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.612	-2.08*	6.09*	-2.20	-0.41*	41.68	54	0.54
	(t: -2.59)	(t: 2.06)	(t: -1.11)	(t: -1.66)	(t: 1.38)		
CC > 0.612	0.22	-20.50*	5.09	-1.30*			
	(t: 1.88)	(t: -2.87)	(t: 1.31)	(t: -1.76)			
GE < 0.622	-1.84**	3.87	-2.77	-0.28	49.05	54	0.57
	(t: -2.78)	(t: 1.49)	(t: -1.59)	(t: -1.3)	(t: 1.93)		
GE > 0.622	0.09	-18.47*	2.96	-1.53*			
	(t: 1.91)	(t: -2.69)	(t: 1.12)	(t: -2.25)			
RQ < 0.651	-1.48**	3.30	-2.37	-0.21	40.94*	54	0.62
	(t: -2.64)	(t: 1.37)	(t: -1.52)	(t: -1.08)	(t: 1.84)		
RQ > 0.651	0.35	-20.34**	5.96	-1.33*			
	(t: 1.69)	(t: -2.77)	(t: 1.38)	(t: -2.63)			
AVE< 0.625	-1.95**	5.28	-2.03	-0.37	42.27	54	0.58
	(t: -2.62)	(t: 1.80)	(t: -1.12)	(t: -1.57)	(t: 1.55)		
AVE > 0.625	0.71*	-24.52**	6.93	-1.50*			
	(t: 2.11)	(t: -2.94)	(t: 1.48)	(t: -2.14)			

year: 1996-2013	log Oil and Gas rents	log GDP per capita	Fertility rate	Gini index	Constant	n	R^2
CC < 0.3	-1.39**	2.04	-3.35**	-0.37	58.66***	54	0.69
	(t: -2.17)	(t: 1.18)	(t: -2.50)	(t: -1.78)	(t: 2.88)		
CC > 0.3	1.13**	-22.41***	-1.29	-1.54**			
	(t: 2.35)	(t: -4.03)	(t: 1.08)	(t: -2.63)			
GE < 0.84	-1.94**	1.88	-4.26**	-0.36	74.79***	54	0.61
	(t: -2.83)	(t: 1.06)	(t: -2.78)	(t: -1.73)	(t: 3.32)		
GE > 0.84	0.61**	-17.69**	-1.82	-1.52*			
	(t: 2.35)	(t: -2.55)	(t: 0.39)	(t: -1.86)			
RQ < 0.8	-1.21**	2.07	-3.14**	-0.12	43.85**	54	0.71
	(t: -2.26)	(t: 1.31)	(t: -2.41)	(t: -0.60)	(t: 2.25)		
RQ > 0.8	1.14**	-21.61***	1.19	-1.68***			
	(t: 2.37)	(t: -4.25)	(t: 0.90)	(t: -3.53)			
AVE< 0.624	-1.92**	1.76	-4.22**	-0.31	73.08**	54	0.62
	(t: -2.88)	(t: 1.05)	(t: -2.8)	(t: -1.43)	(t: 3.28)		
AVE > 0.624	0.44*	-15.21*	2.3	-0.86			
	(t: 2.39)	(t: -2.61)	(t: 0.41)	(t: -1.98)			

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. * Significant at 10%, ** significant at 5% and *** significant at 1%. t-values shown in parenthesis. "n" is the number of countries (observations).

2.4.3 Panel-data threshold regressions

Several authors have recommended that as the research is prone to problems of omitted variable bias it is important to move from cross-section to panel-data regression (Van der Ploeg, 2006 and 2011; Collier and Goderis, 2008). In such a panel approach, gross enrolment rate as the dependent variable needs to be used because of availability of annual data while the same control variables are included. Specifically, the relationship between oil and gas rents and education is examined by providing a panel of 49 developed and developing countries that include basically most of the countries in the previous cross-sectional sample and covering the period from 1996 to 2013.[11]

Figures 2.2 and 2.3 illustrate the relationship between gross enrolment rate in secondary schooling (%) and the log of oil and gas rents (US$) during 1996-2013 in the developed and developing economies respectively, showing that oil and gas rents seems to be positively associated with human capital in the developed economies, while this relationship seems to be negative in developing economies.[12] Therefore, resource-rich developed countries have been able to increase human capital more than resource-rich developing countries. Accordingly, the level of economic development might be an important filter in order to check the relationship between resource rents and education even in the long term.

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[11] Considering the sample of 54 countries, Congo.Dem.Rep, Congo, Rep., Papua New Guinea, Syrian Arab Rep. and Trinidad and Tobago are discarded from the sample due to lack of annually available data for Gross enrolment ratio.

[12]30 countries in the sample are classified as developing and emerging economies based on IMF classification of countries, namely Algeria, Argentina, Bangladesh, Bolivia, Bulgaria, Cameroon, Chile, China, Colombia, Croatia, Ecuador, Egypt, Arab Rep., Guatemala, Hungary, India, Indonesia, Iran, Islamic Rep., Jordan, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, South Africa, Thailand, Tunisia, Turkey, and Venezuela.

And 19 countries are classified as advanced economies namely, Australia, Austria, Canada, Czech Republic, Denmark, France, Greece, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Slovak Republic, Slovenia, Spain, United Kingdom and United States.

Figure 2.2: oil and gas rents and education for developed economies. (1996-2013)

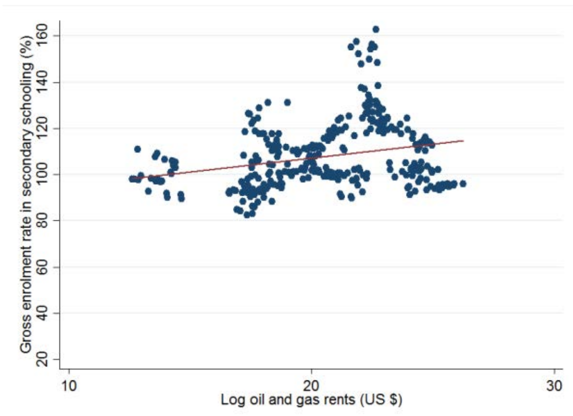
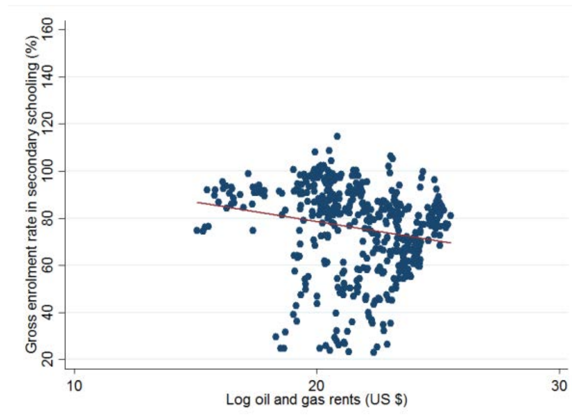


Figure 2.3: oil and gas rents and education for developing economies. (1996-2013)



2.4.3.1 Baseline Results

This sub-section reports the baseline results for panel regressions analysis. The results of the estimations using initial OLS regressions according to Equation (2.3) are summarized in Table 2.6. The justification for applying pooled OLS has been confirmed because of the limited within-country variation in the main variables in the sample (see Table A.2.6). Thus, cross-section fixed effect cannot be applied. Alternatively, the period fixed effect is introduced to account for the influence of unknown time-varying factors affecting all the panel-data units.

Split sample threshold method from Hansen (2000) previously estimated in section 2.4.1 has been applied in order to cover the period from 1996 to 2013. Equation (2.3) estimates using four different models according to the institutional indicators that have been applied (Model A: control of corruption; Model B: government effectiveness; Model C: regulatory quality; and Model D: average of these indicators).

Table 2.6 presents a first set of regressions of resource rents on the measures of human capital and control variables. In all the models, the results indicate that resource rents are negatively associated with human capital below the threshold levels at statistically significant level.

Additionally, this study has revealed several other interesting results. Now the different institutional indicators above the threshold levels perform differently toward the relationship between human capital and resource rents which is in contrast to the previous findings (Bhattacharya and Hodler, 2010; Bulte et al., 2005).[13] Specifically, turning first to model B (government effectiveness as a threshold variable), the coefficient estimate of oil and gas rents is negative and significant when institutions stand above the threshold level. In contrast, the effect of resource rents on human capital becomes significant and positive for countries above the threshold level in both Models A and C concerning control of corruption and regulatory quality as thresholds variables, respectively. On the other hand, when the institutions variable used by the average of these indicators in Model D, the results reveals that above the institutions threshold, resource rents is negative and highly significant determinant of human capital. This result might be due to an aggregate effect which produced by the negative impact of government effectiveness (Model B) on average of these indicators (Model D). Moreover, the absolute values of resource rents are notably smaller above the threshold levels indicating that nations with higher quality of institutions are less dependent on the resource rents in order to generate human capital.

In all models, all the estimated coefficients on GDP per capital, fertility rate and Gini index are consistent either with the literature and previous cross-sectional estimations. The GDP per capita variable is positive and statistically significant in promoting human capital below the threshold level. The coefficients on fertility rate are negative (positive) determinants of human capital on below (above) the institutions threshold. In particular, this shows that as the number of children per family increases, the average investment in education decreases (Barro 2000). In addition, inequality is negatively related to educational level in secondary schooling above the institutions thresholds, indicating that an increase in inequality generates less human capital in advanced countries; although, Gini index is positively associated with gross enrolment rate in countries with lower quality of institutions, meaning that in a developing economy, prioritizing higher education over primary or secondary education can add to the gulf between the haves and the have-nots (Mughal and Diawara, 2011).

[13] Bulte et al. (2005) argued that it is important to highlight that different measures of institutional quality apparently have different effects on the performance of welfare or development indicators.

Table 2.6 Pooled OLS regression results. Dependent variable: Gross enrolment ratio, secondary (%)

	Model A CC		Model B GE		Model C RQ		Model D AVE	
	<0.3	>0.3	<0.84	>0.84	<0.8	>0.8	<0.624	>0.624
log Oil and Gas rents(US$)	-1.55***	0.15***	-1.32***	-0.34**	-1.71***	0.27***	-1.82***	-0.21***
	(-5.49)	(4.17)	(-5.11)	(2.39)	(-7.51)	(5.76)	(-6.49)	(4.12)
log GDP per capita	9.08***	-9.07	8.87***	-8.86	7.76***	-6.65	8.78***	-5.12**
	(11.07)	(-0.42)	(11.27)	(-0.32)	(10.83)	(0.09)	(10.22)	(2.27)
Fertility rate	-8.56***	4.11***	-7.89***	1.78***	-8.78***	7.79***	-8.48***	2.19***
	(-10.00)	(7.31)	(-9.24)	(4.16)	(-8.81)	(7.84)	(-9.80)	(5.20)
Gini index	0.27**	-1.10***	0.28***	-0.58***	0.27***	-0.96***	0.26**	-0.94***
	(3.12)	(-5.16)	(3.34)	(-4.44)	(3.47)	(-5.38)	(3.08)	(-4.02)
Constant	45.45***		40.93***		60.60***		54.68***	
	(4.34)		(4.02)		(7.41)		(5.08)	
Observations	725		725		725		725	
Number of countries	49		49		49		49	
R^2	0.71		0.7		0.72		0.71	

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. t-ratios shown in parenthesis. * means significant at 10%, ** significant at 5% and *** significant at 1%.

2.4.3.2 Robustness checks

The panel results have been tested through different robustness checks. First, the country and time fixed effects are considered. By incorporating the country and time fixed effects, allows us to control for country-specific characteristics and also the unobserved effects are controlled that vary over time (Bhattacharyaa and Collier, 2013). Table 2.7 reports the results taking into account country and time fixed effects. The results are broadly similar to those obtained with OLS estimations, reported in Table 2.6. Comparing to previous results, resource rents coefficient in Model A which yields control of corruption as a threshold variable, turn negative for institutions above the threshold level. Moreover, resource rents coefficient in Model B, turn positive for institutions above the threshold level. Finally, resource rents coefficient in Model D which yields average of institutions as a threshold variables, turn positive and significant.

Table 2.7 Robustness checks including country and time fixed effects

	Model A CC		Model B GE		Model C RQ		Model D AVE	
	<0.3	>0.3	<0.84	>0.84	<0.8	>0.8	<0.624	>0.624
log Oil and Gas rents(US$)	-1.23***	-0.12***	-1.26***	0.61***	-0.41	0.13	-0.82*	0.32***
	(-3.28)	(5.34)	(-3.21)	(5.47)	(-1.00)	(1.34)	(-1.83)	(2.84)
log GDP per capita	15.78***	15.77***	13.34***	13.33	13.63***	16.98***	16.76***	15.1**
	(7.01)	(-8.41)	(5.91)	(-6.78)	(5.78)	(3.55)	(6.92)	(-2.28)
Fertility rate	-8.14***	-6.24	-8.47***	-4.35	-8.20***	-22.72***	-12.73***	-4.34***
	(-6.40)	(-1.28)	(-5.68)	(1.43)	(-5.84)	(-3.21)	(-8.49)	(3.19)
Gini index	-0.36**	0.15	-0.21	-1.34***	-0.23*	-1.13***	-0.22*	-0.87***
	(-2.96)	(-1.65)	(-1.58)	(-4.21)	(-1.78)	(-3.43)	(-1.65)	(-3.21)
Constant	4.82		22.91		64.80***		-10.03***	
	(0.22)		(1.04)		(7.95)		(-0.44)	
Observations	725		725		725		725	
Number of countries	49		49		49		49	
R^2	0.61		0.60		0.60		0.69	

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. t-ratios shown in parenthesis. Dependent variable: gross enrolment ratio (%), secondary schooling.* means significant at 10%, ** significant at 5% and *** significant at 1%.

Second, data has been considered in six periods of three-year means to handle annual volatility and measurement errors which is common in the literature (i.e., Brunnschweiler and Bulte, 2008; Bhtattacharyya and Collier, 2013; Cockx and Francken, 2016). The results shown in Table 2.8 confirm again the hypothesis of the lower and unclear effects of resource rents above the institutions threshold level which depends on the specific dimensions. Comparing to previous results, resource rents coefficients in Model D which yields average of institutions as a threshold variable, turn negative for institutions above the threshold level. As can be seen, employing 3-year averages does not alter previous substantive results.

Table 2.8 Robustness checks using OLS regressions in three-year means

	Model A CC		Model B GE		Model C RQ		Model D AVE	
	<0.3	>0.3	<0.84	>0.84	<0.8	>0.8	<0.624	>0.624
log Oil and Gas rents(US$)	-1.61***	-0.05*	-1.36***	-0.45	-1.85***	0.27***	-1.8***	-0.31*
	(-3.48)	(2.31)	(-3.20)	(1.35)	(-5.16)	(3.73)	(-3.96)	(2.26)
log of GDP per capita	9.40***	9.39	9.26***	9.25	8.21***	8.77	8.76***	12.61*
	(6.88)	(0.05)	(7.09)	(0.67)	(7.00)	(0.24)	(6.57)	(1.76)
Fertility rate	-7.59***	3.07***	-7.22**	0.95**	-8.17***	5.42***	-7.85***	1.02**
	(-5.43)	(3.48)	(-5.22)	(2.15)	(-4.96)	(3.97)	(-5.60)	(2.63)
Gini index	0.23*	-0.94**	0.26*	-0.51**	0.25**	-0.98***	0.25	-0.87*
	(1.66)	(-2.65)	(1.96)	(-2.51)	(2.01)	(-3.11)	(1.86)	(-2.24)
Constant	44.14*		38.27*		57.81**		51.40**	
	(2.49)		(2.23)		(4.37)		(2.84)	
Observations	273		273		273		273	
Number of countries	49		49		49		49	
R^2	0.71		0.71		0.72		0.71	

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. t-ratios shown in parenthesis. Dependent variable: gross enrolment ratio (%), secondary schooling.* means significant at 10%, ** significant at 5% and *** significant at 1%.

Finally, in order to control the possibility of endogeneity in the sense that the flow of gross enrolment rate may influence the resource rents and other control variables, endogeneity issue is tackled by using instrument variables in three-year means using the Two-stage Least Squares (TSLS) instrumental variable (IV) approach. The TSLS results using three-year means are reported in Table 2.9. To address such concerns resource rents and control variables are lagged by one period as the instrumental variables (see for example Bhattacharyya and Collier, 2013)-this strategy including lagged values (of the variables of interest) reduces the reverse causality in the original specification. As can be seen, the results are robust considering lagged one period of independent variables as instrumental variables. The resource rents are still negatively associated with education for institutions below the threshold level in all models. However, above the institutions level the resource rents coefficients are negative and non-significant in Models A, B and D. On the other hand, the negative impact of resource rents on human capital for institutions above the threshold level, turn positive and highly significant in Model C regarding regulatory quality as a threshold variable. Moreover, the F-statistics of the first-stage regression is reported that are always above the required critical values (see Cragg and Donald, 1993).

Table 2.9 Robustness checks using TSLS approach in three year periods data. IV: One period lagged of independent variables

	Model A		Model B		Model C		Model D	
	CC		GE		RQ		AVE	
	<0.3	>0.3	<0.84	>0.84	<0.8	>0.8	<0.624	>0.624
log Oil and Gas rents(US$)	-1.34**	-0.20	-1.41***	-0.81	-2.17***	0.34**	-1.61**	-0.40
	(-3.23)	(1.69)	(-3.63)	(1.00)	(-4.05)	(3.21)	(-3.32)	(1.61)
log of GDP per capita	9.28***	-9.27	9.37***	-9.36	9.72***	-5.42**	10.88***	-9.91
	(5.71)	(-0.81)	(6.56)	(0.68)	(6.19)	(-2.33)	(7.54)	(-0.65)
Fertility rate	-8.12***	7.45**	-7.48***	2.75**	-7.87***	9.10***	-7.03***	4.11**
	(-5.06)	(3.35)	(-4.89)	(2.35)	(-5.44)	(3.67)	(-4.79)	(2.77)
Gini index	0.43***	-1.63**	0.38***	-0.48**	0.38*	-0.67***	0.37*	-1.41***
	(2.69)	(-3.40)	(2.63)	(-2.55)	(2.25)	(-3.53)	(2.51)	(-3.82)
Constant	33.24*		35.29**		49.57**		26.99	
	(1.88)		(2.09)		(3.06)		(1.61)	
Observations	226		226		226		226	
Cragg-Donald F-stat	13.42		61.8		11.41		36.66	
Number of countries	49		49		49		49	
R^2	0.71		0.70		0.72		0.70	

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. z-statistics shown in parenthesis. Dependent variable: gross enrolment ratio (%), secondary schooling. "Cragg–Donald F-stat" indicate Cragg–Donald Wald test for weak identification or weak instruments F-statistic. * means significant at 10%, ** significant at 5% and *** significant at 1%.

