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Document de Travail
Working Paper
2015-35

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On the Quest of Resource blessing: Re-examining the effect of oil on Income Inequality

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Résumé:

Cet article mets en évidence l'influence de la rente pétrolière sur les inégalités en faisant usage d'un échantillon de 52 pays développés et en développement sur la période 1984-2008. Après prise en compte des questions d'endogeneité, l'analyse mène à trois principaux résultats : (1) l'effet de la rente pétrolière sur les inégalités est non-linéaire. La rente pétrolière induit une réduction de l'inégalité pour les pays dans lesquels la valeur de la rente en pourcentage du PIB est en dessous du seuil de 25%. Au-delà de ce seuil, on observe une relation positive. (2) L'effet de la rente dépend de la qualité des institutions. De manière spécifique, la diminution de l'inégalité est moindre dans les pays à niveau élevé de corruption, à faible niveau de transparence et à qualité de régulation faible. (3) Enfin, l'étude montre que la relation entre la rente pétrolière et les inégalités est dépendante de l'horizon temporel. Ainsi à court terme, on observe un effet négatif sur les inégalités, tandis qu'à long terme l'effet est positif.

Mots Clés: Rente pétrolière, Inégalité, qualité institutionnelle

Abstract

This paper provides new insights into how oil rent affects income inequality in 52 developed and developing economies over the period 1984-2008. After taking into consideration the endogeneity aspect, the analysis yields three key findings. First, the effect of oil rent on income inequality is non-linear. Oil productivity wealth induces a decline in income inequality for countries for which the share of oil rent in percentage of GDP is below the threshold of 25%. Above this threshold, we document a positive relationship. Second, the effect of oil rent is heterogeneous across countries, depending upon the institutional quality. Specifically, we find that the decline in income inequality is lower in countries with high corruption, low accountability and weak regulatory quality. Finally, we uncover a time-dependent relationship between oil rent and income inequality. In the short run, the effect of oil rent is negative while in the long run, the opposite is observed.

Key words: Oil rent, Inequality, institutional quality

1. Introduction

The conventional wisdom suggests that oil wealth must promote economic development. However, an abundant literature of many decades has highlighted the paradox of resources-rich countries being kept in extreme poverty. While several studies have questioned the relationship between oil wealth and economic growth, little has been unveiled concerning its effect on income inequality. The literature is even scarcer concerning the potential non-linear effect and the time horizon impact of oil rent.

Since its first appearance in the English newspaper *The Economist* in 1977, the Dutch disease phenomenon has been analyzed in various ways, leading to abundant literature devoted to what is known as the resource curse theory. The existence of the resource curse has been extensively tested in the empirical literature. Using a sample of developing countries, Sachs and Warner (1997) find a negative effect of natural resources on GDP growth. Likewise, Auty (2001a) finds that between 1960 and 1990, the per capita income of resource-poor countries grew faster than the resource-rich countries. These findings have been challenged by other studies. For example, Alexeev and Conrad (2009) provide an evidence of a positive effect of oil abundance on economic growth. Recently, Van Der Ploeg (2011) argued that the negative correlation between oil abundance and economic growth may merely be picking up cross country variation in per capita income.

From this general viewpoint, several papers have addressed the relationship between oil rent and inequality. The widespread view drawn from this literature argues that abundance of resource tends to increase income inequality. Leamer et al. (1999) emphasized that by absorbing a natural-resource-rich country's saving, resource extraction delays the emergence of capital-intensive-manufacturing which requires significant accumulation of human capital. As a result, resource-rich economies may experience higher income inequality compared to resource-scarce economies. According to Gylfason and Zoega (2003), resource dependence leads to both low growth and increased inequality, which could therefore explain the inverse relationship between growth and inequality in cross-country data.

Beside this skeptical view, some authors point out that the effect of resource rent on income inequality may be rather mixed. Ross (2007) argues that the effect of natural resource on inequality can be either positive or negative. Negatively, natural resource boom may trigger a shift in export from traditional sector (agriculture and manufacturing) to the oil sector, leading to a shift in the composition of labor force. If the labor mobility across sectors is limited, one could observe a rise in unemployment and income inequality. Positively, by generating new government jobs that are funded by natural resource revenues, resource abundance may reduce income inequality. Recently, Goderis and Malone (2011) show that the effect of natural resource abundance on inequality differs both in the short and long run. . Accordingly, income inequality will fall in the short run or immediately after the boom and will increase steadily over time as the economy grows, until the initial impact of the boom on inequality disappears. They consider a two-sector growth model, in which learning-by-doing drives growth, to explain the time path of inequality following a resource boom. They assume perfect factor mobility and two main sources of changes in income inequality during resource booms: the unequal distribution of resource income and the shift of the factors of production to the non-traded sector, which uses unskilled labor intensively relative to the traded sector, due to the spending effect related to the resource income. Based on these assumptions, Goderis and Malone (2011) demonstrate that in the short term, the oil boom induces a fall in the Gini coefficient of total income only if the share of unskilled labor in the non-traded sector exceeds the share of unskilled labor in the traded sector and the income inequality in the non-resource sector is above that of the resource (oil) sector. In the long run, the assumption of constant total factor productivity is relaxed. The rate of productivity growth in each sector is determined by the effects of learning-by-doing (LBD) in both sectors, with the possibility of knowledge spillovers. They demonstrate that under the condition of balanced growth, there is no long-run effect of resource booms on income inequality.

This paper builds upon Goderis and Malone (2011) who show that the impact of natural resource on income inequality depends on if we consider the short or long term. . However, our approach is different in a number of ways. First, using an instrumental variable approach, we investigate the causal effect of oil rent on income inequality on a sample of 52 countries during the period 1984-2008. Following Cotet and Tsui (2013); Ebeke et al (2015), we use the variation in the value of oil reserve (product of oil prices and oil reserves) as a source of exogenous change in oil rent. Assuming that the size of oil reserves is not endogenous to income inequality, an unexpected change in oil prices leads to an exogenous variation in oil rent. As an alternative approach, we infer a causal effect of oil wealth by using the induced change in oil rent caused by natural disasters that occurred in regions other than those of the oil producer. Second, relying on the same instrumental variable framework, we provide evidence of a non-monotonic effect of oil rent on income inequality. Third, we allow the effect on oil rent on inequality to differ depending on the quality of institutions. Finally, we use Jordà's (2005) local projection technique to assess the time-horizon effect of oil rent on inequality.

