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Oil Trade Rents and International Income Inequality

Rentas del comercio de petróleo y la desigualdad internacional de la renta

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Abstract

This paper investigates the role of oil rents as implicit transfers that redistribute global income through international trade channels. It involves estimating these rents, calculating the redistributive effect, exploring the role of exports and imports and the different impact depending on income per capita. The results document that (i) implicit international oil trade rents lead to a positive but declining reduction in international income inequality, although it becomes regressive after 2001 using PPP income estimates; (ii) redistribution is basically generated via exports, with imports playing a minor role; and (iii) international oil rents have a greater impact on the countries in the lowest deciles. The novelty of this work is that, for the first time, the international redistributive effect of oil rents is studied, by introducing the concept of implicit transfers in international trade, which opens up new fields of research in the area of global income inequality.

Keywords: Income inequality, international trade, oil rents, redistribution.

Resumen

Este trabajo estudia el papel de las rentas del petróleo como transferencias implícitas que redistribuyen la renta global a través del comercio. Para ello estimamos dichas rentas, calculamos su efecto redistributivo, analizando el papel de las exportaciones y las importaciones, así como su distinto impacto en función de la renta per cápita. Los resultados muestran que (i) las rentas implícitas del comercio internacional de petróleo generan una redistribución positiva decreciente, aunque se convierte en negativa después de 2001 cuando se emplea la renta en PPA; (ii) el efecto redistributivo se genera principalmente a través de las exportaciones, mientras que las importaciones juegan un papel menor; y (iii) las rentas del comercio internacional de petróleo tiene un impacto mayor en los países que se encuentran en los deciles más bajos. La novedad de este trabajo es que, por primera vez, estudia el efecto redistributivo a nivel internacional de las rentas del petróleo, introduciendo el concepto de transferencias implícitas en el comercio internacional, abriendo nuevos campos de investigación en el área de la desigualdad global de la renta.

Palabras claves: desigualdad de la renta, comercio internacional, rentas del petróleo, redistribución.

JEL Classification / Clasificación JEL: D31, F10, Q30.

1. Introduction

Global income inequality has been on the decline since the 1990s (Milanovic, 2016; Bourguignon, 2017; Niño-Zarazua et al., 2017; David and Shorrocks, 2018). This trend, linked to globalization, is two-fold: on the one hand, between-country inequality has decreased as a result of greater growth rates in some developing countries whereas, in contrast, within-country inequality has increased (Milanovic, 2016; Bourguingnon, 2017). When calculating the two types of inequality, studies show that between-country inequality accounts for between 65% and 75% of global income inequality (Bourguignon and Morrison, 2002; Milanovic, 2002; Anand and Segal, 2015; Milanovic, 2016).

There are few factors that can alter the global distribution of income. Income is initially associated with production and its distribution is determined by the market, as well as by the national and international institutional mechanisms that affect it. At the national level, the initial income distribution, determined by production, can be substantially altered ex post by public sector interventions, which can generate a more equal distribution of disposable income through tax and transfer programmes (Immervoll and Richardson, 2011; Causa et al., 2017). However, at the international level, it is far more difficult to alter the initial between-country distribution of income, since there is not any redistributive mechanism as powerful as taxes and transfers (Bourguignon et al., 2009).

Among the few instruments that do redistribute international income ex post, we find two types of transfer: official development assistance and remittances from migrants. Both are reflected on national accounts and on the balance of payments and are perceptible. As regards official development assistance, Bouguignon et al. (2009) estimate a positive redistributive effect of a 0.44 percentage point change in the Gini index, concentrated on countries located in the bottom deciles of international income distribution. With regard to remittances sent by emigrants from the highest income countries to their countries of origin, there is no study that calculates their effects in terms of inequality. However, Adams and Page (2005) estimate that a 10% increase in remittances per capita reduces the share of population below the poverty line in the receiving countries by about 3.5%.

The redistributive power of both instruments is low, such that we may conclude there are few possibilities for international redistribution. However, it is possible to posit the presence of other types of mechanisms that can alter

global income distribution. We refer to certain transfers that are implicit in international trade in non-reproducible goods, such as natural resources. As it is physically limited, this type of good generates a rent for its producers, since the price of the good is significantly higher than the costs of the production factors required to obtain it (Segal, 2011). When these goods are traded internationally, the commercial transaction includes an implicit transfer of rent from the importing to the exporting country, which *de facto* implies ex ante international income redistribution and that is included in the price of traded goods. Among natural resources, oil stands out for its economic importance and volume of international trade. Oil is the most traded commodity worldwide, with exports accounting for 8.3% of total world exports in 2017, worth 875,000 million dollars (UNCSTAD, 2018), and which reflects the redistributive potential of the international oil trade.

The goal of this work is to quantify the redistributive effects of oil trade and analyse its evolution, as well as which factors determine it, in the understanding that it may be triggering an important international redistribution of income. The first problem the study needs to cope with is that there are no official statistics collecting the rents transferred in the international oil trade, such that we first estimate these rents using oil production rents collected by the World Bank. We consider the period from 1995 to 2016 and estimate the rents received by oil exporters and those paid by oil importers. The analysis uses annual frequency data, including 168 countries for which data are available and which represent 95% and 98% of the world population and GDP in 2016, respectively. Estimates illustrate that exporting countries received an average of 647 billion dollars in implicit oil rents annually, accounting for 8.05% of these countries' aggregate GDP, although these numbers display a certain degree of variability over the period.

In order to analyse the redistributive effect of oil trade rents, a counterfactual of the international distribution of income is built by deducting oil rents from each country. The estimates are calculated using two income measures: exchange market rate income (in 2010 US dollars) and Purchasing Power Parity income (in 2011 PPP dollars). We then measure the redistributive effects through the difference in the Gini index before and after accounting for rents (i.e., the Reynolds-Smolensky index). In order to determine to what extent the redistributive effects are due to the improvement of oil exporters, or to the worsening of oil importers, the analysis decomposes the redistributive effects following the method applied in Hierro et al. (2012, 2014) and is based on the factor source decomposition (Shorrocks, 2013). Subsequently, using the incidence analysis by deciles, and following the proposal of Ravaillion and Chen (2003), it studies which countries are affected by redistribution; those with the highest income per capita or those with the lowest income per capita? Finally, it calculates the reranking effect in order to ascertain whether part of the redistributive power is lost by changes in the order of income distribution. To do this, it decomposes the redistributive effect following the method developed by Kakwani (1984).

The findings document that: i) the implicit rents of the oil trade lead to a reduction in international inequality when incomes are measured in US dollars, although this effect declines over the period, whereas the redistributive effect is reversed after 2001, when it is estimated in PPP terms, ii) this redistribution is mainly driven by transfers of rents to exporters, although their impact decreased after 2001 in PPP estimates, while imports play an increasing regressive role, iii) oil trade rents have a higher impact in the lowest deciles of the distribution, and iv) the loss of redistributive capacity due to the reranking effect is relatively low in exchange market rate estimates, but it increased when income was measured in PPP terms.

The contribution of this work is threefold: first, it estimates, for the first time (to the best of our knowledge), the amount of rents transferred through international oil trade. Second, it estimates the redistributive effects of international oil trade and defines in an orderly manner a process to analyse this type of effects, which allow us to explore in depth the redistributive effects of any international transfer of rents. Finally, it incorporates a new concept into the study of global income inequality, that of the implicit transfer of rents in trade, thereby, opening up a new field of research.