As an additional robustness check, we have considered TSLS but using as instruments the first observation of every three-year period included. Following Boschini et al., (2013), the choice of starting year (the point around which the importance of the resource is measured so as to minimize reverse causality) may have an effect on the results. Through this strategy, resource rents in Model D with average of institutional indicators as a threshold variable turn positive and significant. Now, in all countries with quality of institutions lower the threshold level, oil and gas rents have negative impact on education in all models whereas, in countries with quality of institutions above the threshold level, oil and gas rents have a positive impact on education considering regulatory quality and average of institutions as threshold variables. Finally, the F-statistics of the first-stage regression shows that the instruments are valid because the F-statistics are above the required critical values (see Cragg and Donald, 1993).

Table 2.10 Robustness checks using TSLS approach in three year periods data. IV: First annual observation of three year periods of independent variables at each period

	Model A		Model B		Model C		Model D	
	CC		GE		RQ		AVE	
	<0.3	>0.3	<0.84	>0.84	<0.8	>0.8	<0.624	>0.624
log Oil and Gas rents(US$)	-1.07**	-0.13	-1.21***	-0.60	-1.63***	0.51**	-1.47**	0.001*
	(-2.97)	(1.90)	(-3.34)	(1.11)	(-3.82)	(2.83)	(-3.28)	(2.13)
log of GDP per capita	9.30***	-9.28	9.15***	-9.13	8.91***	-12.01	10.17***	-11.06
	(6.78)	(-0.65)	(7.09)	(1.11)	(7.14)	(-1.94)	(7.89)	(-1.04)
Fertility rate	-7.54***	5.02***	-7.20***	0.07	-7.71***	6.61***	-6.94***	2.06*
	(-5.50)	(3.78)	(-5.36)	(1.94)	(-5.98)	(3.64)	(-5.30)	(2.56)
Gini index	0.28*	-1.26***	0.25	-0.93*	0.27*	-1.30***	0.25	-1.11**
	(2.00)	(-3.57)	(1.90)	(-2.19)	(2.06)	(-3.73)	(1.81)	(-3.13)
Constant	33.82*		35.99*		47.73**		32.69*	
	(2.00)		(2.36)		(3.22)		(2.19)	
Observations	273		273		273		273	
Cragg-Donald F-stat	84.13		130.72		44.91		44.61	
Number of countries	49		49		49		49	
R^2	0.71		0.71		0.72		0.70	

Notes: CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average. z-statistics shown in parenthesis. Dependent variable: gross enrolment ratio (%), secondary schooling. "Cragg–Donald F-stat" indicate Cragg–Donald Wald test for weak identification or weak instruments F-statistic. * means significant at 10%, ** significant at 5% and *** significant at 1%.

2.5 Conclusions

This chapter has explored one of the important issues in economic development, the impact of natural resource rents on human capital once quality of institutional quality is considered. The empirical analysis has been developed applying both cross-section and panel-data analysis finding a significant relationship between oil and gas rents and different educational indices either in the short or long-run term and also confirming the important role of the institutions on this relationship.

Using data covering the period from 1996 to 2013, this study examined whether there exists an institutions threshold in resource rents – human capital relationship. One contribution of this chapter was the adoption of the regression model based on the concept of threshold effect proposed by Hansen (2000) considering different indicators of human capital to capture rich dynamics in the relationship between resource rents and human capital. The empirical results suggested that a better institutional environment allows an economy to exploit the benefits of resource rents on human capital. Nevertheless, low quality of institutions tends to distort the ability of resource rents to channel resources to macroeconomic productive activities efficiently (Bulte et al, 2005). To address the causal aspect of the resource rents and human capital, TSLS with IV approach has been applied and the results confirm that the coefficient of resource rents is a statistically significant determinant of human capital.

This research also shows that the different institutional indicators as threshold variables in panel analysis seem to respond differently in countries with higher quality of institutions. Also, the negative impact of resource rents on human capital gets moderated by the quality of institutions. The main results hold across different samples and data frequencies as well as considering period fixed effects, three-year averages of data and instrumental variable estimations.

The findings of the study may have important policy implications. If there is clear evidence that weak institutions significantly hamper the oil and gas rents-education nexus, then policymakers should improve the level of institutional development to explore the blessings of resource rents in promoting human capital accumulation.

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Appendix

Table A.2.1 Data definition and sources

Variable name	Definition	Source
Average years of total schooling (+25) version 1.1, and 2.1.	Average years of total schooling, is the average years of education completed among people over age 25.	Robert J. Barro and Jong-Wha Lee: www.barrolee.com/
Gross enrolment ratio, secondary, both sexes (%)	Total enrollment in secondary education, regardless of age, expressed as a percentage of the population of official secondary education age. GER can exceed 100% due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition.	World Bank, World Development Indicator (UNESCO Institute for Statistics).
Highest Level Attained, Secondary (%)	Percentage of population age 25+ with secondary schooling. Completed Secondary.	Robert J. Barro and Jong-Wha Lee (updated version 2/2016)
Oil and Gas rents(%GDP)	The estimates of natural resources rents are calculated as the difference between the price of a commodity and the average cost of producing it. This is done by estimating the world price of units of specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs. These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP)	World Bank, World Development Indicator
GDP per capita (constant 2005 US$)	GDP per capita is gross domestic product divided by midyear population. Data are in constant 2005 U.S. dollars.	World Bank, World Development Indicator
Fertility rate, (total)	Total fertility rate represents the number of children that would be born to a woman.	World Bank, World Development Indicator
GINI index	Gini index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution.	The Standardized World Income Inequality Database (SWIID), Solt 2014.
Government Effectiveness	Reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Wide Governance indicators (WGI). WGI methodology paper by: Daniel Kaufmann, Aart Kraay and Massimo Mastruzzi (2009).
Regulatory Quality	Reflects perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.	World Wide Governance indicators (WGI).
Control of Corruption	Reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	World Wide Governance indicators (WGI).

Table A.2.2 List of countries

Algeria, Argentina, Australia, Austria, Bangladesh, Bolivia, Bulgaria, Cameroon, Canada, Chile, China, Colombia, Congo, Dem. Rep., Congo, Rep., Croatia, Czech Republic, Denmark, Ecuador, Egypt, Arab Rep., France, Greece, Guatemala, Hungary, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Japan, Jordan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Papua New Guinea, Peru, Pakistan, Poland, Romania, Slovak Republic, Slovenia, South Africa, Spain, Syrian Arab Republic, Thailand, Trinidad and Tobago, Tunisia, Turley, United Kingdom, United States, Venezuela.

Table A.2.3 Second sample split of threshold estimates of institutions

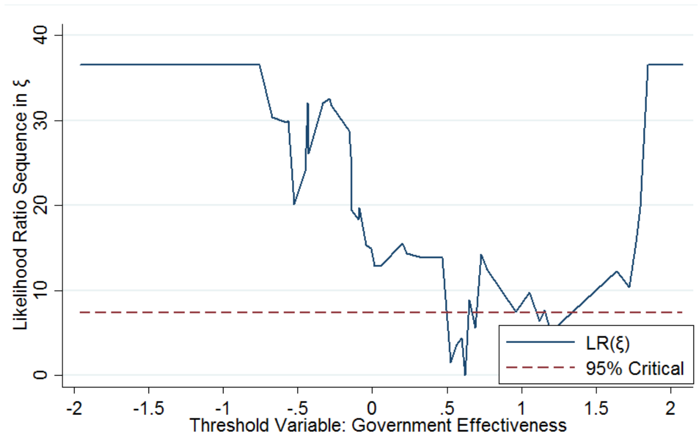
year	2000			
	CC	GE	RQ	AVE
LM test for no threshold	6.78	10.75	6.42	6.77
Bootstrap *p*-value	0.73	0.044	0.754	0.61
year	1996-2013			
	CC	GE	RQ	AVE
LM test for no threshold	7.55	6.62	8.00	9.39
Bootstrap *p*-value	0.429	0.601	0.381	0.118

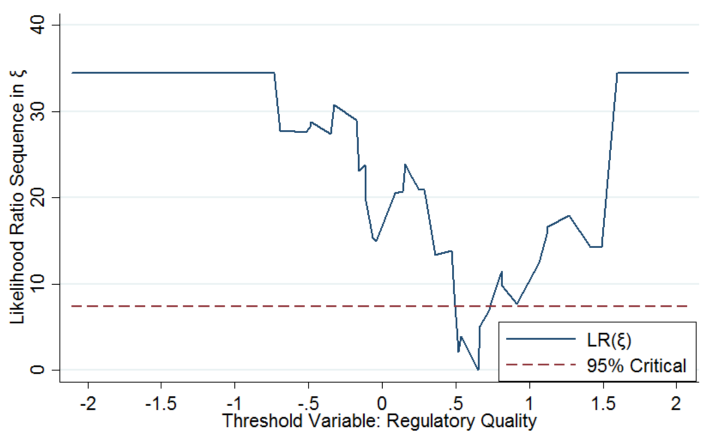
Note: H_0: no threshold effect. CC = control of corruption, GE = government effectiveness, RQ = regulatory quality, AVE = average Dependent Variable: Average years of total schooling, +25 years, version 1.1.

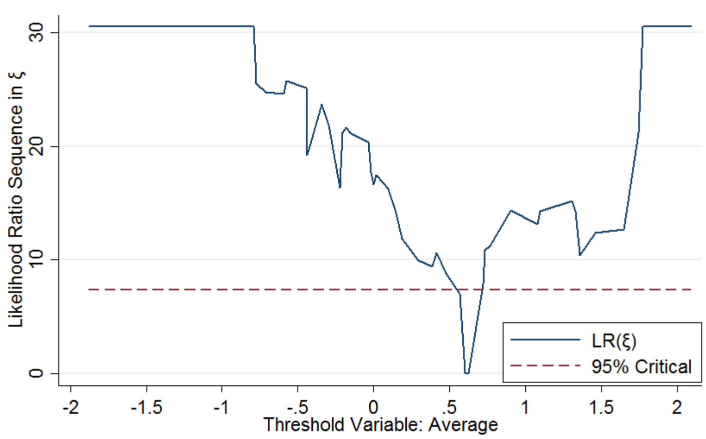
Table A.2.4 Cabrales and Hauk (2010) original results

year	2000					
	log Oil and Gas rents	log GDP	Fertility rate	Gini index	Constant	n
control corruption < 0.6	-0.25***	2.43***	-0.7**	-0.01	6.14*	59
	(t: -2.75)	(t: 3.19)	(t: -2.55)	(t: -0.5)	(t: 1.88)	
control corruption > 0.6	0.26***	-0.33	2.33***	-0.11**		
	(t: 2.98)	(t: -0.23)	(t: 3.01)	(t: -2.03)		
government effectiveness < 0.6	-0.22**	1.84**	-0.74***	-0.009	7.19**	59
	(t: -2.27)	(t: 2.16)	(t: -2.6)	(t: -0.3)	(t: 2.1)	
government effectiveness > 0.6	0.17*	0.98	0.61	-0.06		
	(t: 1.87)	(t: 1.02)	(t: 0.97)	(t: -1.25)		
regulatory quality < 0.7	-0.25***	2.42***	-0.7**	-0.01	6.12*	59
	(t: -2.66)	(t: 3.1)	(t: 2.51)	(t: -0.47)	(t: 1.84)	
regulatory quality > 0.7	0.27***	-0.81	2.39***	-0.13***		
	(t: 3.22)	(t: -0.68)	(t: 3.18)	(t: -2.63)		
average < 0.65	-0.25***	2.43***	-0.7**	-0.014	6.14*	59
	(t: -2.75)	(t: 3.19)	(t: -2.55)	(t: -0.5)	(t: 1.88)	
average > 0.65	0.26***	-0.33	2.33***	-0.118**		
	(t: 2.98)	(t: -0.23)	(t: 3.01)	(t: -2.03)		

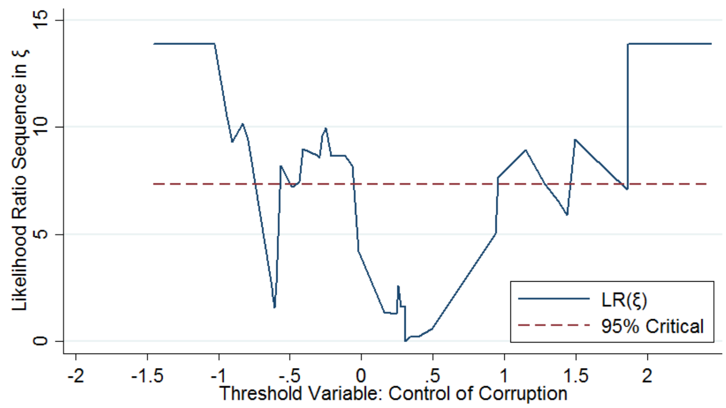
Figures A.2.1.a First sample split: Confidence interval constructions for thresholds in 2000

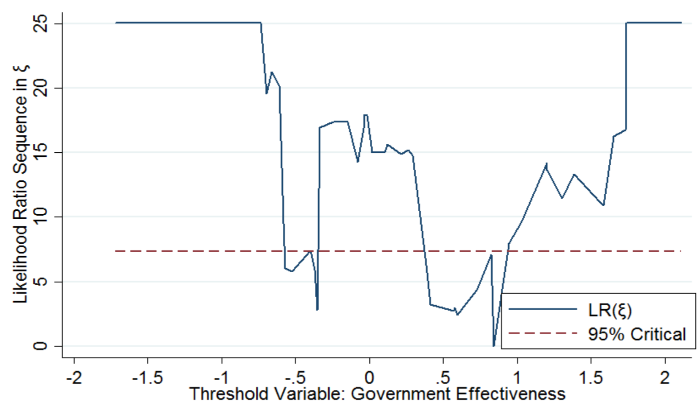


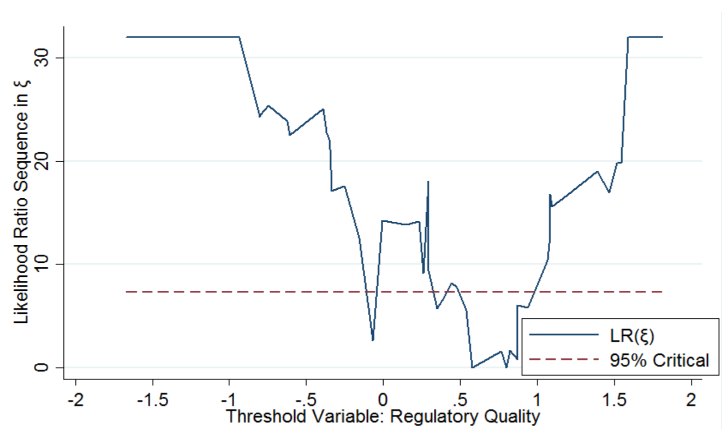




Figures A.2.1.b First sample split: Confidence interval constructions for thresholds in 1996-2013







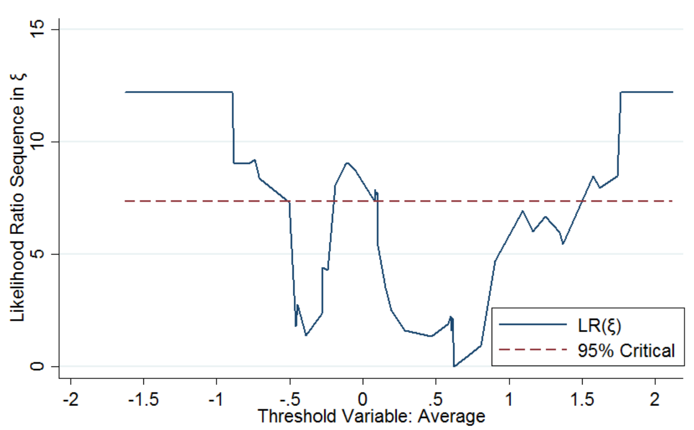

Likelihood Ratio Sequence in ξ
0
5
10
15
-2
-1.5
-1
-.5
0
.5
1
1.5
2
Threshold Variable: Average
LR(ξ)
95% Critical

Table A.2.5 Grouping of countries according to the level of institutional quality

year	2000	countries
CC < 0.612	Algeria, Argentina, Bangladesh, Bolivia, Bulgaria, Cameroon, China, Colombia, Congo, Dem. Rep., Congo, Rep., Croatia, Czech Republic, Ecuador, Egypt, Arab Rep., Guatemala, India, Indonesia, Iran, Islamic Rep., Jordan, Malaysia, Mexico, Pakistan, Papua New Guinea, Peru, Philippines, Romania, Slovak Republic, South Africa, Syrian Arab Republic, Thailand, Trinidad and Tobago, Tunisia, Turkey, Venezuela, RB.	34
CC > 0.612	Australia, Austria, Canada, Chile, Denmark, France, Greece, Hungary, Ireland, Israel, Italy , Japan, Netherlands, New Zealand, Norway, Poland, Slovenia, Spain, United Kingdom, United States.	20
GE < 0.622		32
GE >0 .622	Czech Republic, Malaysia	22
RQ < 0.651		32
RQ > 0.651	Czech Republic, Trinidad and Tobago	22
AVE < 0.625	No change	34
AVE > 0.625	No change	20
year	1996-2013	
CC < 0.3	No change	34
CC > 0.3	No change	20
GE < 0.84	Hungary	35
GE > 0.84		19
RQ < 0.8		33
RQ > 0.8	Slovak Republic	21
AVE < 0624	Greece, Italy ,Poland	35
AVE > 0624	Czech Republic, Malaysia	19

Table A.2.6 Summary statistics

Variables		Mean	Std. Dev.	Min	Max	Observations
Gross enrolment ratio, Secondary (%)	overall	88.45	23.33	22.85	162.61	N=804
	between		22.59	32.77	144.02	n=49
	within		7.13	65.01	123.31	
Log oil and gas rents(US$)	overall	21.39	2.67	12.62	26.26	N=882
	between		2.59	13.48	25.27	n=49
	within		0.72	17.29	24.26	
Log real GDP per capita(US$)	overall	8.83	1.38	5.91	11.14	N=882
	between		1.38	6.2	11.06	n=49
	within		0.15	8.12	9.57	
Fertility rate	overall	2.28	0.96	1.09	5.9	N=882
	between		0.94	1.29	5.36	n=49
	within		0.21	1.57	3.23	
Gini Index	overall	36.45	8.8	22.02	59.4	N=792
	between		8.6	23.3	57.07	n=49
	within		1.64	28.78	41.62	
Average of institutional indices	overall	0.44	0.91	-1.35	2.26	N=882
	between		0.91	-0.97	2.1	n=49
	within		0.13	-0.05	0.98	

Chapter 3

Natural Resources, Institutions and the Quality-adjusted Human Capital

3.1 Introduction

Natural resources seem to be a curse by slowing down the path of economic growth. Natural resources provide prospects for sustained economic growth in few countries, although, in various countries, pernicious impact of natural resources possibly impedes economic growth. The question that is raised substantially in the resource curse literature is why do some countries benefit and others lose from the presence of natural resources? As a matter of fact, studies carried out in Brazil, Colombia and Peru indicated that neither economic growth nor education and health outcomes improved following the collection of large oil or mineral revenue windfalls by governments (UNDP and NRGI, 2016). In this sense, the World Development Report (2017) recently addressed some challenges affecting on today's developing countries such as violence, slowing growth, corruption, and the natural resource curse. Moreover, it has been claimed in the literature that it is not natural resources but economic and socio-political environments that determine the resource curse. These studies argues that factors like economic policies and institutions may determine whether natural resources leads to a blessing or curse (Mehlum et al., 2006; Torvik, 2009; Mavrotas et al., 2011; Boschini et al., 2013; Kim and Lin, 2015).