Three main findings emerge from this analysis. The effect of oil rent on income inequality is non-linear. The lower regime is characterized by a negative impact of oil rent while the upper regime shows a positive relationship. Next, the decline in income inequality driven by the rise of oil revenues is low in countries with poor institutional quality. Finally, the relationship between oil rent and inequality depends on time. In the short run, the effect of oil rent is negative while the opposite is observed in the long run.

The rest of the paper is organized as follows: Section 2 presents the estimation framework and data. The econometric results are presented in Section 3. Section 4 concludes and draws policy implications.

2-Estimation framework and data

In this paper, we test three main hypotheses: (1) Oil rent has a non-linear effect on inequality. (2) The effect of oil rent on inequality is conditional to the quality of governance. (3) In the short run oil rent reduces inequality while the opposite effect occurs in the long run. For this reason, this section focuses on the methodology and describes the data used.

2.1. Estimation framework

Drawing on the specifications of Goderis and Malone (2011) and Carmignani (2013), we consider the following baseline econometric model:

$$Inequality_{it} = \beta Oil_{it} + X_{it}\gamma + \delta_i + \varepsilon_{it} \qquad (1)$$

In (1), $Inequality_{it}$ is the measure of income inequality in country i at time t. Oil_{it} is oil rent as a percentage of GDP for the country i at time t. X is the matrix of control variables used in the literature on inequality (Goderis and Malone, 2011; Gylfason and Zoega, 2003). This includes democracy as a measure of the quality of institutions, education, the logarithm of real GDP per capita, trade openness, inflation and the agriculture value added. Equation (1) will be further augmented with the squared of oil to account for the possible non-linear effect of oil rent. In fact, oil rent may have different impact on inequality, depending on the level of oil abundance. For instance, less endowed countries may make a better redistribution of oil revenues and end up with lower inequality while countries with higher oil windfall might be more prone to rent seeking behavior and fail to reduce inequality. As an illustration, Nigeria, Africa's largest oil producer has witnessed an increase in income inequality since the beginning of oil exploitation whereas country like Malaysia has taped into its oil wealth to reduce inequality. Likewise, researchers have suggested that the difference in term of economic performance observed among natural resources rich countries may be explained by a difference in institutional quality (Sokoloff and Engerman, 2000; Ebeke et al, 2015). Therefore, to test the effect of oil rent conditional to the quality of institution, we add to the model an interaction between oil rent and a measure of the quality of governance. Finally, we modify equation (1) to allow the analysis of both short and long term dynamic of the relationship between oil rent and inequality. We therefore reexamine the early finding of Goderis and Malone (2011) according to which oil windfall lowers inequality in the short run while its exacerbates inequality in the long run[1].

2.2. Data description and sources

In order to analyze the relationship between oil rent and inequality, we use a recent and comprehensive data on inequality and oil revenues.

Income inequality is measured by the Gini coefficient and is obtained from the Standardized World Income Inequality Database (SWIID). We used the SWIID version 5.0 released in October 2014 (Solt, 2014). The SWIID appropriately addresses the trade-off between coverage and comparability by combining information from various sources including the Luxembourg Income Study (LIS), the United Nations University World Institute for Development Economics Research (UNU-WIDER) World Income Inequality Database (WIID), the World Top Income database and the University of Texas Inequality Project. The SWIID provides data on Gini index for 174 countries for the period 1960-2014.

Oil rent as a percentage of GDP is our measure of oil wealth. It is drawn from the World Development Indicator (World Bank, 2011a, b) and computed as the difference between the value of crude oil production at world prices and the total costs of production. This measure is chosen as an alternative to the measure used in the literature (oil exports in percentage of total export, oil export in percentage of GDP) because it captures appropriately the effect of rent on individual's behavior rather than those who might be potentially caused by a distortion in the structure of export (Rosser, 2006; Ebeke et al, 2015). Moreover, the larger country and time coverage of these data help to avoid selection bias (Ebeke et al, 2015).

Following the literature (Goderis and Malone, 2011; Carmignani, 2013), we include in regression as determinants of income inequality, democracy, education, the logarithm of real GDP per capita, trade openness, inflation and the agriculture value added. Democracy is

[1] Note that the sample of countries used by Goderis and Malone (2011) doesn't include major oil exporter such as Nigeria, Oman and Saudi Arabia, which are included in our analysis.

measured by the variable Polity2 from the Polity4 project. This variable ranges between -10 (strongly autocratic) to 10 (strongly democratic). Democracy encourages institutional changes that favor more equal distribution of income. Therefore, we expect a negative effect of democracy measure on income inequality. Higher income inequality is also associated with lower level of education. Higher level of education increases the supply of skilled labor and reduces income inequality (Goderis and Malone, 2011). Education is measured as the total number of combined years of education in the primary and secondary level as obtained from the Barro and Lee (2010). As suggested in the early work of Kuznet (1955), the level of economic development can shape income inequality in a non-linear way. Specifically, as the economy grows, labor force moves from low paid sectors such as agriculture to higher income sector like industry. This structural change may increase inequality in the short run while in the long run, the relative wage in low paid sectors increases, leading to a fall in inequality. Consequently, the expected effect of GDP is ambiguous. Data on real GDP are from the World Development Indicator (World Bank, 2011a). The Hecksher-Ohlin theory suggests that trade openness will shift income toward the factor in which the country is abundant. As a result of that, we should expect a reduction of income inequality in developing countries resulting from the increase in demand of unskilled labor. The opposite effect can be obtained in developed countries. Since our sample consist of developed and developing countries, the expected effect of trade openness on inequality is ambiguous. Inflation is expected to have a positive effect on inequality because low income households are the most vulnerable to the change in the price level. Finally, the rise in the agricultural value added may increase the relative wage in the agriculture and therefore reduce income inequality. Data on trade openness, inflation and agricultural value added are obtained from the World Development Indicator (World Bank, 2011). The analysis covers 52 countries for the period 1984-2008. This choice is mainly based on the data availability of income inequality, controls variables and the instruments that are later used in regression. We also restrict the analysis to this sample to facilitate the comparability across specifications. We test the stationnarity of the variables by reverting to two Fisher type panel unit root tests: the Augmented Dickey Fuller test and the Phillips-Perron test. The null hypothesis of the test is that all panels contain a unit root while the alternative is that at least one panel is stationary. These two tests are chosen over the other well-known tests such as Levin, Lin and Chu (2002), Hadri (2000) or Breintung and Das (2005) for two main reasons. First, unlike the previous ones which make the assumption that all the panels share the same autoregressive parameter, the Fisher type tests allow the autoregressive parameter to be country specific. Second, the tests are easy to implement since they do not require the panels to be strongly balanced. This is particularly suitable in our context because the panel is not balanced and there are gaps in the data. The results of the tests are presented in Table B in appendix. The findings are not conclusive and differ across the tests and depending on the statistics used. Therefore we proceed with the standard regression models while controlling for time fixed effect in all specifications. Moreover, we check the robustness of the results by using local projection and an error correction model later in the paper[2]. Descriptive statistics of the variables used in the econometric model are presented in Table 1.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Oil rent-to-GDP ratio	985	4.294632	7.380244	0	73.33231
Income inequality-Gini Index	985	38.73536	8.871076	21.8	65.33765
Value of oil reserves	985	8.16e+07	6.63e+08	.1151805	1.31e+10
Crude oil price usd1990	985	56.56929	27.00741	25.41454	147.128
Oil reserves in thousand barrels	985	785703.1	5775532	.0022566	8.96e+07
Democracy-Polity4	985	4.595939	6.404964	-9	10
Number of years of education	985	7.220974	2.606277	1.792562	12.91048
Log of GDP per capita	985	8.306258	1.452777	5.722038	11.14323
Trade openness	985	59.21639	33.575	11.06143	224.7984
Inflation	985	0.4076579	2.892718	-.2629999	62.6124
Agricultural value added-to GDP-ratio	985	12.21835	9.843674	0.4892358	51.90365
Ratio of girls to boys in primary and secondary education	709	95.19547	10.08352	46.187	110.419
Corruption	324	0.4636574	0.2424018	0.0081116	0.8888883
Governance effectiveness	324	0.3788969	0.1933716	0.0149724	0.724401
Political stability	324	0.3322203	0.187477	0	0.7752079
Regulatory quality	324	0.3453462	0.1821892	0.034747	0.8065092