The rest of the paper is organized as follows: Section 2 includes the methodology used, Section 3 examines the oil trade rents estimates, while Section 4 provides the results obtained in the analysis of the redistributive effects of oil trade rents; finally, Section 5 provides conclusions and certain implications associated with the obtained results.

2. Methodology

2.1. Methodology for estimating international oil trade rents and country classification

This work employs a sample of 168 countries, spanning the period 1995 to 2016. The sample represents 95% of the world population and 99% of world production in 1995, and 95% of world population and 98% of production in 2016, respectively. The countries included in the analysis were selected based on the availability of data used in the study and are listed in the appendix. We have removed from the sample countries for which some of the variables used were not collected or for which some observations were missing. In exceptional cases, where we found a missing value in the time series, we estimated it through interpolation[1].

[1] We interpolated 7 values of the 1,870 observations of oil rents missing ithe World Bank Adjusted Net Savings database. For this purpose, we proceed as follows: we calculate the growth rate of the annual average rent per barrel and, using the latest available data for countries where missing values are found, we estimate their rents per barrel by applying the annual growth rate of rent per barrel to their previous year's rent per barrel.

Since there are no official data on international oil trade rents, the first problem to be dealt with is to estimate these rents. To this end, we rely on data published in the World Bank's *Adjusted Net Savings* database, where oil production rents as a percentage of GDP are published on an annual basis, and in the *International Energy Statistics* database by the US Energy Information Administration, which publishes data on crude oil production, as well as exports and imports of crude oil. By multiplying oil production rents by current GDP, we obtain total oil production rents in current dollars. We then divide this value by oil production in barrels. In this step, we obtain the value of rent per barrel of oil produced.

Assuming that the amount of rents per barrel of oil produced is the same for crude oil exports, we multiply the value of rents per barrel by the volume of crude oil exports, in barrels, and obtain the total value of rents originating from oil exports. Finally, dividing the latter by current GDP, we obtain the value of rents from exports relative to the size of the economy. This variable, called *Export/GDP*, responds to the following formula:

$$\text{Export} / \text{GDP}_{it} = \frac{\frac{\frac{\text{RentProd}}{\text{GDP}_{it}} \times \text{GDP}_{it}}{\text{Prod}_{it}} \times \text{OilExp}_{it}}{\text{GDP}_{it}} \times 100 \quad (1)$$

where $\frac{RentProd}{GDP_{it}}$ represents rents from oil production as a percentage of GDP, GDP_{it} represents GDP in current U.S dollars, $Prod_{it}$ is oil production expressed in barrels, and $OilExp_{it}$ is the volume of oil exports in barrels.

In the case of oil imports, the estimation is different. Since we do not have information on the origin of each country's imports, we calculate a global average amount of rent by barrel for each year. For this, we calculate the average aunt of rent per barrel weighted by each country's volume of exports with respect to total exports. The result is the average amount of rent per barrel of oil for each year worldwide, which we apply to the volume of oil imports in current dollars for each country. This value is divided by GDP. We thus obtain the variable *Import/GDP*, expressed as aercentage, and which responds to the following formula:

$$\text{Import} / \text{GDP}_{it} = \frac{\left(\sum_{i=1}^{n} \left(\frac{\frac{\text{RentProd}}{\text{GDP}_{it}} \times \text{GDP}_{it}}{\text{Prod}_{it}} \text{x} W_{it} \right) \right) \times \text{OilImp}_{it}}{\text{GDP}_{it}} \times 100 \quad (2)$$

where $OilImp_{it}$ is the volume of oil imports in barrels and W_{it} is the relative weight of each country's oil exports with respect to total oil exports. Finally, we calculate the difference between rents obtained from exports and rents paid

for imports for each country, which is also relativized with respect to GDP. This variable, called *Rent/GDP*, is expressed as a percentage and is in line with the following formula:

$$Rent / GDP_{it} = Export / GDP_{it} - Import / GDP_{it} \quad (3)$$

We should clarify that we estimate oil trade rents from a national account perspective, considering their direct impact on national production. We do not consider the subsequent distribution of those rents, which are included in different national accounting items. Studying the within-country distribution of those rents would require a country by country analysis in order to detect the mechanisms by which rents could be leaked to foreign countries in each, and would entail making strong assumptions, given the lack of data about their national distribution.

Once rents are estimated, we then divide the sample between exporting countries that receive rents from exports which are higher than those they pay for imports and which are, therefore, beneficiaries of implicit redistribution, and importing countries, that paid rents for imports which are higher than those obtained from oil exports, such that these are the countries which transfer rent to exporters.

In order to classify the results within the exporting group, the analysis uses a cluster method, which allows us to define groups so that the dissimilarity between observations within each group is as small as possible and the dissimilarity between different groups is as great as possible.

Initially, we define the measure of dissimilarity[2]. We then group countries into clusters, using the agglomerative hierarchical method which starts from a number of clusters equal to the number of observations and iteratively and hierarchically merges the clusters, such that it does not require the number of clusters to be determined. For clustering, we employ the Ward (1963) method and to determine the optimal number of clusters we used two different methods; a global method called the 'elbow method' (Thorndike, 1953) and a local method based on the Duda and Hart (1973) indexes. The definition of clusters applied to the variable *Rent/GDP* allows us to distinguish groups of countries based on their dependence on international oil trade rents.

[2] The Euclidean distance, *d(i,j)* for two countries i and j is defined as follows:

$$d(i,j) = \sqrt{\sum_{k=1}^{p} \left(X_{ki} - X_{kj}\right)^2}$$

where X is the value of the observation and k = 1, 2,...,p represents the variables to be analysed, which in our case is only *Rent/GDP*.

2.2. Method for analysing the redistributive effect of international oil trade rents

As regards the redistributive effect of the rents estimated above, we consider it necessary to answer the following questions: do oil rents reduce global income inequality? To what extent? How much of the redistributive effect is due to the importer's loss of income and how much to exporter's profits? Is redistribution greater for countries with the lowest or the highest income per capita? And finally, is redistribution less than what would potentially occur as a result of the reranking effect? Or, put differently, is part of the redistribution lost because countries move up and down in the ranking?

2.2.1. Do oil rents reduce international income inequality? To what extent?

In order to analyse whether oil rents reduce global income inequality, it is important to choose the concept of inequality used, since the results may differ, as indeed may any interpretations (Bourguignon et al., 2004; Ghose, 2004). This paper uses international income inequality, following the notation of Milanovic (2005), that is, measuring inequality between countries using income per capita weighted by their population.

Given that data about national inequality and the distribution of oil rents are not available for each country in the period considered, it is not possible to analyse the impact of oil rents on global interpersonal inequality. However, taking into account that around two thirds of global interpersonal inequality is determined by inequality between countries (Bourguignon and Morrison, 2002; Milanovic, 2002; Anand and Segal, 2015, Lakner and Milanovic, 2016), we can deduce that the results obtained would prove relevant in global interpersonal inequality.