Broadly speaking, the literature in the resource curse focused on the effects of natural resources on the economic growth, specifically on the levels of GDP per capita, and emerges that this relationship is rather ambiguous when institutional quality is included (Brunnschweiler, 2008). In addition, in recent years some resource-rich countries experienced positive and rapid economic growth. Thus, the negative effect of natural resources on economic growth may disappear (Badeeb et al., 2017). Recent studies argue convincingly that the resource curse may be operating via negative effects on productivity, financial sector and human capital development (Blanco and Grier, 2012; Farhadi et al., 2015; Badeeb et al., 2017). These studies focus on various economic factors related to growth that might be affected by natural resources. Gylfason (2001) early established the link between natural resource dependence and factors that can drive economic growth and claimed that the adverse effects of natural resource abundance on economic growth in the literature may in part reflect, and possibly displace, the effect of education on growth. Hereafter, several authors investigated the nexus between natural resources and human capital development (Birdsall et al., 2001; Papyrakis and Gerlagh, 2004; Douangngeune et al., 2005; Stijns, 2006; Blanco and Grier, 2012; Cockx and Francken, 2016).

Economists have attempted to identify the factors that explain the negative impact of natural resources on human capital. One of these factors is corruption and institutional quality. In this sense, a group of economists emphasizes the role of institutions in determining the effects of natural resources on human capital (Cabrales and Hauk, 2011; Daniele, 2011; Blanco and Grier, 2012; Cockx and Francken, 2016; Kim and Lin, 2017). This group tends to shed doubt on the validity of the resource curse hypothesis on human capital and they assume that this adverse effect might be conditional based on the level of institutional quality.

This chapter integrates two strands of the natural resource curse literature. The first deals with the curse on human capital, while the second focus on the relationship between natural resources and human capital, paying attention to the role of political institutions. Some authors show that natural capital appears to crowd out human capital (Gylfason, 2001; Stijns, 2006). Other economists find out an inverse association between natural resource and human capital indicators (Papyrakis and Gerlagh, 2007; Daniele, 2011; Blanco and Grier, 2012; Cockx and Francken, 2016). Specifically, most of the papers examined the effects of natural resources on human capital by using quantitative indicators such as; "average years of total schooling"[14](Gylfason, 2001; Douangngeune et al., 2005; Stijns, 2006), "school enrolment rates" (Gylfason et al., 2001; Birdsall et al., 2001; Douangngeune et al., 2005), "human development index" (Daniele, 2011), "literacy rates"[15] (Birdsall et al., 2001, Daniele, 2011), "public educational expenditure"[16] (Gylfason, 2001; Stijns, 2006, Cockx and Francken, 2016), and "average years of total schooling and life expectancy at birth" (Kim and Lin,

[14] Gylfason (2001) uses this data for females. Stijns (2006) believed that reporting this data for females is important because it captures the median level of human capital accumulation and labor market participation in developing countries.

[15] The adult literacy rate is particularly increasing in the context of developing countries and when the distribution of human capital is concern. Indeed, literacy rates tell us more about the median skill levels than other average indicators (Stijns, 2006).

[16] Public expenditure is admittedly an imperfect measure of a nation's commitment to education, because some nations spend more on private education.

2017). Additionally, Gylfson (2001), Papyrakis and Gerlagh (2004) and Birdsall et al., (2001) demonstrate the negative effects of natural resources on both education spending and years of schooling in resource-rich countries. On the other hand, there exist few studies that address the link between natural resources and human capital taking into account the role of institutional quality. Cabrales and Hauk (2011) present theoretical and empirical evidence and suggest the impact of natural resources on enrolment is conditional upon the quality of political institutions. They split the sample based on the quality of institutions in a cross-sectional study of 59 countries in 2000 and find that the relationship between oil and gas rents and enrolment rate is positive only in countries where the quality of institutions is above a threshold level. We have confirmed these results in the second chapter of this dissertation expanding the sample period and using alternative indicators. Moreover, Blanco and Grier (2012) studied the relationship between natural resource dependence and the accumulation of physical and human capital in 17 Latin America countries from 1975 to 2004 and found that resource dependence has no significant effect on physical and human capital, but when they disaggregate the natural resource variable into sub-categories, they found that petroleum exports have a significant negative effect on human capital and results are robust to the inclusion of institutional measures. Cockx and Francken (2016) using panel of 140 countries covering the period from 1995 to 2009, underlined the importance of institutions to analyze the effects of resource dependence on public education expenditure and found that good political institutions can mitigate the resource curse effect. Finally, Kim and Lin (2017) used a panel of 55 developed and developing countries for the period 1970-2011 emphasized the importance of the country's economic and sociopolitical institutions and found that natural resource dependence improves education but worsens health.

Inspired by this literature, in this chapter we analyze the relationship between resource rents and human capital and to do it an indicator of human capital has been used which incorporates the quantity and quality of human capital simultaneously. Specifically, we used a variable that incorporates two dimensions of human capital, education and health, because of their importance as a driver of sustainable economic growth (Barro, 2001). Although previous attempts have had some success in estimating the adverse effect of natural resources on human capital they are not without problems. Over the last quarter-century, assessments of human development have focused primarily on quantitative achievements declining for the quality of human capital (Human Development Report, 2016). In fact, World Bank (2011) first identified the term "quality-adjusted human capital" addressed the limitation of measuring human capital ignoring the quality of human capital.

The empirical analysis is based on a large panel dataset of 162 countries covering the period from 1996 to 2014. The results show that resources rents are negatively associated with quality-adjusted human capital while controlling for several factors, and importantly this negative effect can be mediated by the quality of institutions. Therefore, institutional quality seems to play a critical role in determining the impact of natural resources on human capital. Moreover, the obtained results demonstrate that this resource adverse effect depends on to the type of resource rents; in particular, high dependency on oil rents appears to harm human capital. Finally, the robustness of the estimations has been checked applying instrumental variables in Two-stage Least Squares (TSLS) approach.

This chapter aims at contributing the literature by obtaining additional insights on the impact of resource rents on human capital. Most of the earlier papers on the topic are largely reliant upon either the quantitative measure of human capital or cross-sectional evidence. In this chapter we consider a dynamic approach, using a panel of 162 countries covering the period 1996-2014, and we include a variable of human capital that consider quantitative and also qualitative aspects of human capital. In addition, this chapter departs from previous studies, in that considers the disaggregation of natural resources for almost all countries blessing from natural resources.

The remainder of this chapter is organized as follows; the empirical specification and the data are presented in section 3.2. The results are discussed in section 3.3, and finally, section 3.4 concludes.

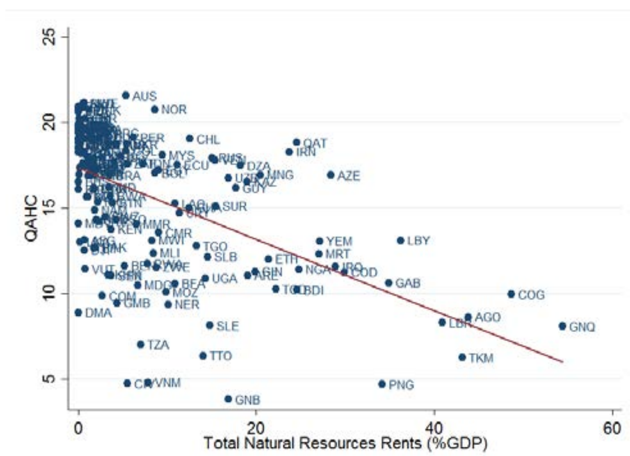
3.2 The empirical specification and data

3.2.1 The empirical specification

The considered empirical approach has two main objectives. First, to examine the relationship between human capital, natural resources rents, and institutions, and second to examine the interaction effect of natural resources rents and institutions on human capital. This analysis uses the quality-adjusted human capital (QAHC) a measure of human capital provided by World Bank (2011) that incorporates information on education and also on health, as it will be detailed at length in the next section.

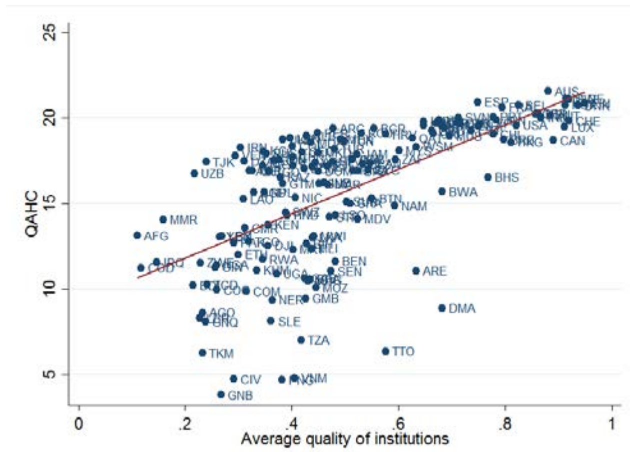
As a first step of the empirical analysis, Figures 3.1 and 3.2 plot the human capital variable (QAHC) against both natural resource rents and institutional quality respectively using average values for each variable over the sample period (1996-2014). Figure 3.1 shows that QAHC is relatively small in countries such as Equatorial Guinea, Turkmenistan, and Angola while blessing from a large amount of natural resources rents. A considerably different picture emerges from Figure 3.2 where Equatorial Guinea, Turkmenistan, and Angola have weaker quality of institutions and QAHC. Nevertheless, Finland and Denmark look stronger from this perspective. Although the two figures are suggestive of a negative and positive association between QAHC and natural resources rents and institutions, respectively, they are of course silent on both the confounding influence of other factors on QAHC determinants as well as the impact of institutions on natural resources rents. In what remains, this section explains how those two important concerns are addressed.

Figure 3.1 Quality-adjusted human capital (QAHC) and total natural resources rents (average values over the period 1996-2014)



Source: QAHC is from World Bank (2011) and natural resource rents are from World Development Indicators (WDI)

Figure 3.2 Quality-adjusted human capital (QAHC) and average of institutional quality (average values over the period 1996-2014)



Source: QAHC is from World Bank (2011) and institutional quality is from World Governance Indicators (WGI)

Thus, the following equation is considered in order to investigate the relationship between resource rents, political institutions and human capital:

$$QAHC_{it} = \alpha + \beta_1.Rent_{it} + \beta_2.Inst_{it} + \beta_3 Z_{it} + \delta + \varepsilon_{it} \quad (3.1)$$

Where i and t refers to countries and years, respectively. α is a constant, δ refers to time-fixed effects controlling for the unobservable time-varying characteristics and shocks, which are common in all countries. and ε is the error term. *QAHC* is the quality-adjusted human capital, $Rent_{it}$ is the GDP share of total natural resources rents, $Inst_{it}$ is an indicator of quality of institutions, and Z_{it} stands for the vector of control variables that includes GDP per capita, population growth, GDP growth, total government expenditure and a Gini index, variables that will be fully justified at length in the next sub-section. As long as wide variety of countries are taken into account, regional dummies are also considered corresponding to Sub Saharan Africa, Middle East and North Africa, Latin America, Europe, Asia, Oceania, and North America. These regional dummies control for the region-specific factors, which might effect on human capital such as the values and attitudes of the people toward education and health. Given the previous discussion, $\beta_1 < 0$ and $\beta_2 > 0$ are expected.

The second objective of empirical specification is to check whether the association between natural resources rents and QAHC varies systematically with the degree of the institutional quality. Hence, the following model can be considered:

$$QAHC_{it} = \alpha + \beta_1.Rent_{it} + \beta_2.Inst_{it} + \beta_3 Z_{it} + \beta_4 (Rent_{it} * Inst_{it}) + \delta + \varepsilon_{it} \quad (3.2)$$

Where *(Rent*Inst)* is the interaction term between natural resources rents and quality of institutions. According to the results showed in the previous chapter, natural resources rents are beneficial to human capital only when institutional quality is high enough. At the margin, the total effect of increasing resources rents can be calculated by examining the partial derivatives of QAHC with respect to the resource rents variable:

$$\frac{\partial(QAHC)}{\partial(Rent)} = \beta 1 + \beta 4\ Inst_{it} \qquad (3.3)$$

Based on the theoretical predictions, the sign of β_4 is expected to be positive, meaning that as long as the institutional quality is high enough, natural resources would have a positive effect on human capital.

Much of the studies in the literature employs either ordinary least squares (OLS) or instrumental-variables (IV) estimation procedures. In particular, it seems natural to consider panel structure of the data, especially to include country fixed effects. This, however, turns out to be problematic because of the little variation over time specifically in the institutional measures (see Table A.3.1 for the summary statistics of variables). The alternative that would be explored is to use pooled OLS (and IV) regressions with time fixed effects. This at least partly addresses time effects considering time-varying characteristics and shocks.

3.2.2 Data

To study the relationship between natural resources rents and quality-adjusted human capital, a big panel of countries that blessing from resource rents is considered. Throughout the analysis, a panel dataset of 162 developed, developing and transition economies from 1996 to 2014 is used which comparing with previous studies cover more countries and relies on recently updated data on natural resources and human capital.[17] In order to control for the business cycle, and also as standard in the literature, the analysis uses observations in 4-year means.[18]

Focusing on the dependent variable, the World Bank (2011) in the 5th chapter of "The changing wealth of nations; Measuring Sustainable Development in the New Millennium" addressed some

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[17] Table A.3.2 list the countries.

[18] Data is split into 4-years periods in order to make the periods homogenous. In this regard the 5 periods included are: 1996-1999, 2000-2003, 2004-2007, 2008-2011, and 2012-2014, being the last one shorter.

limitations for measuring human capital ignoring the quality perspective while checking for the impact of human capital and institutions on intangible capitals. In order to measure human capital, they used the log-linear relation between earning and years of schooling which it was first formulated by Mincer (1974), and then they augmented the indicator of human capital to account for health including adult survival rate as a proxy for health status.[19] Inspired by this contribution, an indicator of human capital is employed in the model that the World Bank (2011) called "quality-adjusted human capital" (QAHC) and incorporates the two dimensions of human capital; education and health. Specifically, education is considered as the quantity index of human capital per person calculated by using data on the gross enrolment ratio, secondary schooling for both sexes from UNESCO Institute for Statistics;[20] and, health is considered indicating the life expectancy at birth; the output of both mortality and morbidity sourced from WDI.[21] The quality-adjusted human capital (QAHC) has been used to explain the joint effects of both the quantity and quality of human capital in different studies; such as stimulating productivity growth by Islam and Madsen (2014) and also the association between human capital, intangible capitals, and institutions by the World Bank (2011).[22]

The data for resource rents are obtained from the WDI. The total natural resources rents as % of GDP includes the sum of oil, natural gas, coal, mineral and forest rents, and is calculated as the difference between the price of a commodity and the average cost of producing it.[23] Based on the concepts that Brunnscheweiler and Bulte (2008) provided for the resource wealth, it is useful to distinguish between resource abundance (a stock measure of in situ resource wealth), resource rents (the windfall flow of income derived from resource stock at some point in time), and resource dependence (the degree of which countries do-or-do not- have access to alternative source on

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[19] Mincer (1974) assumed that human capital of a worker (h) is exponential function of years of schooling.

[20] Secondary-school enrolment is probably the most commonly used indicator of education in empirical growth research, and it is the one that is mostly correlated with economic growth while reflects the quantity of education provided rather than the quality of education received (Gylfason, 2001).

[21] Health is considered to be an important components of workers efficiency often depends critically on their health conditions, particularly in developing countries while should also be more informative than average indicators regarding the medial level of human capital accumulation (Stijns, 2006).

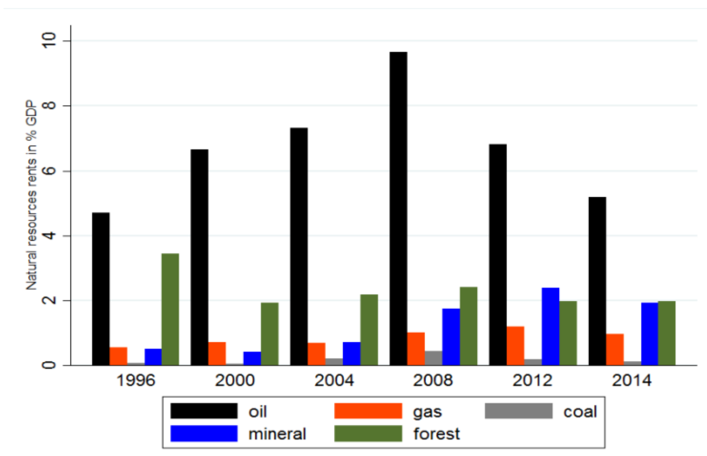
[22] The details on how to calculate QAHC are provided by World Bank (2011).

[23] This is done by estimating the world price of the specific commodities and subtracting estimates of average unit costs of extraction or harvesting costs (including a normal return on capital). These unit rents are then multiplied by the physical quantities countries extract or harvest to determine the rents for each commodity as a share of gross domestic product (GDP).

income other than resource extraction, again at some point in time). This chapter is focused on resource rents for the following reasons. First, resource rents are potentially a good proxy for resource revenues that can potentially be appropriated by political leaders; in contrast, resources in the ground do not pose the same problem for institutional quality or economic performance. Second, considering this variable allows analyzing the performance of different types of resources (oil, gas, coal, mineral, and forest) on human capital. Third, it is fairly wide in terms of country coverage; unlike many of the other measures used in the literature, which is available for a large panel of countries, minimizing the risk of sample selection bias. Finally, this measure has been used by a number of studies focused on analyzing the role of resource rents on economic development (i.e., Ross, 2006; Auty, 2007; Collier and Hoeffler, 2009; Bhattacharyya and Hodler, 2014; Bhattacharyya and Collier, 2013).