3- Initial evidence and estimation results

This Section begins with a visual analysis and fixed effect estimate of the relationship between oil rent and inequality. Next, we address the potential endogeneity of oil rent by resorting to an instrumental variable approach. Finally, we perform several robustness checks

[2] Note that in the local projection approach, the variables enter the model in first différence. Therefore the approach clearly deals with the issue of non stationnarity.

which include testing both the conditional and non-monotonic effect of oil rent as well as the short and long term dynamics.

3.1. Visual evidence and OLS fixed effect estimates

Figure 1 illustrates the positive cross country correlation between oil rent and inequality over the period 1984-2008. The measures of oil rent and income inequality are computed as the residuals of the regression of these variables on the control variables. This approach prevails in the literature and provides measures of oil rent and inequality that are purged from any collinearity with the standards determinants of inequality (Cotet and Tsui, 2013; Ebeke et al, 2015).

The observed positive correlation suggests that oil-rich countries are more likely to witness an increase in income inequality.

Table 2: OLS-Fixed effect estimates of the effect of oil rent on income inequality

Dependent variable:Income inequality-Gini	(2)	(3)
Oil rent-to-GDP ratio	**-0.0977*** **	**-0.0906*** **
	(0.0254)	**(0.0174)**
Democracy-Polity4	0.00895	-0.00141
	(0.0265)	(0.0252)
Number of year of education(Primary+secondary)	-1.551	-4.047***
	(0.986)	(1.063)
Log of GDP per capita	1.215*	1.055*
	(0.621)	(0.567)
Trade openness	-0.00127	-0.00511
	(0.00693)	(0.00994)
Inflation-GDP deflator	0.0343**	0.0454***
	(0.0135)	(0.0126)
Value added-Agriculture	-0.163***	-0.137***
	(0.0452)	(0.0421)
Time fixed effects	No	Yes
Constant	34.03***	39.32***
	(4.239)	(3.594)
Observations	985	985
R-squared	0.277	0.277
Number of groups	53	53

Note: Standards errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 2 presents the results of the country fixed effect estimation of the effect of oil rent on income inequality. The table has two columns. The first column reports the estimates of the baseline model without time effect. According to the results, oil rent negatively and significantly impact income inequality. Column (2) reports the estimates while controlling for time fixed effects. Adding time fixed effects allow to control for any change in inequality that may be explained by overall time trend. The negative correlation between oil rent and inequality is confirmed. This result suggests that once we control for fixed effect, the effect of oil rent on inequality become negative and the magnitude is smaller. Hence, a one unit increase in oil rent in percentage of GDP reduces income inequality by 0.09 percentage point. A possible interpretation of this finding may be related to a country specific (unobserved) heterogeneity in the management of oil resources.

3.2. Instrumental variable estimates

While analyzing the relationship between oil wealth and income inequality, we should care about the potential endogeneity of our variable of interest. For instance, oil rent may be subject to measurement error due to possible mismeasurement in the valuation of production costs. This can lead to attenuation bias if the measurement error is not random or systematic over time. Moreover, oil rent may be correlated with some unobserved potential determinants of income inequality. For example, oil rent may be correlated with natural resources endowment which in turn can shape income inequality. Finally, there is also a possible reverse causality in the sense that policy makers or the elite that are the main beneficiaries of the oil industry might be more willing to tape into the existing resources to consolidate their position of power. In order to tackle the endogeneity of oil rents, we follow the literature (Cotet and Tsui, 2013; Ebeke et al, 2015) and exploit changes in oil reserves as a source of exogenous variation of oil rent. Specifically, we use two main instruments. The first instrument is the value of oil reserves measured as the product of oil prices and oil reserves. The idea behind the choice of this instrument is that the higher is the value of oil reserves, the higher should be the expected oil rent. One may question the quality of this instrument since oil prices is likely to affect income inequality through inflation. However, because we control for the inflation, we ensure that the effect of the instrument on inequality occurs only through the change in the level of oil rent[3]. The second instrument is the product of the out of region disaster and oil reserves (Cotet and Tsui, 2013). This variable measures the value of natural disaster damages for oil producing countries. Specifically, it intends to capture the induced change in oil rent caused by natural disasters that occurred in regions other than the region of

[3] This is also true for the potential impact of oil price on trade because we control for trade openness in the regression.

the oil producer. Cotet and Tsui (2013) consider five types of natural disasters (earthquake, volcano, mass movement, flows and storms) and define the out of region disaster as the difference between the value of all disaster damages and the value of own region damages.