Another important issue is whether oil rents, and therefore, GDP per capita, should be measured in dollars using exchange market rates (US dollars) or PPP exchange rates. Given that oil rents are international flows, converting them into constant US dollars allows us to compare these flows, which are priced internationally. However, global inequality, measured by synthetic indexes, such as the Gini or Theil index, is overestimated when GDP is measured in US dollar terms (Dowrick and Akmal, 2005; Milanovic, 2005; Anand and Segal, 2008). In this regards, using GDP in PPP terms is a better approach to estimate the international income inequality, since it allows the comparison of welfare between individuals across different countries, taking into account the price differences between countries (Stucliffe, 2004; Milanovic, 2012). Despite the advantage of PPP in terms of welfare comparison, oil rents expressed in PPP dollars are not worth the same for every country, so the redistribution is not a zero-sum game.

To address this issue, the analysis first calculates international income inequality using the GDP per capita in constant 2010 U.S. dollars, obtained from the World Bank's *World Development Indicators* database. It then estimates a

counterfactual of international income inequality without accounting for the international oil trade rents previously estimated; that is to say, rents paid in oil imports are added to GDP per capita and rents received from exports are subtracted, both in per capita terms. Alternatively, it performs the same calculations measuring GDP per capita and oil trade rents in constant 2011 PPP dollars, the former obtained from *World Development Indicators* database and the latter converted by multiplying oil trade rents by the ratio of GDP in PPP to GDP in US dollars. In the rest of the paper, we will refer to the former estimation as the *EMR scenario*, and the latter as the *PPP scenario*.

To measure the redistributive effect, the analysis employs the Reynolds and Smolensky (1997) index, which shows the change in income inequality, measured by the Gini index, and which is defined as:

$$RE = G_{BOR} - G_{AOR} \quad (4)$$

where *RE* is the redistributive effect, G_{BOR} is the Gini index of income distribution, excluding oil rents, and G_{AOR}. is the Gini index of the final income distribution, including oil rents. A positive value of this index implies a reduction in income inequality and, therefore, yielding a positive redistribution.

2.2.2. How much of the redistributive effect is due to importer's loss of income and how much to exporter's profits?

In order to determine the weight of exports and imports in t redistributive effect of international oil trade rents, the analysis carries out a factorial decomposition of the redistributive effect. Following the methodology used in Hierro et al. (2012, 2014), based on Shorrocks (2013), the analysis applies a decomposition procedure employing the Shapley value, calculating the average partial effect of exports and imports rents in the redistributive effect by altering the calculation sequence. Table 1 shows the process followed.

2.2.3. Which countries are affected by redistribution? Those with the highest income per capita or those with the lowest?

In order to analyse how the redistributive effect is distributed, the analysis performs an incidence analysis by decile. To this end, it calculates the percentage variation of the average GDP per capita in each decile caused by oil rents and builds a non-anonymous incidence curve, following the methodology of Ravaillion and Chen (2003) and Bourguignon (2011). Income variation for each decile is given by the following equation:

Table 1. Decomposition of the redistributive effect between export and import effect

	Sequence 1 (-M + Ex)	Sequence 2 (Ex-M)	Shapley solution
Imports	$RE_{X\text{-}M}$ (I)	$RE_{X\text{-}M+Ex} - RE_{X+Ex}$ (III)	$RE_M = \frac{1}{2}.(RE_{X-M+Ex} - RE_{X+Ex}) + \frac{1}{2}.(RE_{X-M})$ (V)
Exports	$RE_{X\text{-}M+Ex} - RE_{X\text{-}M}$ (II)	RE_{X+Ex} (IV)	$RE_{Ex} = \frac{1}{2}.(RE_{X-M+Ex} - RE_{X-M}) + \frac{1}{2}.(RE_{Xx})$ (VI)
Total	$RE_{X\text{-}M+Ex}$ (VII)	$RE_{X\text{-}M+Ex}$ (VII)	

Source: Hierro et al. (2012) and authors' own elaboration. Notes: RE refers to the redistributive effect measure by the Reynolds-Smolenksy index. The notations X, Ex and M refers to GDP per capita before including oil rents, rents per capita received from exports and rentser capita paid in imports, respectively.

$$I(d) = \left(\left(\frac{y_{aor}(d)}{y_{bor}(d)}\right) - 1\right) x\ 100 \tag{5}$$

where I(d) is the percentage variation of average GDP per capita for each decile d = 1,2,...,10, $y_{aor}(d)$ is the average GDP per capita of each decile including oil rents, and $y_{bor}(d)$ is the average GDP per capita of each decile prior to including oil rents. This methodology allows us to analyse the relative impact of rents on countries, based on their level of income, and thus to determine how redistribution occurs. Likewise, it also allows us to analyse what happened in redistribution terms throughout the period considered.

2.2.4. Is the redistribution which occurs less than what might occur as a result of the reranking effect?

Another important issue concerns the loss of the redistributive effect due to the fact that, when countries shift in the distribution ranking, there is an increase in inequality, which is known as reranking. Following the methodology proposed by Kakwani (1984), the redistributive effect can be decomposed into two components:

$$RE = V - R \tag{6}$$

where *RE* is the total redistributive effect, *V* is vertical redistribution and *R* represents the reranking effect. Vertical redistribution measures the progressivity of redistribution or the potential redistributive effect, while reranking represents the reduction in the redistributive effect caused by changes in orders in the international distribution of income induced by redistribution itself.

We consider D_{AOR}^{BOR} to be the concentration index of final income (including oil rents) maintaining the initial order (before including oil rents), we can represent the Kakwani decomposition as follows:

$$RE = V - R = (G_{BOR} - D_{AOR}^{BOR}) - (G_{AOR} - D_{AOR}^{BOR}) \quad (7)$$

where the first term in the equation represents vertical redistribution, while the second term represents the reranking effect. By construction, reranking effect will be always positive or zero, while the minus sign in front of the reranking term reflects that it reduces the redistributive effect.

3. Data

3.1. Estimation of international oil trade rents

The average oil rents for each country is shown in the appendix. We order countries from highest to lowest rents in terms of GDP, with Republic of Congo being the country where oil trading rents represent the greatest share of GDP, 32.76%. The group of countries receiving oil rents, henceforth 'exporting countries', consists of 42 countries, and the group of countries which transfer part of their income in the form of payment of oil rents, henceforth 'importing countries', is made up of 126 countries.

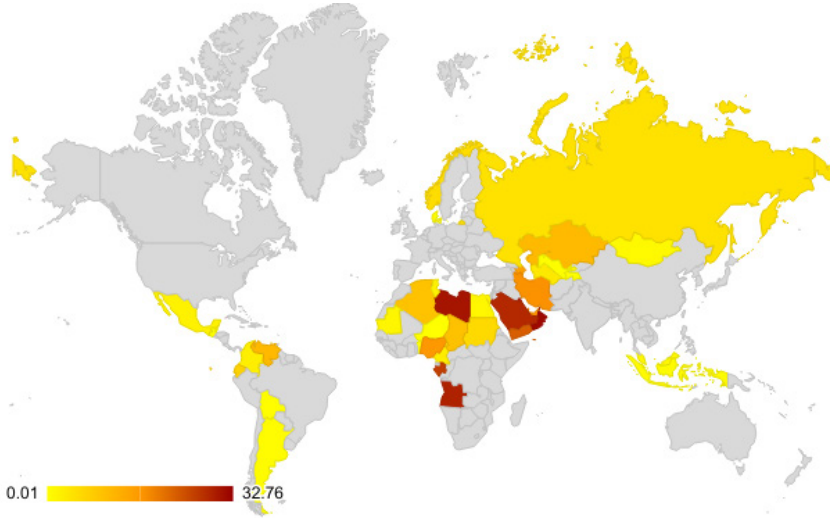
The geographical distribution of oil rents to GDP is shown in Figure 1, where it can be seen that most dependent exporters are concentrated in the areas of the Middle East and the West Coast of Central Africa.

