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Oil Dependency and Quality of Education: New Empirical Evidence

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Abstract

The resource curse hypothesis suggests that resource-rich countries (especially oil dependent economies) show lower economic growth rates compared to resource-poor countries. We add to this literature by providing empirical evidence on a new transmission channel of the resource curse, namely, the negative long-run effect of oil rents on the quality of education. Our empirical analysis for more than 70 countries in the period of 1995-2015 shows a significantly positive effect of oil rents on the quantity of education measured by government spending on primary and secondary education. However, we find a robust and negative long-run effect of oil rents dependency on the objective and subjective indicators of quality of education, controlling for a set of other drivers of education quality and regional dummies. The significant negative effect of oil rents dependency on education quality can be explained by both the demand (e.g., skill acquisition) and supply (e.g., teacher quality) side channels.

Keywords. oil rents, resource curse, quality of education, quantity of education

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1. Introduction

The resource curse hypothesis suggests that resource-rich countries (especially, oil dependent economies), on average and in the long run, show lower economic growth rates compared to resource-poor countries (see Fleming et al., 2015; Badeeb et al., 2017)[1]. Gylfason (2001) pointed out that one channel of the resource curse is degradation of quantity of schooling and education spending. Using extended data, we show that resource (oil) rents are not anymore negatively associated with *quantity* indicators of education.[2] We provide empirical evidence on a new transmission channel of the resource curse, namely, the negative effect of oil rents on the *quality* of education. This channel of the resource curse has been largely neglected in the literature so far.

There is an extensive literature on the positive effect of education on long-run growth in cross-country studies (see, for example, Romer, 1989; Barro, 1991; Murphy et al., 1991; Levine and Renelt, 1992 and Mankiw et al., 1992).[3] In recent years, one of the main criteria for debt forgiveness of the Heavily Indebted Poor Countries has been increased spending on education (Andrews et al., 1999). International organizations, such as the World Bank, are allocating significant budgets for the expansion of schooling in developing countries. In its 2015 annual report, the World Bank emphasized education as one the best ways to end poverty. The Bank's investment in education projects is now more than $14 billion [World Bank (2015)].

In addition to quantity of education, it is also shown that the quality of education and cognitive skills have important direct and indirect effects on long-run economic growth across countries (see Hanushek, 2013; Hanushek and Woessmann, 2008, 2015; and Jamison et al., 2007). However, larger spending on education may not automatically lead to a higher quality of

[1] Gerelmaa and Kotani (2016) analysis shows that from 1970 to 1990, the hypotheses of a resource curse hold. However, they could not support the resource curse hypothesis in the period from 1990 to 2010. They suggest that this is because "manufacturing sectors have grown sufficiently even in resource-rich countries".

[2] Similar results for the case of the United States have been found by James (2017).

[3] For a meta-regression analysis of education-growth nexus see Benos and Zotou (2014).

education (see Hanushek, 2005 for similar argument). In one of its recent feature stories, the World Bank (2016) illustrated the alarming status of education quality in 10 Francophone African countries despite the massive investment in education and access to schooling over the last 15 years. Most assessed students in these countries show significant deficits in language and mathematics tests.[4] Another example is in the Middle East and North Africa (MENA). The Middle East region, which is, on average, one of the resource-richest parts of the world, has increased its education expenditures in the last 20 years and is now allocating a significant share of government budgets to education. In the MENA region, government spending on education as a share of GDP is above the world average [(5.4% MENA vs. 4.4% world average, average from 1995 to 2012, World Bank (2017)]. As a share of GDP, the MENA governments spend even more on education than OECD countries.[5] However, the monetary investment is not reflected in the quality of education, as noted by Kaarsen (2014), who has developed a new index to measure the quality of schooling across countries. He classifies the oil-exporting countries as outliers since – despite their relatively high income per capita – they are not exhibiting the existence of high-quality education. In his words: "*Another group of outliers consists of the oil producing countries Saudi Arabia, Qatar, Kuwait and Oman. In these countries, GDP per worker is relatively high while education quality is low*" (p. 219). Kaarsen does not provide any empirical evidence on the nexus between oil rents dependency and education quality. Our aim is to examine this nexus in a multivariate framework and to clarify the mechanism.