Figure 3.3 shows the evolution of the average values of our resource rents variable from 1996 to 2014. Specifically, oil rents have constituted the larger share of GDP compared to other types of resources. In particular, the average of oil rents as a share of GDP almost doubled from 1996 to 2008, following a decline after, which obviously relates to the volatility of oil prices.

Figure 3.3 Evolution of the natural resources rents (% of GDP) by components: oil, gas, coal, mineral, and forest.



The institutional quality variable considered is the average of the six available governance indicators from Kaufmann et al. (2009), also known as World Governance Indicators (WGI), which are the following: voice and accountability; political stability; government effectiveness; regulatory quality; rule of law; and control of corruption, for all available years between 1996 to 2014. Each index range between -2 and 2 and are recalibrated to assume values between 0 (weakest) and 1 (strongest).[24] The advantages of employing the WGI indicators of institutional quality are threefold. First, these indicators are based on averaging information from many different data sources measuring perceptions of governance. Second, they provide very broad country coverage, greater than that provided by any individual data source on governance (Kaufmann et al., 2016). Third, the WGI index is widely used in the resource curse literature (i.e., Bulte et al., 2005; Brunnschweiler, 2008; Brunnschweiler and Bulte, 2008).

The set of control variables is chosen to minimize omitted variables bias. In particular, the logarithmic of real GDP per capita *(lGDPPC)* is included to control for the level of economic development and for the effect of income as long as wealthier countries may be able to afford better education and health. Population growth in annual percentage *(Pop growth)* is taken into account since the evolution of population over time is likely to influence positively the demand for education, affecting the enrolment rate. Total government expenditure in percentage of GDP *(Totexp)* is considered because an abundance of natural resources may lead to government increasing its spending on education and health (Williams, 2011). Economic growth *(GDP growth)* is controlled due to the benefits provided by improving public services such as education. And a measure of income inequalities *(Gini)* has been introduced because high level of inequality could increase redistributive pressure on the government jeopardizing public investment on education and health (Bhattacharyya and Collier, 2013). [25]

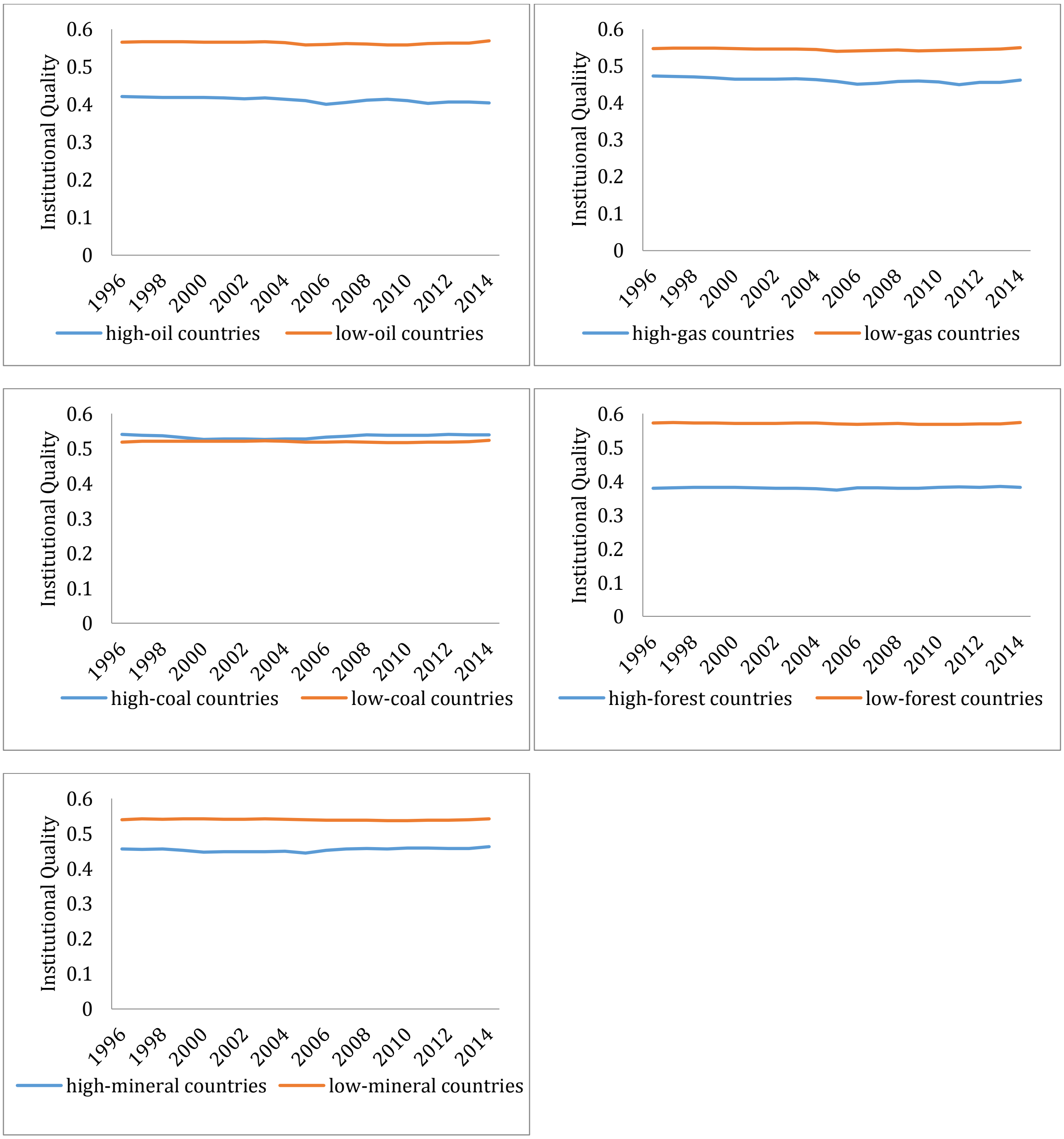
Table A.3.4 reports the correlation matrix among the main variables used in the regressions and allows us to address a number of matters. First, as expected, there is a strong correlation between human capital, GDP per capita and institutional quality. Second, the quality of institutions highly correlates with GDP per capita. This potential concern is might be against that institutions make natural resource rents a curse or blessing for human capital; hence, we check this potential concern in the next section. Third, we find institutional quality to be quite negatively correlated with the total natural resources rents and also components of natural resources, and this is consistent with the hypothesis according to which resource-rich countries tend to perform worse in institutional performance terms. (Isham et al., 2005; Sala-i-Martin and Subramanian, 2003, Daniele, 2011).

[24] Following Mehlum et al., 2006 and Brunschweiler and Bulte, 2008, the measure of institutional quality has been rescaled to positive values in order to directly compare the coefficients.

[25] See Table A.3.3 for the data definitions and sources.

Therefore, in order to analyze the performance of different components of resource rents, Figure 3.4 shows the evolution of institutional quality for the five components of natural resources rents over the period 1996-2014. Moreover, we note that by looking at the development of the institutional quality in our time period of analysis we see that resource-rich (above average) countries from 1996 to 2014 have a lower quality of institutions compare to countries that relatively resource-poor (below average). These figures are not proof of anything except the fact that countries owning from below an average of resources (except coal resources) have been able to advance further the quality of institutions. However, it seems that countries with an abundance of coal rents generating a higher quality of institutions.

Figure 3.4 Institutional developments 1996-2014 in countries with above and below average resource intensity (separately for the five main resource components)



3.3 Empirical results

3.3.1 The impact of total natural resources rents on quality-adjusted human capital

Table 3.1 presents the main results considering equations (3.1) and (3.2) using 4-year means. Because institutional indicators present a small level of within variation (see Table A.3.1), adopting this approach goes some way toward accounting for the possibility that our panel results are being driven by repeated entries. In addition, the use of 4-year means helps control for the business cycle and thus, allows focusing on the structural relationship between the main variables of interest. The estimated impact of the control variables is in line with the literature, showing that the level of income and total government expenditure are both positively associated with human capital, while population growth is negatively related to human capital. The results also indicate that a higher economic growth rate and inequality tend to be associated with more human capital, although these findings are not robust across all specifications.

The results in column 1 of Table 3.1 indicate a statistically significant and negative effect of the total natural resources and a positive effect of institutional quality on human capital. Column 2 introduces the interaction term, which is positive and significant at 1% level, meaning that in countries with high quality of institutions, resource rents increase human capital. Specifically, the institutional threshold level that can be obtained from the estimated coefficients is 0.47. Accordingly, more resource rents require institutions with a high quality to avoid the curse of human capital. In other words, 72 countries of the country sample show higher institutional level, and therefore resource rents increase human capital, while in the rest of the sample (90 countries) with lower levels of institutional quality, resource rents decrease human capital.

Given the positive correlation between quality of institution and income per capita (according to the Table A.3.4), we need to be assure that is really the institutional quality that is driving the results and not income levels. Therefore, column 3 replace the interaction term between resource rents and institutional quality ($Rent_{it} * Inst_{it}$) with the interaction term between resource rents and per capita income ($Rent_{it} *lGDPPC_{it}$). The results notice that the coefficient on this later interaction term is statistically insignificant suggesting that is poor political institutions rather than low-income levels that make resource rents a curse for human capital.

Table 3.1 Resource rents, institutions and QAHC

Dependent variable: Quality-adjusted human capital			
	(1)	(2)	(3)
$Rent_{it}$	-0.01**	-0.06***	0.05
	(0.007)	(0.022)	(0.04)
$Inst_{it}$	1.74**	1.04	1.13
	(0.85)	(0.91)	(0.93)
$Rent_{it}$ * $Inst_{it}$		0.12**	
		(0.06)	
$Rent_{it}$ * $lGDPPC_{it}$			-0.009
			(0.006)
$lGDPPC_{it}$	1.02***	1.06***	1.15***
	(0.11)	(0.12)	(0.14)
$GDPgrowth_{it}$	0.004	0.003	0.01
	(0.03)	(0.03)	(0.03)
$Popgrowth_{it}$	-0.56***	-0.59***	-0.54***
	(0.08)	(0.08)	(0.08)
$Totexp_{it}$	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
$Gini_{it}$	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
constant	5.91**	6.15***	5.10***
	(1.06)	(1.06)	(1.17)
Observations	630	630	630
Adjusted R^2	0.70	0.70	0.70

Note: Robust standard errors in parentheses. Ordinary least squares regressions. ***Significant at 1%; **significant at 5%; *significant at 10%. Time fixed effects and regional dummies are included in all regressions.

3.3.2 Disaggregated results

The severity of the resource curse is claimed by different authors to depend on the type of resource rents. Specifically, Blanco and Grier (2012) find that petroleum exports have a negative long-run effect on human capital. Moreover, Cockx and Francken (2016) indicate that the resource curse effect on education mainly stems from point-source natural resources.[26] In contrast, Cotet and Tsui (2013) argue that oil wealth has led to a significant reduction in infant mortality rates, especially in less democratic oil-rich countries.

To explore whether the adverse effect on human capital depends on the type of natural resources rents, in Table 3.2 we disaggregate the natural resource rents into energy resources and non-energy resources, based on the World Bank report “Commodity Markets Outlook” (2017), where energy resources are defined as the sum of oil, natural gas, and coal resource rents, while non-energy resources are defined as the sum of mineral and forestry resource rents. The results in column 1 of Table 3.2 show a negative impact of energy and non-energy resources on human capital, while institutional quality and other control variables remain unchanged. Columns 2 and 3 include the interaction term of energy and non-energy resources with institutional quality, respectively, and find positive and significant results in the case of energy resources interacted with institutional quality (column 2), but in contrast, not significant results are obtained for the interaction of non-energy resources (column 3). Moreover, the results for control variables remain unchanged. It can be noted that disaggregating resource rents do not alter any of the previously mentioned results on control variables. These results suggest the convenience of disaggregating both energy and non-energy resources into sub-categories in order to check the different impact of each on human capital.

[26] Their definition of point-source natural resources coincides with the World Bank definition of subsoil assets and includes oil, natural gas, coal and minerals.

Table 3.2 Resource rents, institutions and QAHC: disaggregated total natural resource rents

Dependent variable: Quality-adjusted human capital.

	(1)	(2)	(3)
$EnergyRent_{it}$	-0.04*	-0.33***	-0.03*
	(0.02)	(0.08)	(0.02)
$nonEnergyRent_{it}$	-0.07**	-0.08**	-0.0009
	(0.03)	(0.03)	(0.07)
$Inst_{it}$	1.94**	1.38	2.27**
	(0.87)	(0.87)	(0.93)
$EnergyRent_{it}$ * $Inst_{it}$		0.89***	
		(0.23)	
$nonEnergyRent_{it}$ * $Inst_{it}$			-0.2
			(0.2)
$lGDPPC_{it}$	0.97***	0.97***	0.95***
	(0.12)	(0.12)	(0.12)
$GDPgrowth_{it}$	0.004	0.01	0.008
	(0.03)	(0.03)	(0.03)
$Popgrowth_{it}$	-0.56***	-0.64***	-0.56***
	(0.08)	(0.08)	(0.08)
$Totexp_{it}$	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)
$Gini_{it}$	0.01	0.008	0.01
	(0.01)	(0.01)	(0.01)
constant	6.38***	7.00***	6.34***
	(1.13)	(1.13)	(1.13)
Observations	630	630	630
Adjusted R^2	0.7	0.71	0.7

Note: Robust standard errors in parentheses. Ordinary least squares regressions. ***Significant at 1%; **significant at 5%; *significant at 10%. Time fixed effects and regional dummies are included in all regressions.

In Table 3.3 we disaggregate the energy and non- energy rents variables. In Columns 1 to 5, we disaggregate energy rents into oil, natural gas, and coal rents, while in columns 6 to 9 we disaggregate non-energy rents into mineral and forest rents. In the first scenario, we obtain negative and significant effects of oil, gas and non-energy rents on human capital, while coal rents are positively correlated with human capital. In Columns 2 to 5 we include the interaction terms of the different components of energy rents and institutional quality, and with the only exception of the interaction term with oil rents, the other interaction terms do not have a significant effect on human capital. The interaction term of oil rents and institutional quality shows a positive and highly significant result. Accordingly taking into account that oil rents in resource-rich countries have constituted a larger share of GDP (see Figure 3.3), having higher human capital level in these countries allows them to benefit more from resource rents.

The remainder of Table 3.3, from columns 6 to 9, considers the disaggregation of non- energy rents into mineral and forest rents with respect to energy rents showing a positive effect of mineral rents and a negative effect of forest and aggregated energy rents on human capital. By looking at column 7 to 9 and focusing on the significant interaction terms, it can be noticed that higher quality of institutions on forest rents has a negative association with human capital while this dependence is reversed for energy rents. In this regard, Bhattacharyya and Hodler (2010) claimed that forestry rents might be endogenous and they excluded the rents from forestry in their estimations because forestry is a renewable resource and hence involves production and is probably not driven by a more temporary nature of price shocks (Bhattacharyya and Collier, 2013).

Table 3.3 Resource rents, institutions and QAHC: disaggregated energy and non- energy resources rents

Dependent variable: Quality-adjusted human capital.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$OilRent_{it}$	-0.01*	-0.14***	-0.01*	-0.01*	-0.01				
	(0.007)	(0.03)	(0.007)	(0.007)	(0.007)				
$GasRent_{it}$	-0.04	-0.14	0.04	-0.04	-0.03				
	(0.08)	(0.09)	(0.19)	(0.08)	(0.08)				
$CoalRent_{it}$	0.01	0.004	0.02	-1.22*	0.04				
	(0.10)	(0.10)	(0.10)	(0.73)	(0.10)				
$MineralRent_{it}$						0.02	0.11*	0.01	0.01
						(0.02)	(0.06)	(0.02)	(0.02)
$ForestRent_{it}$						-0.12***	-0.12***	0.03	-0.12***
						(0.02)	(0.02)	(0.06)	(0.02)
$EnergyRent_{it}$						-0.04**	-0.04*	-0.04*	-0.32***
						(0.02)	(0.02)	(0.02)	(0.08)
$nonEnergyRent_{it}$	-0.07**	-0.08**	-0.07**	-0.07**	0.001				
	(0.03)	(0.03)	(0.03)	(0.03)	(0.007)				
$Inst_{it}$	1.88**	0.99	1.92**	0.95***	2.26**	2.12**	2.50***	3.00***	01.57*
	(0.89)	(0.90)	(0.89)	(0.273)	(0.96)	(0.86)	(0.89)	(0.92)	(0.86)
$OilRent_{it} * Inst_{it}$		0.39***							
		(0.09)							
$GasRent_{it} * Inst_{it}$			-0.24						
			(0.48)						
$CoalRent_{it} * Inst_{it}$				2.52*					
				(1.46)					
$nonEnergyRent_{it} * Inst_{it}$					-0.22				
					(0.20)				
$MineralRent_{it} * Inst_{it}$							-0.22		
							(0.14)		
$ForestRent_{it} * Inst_{it}$								-0.52***	
								(0.19)	
$EnergyRent_{it} * Inst_{it}$									0.86***
									(0.23)
constant	6.43***	6.93***	6.34***	6.42***	6.43***	7.47***	7.47***	7.82***	8.05***
	(1.14)	(1.13)	(1.16)	(1.14)	(1.14)	(1.15)	(1.15)	(1.15)	(1.15)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	630	630	630	630	630	630	630	630	630
Adjusted R^2	0.70	0.71	0.70	0.70	0.70	0.71	0.71	0.71	0.71

Note: Robust standard errors in parentheses. Ordinary least squares regressions. Controls include: Income (logs), economic growth, population growth, government expenditure and income inequality. ***Significant at 1%; **significant at 5%; *significant at 10%. Time fixed effects and regional dummies are included in all regressions.

Furthermore, in Table 3.4 we decompose the dependent variable (QAHC) into its components of education and health; gross enrollment rate in secondary schooling and life expectancy at birth, respectively, and estimate the regressions independently considering these indicators. Columns 1 and 2, consider gross enrollment rate while columns 3 and 4 consider life expectancy at birth as dependent variables. The results obtained show a negative effect of natural resource rents on both components of human capital; gross enrollment rate and life expectancy at birth. Nevertheless, this finding is against Kim and Lin (2017) results which, as discussed before, claimed that natural resource dependence improves education.[27] Moreover, quality of institutions remains unchanged (positive and highly significant) while the interaction terms have positive although insignificant effects. Based on these results, it seems that the interaction term have significant effect only considering the human capital variable with both components as a dependent variable.[28]

Table 3.4 Resource rents, institutions, and human capital: disaggregated QAHC

Dependent Variables:	(1) gross enrollment rate	(2) gross enrollment rate	(3) life expectancy at birth	(4) life expectancy at birth
$Rent_{it}$	-0.22***	-0.37*	-0.04**	-0.07
	(0.07)	(0.22)	(0.01)	(0.05)
$Inst_{it}$	45.24***	45.53***	8.64***	8.11***
	(9.29)	(9.96)	(2.26)	(2.42)
$Rent_{it}$ * $Inst_{it}$		0.48		0.09
		(0.63)		(0.15)
Controls	YES	YES	YES	YES
Observations	689	689	689	689
Adjusted R^2	0.63	0.63	0.72	0.71

Note: Robust standard errors in parentheses. Ordinary least squares regressions. Controls include: Income (logs), economic growth, population growth, government expenditure and income inequality. ***Significant at 1%; **significant at 5%; *significant at 10%. Regional dummies are included in all regressions.