Rents received by exporters amount to an average of 646,905 million dollars a year, although their evolution does provide evidence of a certain degree of volatility. As can be seen in Figure 2, there is a period displaying an increasing trend which stretches from 1995 to 2008, the year when the global crisis began, and another displaying a decreasing trend from 2009 to 2016.

Figure 3 shows the evolution of rents of exporting and importing countries as a percentage of their GDP. Rents paid by importers account for an average of 1.06% of their aggregate GDP, while for exporters they represent an average of 8.05%. That is, oil rents are far more relevant in economic terms for the economies of exporting countries than for the economies of importing countries, which means that exporting countries are more exposed to changes in the sector than are importing countries.

Focusing on exporting countries, we apply cluster analysis to group these countries according to their dependence on the rents from exports, using the average *Rent/GDP* for the period 1995-2016. As regards the optimal number of clusters, the Duda/Hart indexes suggests the existence of between four and five clusters. The elbow method also suggests that the optimal number of clusters is four. Therefore, we chose to define four different groups based on the average value of the variable *Rent/GDP* during the period analysed.

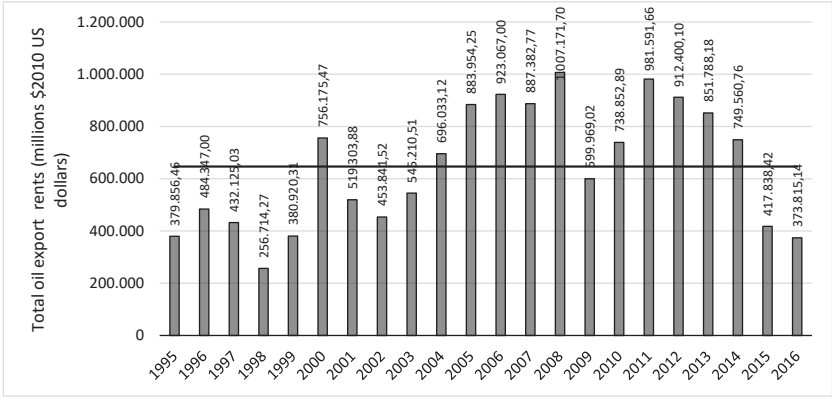
Figure 1. Global distribution of international oil trade rents to GDP for oil exporting countries



Source: Authors' own compilation. Note: only exporting countries, as previously defined, are included.

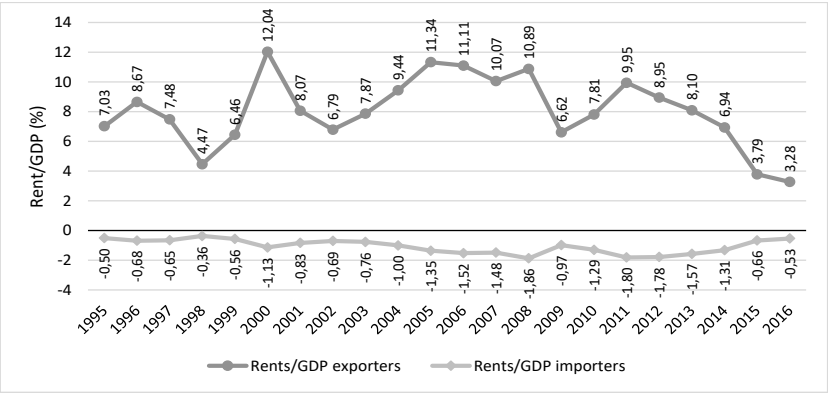
Table 2 shows the groups obtained, as well as the main statistics of each group. We classify countries into four groups: very high, high, medium, and very low dependence on oil rents based on the average value of the groups.

Figure 2. Evolution of oil export rents in the period 1995-2016



Source: Authors' own compilation. Notes: Oil export rents are calculated as the sum of rents received from exports by every country in the sample. Export rents are expressed in constant 2010 US dollars. The black line represents the average oil exports rents for the whole period.

Figure 3. Evolution of exporting and importing rents to GDP (1995-2016)



Source: Authors' own compilation. Notes: rent/GDP are calculated as the sum of rents in net terms (export rents – import rents) divided by the aggregate GDP of each group. The group of exporting countries is formed by 42 countries with an average *Rent/GDP* above zero, while importing countries are the group of 126 countries with zero or a negative average *Rent/GDP*.

Table 2. Classification of exporting countries according to cluster analysis results

Group	1	2	3	4
Oil trade rents dependence	Very high	High	Medium	Very low
Number of countries	8	6	8	20
Average Rent/GDP (%)	28.82	17.21	8.11	1.23
Std. Deviation	3.26	1.48	2.57	1.08
Countries	Gabon	Azerbaijan	Algeria	Argentina
	Oman	Nigeria	Russia	Mauritania
	Kuwait	Brunei	Norway	Denmark
	Yemen	Iran	Chad	Turkmenistan
	Congo	UAE	Venezuela	Belize
	Angola	Qatar	Kazakhstan	Egypt
	Saudi Arabia		Ecuador	Guatemala
	Libya		Sudan	Tunisia
				Tajikistan
				DRC
				Mongolia
				Malaysia
				Cameroon
				Colombia
				Benin
				Bolivia
				Uzbekistan
				Niger
				Indonesia
				Mexico

Source: Authors' own compilation.

The first cluster is that of countries with a very high dependence on oil rents, which account for around a third of GDP. For the second group, dependence on oil rents is high, and accounts for around a fifth of their GDP. However, the most numerous groups are those displaying medium dependence (around 8.11% of GDP) and very low dependence (1.23% of GDP). For the latter, their economy does not depend on the rents obtained from oil exports.

With reference to dependence, it should be remembered that we are talking about dependence on oil rents from abroad, not dependence on the oil production sector, which may have a substantially greater weight in the country's economy, even if it does not produce foreign revenues.

4. Empirical analysis

4.1. Estimation and analysis of the redistributive effect of international oil trade rents

4.1.1. Do oil rents reduce global income inequality? To what extent?

The answer to both questions can be found in Table 3. Columns 1 and 2 show the value of the Gini index of international distribution of income before including oil rents and the redistributive effect of this rents, respectively, when using the exchange market rate. As can be seen, international inequality is high, with an average Gini index of 67.41, although it has experienced a decline over the period. Oil rents do lead to a reduction in this inequality. The redistributive effect is positive over the whole period, such that rents implicit in the international oil trade reduce international inequality; in other words, a progressive redistribution takes places, since it makes global income more equal. Nevertheless, the size of this redistributive effect experiences a decreasing trend over the period analysed.