Table 3 presents the results of the instrumental variable estimates of the effect of oil rent on income inequality. We test three main specifications. For the first one (Columns 1 & 3), we report estimates using only the value of oil reserves as the instrument. Column (1) presents the estimates with country fixed effect, but without time effect. Column (2) reports the results with both country and time fixed effect. In both cases, oil rent has a negative and significant effect on income inequality. However, the magnitude of the effect is higher when time fixed effect is added to the model. Turning to validity of the instrument, the Fisher statistics of weak identification test stands respectively at 50.19 and 73.42 and are far above the Stock & Yogo (2005) critical values (24.09 at the 5% level of significance). Hence, the instrument used is not weak. In regards to the second specification, we use value of natural disaster damages for oil producing countries as an instrument. Columns 2 & 4 show that the results are qualitatively similar. In addition, the instrument performs quite well. Finally, we use the two instruments in the same regression. This approach improves our identification strategy and allows testing the validity of the instruments.

The results are reported in columns (5) & (6) and show that the negative effect of oil rent remains robust. The Hansen over-identification statistic suggests that the null hypothesis of the orthogonality between instruments and the error term cannot be rejected. Based on this specification, a one unit increase in oil rent in percentage of GDP leads to 0.35 percentage point fall in income inequality.

3.3. Assessing the non-linear effect of oil rent on income inequality

In the previous sections, we carried out the analysis assuming a linear relationship between oil rent and income inequality. However, it is likely that the effect of oil rent on income inequality may vary across countries, depending on the level oil dependence. High dependence on oil may hinder government effectiveness, leading to low effectiveness of public spending and uneven distribution of oil windfall. We augment the specification (1) with the squared of oil rent in percentage of GDP.

$$Inequality_{it} = \beta Oil_{it} + \alpha Oil_{it}^2 + X_{it}\gamma + \delta_i + \varepsilon_{it} \quad (2)$$

In this specification, we expect $\beta < 0$ and $\alpha > 0$. In other words, below a certain threshold, oil rent is expected to negatively impact income inequality while above this threshold, the relationship is positive.

Table 3: 2SLS estimates of the effect of oil rent on income inequality

Dependent variable: Income inequality-Gini	(1)	(2)	(3)	(4)	(5)	(6)
Oil rent-to-GDP ratio	**-0.279*** **	**-0.281*** **	**-0.341* **	**-0.319* **	**-0.284*** **	**-0.359*** **
	(0.063)	**(0.066)**	**(0.176)**	**(0.188)**	**(0.067)**	**(0.123)**
Democracy-Polity4	-0.005	-0.005	-0.007	-0.006	-0.005	-0.007
	(0.030)	(0.030)	(0.033)	(0.032)	(0.026)	(0.028)
Number of year of education(Primary+secondary)	-1.133	-1.130	-3.699***	-3.730***	-1.122	-3.674***
	(1.130)	(1.122)	(0.962)	(0.949)	(0.791)	(1.131)
Log of GDP per capita	0.639	0.634	-0.081	0.020	0.624	-0.161
	(0.684)	(0.682)	(1.077)	(1.091)	(0.750)	(1.055)
Trade openness	-0.002	-0.002	-0.009	-0.009	-0.002	-0.009
	(0.007)	(0.007)	(0.010)	(0.011)	(0.008)	(0.008)
Inflation-GDP deflator	0.039***	0.039***	0.046***	0.046***	0.039***	0.046***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.012)	(0.013)
Value added-Agriculture	-0.207***	-0.207***	-0.193***	-0.188***	-0.208***	-0.197***
	(0.047)	(0.048)	(0.067)	(0.069)	(0.040)	(0.048)
First step equation						
	Oil rent	**Oil rent**	**Oil rent**	**Oil rent**	**Oil rent**	**Oil rent**
Log of value of oil reserves	0.254***		0.216***		-0.243*	-0.043
	(0.036)		(0.025)		(0.144)	(0.311)
Log(Out of region disaster)*log(Oil reserves)		0.227***		0.212***	0.264***	0.216***
		(0.037)		(0.026)	(0.029)	(0.031)
Country Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time Dummies	No	No	Yes	Yes	No	Yes
N	985	985	985	985	984	984
No of countries	52	52	52	52	52	52
F-stat for weak ident.	50.191	38.088	73.424	66.057	41.096	23.616
Hansen J test					0.712	0.1285

Note: Standards errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Table 4 reports the 2SLS estimates of the equation (2). We use the same instruments as those previously mentioned for oil rent and the squared of these instruments as source of exogenous variation for the square of oil rent. Column (1) presents the estimates using the value of natural disaster damages for oil producing countries as an instrument. Column (2) reports the estimates using the value of oil reserve as instrument and the third column shows the results using the two set of instruments. Irrespective of the specification used and the type of instrument, the assumption of a non-linear effect of oil rent on income inequality is supported by data. In fact, oil rent negatively affects income inequality until a certain threshold above which the relationship become positive.

Figure 2 depicts the predictive marginal effect of oil rent with 95% confidence interval. The threshold above which the nature of the relation changes is computed as follow:$Threshold = \frac{-\beta}{2\alpha}$.

Using the estimates reported in the third column of Table 4, the threshold is around 24.34% of the GDP and concerns 25% of the sample[4]. This group includes countries such as Angola, Nigeria, Saudi Arabia or Venezuela. Therefore, the results suggest that there is no resource curse below the threshold of 24.34%. A potential explanation is that as long as oil revenues in percentage of GDP remains low, it does not trigger rent seeking behaviors because the government cannot only count on these resources to address the basic needs of population. Moreover, because resources are not enough to be used for political patronage, there is less inefficiency in the management of public spending.

[4] The list of the countries that are above the threshold is presented in Appendix.

Table 4: The non-linear effect of oil rent on income inequality

Dependent variable: Income inequality-Gini	**(1)**	**(2)**	**(3)**
Oil rent-to-GDP ratio	**-0.91405***	**-1.11836****	**-0.59848*****
	(0.47426)	**(0.56196)**	**(0.18436)**
Oil rent-to-GDP ratio squared	**0.01914***	**0.02198***	**0.01227****
	(0.01114)	**(0.01316)**	**(0.00488)**
Democracy-Polity4	0.01477	0.01536	0.00772
	(0.02084)	(0.02386)	(0.02811)
Number of year of education(Primary+secondary)	-4.69856***	-4.68027***	-2.05048
	(1.05124)	(1.08597)	(1.32428)
Log of GDP per capita	0.22430	-0.27258	0.93966
	(0.66470)	(0.76391)	(0.69654)
Trade openness	-0.00221	-0.00310	0.00312
	(0.00677)	(0.00737)	(0.00705)
Inflation-GDP deflator	0.04216***	0.04194***	0.03722***
	(0.01200)	(0.01275)	(0.01272)
Value added-Agriculture	-0.15124***	-0.17179***	-0.16737***
	(0.03744)	(0.03935)	(0.04668)
First step equation			
	Oil rent	**Oil rent**	**Oil rent**
Log(Out of region disaster)*log(Oil reserves)	-1.58425***		-2.00753***
	(0.31767)		(0.38125)
Log(Out of region disaster)*log(Oil reserves) squared	0.03694***		0.03412***
	(0.00699)		(0.00740)
Log of value of oil reserves		-0.55613***	0.56128***
		(0.15821)	(0.17097)
Log of value of oil reserves squared		0.03423***	
		(0.00819)	
	Oil rent squared	**Oil rent squared**	**Oil rent squared**
Log(Out of region disaster)*log(Oil reserves)	-74.21830***		-76.92524***
	(17.49957)		(15.70041)
Log(Out of region disaster)*log(Oil reserves) squared	1.67639***		1.54392***
	(0.38829)		(0.30251)
Log of value of oil reserves		-30.24162***	8.04132*
		(7.64088)	(4.64915)
Log of value of oil reserves squared		1.67085***	
		(0.41298)	
Country and time effects	Yes	Yes	Yes
N	985	985	985
Number of countries	52	52	52
Threshold	**23.87**	**25.44**	**24.39**
% of countries above the threshold	**25**	**21**	**25**
F-stat for weak ident.	10.38672	7.96586	10.76027
Hansen J test	.	.	0.12349