[27] Kim and Lin (2017) used average years of schooling as an indicator for education with 5-year interval from 1970-2011.

[28] Apart from using the pooled data with time fixed effects, the panel dimension further by including country fixed effects has been also exploited. As expected, this wash out all results involving institutions in this setting as there is simply not enough within-country variation (see Table A.3.1).

3.3.3 Robustness checks

This section explores whether the results are robust in several additional ways. One potential concern is that there might be reverse causality between the measure of human capital and some of the explanatory variables. If there is endogeneity, the OLS estimation would lead to inappropriate implications. One possible way to deal with the causal effect is to use instrumental variables techniques considering a two-stage least square (TSLS) strategy. The instrument that has been used for resource rents in the literature is international commodity prices following Bhattacharya and Collier (2013).[29] As the analysis is performed taking 4-year periods, for each period international commodity price is defined as an average over 4 years. Taking averages of prices over several years has additional advantages of reducing the role of extremely transitory shocks as well as measurement error (Caselli and Tesei, 2016). Results presented in Table 3.5 column 1 using natural resource rents instrumented by international commodity price have positive, although insignificant, effects on human capital.

Another concern is that the institutional quality will, in general, be endogenous and also subject to measurement error (Glaeser et al., 2004; Arezki and Van der Ploeg, 2007; and Acemoglu et al., 2014). The instruments that have been used in the literature are time-invariant variables and acceptable instruments for various types of institutions are not available in panel data (Bhattacharya and Hodler, 2014). However, three sets of instruments are considered: settler mortality (as in Acemoglu et al., 2001; Sala-i-Martin and Subramanian, 2008; Collier and Hoeffler, 2009); fraction of the population speaking European languages (Hall and Jones, 1999); and latitude (Boschini et al., 2013). Nevertheless, the results using these instruments are not significant according to Cragg and Donald (1993) test for weak identification or weak instruments.

As it is often the case, finding strong and valid instruments is not an easy work. Instead, lag of endogenous variables as instruments are used to address endogeneity and reverse causality concerns. Institutional quality, resource rents and also GDP per capita are considered to be endogenous and have casual effects with human capital. Hence, the robustness of the results is pursued further in Table 3.5 which shows the TSLS regressions using instruments of the potential

[29] Following a recent paper (Bhattacharya and Collier, 2013), the international commodity price variable is calculated for crude oil, natural gas, coal, metals and minerals, and forest to compute resource rents. Then international market price of these commodities is used which is weighted by the national exports of country of that commodities in our time period.

endogenous variables; specifically, one period lag (4 years) in the case of 4-year means in columns 2 and 3.[30] The argument to do so is that although current values might be endogenous to import penetrations, it is unlikely that past values are subject to the same problem. More importantly concerning the objective, the substantive results remain unchanged: column 2 continues to find that natural resource rents have a negative and significant impact on human capital while institutional quality has a positive but insignificant impact. Checking the interaction term between natural resources and institutions in column 3, we find again positive and significant results and the cutting level of institutional quality on natural resource rents is very similar to the previous check (0.54).

Compared to the OLS regressions, employing TSLS tend to increase both the estimated impact and statistical significance of resource rents on quality-adjusted human capital. This is consistent with the presence of reverse causality, something that, recall, should reduce the OLS point estimates. Moreover, the F-statistics of the first-stage regression is reported that are always above the required critical values (see Cragg and Donald, 1993).

[30] In addition, generalized method of moments (GMM) is applied obtaining relatively similar results.

Table 3.5 Robustness checks: Instrumenting for resource rents, institutions and GDP per capita

Dependent variable: Quality-adjusted human capital.			
		TSLS	
	(1)	(2)	(3)
$Rent_{it}$	0.66	-0.04***	-0.12***
	(0.60)	(0.01)	(0.03)
$Inst_{it}$	20.13	0.97	-0.56
	(19.37)	(1.09)	(1.21)
$Rent_{it}$ * $Inst_{it}$			0.22***
			(0.07)
$lGDPPC_{it}$	-0.34	1.00***	1.10***
	(0.32)	(0.13	(0.14)
$GDPgrowth_{it}$	-0.34	0.01	0.01
	(0.32)	(0.03	(0.03)
$Popgrowth_{it}$	-1.08*	-0.37***	-0.43***
	(0.65)	(0.08	(0.08)
$Totexp_{it}$	0.01	0.02**	0.02**
	(0.04)	(0.01	(0.01)
$Gini_{it}$	0.13	0.003	-0.004
	(0.10)	(0.01	(0.01)
constant	9.69***	8.39***	8.73***
	(2.73)	(1.14	(1.14)
Observations	483	506	506
Cragg-Donald F-stat	1.33	51.38	37.9
Adjusted R^2	0.69	0.67	0.68

Note: All regressions report robust standard errors in parentheses and include regional dummies. Natural resource rents is instrumented using international commodity price (regression 1) and employing one period lagged values of natural resource rents, institutional quality and lGDPPC (regressions 2 and 3). "Cragg–Donald F-stat" indicate Cragg–Donald Wald test for weak identification or weak instruments F-statistic. ***Significant at 1%; **significant at 5%; *significant at 10%.

3.4 Conclusions

This chapter has found a negative impact of resource rents on human capital and confirms this result by using an indicator that incorporates the quantity but also the quality of human capital which is the quality-adjusted human capital variable from World Bank (2011). Furthermore, this analysis has emphasized the crucial role of political institutions and has shown that the negative impact of resource rents can be reversed if the quality of institutions is high enough.

The empirical evidence was based on a large sample of 162 countries over the period 1996-2014 and accounting for the confounding effect of other variables, provides robust support of the negative impact of resource rents on quality-adjusted human capital on 4-year means data. In addition, the institutional quality has shown a positive association with human capital in all specifications which support the literature.

Moreover, it has been explored to what extent a more detailed understanding of this result can be obtained by studying the disaggregation of the resource rents. The results indicate a negative impact of both disaggregated measures of resource rents on human capital. However, the results of disaggregating energy and non- energy rents into sub-categories show a negative and significant impact only considering oil and forest rents on human capital. Accordingly, the findings indicate that the adverse effect on human capital stems basically from oil rents. Furthermore, the negative impact of oil rents on human capital seems to be reversed with a higher quality of institutions while the results of interaction terms of institutional quality and other components of resource rents are not statistically significant.

The components of quality-adjusted human capital are also considered independently, which shows a negative impact of resource rents on both education and health indicators meaning that the resource rents is negatively associated with human capital either considering education or health, as the components. Finally, in the robustness checks, endogeneity and reverse causality are controlled using instrumental variables and the results are not held in some specifications.

Returning to the question raised in this chapter being "why do some countries benefit and others lose from the presence of natural resources?" it can be answered according to the findings indicating that institutional quality indeed can make a difference for the impact of natural resources on human capital especially in oil-rich countries. The evidence suggests the policy toward better political institutions may help countries to improve social outcomes such as health and education which offer high social returns.

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Appendix

Table A.3.1 Summary statistics, 1996-2014 (4-year average periods)

Variables		Mean	Std. Dev.	Min	Max	Observations
QAHC	overall	16.5	3.77	0.96	22.14	N=717
	between		3.49	7.03	21.42	n=162
	within		1.72	8.83	21.06	
Rent (Total Natural Resources)	overall	7.37	11.71	0	74.33	N=805
	between		10.85	0.001	48.57	n=162
	within		4.46	-26.71	33.74	
oil	overall	3.47	9.27	0	70.32	N=805
	between		8.63	0	48.57	n=162
	within		3.45	-30.42	33.74	
gas	overall	0.59	3.02	0	46.57	N=805
	between		2.63	0	28.39	n=162
	within		1.49	-10.78	18.76	
coal	overall	0.15	0.74	0	16.10	N=805
	between		0.56	0	5.85	n=162
	within		0.48	-5.12	10.40	
mineral	overall	1.27	3.84	0	38.97	N=805
	between		3.18	0	22.80	n=162
	within		2.17	-13.50	19.58	
forest	overall	2.30	4.97	0	40.28	N=805
	between		4.83	0	34.94	n=162
	within		1.22	-6.32	12.96	
Inst	overall	0.50	0.20	0.03	0.96	N=801
	between		0.20	0.11	0.94	n=162
	within		0.03	0.35	0.66	
lGDPPC	overall	8.29	1.50	5.26	11.54	N=805
	between		1.50	5.37	11.46	n=162
	within		0.19	7.05	8.96	
GDPgrowth	overall	4.27	4.45	-13.79	66.49	N=806
	between		2.74	-1	24	n=162
	within		3.53	-18.56	46.76	
popgrowth	overall	1.46	1.42	-1.65	14.19	N=810
	between		1.28	-1.26	7.55	n=162
	within		0.61	-4.04	8.11	
Totexp(%GDP)	overall	15.37	5.42	1.76	43.83	N=783
	between		5.15	1.92	35.09	n=162
	within		2.10	5.90	29.30	
Gini	overall	38.84	8.15	22.45	60.75	N=708
	between		7.97	23	60.60	n=162
	within		1.35	32.59	45.44	

Table A.3.2 Country codes and countries

Country code	Country	Country code	Country	Country code	Country
AFG	Afghanistan	CMR	Cameroon	GAB	Gabon
ALB	Albania	CAN	Canada	GMB	Gambia, The
DZA	Algeria	TCD	Chad	GEO	Georgia
AGO	Angola	CHN	China	DEU	Germany
ARG	Argentina	COL	Colombia	GHA	Ghana
ARM	Armenia	COM	Comoros	GRC	Greece
AUS	Australia	COD	Congo, Dem. Rep.	GTM	Guatemala
AUT	Austria	COG	Congo, Rep.	GIN	Guinea
AZE	Azerbaijan	CRI	Costa Rica	GNB	Guinea-Bissau
BHS	The Bahamas	CIV	Cote d'Ivoire	GUY	Guyana
BGD	Bangladesh	HRV	Croatia	HND	Honduras
BRB	Barbados	CYP	Cyprus	HKG	Hong Kong SAR, China
BLR	Belarus	CZE	Czech Republic	HUN	Hungary
BEL	Belgium	DNK	Denmark	IND	India
BLZ	Belize	DJI	Djibouti	IDN	Indonesia
BEN	Benin	DMA	Dominica	IRN	Iran, Islamic Rep.
BTN	Bhutan	DOM	Dominican Republic	IRQ	Iraq
BOL	Bolivia	ECU	Ecuador	ISR	Israel
BWA	Botswana	EGY	Egypt, Arab Rep.	ITA	Italy
BRA	Brazil	SLV	El Salvador	JAM	Jamaica
BRN	Brunei Darussalam	GNQ	Equatorial Guinea	JPN	Japan
BGR	Bulgaria	EST	Estonia	JOR	Jordan
BFA	Burkina Faso	ETH	Ethiopia	KAZ	Kazakhstan
BDI	Burundi	FJI	Fiji	KEN	Kenya
CPV	Cabo Verde	FIN	Finland	KIR	Kiribati
KHM	Cambodia	FRA	France	KOR	Korea, Rep.

Country code	Country	Country code	Country	Country code	Country
KGZ	Kyrgyz Republic	NIC	Nicaragua	VCT	St. Vincent and the Grenadines
LAO	Lao PDR	NER	Niger	SUR	Suriname
LVA	Latvia	NGA	Nigeria	SWZ	Swaziland
LBN	Lebanon	NOR	Norway	SWE	Sweden
LSO	Lesotho	PAN	Panama	CHE	Switzerland
LBR	Liberia	PNG	Papua New Guinea	TJK	Tajikistan
LBY	Libya	PRY	Paraguay	TZA	Tanzania
LTU	Lithuania	PER	Peru	THA	Thailand
LUX	Luxembourg	PHL	Philippines	TGO	Timor-Leste
MKD	Macedonia, FYR	POL	Poland	TGO	Togo
MDG	Madagascar	PRT	Portugal	TON	Tonga
MWI	Malawi	QAT	Qatar	TTO	Trinidad and Tobago
MYS	Malaysia	ROU	Romania	TUN	Tunisia
MDV	Maldives	RUS	Russian Federation	TUR	Turkey
MLI	Mali	RWA	Rwanda	TKM	Turkmenistan
MRT	Mauritania	WSM	Samoa	UGA	Uganda
MUS	Mauritius	STP	Sao Tome and Principe	UKR	Ukraine
MEX	Mexico	SEN	Senegal	GBR	United Kingdom
MDA	Moldova	SYC	Seychelles	USA	United States
MNG	Mongolia	SLE	Sierra Leone	URY	Uruguay
MAR	Morocco	SVK	Slovak Republic	UZB	Uzbekistan
MOZ	Mozambique	SVN	Slovenia	VUT	Vanuatu
MMR	Myanmar	SLB	Solomon Islands	VEN	Venezuela, RB
NAM	Namibia	ZAF	South Africa	VNM	Vietnam
NPL	Nepal	ESP	Spain	YEM	Yemen, Rep.
NLD	Netherlands	LKA	Sri Lanka	ZWE	Zimbabwe
NZL	New Zealand	LCA	St. Lucia		

Table A.3.3 Data definition and sources

Variable name	Definition	Source
QAHC	Quality-adjusted human capital is the log-linear relationship between education and health. Indicator of education is gross enrolment ratio in secondary schooling (%) and health indicator is life expectancy at birth.	Our calculation and World Bank, World Development Indicator (UNESCO Institute for Statistics).
Total natural resource rents (%GDP)	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.	World Bank, World Development Indicator (WDI)
Institutional quality	Average of six indicators of World Governance Indicators (WGI); voice and accountability; political stability and absence of violence; government effectiveness; regulatory quality; rule of law; and control of corruption.	World Wide Governance Indicators (WGI). The paper by Daniel Kaufmann, Aart Kraay and Massimo Mastruzzi (2009).
GDP per capita (constant 2010 US$)	GDP per capita is gross domestic product divided by midyear population. Data are in constant 2010 U.S. dollars.	WDI
GDP growth	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars.	WDI
Population growth	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage.	WDI
Total government expenditure (%GDP)	General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees).	WDI
GINI index	Estimate of Gini index of inequality in equalized (square root scale) household disposable (post-tax, post-transfer) income.	The Standardized World Income Inequality Database (SWIID), version 6.1 2016.
Government Effectiveness	Explained in previous chapter.	WGI
Regulatory Quality	Explained in previous chapter.	WGI
Control of Corruption	Explained in previous chapter.	WGI
Political Stability	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.	WGI
Rule of Law	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.	WGI
Voice and Accountability	Voice and Accountability capture perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.	WGI

Table A.3.4 Correlation matrix for the entire sample.

	HC	Rent	oil	gas	coal	mineral	forest	Inst	lGDPPC	Popgrowth	GDPgrowth	Totexp	Gini
HC	1												
Rent	-0.25*	1											
oil	-0.08*	0.90*	1										
gas	0.03	0.43*	0.33*	1									
coal	0.03	0.05	-0.02	-0.01	1								
mineral	-0.1*	0.24*	-0.04*	-0.02	0.23*	1							
forest	-0.56*	0.26*	-0.05	-0.07*	-0.05*	0.15*	1						
Inst	0.60*	-0.36*	-0.22*	-0.14*	-0.02	-0.12*	-0.38*	1					
lGDPPC	0.72*	-0.21*	-0.01	-0.01	-0.01	-0.16*	-0.54*	0.79*	1				
Pop growth	-0.54*	0.29*	0.18*	0.01	-0.05	0.08*	0.35*	-0.35*	-0.34*	1			
GDP growth	-0.26**	0.24*	0.18*	0.08*	0.04	0.06	0.16*	-0.25*	-0.21*	0.25*	1		
Totexp	0.14*	0.28*	0.34*	0.15*	-0.01	-0.01	-0.1*	0.22*	0.17*	-0.12*	-0.1*	1	
Gini	-0.26*	-0.03	-0.01	-0.03	0.05	0.08	0.001	-0.34*	-0.33*	0.26*	0.12*	-0.16*	1

Note: *significant at 5%.

Chapter 4

Commodity price shocks and inequality: cross-country evidence

4.1 Introduction

Over the last years, developing countries have specialized in primary goods with substantial volatility of prices. Thus, these countries have experienced more volatility in terms of trade, more volatility in foreign direct investment, lower growth rates, and higher socio-political instability (Acemoglu et al., 2003; Van der Ploeg and Poelhekke, 2009; Sala-i-Martin and Subramanian, 2013). For these types of countries, the resource curse is an urgent puzzle (Ross, 1999).[31] In addition, resource abundance may lead to increases in inequality and higher inequality may lower economic development.[32] Natural resources influence the initial distribution of income, and thus also the economic power (Acemoglu and Robinson, 2006). In fact, Sub-Saharan Africa and Latin America, two of the most resource-rich regions of the world, are nowadays also the most inequitable ones (UNCTAD, 2014). One reason for this connection between resource abundance and high inequality is that in many resource-rich-developing countries, local elites, together with foreign capital, have been able to appropriate most of the rising rents from natural resources. However, the nature and magnitude of the impact of natural resource abundance on income distribution may be dependent on both the type of natural resources and several country characteristics. This chapter investigates to what extent inequality can be understood as another mechanism of the resource curse.

Surprisingly little is known about the cross-country relationship between resource booms and the distribution of income. In fact, this might be because of the paucity of time series data on inequality in resource-rich economies. Building on previous evidence on resource booms and distribution of income, differentiated effects of resource booms on income inequality are analyzed in this chapter. In particular, in contrast to what is found for the rest of the world, a significant inequality-increasing effect of positive price shocks in capital intensive (non-agricultural commodities) is

[31] "Three-quarters of states in sub-Saharan Africa and two-thirds of those in Latin America, the Caribbean, North Africa, and the Middle East still depend on primary commodities for at least half of their export income" (Ross, 1999).