The scale of the redistributive effect is, on average, 0.12 points on the Gini index, reaching a maximum value of 0.32 points in 1996. The redistributive effect of Official Development Assistance (ODA), the main instrument of redistribution at the international level, is 0.44 points on the Gini index, according to the estimates by Bourguignon et al. (2009) for 2004. Therefore, taking explicitly into account that the possibilities and size of redistribution at international levels are low, the redistributive effect of oil trade rents is considerable.

Columns 5 and 6 in Table 3 show the international inequality, measured by the Gini index, and the redistributive effect when GDP per capita and oil rents are converted into PPP dollars. In these estimates, income inequality is found to be lower, given that market exchange rates undervalue the standard of livings of the poorer countries, and therefore, to overstate the international inequality (Dowrick and Akmal, 2005; Anand and Segal, 2008). As in the EMR scenario, we found a declining trend in the redistributive effect. In this

Table 3. Redistributive effect of international oil trade rents (1995-2016)

	EMR				PPP			
Year	$GINI_{BOR}$	RE	V	R	$GINI_{BOR}$	RE	V	R
1995	70.85	0.247	0.288	-0.041	58.39	0.221	0.385	-0.164
1996	70.72	0.324	0.420	-0.096	58.02	0.295	0.483	-0.188
1997	70.59	0.191	0.288	-0.097	57.87	0.238	0.362	-0.124
1998	70.49	0.114	0.117	-0.003	57.62	0.011	0.045	-0.034
1999	70.44	0.119	0.138	-0.019	57.34	-0.009	0.064	-0.073
2000	70.55	0.287	0.571	-0.284	57.48	0.158	0.463	-0.305
2001	70.09	0.129	0.154	-0.025	56.77	-0.033	0.082	-0.115
2002	69.69	0.077	0.091	-0.014	56.24	-0.099	-0.038	-0.061
2003	69.26	0.086	0.109	-0.023	55.55	-0.16	-0.091	-0.069
2004	68.90	0.115	0.137	-0.022	54.85	-0.172	-0.072	-0.100
2005	68.48	0.144	0.205	-0.061	54.04	-0.217	-0.105	-0.112
2006	67.91	0.123	0.174	-0.051	53.12	-0.265	-0.147	-0.118
2007	67.24	0.137	0.182	-0.045	52.04	-0.232	-0.122	-0.110
2008	66.62	0.142	0.215	-0.073	51.14	-0.289	-0.156	-0.133
2009	65.53	0.082	0.102	-0.020	49.50	-0.228	-0.143	-0.085
2010	65.04	0.132	0.155	-0.023	48.69	-0.226	-0.091	-0.135
2011	64.58	0.138	0.169	-0.031	48.03	-0.292	-0.119	-0.173
2012	64.05	0.069	0.118	-0.049	47.33	-0.381	-0.199	-0.182
2013	63.53	0.021	0.067	-0.046	46.63	-0.41	-0.235	-0.175
2014	63.12	0.021	0.040	-0.019	46.09	-0.363	-0.244	-0.119
2015	62.86	0.015	0.020	-0.005	45.80	-0.201	-0.170	-0.031
2016	62.40	0.006	0.009	-0.003	45.41	-0.164	-0.142	-0.022
Average	67.41	0.120	0.171	-0.048	52.63	-0.128	-0.009	-0.119

Source: Authors' own compilation. Notes: GiniBOR represents the Gini index of the international distribution of income before including oil trade rents. RE is the redistributive effect of oil trade rents, measured by the Reynolds-Smolensky index. V and R are the Vertical and Reranking effects, estimated following equation (7). EMR and PPP represent the estimations using constant 2010 US dollars and constant 2011 PPP dollars, respectively.

case, the evolution of the redistributive effect can be divided into two different periods: a first period yielding a positive redistribution, on a similar scale to the EMR estimates, which ends in 2000; and a second period after 2001, when redistribution turns negative, implying that oil trade rents turn into being inequality-increasing.

Given that the impact in relative terms of oil trade rents in both scenarios does not differ by construction, the divergence patterns in the redistributive effect should be explained by the shifts of countries in the international distribution of income due to different income and rents measures. These

changes affect both the effect of exports and imports on the total redistribution and the magnitude of reranking. These issues will be addressed in the next subsections.

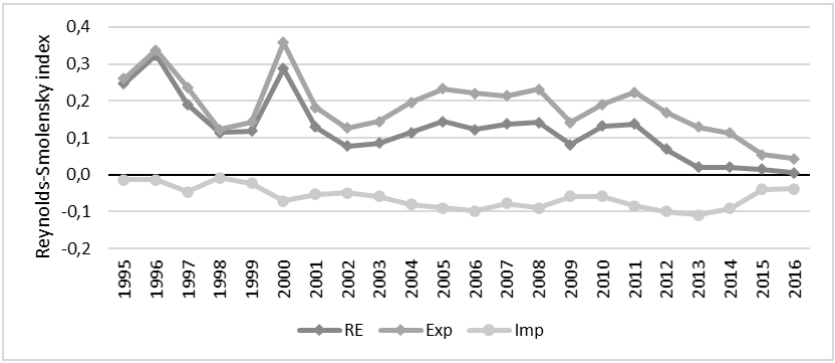
4.1.2. What part of the redistributive effect is due to the loss of income from imports and what part to exporters' profits?

The redistributive effect may be caused by exporting countries' GDP per capita improvements thanks to the oil rents received and by importing countries' GDP per capita reduction due to the payment of these implicit rents. In order to know the importance and direction of each of these effects, we decompose the redistributive effect between the export and import effect (Table 4), the progression for which is shown in Figures 4a and 4b.

As can be seen in Figure 4a, in the EMR estimates, the total redistributive effect is driven by the rents received by oil exporters, which are those that operate progressively. The rents paid in imports generate a negative redistributive effect; that is, they show a regressive behaviour and do not reduce inequality, but in fact, increase it. As regards the progression over time, it can be observed that as of 2000, the negative redistributive effect of imports increases. Coupled with the loss of the redistributive effect of exports, this has led to a substantial reduction in the redistributive effect of oil rents.

In the PPP estimates (Figure 4b), exports rents are the main drivers of the positive redistributive effect until 2001. During this period, imports show a slightly regressive behaviour, but it is almost negligible. We find a downward trend in the exports redistributive effect after 2002, turning into negative

Figure 4a. Evolution of the redistributive effect of oil exports and imports (constant 2010 US dollars)



Source: Authors' own compilation. Note: RE refers to the redistributive effect Exp refers to the redistributive effect of oil export rents and Imp refers to the redistributive effect of oil import rents.