Note: Standards errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1

3.4. Assessing the conditional effect of oil rent on income inequality

Several studies have showed that the impact of oil wealth on economic outcomes may critically depends on institutional quality (Ebeke et al, 2015; Vicente, 2010). According to Bulte and Damania (2008), resource abundance translates into poor economic performances especially in countries with weak institutions. To re-examine this finding, equation (1) is rewritten to include an interaction term between oil rent and a measure of quality of institution.

$$Inequality_{it} = \beta Oil_{it} + \gamma Oil_{it} * Inst_{it} + \tau Inst_{it} + X_{it}\gamma + \delta_i + \varepsilon_{it} \quad (3)$$

We report the results using three measures of institution quality: the level of corruption, the quality of the regulation and the voice and accountability[5].

Corruption captures the extent to which public power is used for private gain. This includes both petty and grand forms of corruption, as well as the capture of the state by elites and privates interests (Kaufman et al, 2010). Voice and accountability measures the extent to which citizens are able to participate to the selection of their government. It also captures the freedom of expression as well as the freedom of association. Finally, the quality of the regulation captures the ability of the government to implement sound policies and regulations that enhance private sector development.

The data are obtained from the World Governance Indicator (World Bank, 2011b). The original indicators have been reversed and normalized so that the new variables range between 0 and 1, the lowest value referring to the highest institutional quality. We use the following formula:

$Inst = \frac{(maxinst - Inst)}{(maxinst - mininst)}$, where $maxinst$ is the maximum value of the variable,$mininst$, the minimum value.

In the equation (1), we expect $\beta < 0$ and $\gamma > 0$. Therefore, countries with highest institutional quality should experience a fall in income inequality following and increase in oil rent.

[5] Note that we also tested the three other measures provided by the World Governance Indicators (Political Stability and absence of violence, governance effectiveness and rule of law). We report only significant results. Moreover, Lack of Transparency in the management of oil resources, the quality of the regulation and corruption have always been pointed in the literature among the key factors explaining the resource curse (see Sala-i-Martin and Subramanian, 2012).

Table 5: Conditional effect of oil rent on income inequality

Dependent variable: Income inequality-Gini	(1)	(2)	(3)
Oil rent-to-GDP ratio	**-1.21843*** **	**-1.17729*** **	**-0.95058*** **
	(0.44604)	**(0.28928)**	**(0.23845)**
Oil*Corruption	**1.12719***		
	(0.66688)		
Oil*Regulatory quality		**1.07905** **	
		(0.47622)	
Oil*Voice & Accountability			**0.76803** **
			(0.35773)
Corruption	1.76358		
	(2.07342)		
Regulatory quality		-2.95801	
		(2.10933)	
Voice & Accountability			0.26756
			(2.10988)
Democracy-Polity4	0.05410	0.04131	0.08571*
	(0.05698)	(0.05678)	(0.04435)
Number of year of education(Primary+secondary)	-9.16985*	-8.42692*	-8.80338*
	(4.78717)	(4.58355)	(4.63407)
Log of GDP per capita	-2.70943**	-4.28712***	-4.42841***
	(1.23284)	(0.71417)	(0.54191)
Trade openness	0.01422	0.01556	0.01220
	(0.01412)	(0.01413)	(0.01386)
Inflation-GDP deflator	2.63283**	2.71381***	2.71072**
	(1.31850)	(0.94258)	(1.08581)
Value added-Agriculture	-0.14603**	-0.12372*	-0.14473**
	(0.06509)	(0.06726)	(0.06143)
Ratio of girls to boys-education	-0.03072	0.00667	-0.01906
	(0.04681)	(0.05647)	(0.04926)
First step equation			
	Oil rent	**Oil rent**	**Oil rent**
Log of value of oil reserves	0.11662***	0.11238***	0.14021***
	(0.01838)	(0.01830)	(0.01772)
Log of value of oil reserves*corruption	1.78e-09***		
	(5.21e-10)		
Log of value of oil reserves*regulatory quality		1.45e-09**	
		(5.10e-10)	
Log of value of oil reserves*Voice & accountability			1.71e-09***
			(4.48e-10)
	Oil*Corruption	**Oil*Regulatory quality**	**Oil*Voice & Accountability**
Log of value of oil reserves	0.0653598***	0.0493404***	0.0665718 ***
	(0.0127252)	(0.011937)	(0.0089454)
Log of value of oil reserves*corruption	1.53e-09***		
	(3.71e-10)		
Log of value of oil reserves*regulatory quality		1.35e-09**	
		(3.17e-10)	

Log of value of oil reserves*Voice & accountability			1.72e-09***
			(2.97e-10)
N	324	324	324
Number of countries	48	48	48
Joint significance of oil rent coefficient-Chi2 test	47.59	49.36	44.31
F-stat for weak ident.	24.92397	32.76502	31.87063

Note: Standards errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1. Country and time fixed are included in all regressions.

Table 5 reports the results. The number of countries used in the regression drops from 52 to 48 and the number of observations from 985 to 324. The main reason is that data on governance are available only from 1996.

We use three specifications, each one referring to a specific measure of institutional quality. Column (1) presents the estimates of the effect of oil rent conditional to the level of corruption. As expected, the coefficient of the interaction term is positive and shows that the higher the level of corruption, the lower the negative effect of oil rent on income inequality. In addition, the coefficient of the multiplicative variable (oil*corruption) is below the one of the additive variable (oil rent). This suggests that oil rent reduces income inequality even in the most corrupted countries.