[32] The volatility of commodity prices and terms-of-trade is also larger in low-income countries than in other income groups (Raddatz, 2007).

found for Sub-Saharan African (SSA) and Latin American (LA) countries. As shown, this may be explained by higher initial levels of inequality and lower initial levels of institutional quality in these countries.

To outline the channels through how commodity price shocks affect income inequality this chapter follows the framework presented by Dube and Vargas (2013), who assumed two opposite effects namely; opportunity cost and rapacity effects in the relationship between disaggregated commodity price shocks and conflict. Based on this assumption, a rise in commodity prices will generate contradictory pressures depending on the type of commodities. Price shocks on agricultural (labor-intensive) commodities seem to reduce inequality, and this seems to happen due to an increase in wages, signaling opportunity cost effects. By contrast, price shocks on non-agricultural (capital-intensive) commodities increase inequality, and this seems to happen due to an increase in capital-tax revenues (rapacity effects). Therefore, the existence of opportunity cost and rapacity effects, help us understand how different types of commodities may mitigate or exacerbate inequality. Furthermore, the main finding that positive commodity price shocks increase inequality when given in capital-intensive commodities seems stronger when the initial level of inequality is high and/or the quality of institutions is low. This is the case of many Sub-Saharan African and Latin-American countries.

In relation to existing studies, this chapter is linked to two main strands of the literature. First, the resource curse literature which study the cross-country relationship between natural resources and inequality (i.e., Gylfason and Zoega, 2003, Fum and Hodler, 2010; Carmignani and Avom, 2013; Parcero and Papyrakis, 2016; Kim and Lin, 2017; Behzadan et al., 2017, for world samples, Leamer et al., 1999, for Latin America, Farzanegan and Krieger, 2018, for Iran). Second, the chapter also linked to economic conflict literature which focus on the idea that commodity price shocks can have differentiated effects on conflict and civil war depending on the factor intensity of the commodity (i.e., Dube and Vargas, 2013, for Colombia, Bazzi and Blattman, 2014; Ciccone, 2018, for world samples). The literature suggests that inequality might be one of conflict risk factors.[33] The question which is raised here is that: Do the effects of commodity price shocks can also influence income distribution? The income inequality has always been viewed as closely related to conflict in the economic conflict literature (i.e., Collier and Hoeffler, 1998, 2004; Fearon and Laitin, 2003;

[33] Absolute and relative levels of deprivation (inequality) are commonly cited predictors of conflict (Bazzi and Blattman, 2014).

Sambanis, 2005; Fearon, 2008; Blattman and Miguel, 2010; Esteban and Ray, 2011).[34] Another strand of the literature, which is similar in vein to this chapter, focus on relationship between resource booms specifically commodity price shocks and income distribution. Particularly, Goderis and Malone (2011) used a theoretical framework suggesting that positive commodity shock will lower pay inequality in the short-run, as the demand for low-skilled labor-intensive non-traded sectors increases. In contrast, booms in commodity shock increase inequality in the long-run. Goderis and Malone (2011) used only manufacturing pay inequality as a measure of household income inequality which might miss inequality in other sectors. In terms of country-specific studies, Bhttacharyya and Williamson (2016) investigate the relationship between commodity price shocks and distributional income share in Australia and find that a rise in prices increases rents through a higher income inequality. This chapter addresses the gap in the literature by investigating the effects of commodity price shocks on income inequality in a cross-country analysis. Also, further evidence is provided having opposing effects of different types of commodities on income inequality; opportunity cost and rapacity mechanisms, using cross-country, rather than state-level, data.

The first main finding is that commodity price shocks increase inequality in specific contexts where capital-intensive price shocks and initial country characteristics such as level of inequality play an important role specifically in SSA and LA. Also in line with Dube and Vargas (2013), labor-intensive price shocks increase wages (opportunity cost mechanism) and capital-intensive price shocks increase capital tax revenues (rapacity mechanism). Besides, the existence of opportunity cost and rapacity effects, suggests that different types of commodities may mitigate or exacerbate inequality, depending on the various definitions of the inequality where capital-intensive price shocks significantly increase capital rents inequality.

The remainder of the chapter is organized as follows. Section 4.2 describes the data used to study the relationship between commodity price shocks and inequality. Section 4.3 presents the empirical analysis including descriptive and econometric analysis. Finally, Section 4.4 concludes.

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[34] According to Dal Bo and Dal Bo (2011), there is a positive association between inequality and conflict. And higher income inequality provides a possible motive for conflict (Fearon, 2008) and it would be crucial in explaining the economic incentives for rebellion (Blattman and Miguel, 2010).

4.2 Data

The initial analysis is based on unbalanced dynamic panel dataset consisting of 80 countries over the 1990 to 2016.[35] Annual data is considered in order to check the effects of commodity price shocks on inequality in a cross-country analysis.

Commodity Price Shocks

The measure of resource booms is the export-share-weighted commodity price shock which is constructed using a similar methodology to Bazzi and Blattman (2014), Musayev (2014) and Castells-Quintana (2017). The price data for 20 commodities is collected from the IMF-IFS International Financial Statistics, the World Bank, the FRED Federal Reserve Economic Data and the World Gold Council. The primary sources of commodity export data is the UNCTSD (United Nations Commodity Trade Statistics Database). The commodities that are analyzed includes, oil, gas, coal, gold, diamond, silver, zinc, aluminum, iron, copper, tin, nickel and lead, coffee, banana, wheat, cotton, wool, wood and rubber which contain almost 65% of all commodities that have been exported in year 2016 according to International Trade Statistics Yearbook, 2016. The result constructs a database with shares of 20 different commodities in total exports by country and year.

The commodity price shock is calculated from a commodity export price index, P_{it} as a geometrically-weighted index of international export prices for country *i* in year *t*:

$$P_{it} = \frac{\prod_{j=1}^{J} P_{jt}^{w_{ijt-k}}}{cpi_t}$$

Where P_{jt} captures price fluctuations on international markets for commodity *j* in year *t* (normalized to 100 in 2010). Since prices are dollar-denominated, the index is deflated by the US consumer price index, cpi_t. Following Bazzi and Blattman (2014), each commodity price is weighted by w_{ijt-k}, its average share in total national exports (excluding re-exports) from *t*-2 to *t*-4. This might avoids possible endogeneity problems arising in the event of a volume response to price changes.[36] The reasons why the export weight is used are; First because of the widespread

[35] 80 countries are selected based on the top nations in exporting the selected commodities. And the time period is considered according to the available data for share of exports.

[36] However, Ciccone (2018) recently claimed that Bazzi and Blattman dataset are measured with some errors. He argued that price shocks based on time-varying export share partly reflect changes in the quantity and

availability of export data, as opposed to data on productions and stocks. Second, the stocks measure may not accurately capture the effects of international price volatility on products produced and consumed.[37]

Annual shocks are calculated as the log difference of the price index P_{it}, and scale it by the weight of total commodity exports to GDP-a time-invariant measure of the importance of commodity prices in the economy for country *i* in time *t*.[38] So the shock measure multiplies the price difference by the ratio of total commodity exports to GDP because the economy in commodity-dependent nations is most sensitive to commodity price shocks.[39]

Hence, S_{it} is calculated as the annual difference in each country's log commodity export price index:

$$S_{it} = (\log P_{it} - \log P_{it-1}) * \frac{X_{iT}}{GDP_{iT}}$$

The measurement of commodity price shocks using shares of commodities has several advantages. First, export price shocks estimate local average treatment effects of income changes to the households or states that receive the revenues from traded commodities. Second, the index does not capture resource discoveries and other quantity shocks or temporary volume shocks. Third, international commodity prices are typically not affected by individual countries and therefore are not likely to be endogenous with respect to the growth of individual countries.

According to our framework, the aggregated commodities are disentangled into labor intensive and capital intensive goods. The labor-intensive goods are mainly agricultural goods including; coffee, banana, wheat, cotton, wool, wood and rubber while the capital intensive goods are hydrocarbons and minerals including; oil, gas, coal, gold, diamond, silver, zinc, aluminum, iron, copper, tin, nickel and lead.

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variety of countries export, which jeopardizes causal estimation. He used to obtain fixed-weight commodity price shocks either in a specific year or average export shares over the sample period.

[37] The problem with simply weighting the commodity price index by the share of the commodity in exports to GDP is that this scaling exercise implies that this variable is no longer independent of economic policies and institutions, and is potentially endogenous to domestic economic conditions (McGregor, 2017).

[38] The average of the ratio is taken in 1990 to 2016 to calculate *X/GDP* for each country.

[39] This scaling increases the expected size and precision of any impact of prices on growth and political instability (Bazzi and Blattman, 2014).

Inequality

Data for income inequality for several countries and for a long time span is scarce. To overcome this limitation, the data from the SWIID (Standard World Income Inequality Database) version 6.1 (Solt, 2016) is used. SWIID uses a custom missing-data multiple-imputation algorithm to standardize observations collected from multiple sources (i.e., OECD Income Distribution Database, The Socioeconomic Database for Latin America and the Caribbean generated by CEDLAS and the World Bank, Eurostat, the UN Economic Commission for Latin America and the Caribbean, national statistical offices around the world, and many other sources). The SWIID is the most comprehensive dataset on inequality providing a very wide coverage of comparable inequality data across countries. The coefficient ranges between 0 and 1, with larger values corresponding to more unequal income distributions. The observations that are considered are based on household disposable post-tax income data rather than household market pre-tax income data because inequality after the political processes of rent-seeking and redistribution is more drawing attention.

In exploring the opportunity cost mechanism, the pay inequality data of the UTIP-UNIDO dataset is used as a part of the University of Texas Inequality Project (UTIP). This variable focuses on measuring and explaining movements of inequality in wages and earnings, based on United Nations Industrial Development Organization (UNIDO). This enables us to analyze the inequality among the employed individuals and observe if a shock in labor-intensive commodities has any impact on labor wages inequality.

In examining the rapacity mechanism, the difference between the household disposable income inequality and pay inequality is considered. This variable might help us to address the channel through which a shock in capital intensive commodities effects on capital rents inequality.

Conflict

In terms of checking the impacts of both commodity prices shocks and inequality on conflict and also tests if our theoretical framework is in line with the literature, the intentional homicides (per 100,000 people) is used from UN Office on Drugs and Crime's intentional Homicide Statistics database. The measurement of conflict using the intentional homicides has some advantages. First, this variable is taken with respect to the country's population. Second, using this variables cover longer time for the countries included.[40]

Finally, the following control variables are used in our model that the literature has found to potentially influence inequality at country level: economic growth, income per capita (in logs), share of investment, share of government spending and schooling. As robustness, additional variables are considered, including, total population, fertility rates and quality of institutions. Other variables that may be correlated with commodity price shocks, like trade openness and inflation rate are also considered. All of these variables come from different sources, including World Bank, ICRG dataset and the Penn World Table. Table A.4.1 lists all variables definitions and sources, while descriptive statistics for main variables, as well as list of countries included in the analysis, can be found in Tables A.4.2 and A.4.3.

4.3 Inequality and commodity price shocks: an empirical analysis

4.3.1 Descriptive analysis

As a first step in examining empirically the relationship between our main variables of interest, a pairwise correlation matrix is considered. Table 4.1 shows cross-correlation statistics for our key variables in levels: commodity price shocks, inequality, conflict, and economic growth. A positive correlation between commodity price shocks and inequality is found; price shocks are positively associated with higher inequality. There is also a negative association between commodity price shocks and conflict measured by intentional homicides, in line with the literature; Bazzi and Blattman (2014) also did not find a large, consistent and robust decline in conflict or coup risk when prices fall. Other correlations also give interesting results. There is a positive association between inequality and conflict, in line with the literature (Collier and Hoeffler, 1998, 2004; Fearon and Laitin, 2003; Sambanis, 2005; Fearon, 2007; Blattman and Miguel, 2010; Esteban and Ray, 2011). The commodity price shocks and GDP per capita have a positive correlation. This is consistent with the existing literature where a raise from resource windfalls is associated with a short-run rise in income changes (Deaton, 1999; Musayev, 2014; Mc Gregor, 2017). Inequality is

[40] Battle-related deaths from the UCDP Uppsala Conflict Data Program is employed which is also used by Bazzi and Blattman (2014). The problem considering the UCDP data is that has few observations regarding our panel data.

negatively correlated with GDP per capita, also in line with the literature (Acemoglu and Robinson, 2001; Gupta et al., 2002; Papaioannou and Siourounis, 2008; Aidt, T. S., 2009).

Next, Tables 4.2.a, 4.2.b, and 4.2.c check the pairwise correlations between our main variables once controls for year and country fixed effects. Figures 4.1.a, 4.1.b and 4.1.c, plot these associations. The introduction of country fixed effects allows us to control for country-specific characteristics, while the introduction of year fixed effects allows us to control for global shocks.[41] As can be seen, controlling for year and country fixed effects does not significantly change the results from Table 4.1.[42]

Following our framework, the commodities are disaggregated into agricultural and non-agricultural (hydrocarbons and minerals) goods: Tables 4.3.a and 4.3.b, respectively.[43] Table 4.3.a shows a negative association between inequality and agricultural price shocks, while Table 4.3.b shows a positive association between inequality and non-agricultural price shocks, even once controlling for country and year fixed effects.[44] These findings will be discussed at length in the next section. Also, Figures 4.2.a and 4.2.b plot these associations.

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[41] The binned scatter plots have been applied based on all data points in order to purge from year and country fixed effects. Here, every point in the figures shows 20 observations.

[42] I also checked the data and these points are not the individual outlier countries.

[43] Table A.4.4 lists all commodities.

[44] Figure A.4.1 illustrates the monthly evolution of agricultural and non-agricultural commodity prices from 1990 to 2016. The main shocks are around 1995, 2008 and 2012, which all correspond to major global economic crisis. Following the Great Commodities Depression of the 1980s and 1990s, the 2000s commodities boom was the rise and fall of many physical commodity prices.

Table 4.1: Correlation matrix between the main variables

	commodity price shocks	inequality	conflict	GDPpc
commodity price shocks	1			
inequality	0.046*	1		
conflict	-0.054*	0.045	1	
GDPpc	0.011	-0.013	-0.089*	1

Note: All variables are in changes. * shows significance at the 10% level.

Table 4.2.a: inequality and conflict

	No Year FE	Year FE
No country FE	0.045	0.056*
Country FE	0.045	0.055*

Note: The panel includes 889 observations. * p<0.1.

Table 4.2.b: conflict and commodity price shocks

	No Year FE	Year FE
No country FE	-0.054*	-0.052
Country FE	-0.054*	-0.051

Note: The panel includes 947 observations. * p<0.1.

Table 4.2.c: inequality and commodity price shocks

	No Year FE	Year FE
No country FE	0.046*	0.035
Country FE	0.046*	0.034

Note: The panel includes 1528 observations. * p<0.1.

Figure 4.1.a: inequality and conflict

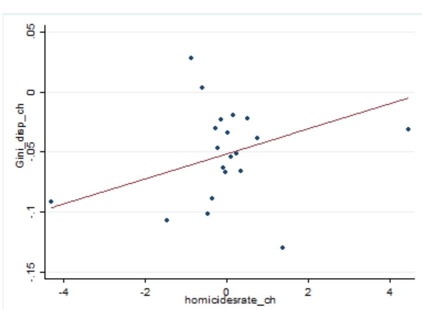


Figure 4.1.b: conflict and commodity price index

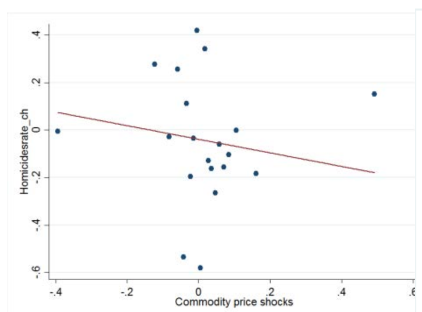
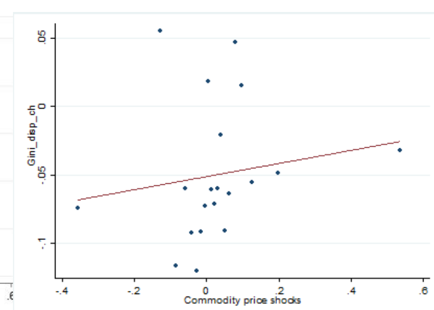


Figure 4.1.c: inequality and commodity price index



Note: binned scatterplots based on all data points purged from year and country fixed effects (n=20)

Table 4.3.a: inequality and agricultural price shocks

	No Year FE	Year FE
No country FE	0.012	-0.004
Country FE	0.012	-0.003

Note: The panel includes 1520 observations for 80 countries. * p<0.05.

Table 4.3.b: inequality and non-agricultural price shocks

	No Year FE	Year FE
No country FE	0.049*	0.043*
Country FE	0.049*	0.043*

Note: The panel includes 1520 observations for 80 countries. * p<0.05.

Figure 4.2.a: inequality and agricultural price shocks

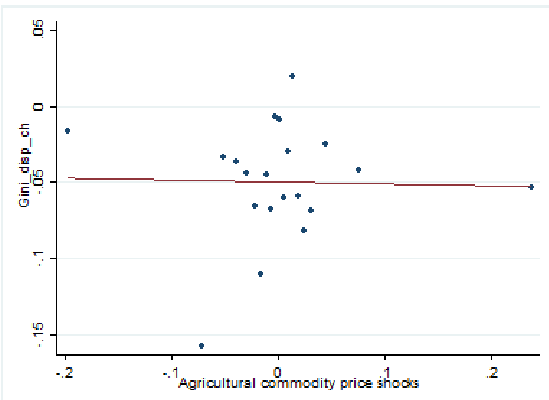
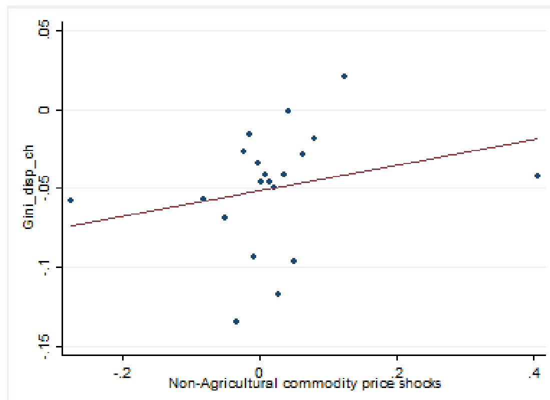


Figure 4.2.b: inequality and non-agricultural price shocks



Note: binned scatterplots based on all data points purged from year and country fixed effects (n=20)

Since this study analyzes the impact of commodity prices on inequality in different regions, it might be interesting to check the average Gini index in our time span in these regions. The regions studied in this study includes: Europe, America, Asia, Oceania, Latin America, Sub-Saharan Africa, and Middle East. Concerning this, Table A.4.5 in Appendix shows that the Gini_mean for the whole sample is 38.62. According to this table, Europe (EU), North America (NAM) and Oceania (OC) have inequality lower than the average. However, Latin America (LA) and Sub-Saharan Africa (SSA) have inequality higher than the average. Moreover, Table A.4.5 also shows the average rate of quality of institutions in these regions. Figure 4.3.b shows that higher prices of non-agricultural commodities are associated with higher inequality in LA and SSA while in EU, NAM and OC that is not the case.