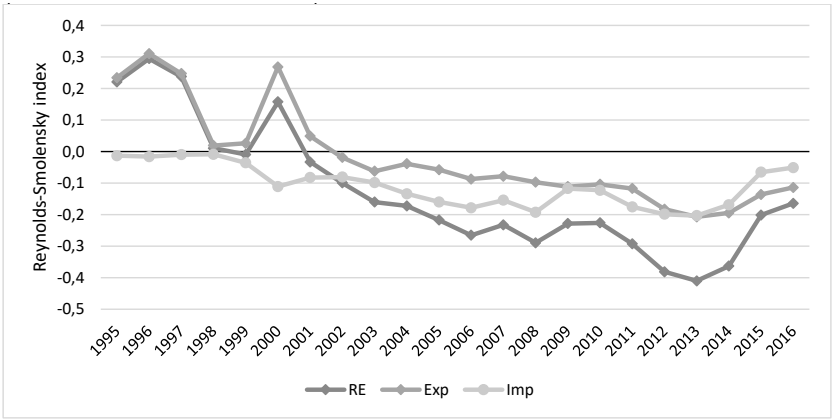
Table 4. Redistributive effect of oil exports and imports (1995-2016)

	EMR			PPP		
Year	RE	RE_{Ex}	RE_{Imp}	RE	RE_{Ex}	RE_{Imp}
1995	0.247	0.260	-0.013	0.221	0.234	-0.013
1996	0.324	0.338	-0.014	0.295	0.311	-0.016
1997	0.191	0.237	-0.046	0.238	0.248	-0.010
1998	0.114	0.122	-0.008	0.011	0.020	-0.009
1999	0.119	0.143	-0.023	-0.009	0.027	-0.036
2000	0.287	0.358	-0.071	0.158	0.268	-0.110
2001	0.129	0.182	-0.053	-0.033	0.049	-0.082
2002	0.077	0.126	-0.049	-0.099	-0.018	-0.080
2003	0.086	0.144	-0.058	-0.160	-0.062	-0.098
2004	0.115	0.196	-0.081	-0.172	-0.039	-0.134
2005	0.144	0.233	-0.089	-0.217	-0.058	-0.159
2006	0.123	0.220	-0.098	-0.265	-0.087	-0.178
2007	0.137	0.214	-0.077	-0.232	-0.078	-0.154
2008	0.142	0.232	-0.090	-0.289	-0.097	-0.192
2009	0.082	0.141	-0.059	-0.228	-0.111	-0.117
2010	0.132	0.190	-0.059	-0.226	-0.103	-0.123
2011	0.138	0.223	-0.085	-0.292	-0.117	-0.175
2012	0.069	0.168	-0.099	-0.381	-0.183	-0.199
2013	0.021	0.130	-0.109	-0.410	-0.207	-0.203
2014	0.021	0.113	-0.091	-0.363	-0.195	-0.169
2015	0.015	0.054	-0.039	-0.201	-0.136	-0.065
2016	0.006	0.044	-0.038	-0.164	-0.114	-0.051
Average	0.124	0.185	-0.061	-0.128	-0.020	-0.108

RE is the redistributive effect of oil trade rents, measured by the Reynolds-Smolensky index. RE_{Ex} and RE_{M} represent the redistributive effect of exports and imports, respectively, estimated following the methodology shown in Table 1. EMR and PPP represent the estimates using constant 2010 US dollars and constant 2011 PPP dollars, respectively.

and, thus, contributing to the negative total redistributive effect observed. Imports also show an increasing regressive effect, higher than the observed in the EMR scenario, thus, reinforcing the contribution of exports to the negative redistributive effect.

Fig 4b. Evolution of the redistributive effect of oil exports and imports (constant 2011 PPP dollars)



Source: Authors' own compilation. Note: RE refers to the redistributive effect Exp refers to the redistributive effect of oil export rents and Imp refers to the redistributive effect of oil import rents.

4.1.3. Which countries are affected by redistribution? Those with the highest income per capita or those with the lowest?

The distribution of the redistributive effect by country can be gauged by calculating the impact of oil rents on the average GDP per capita of each decile of international income distribution, shown in Table 5. For simplicity, the impact has been calculated for an average five-year period, with the exception of the last period, which merges the years 2015 and 2016.

Table 5 shows that in the EMR estimates, oil exports initially have a greater impact on the lowest deciles (1 and 4), while oil imports have also a greater negative impact on the lowest deciles (2 and 3). Deciles 6, 7, 8 and 9 also benefit from oil rents. Table 5 also shows a shift in the impact of export rents towards the upper deciles over the period, reducing the redistributive capacity of exports, since rents have an impact on higher deciles than they did in previous periods. On the other hand, the negative effect of imports increases in the lowest deciles to a greater extent than in high income deciles, thus increasing the regressive effect of imports. These results explain the reduction in the size of the redistributive effect at the end of the period analysed, which can be seen in Figure 4a.

A similar evolution can be seen in the PPP scenario. However, important differences emerge. Firstly, countries in deciles 1 and 2 benefit from oil rents over the whole period, in contrast to the results found in the EMR scenario, where the greater impact after 2000 is found on deciles 4 and 5. This means

Table 5. Impact of international oil trade rents on average GDP per capita by decile

	1995-1999		2000-2004		2005-2009		2010-2014		2015-2016	
Decile	EMR	PPP	EMR	PPP	EMR	PPP	EMR	PPP	EMR	PPP
1	2.34	13.42	-0.34	1.71	1.20	0.11	0.31	0.13	0.19	0.14
2	-0.90	0.97	-1.02	-1.70	-1.89	0.74	-1.98	5.41	-0.86	1.38
3	1.49	-0.81	-2.36	-2.36	-3.84	-3.84	-4.66	-4.67	-1.73	-1.67
4	5.70	1.19	4.24	2.66	5.28	1.27	2.19	-3.98	0.38	-1.60
5	-0.14	-0.14	-0.80	-0.80	-0.47	-1.57	2.10	0.02	0.73	0.00
6	1.08	-0.71	-0.80	-0.83	-1.57	-1.57	-1.59	-1.59	-0.04	0.01
7	3.81	0.73	5.41	6.60	1.37	1.71	-1.26	-0.34	-0.60	-0.60
8	0.73	2.91	2.34	2.56	3.46	3.69	2.98	2.25	0.88	0.71
9	0.49	0.12	0.45	1.44	1.09	2.37	0.92	1.97	0.62	-0.06
10	-0.25	0.75	-0.41	-0.24	-1.10	-0.38	-1.17	-0.32	-0.42	0.73

Source: Authors' own compilation. EMR and PPP represent the estimates using constant 2010 US dollars and constant 2011 PPP dollars, respectively.

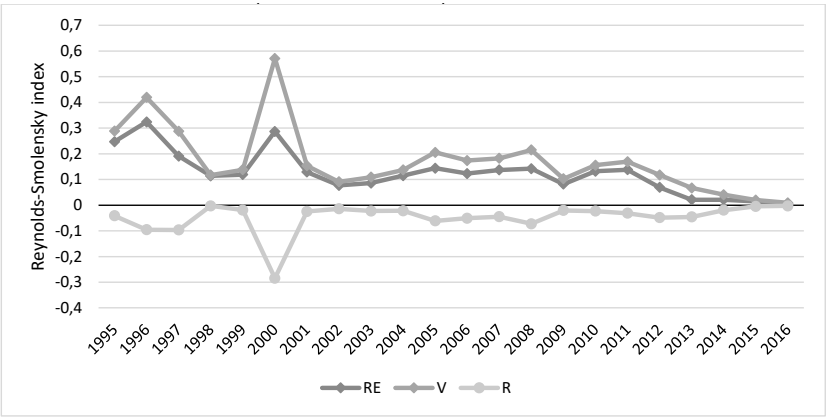
that the oil-exporting countries located in those deciles in the EMR scenario (Angola, Cameroon, Yemen, Rep. of Congo) move down in the distribution due to the increase in India's GDP per capita in PPP with respect to US dollars. On the other tail of the distribution, the negative impact of oil trade rents in decile 10 is smaller in the PPP estimates, even turning positive in periods 1995-1999 and 2015-2016. In the same line, deciles 8 and 9 experience an average higher positive impact of oil rents in this scenario, thus making the redistributive effect of oil rents more regressive. These variations are explained by shifts of high-income oil-exporting countries (i.e., Saudi Arabia, Brunei, United Arab Emirates, Kuwait, Oman, and Russia) in the international distribution when converting GDP per capita into PPP terms. These differences become more pronounced after 2001, explaining the deeper decline of the redistributive effect in the PPP scenario and the increasing divergences with respect to the estimated in the EMR scenario.