However, this effect is moderate, representing only 7.74% of the magnitude of the drop in inequality observed in the less corrupted countries[6]. The same qualitative results are obtained when we consider the two other measures of governance. In both cases, the level of the drop in income inequality is lower for countries with weak institutions.

3.5. Time horizon effect of oil rent on income inequality

In their paper, Goderis and Malone (2011), show that income inequality falls in the short run following a resource boom, and then increases over the time until the disappearance of the initial effect[7]. In this section, we reexamine this finding by resorting to two methodological approaches. First, we apply the Jordà,s (2005) local projection technique to estimate the time horizon effect of oil rent and calculate impulse responses. The jordà method

[6] Based on the fact that the most corrupted country theoretically has a value of corruption equal to one, the net effect of oil rent is computed as $\gamma = -.091232$; for the less corrupted country, this effect is simply β. Therefore, the fall in income inequality in the most corrupted country in percentage of the same fall in the less corrupted countries is: $100 * (\beta + \gamma)/\beta$

[7] However, we have to clearly mention that in their theoretical model (proposition 6), they show that under conditions of balanced growth, a permanent increase in resource income has no long-run effect on inequality.

consists estimating a set of regression for each horizon time. The specification is the following:

$$Inequality_{it+h} = \beta_h Oil_{it} + X_{it}\gamma + \delta_i + \tau_t + \varepsilon_{it} \quad (4)$$

In this equation, the coefficient β_h gives the response of the income inequality at time $t+h$ to the change in oil rent at time t. Therefore, the impulse response is constructed as the sequence of β_h coefficients over the time horizon$h$. In order to obtain the response of income inequality to a one percent change in oil rent, we convert the variables to the same unit by dividing each one by the Gini index. The variables are rewritten as follow:

$$\frac{Inequality_{i,t+h} - Inequality_{i,t-1}}{Inequality_{i,t-1}}; \qquad \frac{Oil_{i,t+1} - Oil_{i,t-1}}{Inequality_{i,t-1}} \quad (5)$$

The Jordà technique has several advantages. First, we can use the same specification as the one used for the baseline model. This ensures that the results are not driven by the change in the specification or the change in the estimation method. Second, it does not constrain the shape of the impulse response and consequently less sensitive to misspecification. Third, the technique is flexible and do not require (as in a standard VAR) the left-hand-side variables and the right-hand-side variables to have the same form[8].

Figure 3 presents the response of income inequality to a one percent change in the oil rent. The bands are 95 percent confidence interval.

The figure shows that following an increase of oil rent, the income inequality falls steadily until the twelfth year, then begins to rise. We estimate the cumulative change of income inequality for 8 years, 12 years and 15 years respectively around -1.49; -3.35 and -6.16%.

Further, we test the robustness of this finding by estimating an error correction model, as done by Goderis and Malone (2011). According to their theoretical model, under the condition of balanced growth, there is no long run effect of natural resource boom on income inequality. However, the long term effect of oil resource on income inequality occurs mainly through the increase in the proportion resource income in total income. Therefore, if the share

[8] Ramey et al, 2013 and Ramey(2012) provide a thorough discussion of the advantages and disadvantage of the Local Projection technique

of the resource income in the total income increases over time, income inequality is more likely to raise in the long run.

To increase the country coverage, we take average of data over five non-overlapping years. Therefore, the number of countries increases from 52 to 88. Following Pesaran et al (1999), we assume the following error correction model:

$$\Delta Inequality_{it} = \varphi(Inequality_{i,t-1} - \beta_0' x_{it}) + \delta \Delta Inequality_{i,t-1} + \gamma_1' \Delta x_{i,t} + \mu_i + \varepsilon_{it} \qquad (6)$$

The first part of equation (6) in level captures the long relationship while the second part in difference is the short run adjustment to the long run equilibrium. The parameter φ is the error-correcting term and measures the speed of adjustment. This parameter should be negative and significant to validate the existence of a long run relationship. x_{it} is the vector of explanatory variables including oil rent in percentage of GDP and the other explanatory variables described in equation (1).

We estimate this model using the dynamic fixed effect (DFE) estimator. This estimation approach uses pooled data and allows the intercept to differ across groups. The choice of this estimator is mainly explained by the need to remain consistent with the previous specification that control for both time and country fixed effect[9]. The results are reported in Table 6. The error correction term is negative and significant, thus supporting the choice of the error correction model. We test several specifications to assess the robustness of the findings. Irrespective to the specification adopted, the long run coefficient is positive and significant. Likewise, the short run coefficient is always negative and significant. We therefore conclude that an increase in oil rent leads to a fall in income inequality in the short run while it is associated with a rise of income inequality in the long run. This finding is consistent with the visual observation of the impulse response constructed using the Local projection technique. However, the results contrast with the findings of Goderis and Malone (2011) as the short and long run effects are significant in our model.

Another possible explanation is that Goderis and Malone (2011) use commodity prices as a measure of oil wealth whereas we use oil rent. This latter measure is more likely to reflect the effect of oil abundance on individual behaviors rather than a mere distortion of the price structure (Rosser, 2006; Ebeke et al, 2015).

[9] The Pooling Mean Group estimator which might be more consistent in this case does not converge. The gaps in the data may explain this lack of convergence.

Table 6: Dynamic fixed effect estimates of the effect of oil rent on income inequality