Figure 4.3.a: inequality and agricultural price shocks in SSA and LA

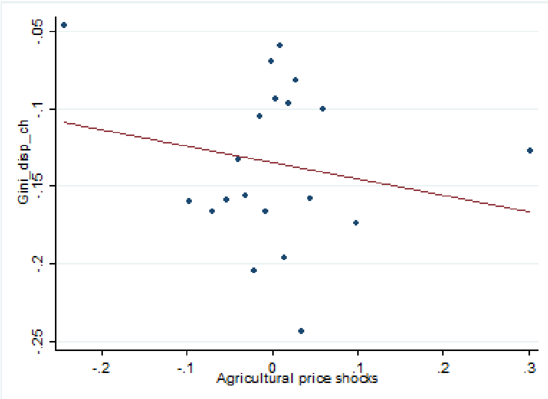


Figure 4.3.b: inequality and non-agricultural price shocks in SSA and LA

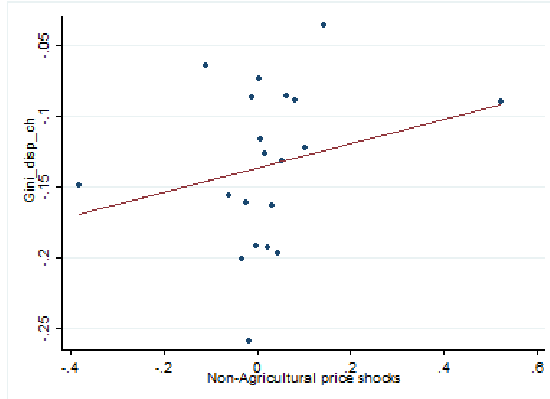


Figure 4.4.a: inequality and agricultural price shocks in EU, NAM and OC

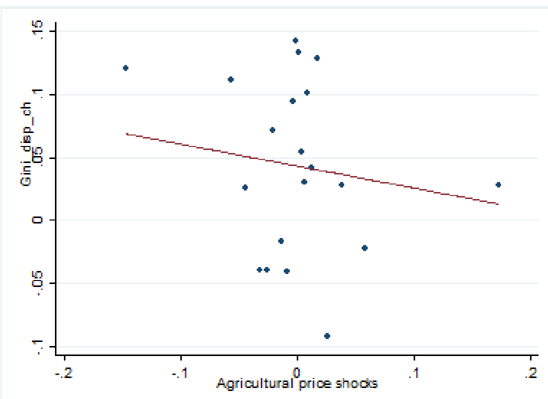
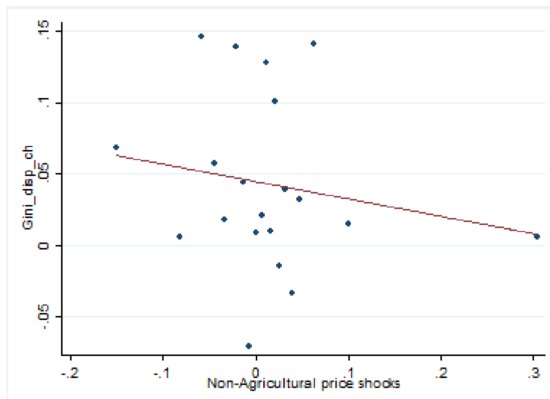


Figure 4.4.b: inequality and non-agricultural price shocks in EU, NAM and OC



Note: binned scatterplots based on all data points purged from year and country fixed effects (n=20)

4.3.2 Econometric analysis

In this section, we turn to econometric analysis with an empirical specification that allows us to test the relationship between resource booms and income inequality. In particular, the effect of commodity price shocks on income inequality is analyzed using the following model:

$$\Delta inequality_{it} = \alpha_i + \delta_i + \beta_1 S_{it} + controls_{it} + \varepsilon_{it} \qquad (4.1)$$

In the above equation, the subscripts i = 1, ..., N and t = 1, ..., T index the countries and years in the panel, respectively. Here, $inequality_{it}$ stands for changes in household income inequality in country i in year t, α_i is a country- fixed effect, δ_i is a time-fixed effect and ε_{it} is the error term. The key independent variable is S_{it} , the annual commodity prices shocks in country i in year t.[45] $controls_{it}$ is the list of controls. The coefficient of interest is β_1 which captures the relationship between commodity price shocks and income inequality. Commodities are also disaggregated in order to check if different types of commodities have a different impact on inequality.

In addition, different mechanisms are considered through the idea of rapacity and opportunity cost channels. To investigate the opportunity cost channel, this study analyzes whether changes in prices of labor-intensive goods affect labor market outcomes differentially by using wages and pay inequality dataset in countries producing these commodities more intensively. To examine the rapacity channel, we can assess how price shocks for capital-intensive goods affects capital tax revenues and capital rents inequality. Specifically, to estimate the effects of labor-intensive and capital-intensive commodities on disentangled inequality, this specification is used:

$$\Delta\, g_{it} = \alpha_i + \delta_i + \gamma_1 agri_{it} + \gamma_2 nonagri_{it} + controls_{it} + \epsilon_{it} \qquad (4.2)$$

Where g_{it} is either wage and pay inequality or capital tax and capital rents inequality of country i in year t. $agri_{it}$ stands for agricultural price shocks and $nonagri_{it}$ stands for non-agricultural price shocks. ϵ_{it} is the error term. The predictions from these theories are opposite to each other: we expect that higher prices of labor-intensive (agricultural) commodities should increase wages and therefore reduce industrial pay inequality, while higher prices of capital-intensive (non-agricultural) commodities increase capital tax revenues and therefore increase capital rents inequality.

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[45] The analysis also considers the shocks over 3-year periods and shocks without scaling.

All control variables are included one period before to reduce problems of reverse causality. As data to measure income inequality comes from Solt (2016), all estimations are done using multiple imputation estimates (100 imputations) and clustering errors at the country level. Then this analysis concerns time-varying factors correlated with both export price shocks and inequality. Time effects are included to control for global shocks and, country FEs, to control for country-specific characteristics. Commodity prices shocks are typically not affected by individual countries and therefore are not likely to be endogenous thus are exogenous to inequality levels of each country.

Following the literature, this analysis first considers conflict as a dependent variable before checking the impact of commodity price shocks on inequality, in order to see if the findings reproduce the results in the literature.[46] Table A.4.6 presents these results of estimating the impact of commodity price shocks on conflict. Results suggest that higher commodity prices, either in aggregated or disaggregated way (agricultural and non-agricultural), decrease conflict. The existing studies achieve seemingly similar conclusions: they find weak evidence that conflict decreases as prices rise (i.e., Bruckner and Ciccone, 2010; Bazzi and Blattman, 2014; Ciccone, 2018). Bazzi and Blattman (2014) argued that higher rents from commodity prices weakly lower the risk and length of the conflict. Besides, Ciccone (2018) find that international commodity price downturns sparked civil war in Sub-Saharan Africa and beyond.[47]

Table 4.4 presents the results of estimating Equation (4.1); the impact of commodity price shocks on inequality, relying on our cross-country panel data. Column 1 presents pooled-OLS estimates. Results yield a positive and significant coefficient, indicating that the higher export-share-weighted average of commodity prices, the higher inequality. Columns 2 and 3 introduce controls (at the expense of losing observations). Controls have the expected signs; included controls are: economic growth, investment, and government consumption.[48] Results hold for commodity price shocks. Column 3 introduces country and time fixed effects. The coefficient for commodity price shocks

[46] According to Table 4.2.b in section 4.3.1, a negative association between commodity price shocks and conflict is shown.

[47] The last two columns of Table A.4.6 controls for the effects of inequality on conflict. The main results hold and higher inequality is found to increase the conflict which is in line with the literature (i.e., Collier and Hoeffler, 1998, 2004; Fearon and Laitin, 2003; Sambanis, 2005; Fearon, 2007; Blattman and Miguel, 2010; Esteban and Ray, 2011).

[48] Table A.4.7 shows the coefficients for all controls.

yields a positive but no longer significant result. Next, the study investigates whether the short-run effect of higher commodity prices varies across capital-intensive and labor-intensive commodities. The results reported in columns 4 to 6. In column 4 both variables enter with a positive sign but only the capital-intensive shocks is now significant at 5 percent level. Column 5 includes the control variables. Results hold for both sub-indices. Column 6 introduces country and time FEs. Now, the agricultural commodity price shocks negatively impact on inequality. However, this coefficient is not significant.[49] In columns 7 and 8, the additional controls are included (population in logs, fertility rate, openness, quality of institutions, and inflation in logs). The main results hold. Hence, these results are consistent with the theoretical prediction that inequality increases in response to a resource boom, especially when associated with capital-intensive commodities.

We try to test for the robustness of main results. First, Table A.4.8 controls for the level of inequality. The lagged level of inequality enters with a negative sign and is significant at 1 percent. The size of the coefficient in the (preferred) fixed effects specification indicates that the speed of adjustment to long-run equilibrium is around 2 percent per year (following Goderis and Malone, 2011).[50] Second, Table A.4.9 considers the level of inequality as a dependent variable. The main results hold. Finally, commodity price shocks are aggregated over 3-years periods to reduce short-run noise in the data.[51] The results are presented in Table A.4.10. The results support earlier findings.

[49] The difference in significance might reflect a genuine difference in spending patterns. Non-agricultural revenues typically accrue to governments, who might spend a large part of it, whereas revenues from agriculture accrue predominantly to farmers, who might save more (Goderis and Malone, 2011). The resource curse literature suggests that countries exporting non-renewable resources (minerals, oil and gas) are more adversely affected than countries exporting renewable natural resources such as agricultural commodities (i.e., Isham et al., 2005; Bhattacharya and Williamson, 2016).

[50] The dynamic model is also estimated using different techniques (including GMM estimations), in which inequality in time t depends on inequality in $t-1$. The coefficient for the lagged dependent variables is positive and highly significant, confirming the persistence of inequality, but the commodity price shock is no longer significant.

[51] The average of price changes over years is taken to reduce the role of extremely transitory shocks as well as measurement error. Hence the change in commodity prices is the average over the $t-3$, $t-2$, $t-1$, and t. However, constructing the rolling windows introduce serial correlation in the estimates. To account for this, the standard error at the country level is clustered in all regressions, allowing for heteroscedasticity and arbitrary correlation in the error term (Caselli and Tesei, 2016).

Table 4.4 Main results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in Inequality (Gini coefficient)								
Commodity price shocks	0.09**	0.07*	0.03				0.04	
	(0.03)	(0.03)	(0.04)				(0.05)	
Agricultural price shocks				0.006	0.022	-0.141		-0.19
				(0.11)	(0.12)	(0.1)		(0.12)
Non-agricultural price shocks				0.12**	0.086*	0.1**		0.11**
				(0.04)	(0.04)	(0.04)		(0.04)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Additional controls	No	No	No	No	No	No	Yes	Yes
Observations	1528	1153	1153	1528	1153	1153	953	953
No. of countries	80	75	75	80	75	75	66	66

Note: all control variables are lagged one year. Controls include: income (logs), economic growth, investment, government consumption and secondary schooling. Additional controls include: population (logs), fertility rate, openness, quality of institutions, and inflation (logs). The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

4.3.2.1 Results by world regions

Table 4.5 presents the results by regions to analyze whether splitting the sample changes our (fixed effects) results in column 6 of Table 4.4. Columns 1 to 4 examine whether the short-run effect of higher commodity price shocks on inequality differs between developing and developed countries for subsamples of non-OECD members (developing countries) and OECD members (developed countries). The results for the subsample of 56 non-OECD members are reported in Table 4.5, columns 1 and 2. There is a positive and significant coefficient for aggregated commodity price shocks, also the coefficient of the labor-intensive prices is negative while for capital-intensive prices is positive and significant at 5 percent. The results for the subsample of 22 OECD members are reported in Table 4.5, columns 3 and 4. Now the coefficient of the change in labor-intensive prices is positive while for capital-intensive prices is negative. These results indicate that the positive short-run effect of higher capital-intensive prices on inequality occurs only in resource-rich developing countries and not in resource-rich developed countries.

According to Figures 4.3 and 4.4 in section 4.3.1, the relationship between commodity price shocks and income inequality is different in SSA and LA than in rest of the world. Columns 5 and 6 consider SSA and LA while in columns 7 and 8 Europe, North America and Oceania are considered. As results show, there is only a positive and significant coefficient for non-agricultural price shocks in SSA and LA.

Table 4.5 Results by world regions

	Non- OECD		OECD		LA and SSA		EU, NAM and OC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in inequality (Gini coefficient)								
Commodity price shocks	0.06*		-0.12		0.05		-0.12	
	(0.03)		(0.09)		(0.04)		(0.08)	
Agricultural prices shocks		-0.15		0.18		-0.26*		-0.08
		(0.13)		(0.2)		(0.1)		(0.23)
Non-agricultural price shocks		0.13***		-0.34		0.14***		-0.15
		(0.03)		(0.24)		(0.03)		(0.23)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	714	714	439	439	493	493	440	440
No. of countries	53	53	22	22	38	38	22	22

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Overall results so far support the hypothesis that in developing countries especially in SSA and LA, a rise in non-agricultural commodity prices increases inequality. As mentioned before, SSA and LA show high levels of inequality and low levels of institutional quality. Table 4.6 explores the potential role of initial inequality levels and institutional quality in the impact of commodity prices shocks on the evolution of income inequality. Results show that commodity price shocks increase inequality controlling for a potential differential role in SSA and LA (column 1). Also, results show that commodity price shocks significantly increase inequality, only when initial inequality is already high (column 2). Similarly, the inequality-increasing effect of commodity price shocks is reduced in the presence of good institutions (column 5). Interestingly, the inclusion of initial inequality levels and quality of institutions makes the differential effect for SSA and LA to go non-significant. In other words, the inequality-increasing effect of commodity price shocks in SSA and LA may be explained by an initially high level of inequality and low institutional quality of countries in these two regions.

Table 4.6 The role of initial level of inequality and quality of institutions

	(1)	(2)	(3)	(4)	(5)
Dependent variable: the change in Inequality (Gini coefficient)					
Commodity price shocks	-0.05	-0.04	-0.3**	-0.37**	0.28
	(0.1)	(0.1)	(0.14)	(0.15)	(0.63)
Commodity price shocks*SSA_LA	0.11	0.1	-0.05	-0.08	-0.17
	(0.11)	(0.11)	(0.16)	(0.17)	(0.23)
Inequality		0.02*	0.02*	0.02**	0.02**
		(0.01)	(0.01)	(0.01)	(0.01)
Commodity price shocks * Inequality			0.008*	0.01**	0.01**
			(0.004)	(0.004)	(0.004)
Quality of Institutions				0.006	0.006
				(0.004)	(0.004)
Commodity price shocks * Quality of Institutions					-0.008
					(0.008)
Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes
Observations	1153	1153	1153	970	970
No. of countries	75	75	75	67	67

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

4.3.2.2 The opportunity cost and rapacity mechanisms

Table 4.7 analyses if different types of commodities affect inequality via different channels. Disaggregated commodity shocks should help to distinguish between rapacity and opportunity cost effects. Following Dube and Vargas (2013), we consider employ wage and capital tax. Table 4.7 present the results of estimating Equation (4.2). Columns 1 to 4 study the association between price shocks and wages (columns 1 and 2) and capital tax rents (columns 3 and 4), distinguishing price shocks by type of commodity: agricultural vs. non-agricultural. With respect to wages, results show a positive association with agricultural (labor-intensive) commodity price shocks but a negative with (capital-intensive) non-agricultural commodity price shocks (although coefficients are borderline significant). With respect to capital tax rent, we find the opposite: a negative association with agricultural commodity price shock and a positive with non-agricultural commodity price shocks. The results suggest the existence of two opposing effects: opportunity cost and rapacity effects, and are consistent with Dube and Vargas (2013). In columns 5 to 8, we focus on inequality. As expected, a rise in wages is found to decrease pay inequality (column 5). Moreover, results show that controlling by wages and capital rents, higher prices of capital-intensive (non-agricultural) commodities reduce pay inequality (columns 5 and 6)[52] but increase capital rents inequality (columns 7 and 8), in line with our theoretical framework.

[52] These results is in line with Goderis and Malone (2011) which they used manufacturing pay inequality as a measure of inequality and found that a rise in the prices of non-agricultural commodities lowers inequality in the short-run.

Table 4.7 The mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variables:	wage		capital tax rents		pay inequality		capital rents inequality	
wage					-0.05**	-0.05		
					(0.04)	(0.04)		
capital tax rents							0.005	0.002
							(0.01)	(0.22)
Agricultural prices shocks	0.05	0.24	-1.31	-0.79	0.77*	0.8	-0.89*	-0.87
	(0.36)	(0.33)	(1.01)	(0.91)	(0.4)	(0.55)	(0.48)	(0.52)
Non-agricultural price shocks	-0.09	-0.10	0.97	0.96	-0.32*	-0.41**	0.44**	0.52**
	(0.17)	(0.17)	(0.64)	(0.73)	(0.2)	(0.18)	(0.21)	(0.22)
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1760	1302	1096	887	895	895	727	618
No. of countries	80	77	67	63	60	60	50	47

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

4.4 Conclusions

Commodity price shocks play an important role in the process of economic development, as the panel results confirmed. In this regard, this chapter has analyzed how inequality is affected by commodity price shocks. Results find that capital-intensive price shocks significantly increase inequality. Results also find evidence on the relevance of differences across countries, in particular, related to the initial levels of inequality and institutional quality, on the relationship between commodity price shocks and income inequality. High inequality and low institutional quality is a common reality in many Sub-Saharan Africa and Latin American countries.

Building on Dube and Vargas (2013), this chapter has also studied potential mechanisms for commodity price shocks to affect the evolution of inequality. It has been argued and tested that agricultural (labor-intensive) price shocks increase wages (opportunity cost effect) while non-agricultural (capital-intensive) price shocks increase capital-tax revenues (rapacity effect). The existence of these two effects helps explain different effects of commodity price shocks depending on the type of inequality, where capital-intensive commodity price shocks significantly reduces pay inequality but increases capital rents inequality.