4.1.4. Is redistribution less than what might occur as a result of the reranking effect?

Figure 5a and 5b displays the decomposition of the redistributive effect into vertical redistribution (potential redistribution) and reranking effect, following equation (7).

In the EMR estimates, the reranking effect exists, albeit it remains low. For this reason, vertical redistribution is slightly greater than the total redistributive effect. This implies that oil rents implicit in international trade do not lose excessive redistributive potential because of countries changing their position

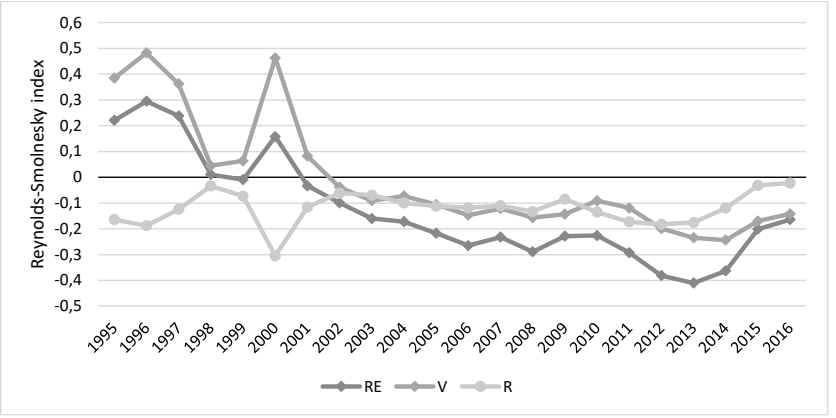
Figure 5a. Progression of the components of the redistributive effect: Vertical and Reranking effects (2010 US dollars)



Source: Authors' own compilation. Note: RE refers to the redistributive effect, V refers to vertical redistribution and R refers to reranking effect.

in the distribution. It is also observed that this loss of potential redistribution evolves inversely to that of vertical redistribution, such that in periods when the redistributive potential is greater (vertical effect), the loss of the redistributive effect due to reranking is also greater. This behaviour is perfectly explainable

Figure 5b. Progression of the components of the redistributive effect: Vertical and Reranking effects (2011 PPP dollars)



Source: Authors' own compilation. Note: RE refers to the redistributive effect, V refers to vertical redistribution and R refers to reranking effect.

since when oil rents are very high, the increased GDP per capita of exporters and the reduced GDP per capita of importers is greater, such that the former are more likely to surpass the latter in the distribution of income, and vice versa when oil rents decrease.

The potential redistributive effect and reranking follow a different evolution in the PPP scenario (Figure 5b). Firstly, the reranking effect is on average 2.5 times higher in this scenario. The smaller income inequality estimated when using PPP dollars means that GDP per capita differences between countries are smaller as well, making reranking more likely to occur. Given this, reranking offsets almost half of the positive redistributive potential of oil trade rents in the period before 2001, thus, reducing the actual redistributive effect.

The loss of redistribution caused by reranking is coupled with a declining potential redistributive effect after 2001, which could be explained by the upward movement of high-income oil-exporting countries in the top deciles of the income distribution, as shown in Table 5, generating a potential regressive impact of oil rents. The evolution of both effects (i.e., reranking and the potential redistribution) explains the negative redistribution, which takes place after 2001 and the increasing divergence in the redistributive effect between EMR and PPP estimates.

5. Conclusion and policy implications

Every natural resource which is physically limited incorporates an economic rent in its price associated with its scarcity. When this limited natural resource is traded internationally, the rent that it incorporates works as an implicit transfer from the importing to the exporting country, thereby, contributing to the international redistribution of income. Oil is the limited natural resource with the greatest weight in international trade. As a result, these rents implicit in its price can be one of the most powerful mechanisms for global redistribution.

This paper calculated these rents. It estimated these to involve an average implicit annual transfer of around 647 billion 2010 U.S. dollars over the period 1995-2016. On average, this accounts for 8.05% of exporting countries' GDP (42 countries), reaching a maximum of 12.04% in 2000. However, it only represents 1.06% of GDP on average for importing countries (126 countries). That is, it is a small transfer for importers, but a relatively large one for exporters, particularly for those who have been classified as extremely highly dependent countries (i.e., Congo, Angola, Libya, Kuwait, Gabon, Oman, Yemen and Saudi Arabia) and highly dependent countries (i.e., Azerbaijan, Nigeria, Brunei, Iran, United Arab Emirates and Qatar).

Once international oil trade rents were estimated, we determined their redistributive effect. A progressive redistribution was found that reduced international income inequality by an average of 0.12 points on the Gini index, with a maximum of 0.32 points in 1997, when income was measured in US dollars. This places the international redistribution of rents implicitly

into international oil trade close to the official development assistance (i.e., technical development cooperation, grant equivalent of concessional lending and debt relief) whose redistributive effect was 0.44 points of the Gini index in 2004 (Bourguignon et al., 2009). However, the redistributive effect of oil trade rents became regressive after 2001 when income was measured in PPP dollars, showing a deeper downward trend than the one found in the exchange market rate estimates.

This redistributive effect revealed that most of it took place trough rents received in exports, although they lost ground after 2001 in terms of PPP estimates. Overall, oil trade rents reduced inequality by increasing the income of exporting countries, whereas their reversion in PPP estimates was caused by a shift of oil export rents gains to the upper deciles. In contrast, imports had a regressive effect. This regressive effect, which increased at the end of the period analysed, was due to the fact that oil imports had a greater relative weight in countries with a lower GDP per capita. When we analysed the impact of oil rents by levels of GDP per capita, the overall result was that the lowest deciles in international income distribution were those that experienced the greatest increases in GDP per capita as a result of oil rents, although the impact on these countries decreased at the end of the same period. A further decline in the redistributive effect of international oil rents can be expected in both scenarios, given the shift that high-income oil exporters in the international income distribution have experienced and the incorporation of the United States as an oil exporter after the shale oil revolution.

The results also documented that the redistributive potential or capacity of oil rents was affected by the reranking effect, that is, by changes in the order (the position in income distribution before and after accounting for oil rents). This loss of redistributive capacity was small in exchange market rate estimates. However, the reranking effect was 2.5 times higher when it was estimated using PPP incomes, thus, generating a bigger loss of potential redistribution.