	(1)	**(2)**	**(3)**	(4)
Long Run				
Income Inequality-Gini				
Error correction term	-0.581***	-0.568***	-0.568***	-0.552***
	(0.0310)	(0.0305)	(0.0305)	(0.0309)
Oil rent-to-GDP ratio	**0.536*** **	**0.545*** **	**0.545*** **	**0.522*** **
	(0.151)	**(0.149)**	**(0.149)**	**(0.154)**
Democracy-Polity4	-0.385**	-0.319**	-0.319**	-0.384**
	(0.151)	(0.152)	(0.152)	(0.162)
Number of year of education(Primary+secondary)	-17.67***	-13.24***	-13.24***	-12.77***
	(4.700)	(3.858)	(3.858)	(4.009)
Log of GDP per capita	0.746	2.504	2.504	0.554
	(3.044)	(2.748)	(2.748)	(3.125)
Trade openness	0.0174	0.0254	0.0254	0.0291
	(0.0228)	(0.0226)	(0.0226)	(0.0255)
Inflation-GDP deflator	-0.0395	-0.0918	-0.0918	-0.162
	(0.161)	(0.165)	(0.165)	(0.193)
Value added-Agriculture	-0.0779	-0.0674	-0.0674	-0.228
	(0.113)	(0.116)	(0.116)	(0.142)
Short Run				
D(Income inequality-Gini)				
D(Income inequality-Gini),t-1	-0.0141	-0.0155	-0.0155	-0.0171
	(0.0115)	(0.0116)	(0.0116)	(0.0116)
D(Oil Rent-to-GDP ratio)	**-0.284** **	**-0.302** **	**-0.302** **	**-0.307** **
	(0.131)	**(0.130)**	**(0.130)**	**(0.129)**
D(Democracy-Polity4)				0.118*
				(0.0670)
D(Number of year of education(Primary+secondary))				1.674
				(2.088)
D(Log of GDP per capita)				0.00748
				(0.0155)
D(Trade openness)				0.0553
				(0.0673)
D(Inflation-GDP deflator)				0.128*
				(0.0696)
D(Value added-Agriculture)	-0.224**	-0.181**		
	(0.0878)	(0.0863)		
Number of year of education(Primary+secondary)		-7.513***		
		(2.136)		
Log of GDP per capita		1.422	1.422	
		(1.560)	(1.560)	
Trade openness			0.0144	
			(0.0128)	
Inflation-GDP deflator			-0.0521	
			(0.0935)	

Value added-Agriculture			-0.0383	
			(0.0655)	
Constant	39.50**			
	(16.46)			
Country fixed effect	Yes	Yes	Yes	Yes
Time dummies	Yes			
Observations	388	353	365	364
Number of countries	89	88	88	88

Note: Standards errors are in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Moreover, the period of the analysis differs as well as the sample. Our results clearly suggest that the decline of income inequality is temporary. Therefore, the prediction of the Goderis and Malone’s (2011) theoretical model according to which there is no long run effect of oil boom on inequality may still hold.

Overall, the empirical analysis of the relationship between oil rent and income inequality provides several key findings that should be highlighted. The effect of oil rent on income inequality is non-linear. The lower regime is characterized by a negative impact of oil rent while the upper regime shows a positive relationship. Next, the decline in income inequality driven by the raise of oil revenues is low in countries with weak institutions. Finally, the relationship between oil rent and inequality depends on time. t. In the short run, the effect of oil rent is negative while the opposite is observed in the long run.

4. Conclusion

Arguments abound for the relatively poor performance of resource-rich countries for the past four decades. This paper has empirically analyzed the path of income inequality induced by oil abundance in 52 countries during the period 1984-2008. We use the unexpected change in the value of oil reserve to document a causal effect of oil rent on income inequality.

The analysis unveils several key results. First, the effect on oil rent on income inequality is non-linear. Oil richness induces a decline in income inequality for countries in which the share of oil rent in percentage of GDP is below the threshold of 25%. Above this threshold, we document a positive relationship. Second, the effect of oil rent is heterogeneous across countries, depending upon the institutional quality. Specifically, we find that the decline in income inequality is low in countries with high corruption, low accountability and weak regulatory quality. Finally, we uncover a time-dependent relationship between oil rent and income inequality. In particular, income inequality steadily decreases during the twelve years which follow the rise of oil rent, then increase after.

On the policy perspective, our findings suggest that the natural resource curse can be turned into blessing if oil wealth is well managed. In this line, countries which are endowed with natural resources should put in place an oil management framework prior to the beginning of oil production. This framework should include institutional arrangements and laws that ensure a more equal distribution of income. Moreover, our findings suggest a threshold effect of oil rent, pointing to a necessary diversification of resource-rich countries' economies. Accordingly, oil rich countries must invest a huge part of the oil rent in the development of other sectors such agriculture, high technology industry and services. This will reduce oil dependency and put the countries in a sustainable growth path.

APPENDIX A: List of countries

Table A. List of countries

Country		
Albania	India	Venezuela
Algeria	Indonesia	Vietnam
Argentina	Iran	
Australia	Italy	
Austria	Japan	
Bangladesh	Jordan	
Bolivia	Malaysia	
Brazil	Mexico	
Bulgaria	Morocco	
Cameroon	Netherlands	
Canada	New Zealand	
Chile	Norway	
China	Pakistan	
Colombia	Papua New Guinea	
Congo, Republic of	Peru	
Cote d`Ivoire	Philippines	
Denmark	Poland	
Ecuador	South Africa	
Egypt	Spain	
Gabon	Thailand	
Germany	Trinidad &Tobago	
Ghana	Tunisia	
Greece	Turkey	
Guatemala	United Kingdom	
Hungary	United States	

Table B. Unit root tests

Variables	**ADF**		**PP**	
	Statistic	p-value	Statistic	p-value
Income inequality	**Z**:0.90	0.81	**Z**:1.62	0.94
	Pm:4.17	0.00	**Pm**:9.89	0.00
D.(Income inequality)	**Z**: -2.59	0.00	**Z**: -15.64	0.00
	Pm: 3.99	0.00	**Pm**: 33.54	0.00
Oil rent in % GDP	**Z**: 4.33	1.00	**Z**: -8.02	0.00
	Pm:-5.39	1.00	**Pm**:9.55	0.00
D(Oil rent in % GDP)	**Z**: -16.64	0.00	**Z**: -32.06	0.00
	Pm: 24.07	0.00	**Pm**: 60.49	0.00

Table C. List of countries above the threshold

Countries above the threshold
Angola
Azerbaijan
Brunei
Congo, Republic of
Gabon
Kuwait
Libya
Nigeria
Oman
Qatar
Saudi Arabia
Venezuela
Yemen