[4] http://www.worldbank.org/en/news/feature/2016/03/10/education-quality-measuring-learning-outcomes-in-francophone-africas-primary-schools

[5] We see the same impressive funding of education, when we consider its share of government total spending (16.3% in the MENA vs. 13.9% world average). In addition, educational spending per student at the secondary level (in relation to GDP per capita) is higher in the resource-rich MENA region (19.5%) than in East Asia (14.7%) or Latin America (13.9%).

The remainder of this paper is structured as follows. Section 2 discusses the literature on the nexus between education and natural resource rents. Using more recent data, Section 3 presents a re-examination of the question whether oil-rich countries spend less on education.[6] Section 4 turns to the question whether oil-rich countries generate lower educational qualities. Section 5 discusses the possible transmission channels, which can explain the effect of oil rents on education quality. Section 6 concludes the paper.

2. Resource rents and education: a review of literature

Earlier studies, such as Sachs and Warner (2001), focus on the direct association between development and resource rents. Since then, a large body of literature has aimed at explaining the transmission channels of the resource curse. Why do resources generate lower growth? Some contributions highlight the role of institutions, corruption and social trust (e.g., Mehlum et al., 2006; Kolstad and Søreide, 2009; Kolstad and Wiig, 2012), while others refer to structural economic impacts of large resource rents positive and negative shocks, e.g., the Dutch disease (van Wijnbergen, 1984; Farzanegan and Markwardt, 2009; Farzanegan, 2011). Ethnical and political fractionalizations are also examined as important factors in the development-rent nexus. Countries with ethnically and/or politically fractionalized system face more often the resource curse than homogenous countries (Hodler, 2006; Bjorvatn et al., 2012, 2013; Bjorvatn and Farzanegan, 2015). Using geocoded data of mines, Lessmann and Steinkraus (2017) demonstrate that spatial distribution of resource endowments within countries drives the curse of natural resources.

Gylfason (2001) stresses the neglect of education as a crucial factor behind the curse of resources, particularly in oil-rich countries. In his cross-country regression analysis, he finds that key education indicators – such as public expenditure on education as a percentage of GDP,

[6] Literature shows that the curse is in point-resources such as oil and gas which offer significant economic rents (Ross, 2012). Thus, in this paper we focus on oil rents dependency.

secondary enrolment, and expected years of schooling for girls – are negatively correlated with resource rents and that economic growth and education are positively correlated. He concludes that neglecting education is as important as other channels, such as rent seeking and the Dutch disease, in explaining the so-called resource curse. Stijns (2006) shows that the correlation between natural resource abundance and human capital accumulation crucially depends on the definition of resource abundance. In particular, subsoil wealth, which is a measure of the remaining resource wealth of a country, is positively correlated with human capital accumulation. There are also some more descriptive studies on the subject. For instance, Birdsall et al. (2001) use arable land per capita as a proxy for resource abundance and argue that the distribution of resource rents reduces the incentives to invest in education.[7] In contrast to earlier findings on the negative effect of resource rents (especially oil rents) on quantity of education, James (2017) uses a panel of U.S. state-level data and shows that public school enrollment and education funding is relatively high in resource rich states. In addition, he finds an improvement in the relative teacher salaries and teacher-student ratios during resource booms in a sample of U.S. states.

Contribution of this paper

Our study differs from Gylfason (2001) by emphasizing education *quality* as a transmission channel for the resource curse. Under-estimating the role of education quality may explain the mixed results in the literature on the nexus between education spending and development. One group finds that government spending on education and health care can increase economic growth and reduce poverty (e.g., see Barro 1991; Tanzi and Chu 1998; Sylwester 2002). Another group highlights the important role of institutions in the final growth effects of

[7] Davis (1995) sees positive effects of resource rents on schooling, as literacy rates and enrollment are higher in resource-rich countries than in other (developing) countries.

education spending. Education spending may not lead to economic growth when the quality of economic and political institutions is weak (Pritchett 2001; Benhabib and Spiegel 1994)[8].

The two main questions that we are examining in our study are as follows:

Q1: Do oil-rich countries invest less in education systems, particularly at primary and secondary levels?

Q2: Does higher dependency on oil rents affect the quality of the education system negatively?