This paper breaks new ground in the study of the redistributive effect of international oil trade on international income distribution. It estimates for the first time the oil rents transfers in the international market. In addition, it applied a set of methodologies that provide an exhaustive analysis of the effects of any international rent transfer. Finally, the main contribution is that it introduced a new concept, the implicit transfer of rent on trade, which opens up new fields of research in terms of global income inequality. Specifically, it is applicable to other natural resources traded internationally and other rents, such as those that may derive from the monopolistic or oligopolistic functioning of international markets.

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Appendix

Table A1. Average Rent/GDP by country (1995-2016)

Country	Rent/GDP	Rents (millions)	Country	Rent/GDP	Rents (millions)	Country	Rent/GDP	Rents (millions)
Rep. of Congo	32.76	3,322.96	Mauritania	1.44	87.12	Hong Kong	0.00	0.00
Oman	31.69	15,390.12	Malaysia	1.17	2,242.90	Iceland	0.00	0.00
Libya	30.51	17,136.25	Mongolia	0.92	84.12	Kiribati	0.00	0.00
Kuwait	29.61	32,502.28	Indonesia	0.64	3,066.70	Lao	0.00	0.00
Angola	29.08	17,407.92	Argentina	0.50	1,609.26	Latvia	0.00	0.00
Saudi Arabia	28.33	136,925.15	Bolivia	0.39	73.62	Maldives	0.00	0.00
Gabon	25.98	3,657.91	Guatemala	0.30	119.58	Malta	0.00	0.00
Yemen	22.58	4,902.17	Denmark	0.27	867.95	Mauritius	0.00	0.00
Brunei Darussalam	19.23	2,520.48	Uzbekistan	0.22	105.38	Mozambique	0.00	0.00
Qatar	18.61	11,698.23	Benin	0.06	3.56	Nepal	0.00	0.00
Iran	17.09	62,673.23	Tajikistan	0.03	1.13	Puerto Rico	0.00	0.00
United Arab Emirates	16.83	44,847.49	Niger	0.01	0.57	Rwanda	0.00	0.00
Nigeria	16.31	37,532.76	Lesotho	0.00	0.00	St. Kitts and Nevis	0.00	0.00
Azerbaijan	15.21	6,085.23	Luxembourg	0.00	0.00	St. Lucia	0.00	0.00
Venezuela	11.02	37,898.86	Antigua and Barbuda	0.00	0.00	St. Vincent and the Grenadines	0.00	0.00
Kazakhstan	11.02	13,470.88	Armenia	0.00	0.00	Samoa	0.00	0.00
Chad	9.83	969.66	Bhutan	0.00	0.00	Seychelles	0.00	0.00
Algeria	9.63	14,147.03	Burkina Faso	0.00	0.00	Sierra Leone	0.00	0.00
Ecuador	7.22	4,608.15	Burundi	0.00	0.00	Solomon Islands	0.00	0.00

Sudan	5.92	2,598.30	Cabo Verde	0.00	0.00	Suriname	0.00	0.00
Norway	5.54	22,206.63	Cambodia	0.00	0.00	Togo	0.00	0.00
Russia	4.65	61,590.41	Central African Republic	0.00	0.00	Tonga	0.00	0.00
Turkmenistan	3.49	594.75	Comoros	0.00	0.00	Uganda	0.00	0.00
Cameroon	2.86	628.45	Dominica	0.00	0.00	Vanuatu	0.00	0.00
Dem. Rep. of the Congo	2.77	504.25	Estonia	0.00	0.00	Zimbabwe	0.00	0.00
Colombia	2.53	6,773.11	Grenada	0.00	0.00	Fiji	0.00	0.00
Mexico	2.04	20,365.71	Guinea	0.00	0.00	Lebanon	0.00	-0.03
Tunisia	1.96	751.60	Guyana	0.00	0.00	Malawi	0.00	-0.01
Belize	1.60	21.96	Haiti	0.00	0.00	Mali	0.00	-0.02
Egypt	1.50	2,539.76	Honduras	0.00	0.00	Moldova	0.00	-0.02
Botswana	0.00	-0.04	Bosnia and Herzegovina	-0.97	-166.02	Greece	-2.24	-6,058.36
Eswatini	0.00	-0.17	China	-1.00	-53,447.26	Jamaica	-2.27	-304.21
Namibia	0.00	-0.51	Japan	-1.01	-57,006.06	Slovakia	-2.28	-1,726.70
Kyrgyzstan	-0.04	-1.60	Italy	-1.08	-22,819.16	North Macedonia	-2.36	-190.90
Slovenia	-0.05	-15.15	Zambia	-1.09	-168.04	Ukraine	-2.40	-2,796.52
Georgia	-0.06	1.08	El Salvador	-1.11	-190.40	Côte d'Ivoire	-2.56	-621.58
Gambia	-0.06	-0.70	Turkey	-1.14	-7,613.75	Nicaragua	-2.58	-210.39
Guinea-Bissau	-0.07	-0.47	Dominican Rep.	-1.17	-499.26	Trinidad and Tobago	-2.82	-554.94
Paraguay	-0.07	-14.13	Sweden	-1.22	-5,653.99	India	-2.93	-44,052.59
Brazil	-0.12	-1,492.26	Pakistan	-1.26	-2,002.67	Rep. of Korea	-3.29	-33,043.33
Tanzania	-0.15	-23.22	Czech Rep.	-1.29	-2,399.13	Bahamas	-3.46	-346.59

Ethiopia	-0.17	-19.70	Finland	-1.34	-3,164.52	Thailand	-3.96	-11,979.47
Papua New Guinea	-0.17	-17.08	Ghana	-1.35	-167.92	Bulgaria	-4.80	-2,082.74
Canada	-0.18	-2,695.09	Spain	-1.38	-18,052.85	Jordan	-5.62	-1,164.18
United Kingdom	-0.18	-4,569.75	Israel	-1.48	-3,129.17	Lithuania	-6.82	-2,377.96
Barbados	-0.22	-10.55	Hungary	-1.52	-1,894.10	Singapore	-7.87	-15,214.70
Switzerland	-0.26	-1,401.22	Poland	-1.53	-6,518.40	Bahrain	-8.56	-1,391.41
Australia	-0.27	-2,781.42	Sri Lanka	-1.53	-682.98	Belarus	-12.23	-5,426.09
Bangladesh	-0.38	-363.11	Kenya	-1.59	-506.68			
Costa Rica	-0.39	-114.47	Chile	-1.59	-3,024.22			
Madagascar	-0.42	-30.60	Uruguay	-1.65	-570.81			
Ireland	-0.43	-877.36	Portugal	-1.65	-3,725.34			
Austria	-0.61	-2,273.22	Romania	-1.66	-2,395.15			
Cyprus	-0.70	-189.07	Senegal	-1.77	-251.83			
Panama	-0.70	-109.22	Netherlands	-1.90	-15,236.41			
New Zealand	-0.74	-1,015.30	Philippines	-1.97	-3,283.10			
France	-0.85	-21,624.18	South Africa	-2.00	-6,790.44			
Germany	-0.87	-29,045.75	Croatia	-2.02	-1,109.12			
United States of America	-0.87	-125,269.57	Belgium	-2.11	-9,588.85			
Peru	-0.89	-1,127.55	Morocco	-2.19	-1,701.15			

Source: Authors' own compilation. Rents are expressed in millions $2010 U.S. dollars.