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Appendix

Table A.4.1 Variable names, definitions and sources

Main variables	Description	Source
Inequality (changes)	Income inequality measured by the Gini coefficient	SWIID v6.1 (Solt, 2016)
S_{it}	Commodity price shocks	Constructed with data from the IMF-IFS and from the UNCTSD (2017)-Comtrade
Conflict	Intentional homicide, Number of deaths purposely inflicted by another person, per 100,000 population	World Bank-World Development Indicators
Pay inequality (changes)	Calculate measures of industrial pay inequality and provides a wage inequality Theil measure.	UTIP-Unido
Capital rents inequality (changes)	The difference between income inequality and pay inequality	Our calculation
Wage (changes)	Wage and salaried workers, total (% of total employment)	World Bank-World Development Indicators
Capital tax rents (changes)	Taxes on income, profits and capital gains (% of total taxes)	World Bank-World Development Indicators
GDP per capita	Per capita GDP (in logs)	World Bank-World Development Indicators
Growth rate of GDP per capita	Cumulative annual average per capital GDP growth rate	World Bank-World Development Indicators
Institutions	The sum of the political risk components including Government stability, Socioeconomic conditions, Investment Profile, Internal conflict, External conflict, Corruption, Military in politics, Religious tensions, Law and Order, Ethnic tensions, Democratic accountability and Bureaucracy quality.	ICRG International Country Risk Guide
Investment	Investment share (%GDP)	World Bank-World Development Indicators
Government consumption	Government consumption (%GDP)	World Bank-World Development Indicators
Schooling	Gross enrolment ratio, secondary, both sexes (%)	World Bank-World Development Indicators
Population	Total population (in logs)	World Bank-World Development Indicators
Fertility	Fertility rate, total (births per woman)	World Bank-World Development Indicators
Openness	Trade openness, measured as the sum of exports and imports of goods and services (%GDP)	World Bank-World Development Indicators
Inflation	Inflation, consumer prices (annual %)	World Bank-World Development Indicators

Table A.4.2 Descriptive statistics

Variable	Obs.	No. of countries	Mean	Std.Dev.	Min	Max
Income inequality (changes)	1781	80	-0.011	0.42	-2.09	2.30
Commodity price shocks	1760	80	0.0215	0.2	-1.21	2.99
Agricultural commodity price shocks	1760	80	-0.0004	0.093	-0.76	0.83
Non-agricultural commodity price shocks	1760	80	0.014	0.15	-1.21	2.61
Conflict (changes)	947	73	-0.04	2.18	-14.9	36.2
Pay inequality (changes)	1101	66	0.07	1.45	-10.93	14.71
Capital rents inequality (changes)	1070	62	-0.02	1.32	-9.1	10.59
Wage (changes)	1975	79	0.23	1.13	-9.3	7.58
Capital tax rents (changes)	1243	66	0.15	4.08	-59.55	56.43
GDP per capita (logs)	2130	80	8.4	1.67	5.09	11.42
GDP per capita (growth)	2046	80	2.02	4.44	-67.80	36.98
investment	2084	80	22.66	7.78	0	61.46
Government consumption	2072	80	15.74	6.2	2.04	76.22
schooling	1642	79	75.43	34.08	5.21	163.93
population	2157	80	16.65	1.5	11.15	21.04
fertility	2160	80	3.25	1.81	0.91	7.72
openness	2108	80	75.7	55	0	442.62
institutions	1704	72	66.37	13.68	19.16	96.08
inflation	1975	80	1.72	1.41	-4.09	10.1

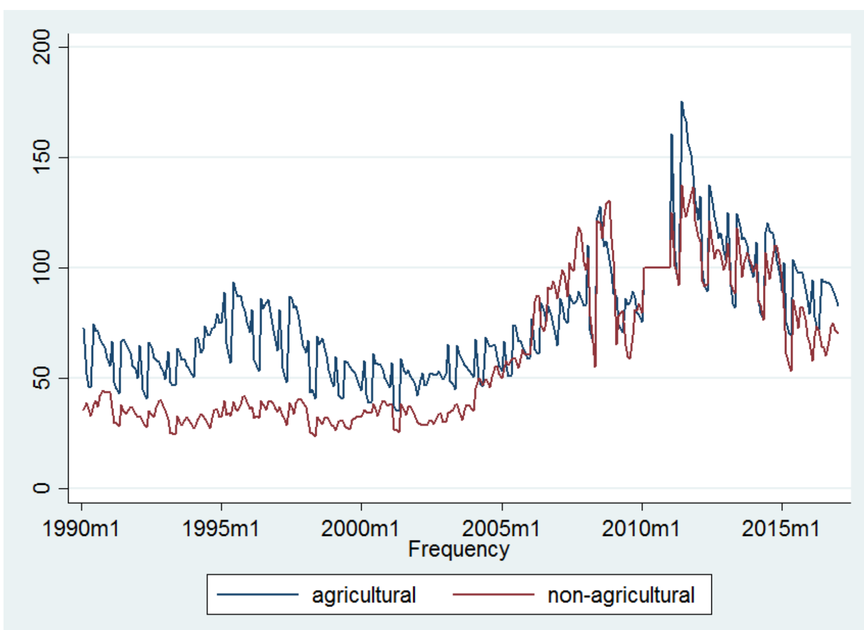
Table A.4.3 List of countries

1	Algeria	29	Honduras	57	Peru
2	Angola	30	Hong Kong	58	Philippines
3	Argentina	31	Hungary	59	Poland
4	Australia	32	India	60	Qatar
5	Belgium	33	Indonesia	61	Romania
6	Benin	34	Iran	62	Russia
7	Bolivia	35	Iraq	63	Rwanda
8	Brazil	36	Ireland	64	Senegal
9	Bulgaria	37	Italy	65	Singapore
10	Burkina Faso	38	Japan	66	South Africa
11	Burundi	39	Kazakhstan	67	Spain
12	Cameroon	40	Kenya	68	Sweden
13	Canada	41	Korea	69	Switzerland
14	Central African Republic	42	Lesotho	70	Thailand
15	Chile	43	Lithuania	71	Togo
16	China	44	Madagascar	72	Turkey
17	Colombia	45	Malawi	73	Uganda
18	Costa Rica	46	Malaysia	74	United Kingdom
19	Czech Republic	47	Mali	75	United States
20	Dominica	48	Mauritania	76	Uruguay
21	Ecuador	49	Mexico	77	Venezuela
22	Ethiopia	50	Netherlands	78	Viet Nam
23	France	51	New Zealand	79	Zambia
24	Gambia	52	Nicaragua	80	Zimbabwe
25	Germany	53	Niger		
26	Ghana	54	Nigeria		
27	Guinea	55	Norway		
28	Haiti	56	Paraguay		

Table A.4.4 List of Commodities

Non-Agricultural		
Oil	Zinc	Nickel
Natural Gas	Aluminum	Diamond
Coal	Iron	Lead
Gold	Copper	
Silver	Tin	
Agricultural		
Coffee	Cotton	Rubber
Banana	Wool	
Wheat	Wood	

Figure A.4.1 The monthly evolution of commodity prices



Note: the commodity price index 2010=100

Table A.4.5 The average rate of inequality and quality of institutions in different regions of the sample

	inequality	institutions
Asia	39.8	68.42
Europe	30.45	78.09
Latin America	**45.92**	**63.28**
Middle East	38.84	57.18
North America	33.51	83.55
Oceania	32.16	85.23
Sub-Saharan Africa	**41.04**	**55.98**
Total	38.62	66.37

Table A.4.6 Conflict and commodity price shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in conflict (intentional homicides)								
Income Inequality							0.53	0.52
							(0.48)	(0.48)
Commodity price shocks	-0.55**	-0.51**	-0.25				-0.32	
	(0.25)	(0.26)	(0.22)				(0.22)	
Agricultural price shocks				-1.7**	-0.96	-0.83		-0.71
				(0.77)	(0.74)	(1.23)		(1.24)
Non-agricultural price shocks				-0.2	-0.39	-0.08		-0.19
				(0.34)	(0.3)	(0.34)		(0.35)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Observations	947	796	766	947	796	796	766	766
Number of countries	73	65	65	73	65	65	61	61

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. Additional controls include: population (logs), fertility rate, openness, quality of institutions, and inflation (logs). The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Table A.4.7 The coefficients of Table 4.4 (controls)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in Inequality (Gini coefficient)								
Commodity price shocks	0.09**	0.07**	0.03				0.04	
	(0.03)	(0.03)	(0.04)				(0.05)	
Agricultural price shocks				0.006	0.022	-0.14		-0.17
				(0.11)	(0.12)	(0.1)		(0.11)
Non-agricultural price shocks				0.12**	0.08*	0.1**		0.1**
				(0.04)	(0.04)	(0.04)		(0.04)
Log (income)		0.04**	-0.11		0.04**	-0.1	-0.11	-0.09
		(0.01)	(0.23)		(0.01)	(0.23)	(0.2)	(0.26)
Economic growth		0.004	-0.003**		0.004	-0.003	-0.002	-0.002
		(0.003)	(0.004)		(0.003)	(0.004)	(0.004)	(0.004)
investment		0.0001	-0.003		0.00009	-0.003	-0.003	-0.003
		(0.01)	(0.004)		(0.001)	(0.004)	(0.004)	(0.004)
Government spending		0.008**	0.01**		0.008**	0.01**	0.009	0.01
		(0.002)	(0.006)		(0.002)	(0.006)	(0.007)	(0.007)
Schooling		-0.0005	-0.003*		-0.0005	-0.003*	-0.005	-0.005
		(0.0007)	(0.002)		(0.0007)	(0.002)	(0.002)	(0.002)
Total population							0.51	0.49
							(0.33)	(0.32)
Fertility							0.2**	0.2*
							(0.1)	(0.1)
Openness							-0.001	-0.001
							(0.001)	(0.001)
Quality of Institutions							0.03**	0.03**
							(0.01)	(0.01)
inflation							-0.01	-0.01
							(0.03)	(0.03)
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Observations	1528	1153	1153	1528	1153	1153	969	969
Number of countries	80	75	75	80	55	78	67	67

Table A.4.8 Controlling for inequality in levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in Inequality (Gini coefficient)								
Inequality $_{t-1}$	-0.007***	0.008***	-0.02*	-0.007***	-0.008***	-0.02*	-0.02*	-0.02**
	(0.001)	(0.001)	(0.01)	(0.001)	(0.001)	(0.01)	(0.01)	(0.01)
Commodity price shocks	0.1**	0.09**	0.03				0.04	
	(0.03)	(0.04)	(0.04)				(0.05)	
Agricultural price shocks				0.006	-0.01	-0.13		-0.2
				(0.11)	(0.12)	(0.1)		(0.12)
Non-agricultural price shocks				0.14**	0.12**	0.1**		0.12**
				(0.04)	(0.05)	(0.04)		(0.04)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Additional controls	No	No	No	No	No	No	Yes	Yes
Observations	1528	1153	1153	1528	1153	1153	953	953
Number of countries	80	75	75	80	75	75	66	66

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. Additional controls include: population (logs), fertility rate, openness, quality of institutions, and inflation (logs). The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Table A.4.9 Inequality in levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Inequality in levels (Gini coefficient)								
Commodity price shocks	1.72	2.14	0.14				0.23	
	(1.41)	(1.58)	(0.39)				(0.41)	
Agricultural price shocks				-1.83	-4.09**	0.03		-0.73
				(1.69)	(1.93)	(0.7)		(0.6)
Non-agricultural price shocks				3.07	4.27**	0.19		0.52
				(1.86)	(1.96)	(0.6)		(0.58)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Additional controls	No	No	No	No	No	No	Yes	Yes
Observations	1539	1159	1159	1539	1159	1159	958	958
Number of countries	80	76	76	80	76	76	67	67

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. Additional controls include: population (logs), fertility rate, openness, quality of institutions, and inflation (logs). The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Table A.4.10 3-year commodity price shocks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: the change in Inequality (Gini coefficient)								
3-year commodity price shock	0.19***	0.14**	0.04				0.05	
	(0.05)	(0.05)	(0.07)				(0.08)	
3-year agricultural price shock				0.11	0.08	-0.26		-0.38**
				(0.1)	(0.1)	(0.19)		(0.19)
3-year non-agricultural price shock				0.21**	0.15**	0.14*		0.19**
				(0.06)	(0.06)	(0.08)		(0.07)
Controls	No	Yes	Yes	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	No	Yes	Yes	Yes
Country FE	No	No	Yes	No	No	Yes	Yes	Yes
Additional controls	No	No	No	No	No	No	Yes	Yes
Observations	1613	1205	1205	1613	1205	1205	1034	1034
Number of countries	80	75	75	80	75	75	66	66

Note: all control variables are lagged one year. Controls include: Income (logs), economic growth, investment, government consumption and secondary schooling. Additional controls include: population (logs), fertility rate, openness, quality of institutions, and inflation (logs). The time span goes from 1990 to 2016. All estimations are done with multiple-estimation regressions (100 imputations). Robust standard errors (clustered by country) in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Chapter 5

Conclusions

"The first lesson of economics is scarcity: There is never enough of anything to satisfy all those who want it. The first lesson of politics is to disregard the first lesson of economics."

Thomas Sowell (1930-…)

This dissertation has examined the relationship between natural resources, economic development and political institutions from different perspectives. First, it has confirmed the existence of institutional quality thresholds in the relationship between oil and gas rents and different educational indicators (Chapter 2). Second, it has shown that the negative association between total resource rents and quality-adjusted human capital can be reversed if quality of institutions is high enough (Chapter 3). And finally, it has provided evidence on how non-agricultural commodity price shocks increase income inequality in contexts of low institutional development, like Latin America and Sub-Saharan Africa (Chapter 4). This concluding chapter summarizes the main findings of the three studies implemented and the implications gathered from all of them.

Over these three chapters, the research work delved into questions like: *are natural resources a blessing or curse for economic development? What is the role of institutions in the resource rents-human capital relationship? Why do some countries benefit and others lose from the presence of natural resources? Do the effects of commodity price shocks can also influence income distribution? If yes, which regions of the world have experienced effects on their income distribution from commodity price shocks?* Hopefully, the results obtained in this thesis can provide some hints help answer these questions.

The importance of natural resources and its effects on economic development has received an increasing attention during the last years. The debate on whether natural resources are a blessing or curse has often emerged as point of divergence among economists. Chapter 2 finds that oil and gas rents are negatively associated with different indicators of education over the period 1996-2013. The empirical results also suggest that a better institutional environment allows us to exploit the benefits of resource rents on education. By contrast, low quality of institutions tends to distort the ability of resource rents to channel resources to macroeconomic productive activities efficiently (in line with Bulte et al, 2005). Furthermore, the results suggest the existence of institutional quality thresholds in the relationship between resource rents and education. Meaning that countries with quality of institutions above the threshold level are mainly developed economics which are succeed in managing natural resource revenues.

In Chapter 3 the focus turned to the resource rents impacts on quality and quantity of human capital. It considered all countries blessing from natural resources in a panel data model. This analysis emphasizes the crucial role of political institutions and shows that the negative impact of resource rents can be reversed if the quality of institutions is high enough. Additionally, the results suggest that the negative impacts of resource rents stems basically from oil rents which according to the evolution of resource rents over time in our sample, oil rents have constituted the larger share of GDP compared to other types of resource rents. Also, resource rents mitigate both education and health either simultaneously (QAHC) or independently. Undoubtedly, more resource rents require better quality of institutions to avoid the curse of human capital. Specifically, the overall institutional threshold for average of all indicators is 0.47. In other words, in 72 countries of the sample because of higher institutional level, resource rents increase human capital, while in the rest of 90 countries because of lower levels of institutional quality, resource rents decrease human capital. This result indicating that institutional quality indeed can make a difference for the impact of natural resources on human capital especially in oil-rich countries.

Finally, Chapter 4 assessed the distributional income impact of resource booms. It considered commodity price shocks for 80 developed and developing countries from 1990 to 2016. The results of the analysis confirm the significant positive impact of non-agricultural price shocks on inequality. According to the estimations, countries with stronger inequality-increasing effects from non-agricultural price shocks are those with already higher initial levels of inequality and lower initial levels of institutional quality (mainly countries in Latin America and Sub-Saharan Africa). Chapter 4 also highlights the different channels through which shocks driven by different types of commodity affect inequality. The results also indicate that the capital-intensive (non-agricultural commodities) price shocks significantly increases capital rents inequality through increasing capital tax revenues.

Results bear some significant policy implications, particularly when thinking about the impact of natural resource revenues on economic performances, either in developed or developing countries. First, there are reasons to contend claims about the improvement of quality effectiveness of political institutions specifically in developing countries. In these countries, policy is oriented to expand access to natural resource revenues from national budget. Therefore, weak quality of institutions usually associated with corrupted behavior might leads to inefficient spending patterns. Hence, there seems to be an appropriate reason to separate natural resource rents specifically oil revenues from the budget account and incentivize the commitment to spend these rents only on productive investments, as some developed countries have done. Second, according to our results, abundance of natural resource rents has negative impact on the accumulation of human capital. Thus, improving social outcomes such as education and health and investing in expert, committed and pragmatic human resources may help resource-rich countries to advance their economic development. In total, all these policy implications share a common aspect. Hence, building up a virtuous cycle between efficiency and investing levels, getting a more productive human resource and limiting the political use of resource revenues, are finally linked to a better quality of government institutions. In this regards, all policy proposals made in this study must be carried out as a way of boosting transparency and accountability in the management of natural resource revenues.

There are limitations in the research carried out this thesis. These limitations help us identify future research lines. In order to improve the research about the natural resource endogeneity and its effect on political institutions, we could consider exogenous discovery of natural resources. Because the quality of institutions may deteriorate as a result of natural resource discovery, suggesting that even countries with relatively good institutions are not necessarily immune to the adverse effects of resource discovery (see for example, Van der Ploeg and Poelhekke, 2017). Another limitation is regarding to propose an instrumental variable for institutional indicators. Future work needs to carefully determine an appropriate instrumental variable in panel data analysis. Moreover, country fixed effects needs to be considered cautiously even if institutional indicators have small within variations. In addition, we have seen that the positive impact of commodity price shocks on inequality is more intense in Latin America and Sub-Saharan Africa. This may be explained by higher initial levels of inequality and lower initial levels of institutional quality in these countries. So in this regards, we needs to clearly explore why in these countries commodity price shocks increase inequality.

There is still a lot we do not know about the resource curse - the resource curse can take place at multiple levels (at the country, regional or local level) or many of its effects can not directly be quantifiable for instance the impacts of social and cultural impact (see for example; Gilberthorpe and Rajak, 2017). Future research needs to consider heterogeneity attentively across countries taking into account the different contexts. And also explore more deeply the different mechanisms of the resource curse such as labor market, quality of institutions, etc.

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