APPENDIX B: Figures

FIGURES

Figure 1: Oil rent and inequality, cross sectional relationship over 1984-2008

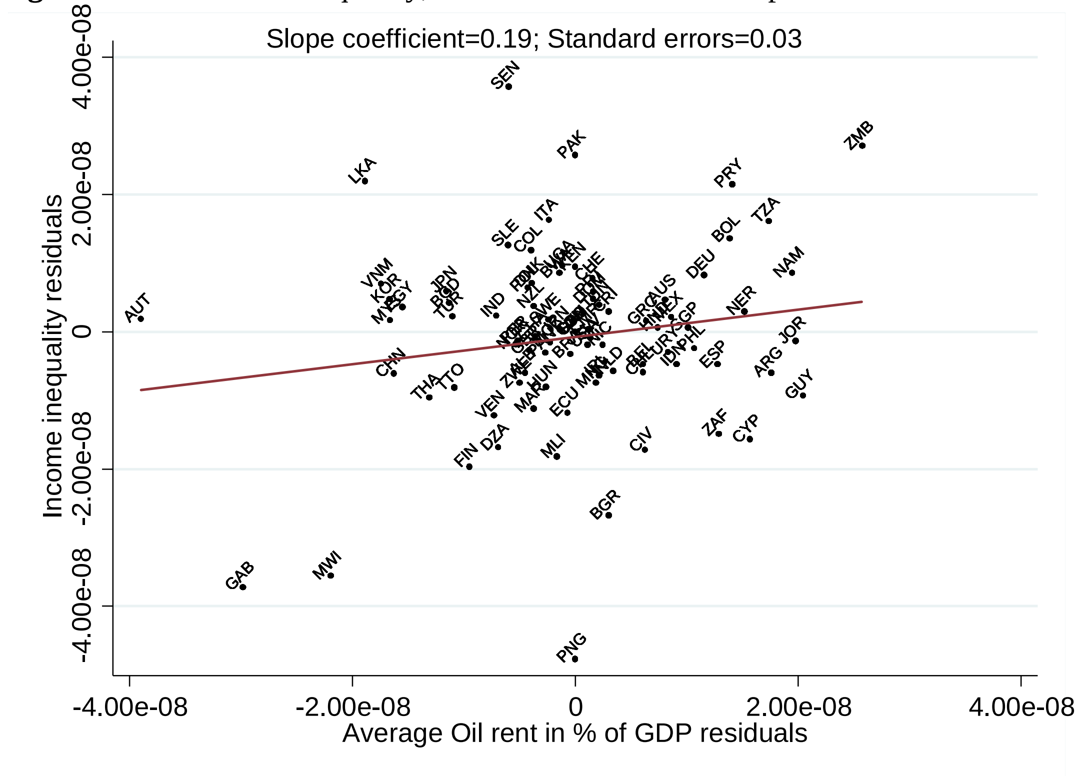


Figure 2: Marginal effect of oil rent on income inequality

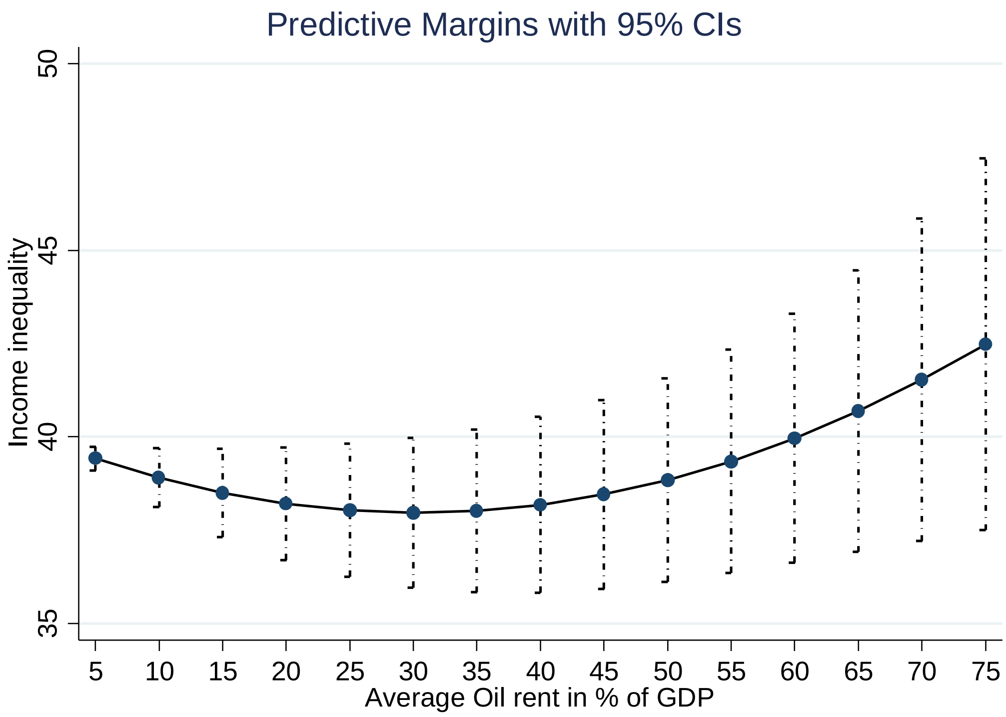
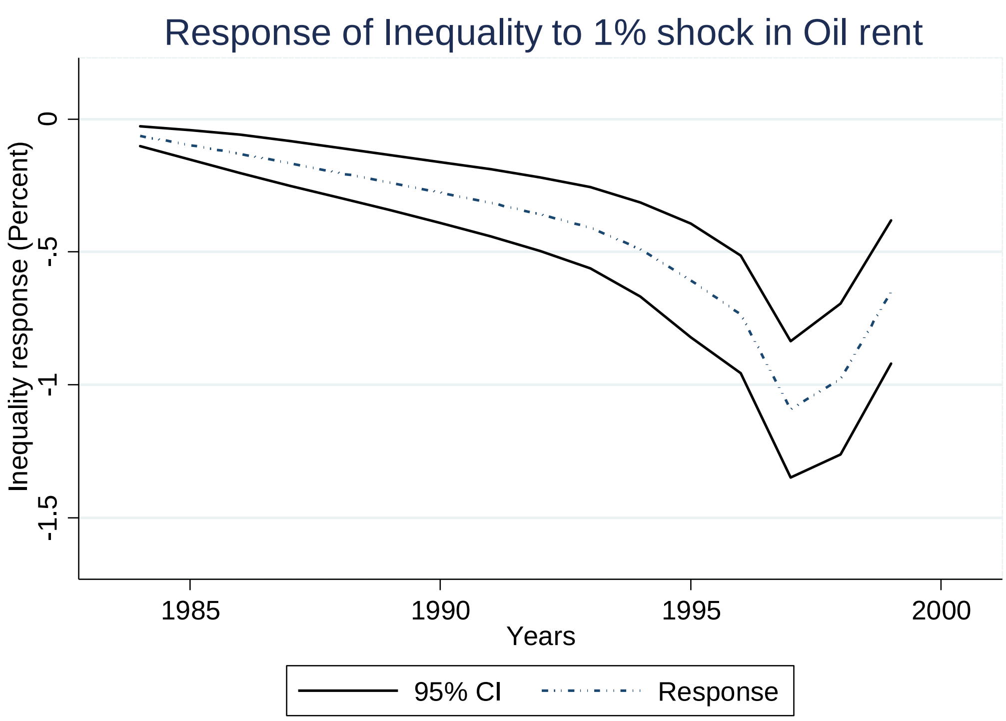


Figure 3: Response of income inequality to the change in oil rent



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