With Q1, we replicate some parts of Gylfason's analysis on the rent-spending nexus with more recent data.[9] Q2 then shifts the focus to education quality. To answer these questions, we use data on education spending (2006-15) as well as recently published data on the (objective and perceived) quality of education. The oil rents and other control variables are measured as the average of the period 1995-2005. The cross-country analysis for more than 70 countries shows a significantly positive effect of oil rents on government spending on primary and secondary education. Hence, the underspending hypothesis championed by Gylfason (2001) no longer holds with newer data. However, we find a robust and negative effect of oil rents on the current quality of education, controlling for a set of other drivers of education quality and regional dummies. Despite spending significant shares of domestic GDP on education, the oil-rich countries still suffer from an insufficient quality of primary and secondary education, which may hamper their growth potentials.

[8] We have also investigated the effect of education spending and education quality on the long-run economic growth rates in our sample of analysis, controlling for other possible drivers of growth. The results are shown in Appendix Tables A2 and A3. Our cross-country results support the argument of scholars who are questioning the effectiveness of education spending *per se* on long-term growth. However, we find that there is a robust positive effect of education quality on long-term growth, which is also in line with findings of Hanushek and Woessmann (2013).

[9] We also re-examine the resource-curse hypothesis by regressing the degree of dependency of economy to oil rents in 1990 on the GDP per capita growth rates from 1990 to 2015, controlling for a couple of other growth drivers and regional dummies. The initial dependence on oil rents has a negative and significant effect on the long-term growth rates in our sample, which is in line with resource curse hypothesis (see Table A1 in Appendix). There is also a line of literature, which argues for positive long-run growth effect of natural resource wealth (see Alexeev and Conrad, 2009). Alexeev and Conrad (2011) also finds little evidence for the resource curse in a sample of transition countries.

3. Public spending on education and resource rents

As a prerequisite to our key research question (Q2), we re-examine the earlier hypothesis in the resource curse literature that resource-rich countries are under-spending in their educational system. We use recent data on public spending on education at primary and secondary levels. To answer Q1 we employ the following specification:

$$eduexp_i = cons + \beta_1 \cdot rent\_gdp_i + \beta_2 \cdot Z_i + \varepsilon_i \quad (1)$$

where *eduexp* stands for the government expenditure on education, *rent_gdp* stands for the ratio of resource rents to GDP, and *Z* covers the set of other control variables.

Data

We use the (log of) PPP adjusted spending per student on both primary and secondary education as dependent variables.[10] It is important to adjust per student spending by considering the purchasing power in different countries. For example, spending 500 US$ on education buys quite different amounts of teaching hours in Yemen and Germany.[11] We use the simple average from 2006 to 2015.

Our key variable of interest in explaining cross-country differences in public spending on education is the dependency on resource rents. In line with most of the literature on the resource curse, we focus on oil rents, as oil is the economically most relevant resource. Oil rents are defined as the difference between the value of crude oil production at world prices and total costs of production. The rent-to-GDP ratio captures the relative importance of rents in a country and has been used frequently in the resource curse literature (e.g., Bjorvatn and Farzanegan 2015; Arezki and Gylfason 2013). The oil rents data are from the World Bank (2017). This and

[10] We are not considering the tertiary level of education in our analysis because our main focus is also on the quality of the educational system, which is measured up to the secondary level of schooling.

[11] As the World Bank (2017) data on education expenditures is expressed in relation to GDP per capita of a country, we first multiply the government expenditure per student (percentage of GDP per capita) by GDP per capita in the local currency of each country. The outcome is then divided by the PPP conversion factor.

other control variables are measured as the average of the period 1995-2005. This strategy helps us to not only reduce the risk of reverse feedback from the dependent variables (2006-2015) on a couple of right-hand-side variables, such as GDP but also acknowledges the time needed to influence the dependent variable in our model.

In addition to oil rents, we need to control for a couple of other channels, which may affect the education spending per student at primary or secondary levels. In the *Z* vector, we control for the logarithm of GDP per capita (constant 2010 US$). If education is a normal good, rising per capita incomes will induce parents to demand higher investments in education. Hence, we expect to observe a positive association between income per capita and the quantity of education. We also control for population growth, as a higher growth rate in the past decade will increase the entry into primary and secondary schools in the current period and reduce the available public funds for education per student. The openness to international trade and investors can also influence the government spending on education. To remain an attractive market for international investors and traders, an economy should be able to provide facilities and infrastructure for human capital formation. Thus, we control for trade (as a percentage of GDP) and foreign direct investment (FDI) (as a percentage of GDP). The source of data for the control variables is the World Bank (2017).

In addition to these economic and demographic controls, we have also included an indicator for the quality of economic and political institutions. Following Mehlum et al. (2006), we use an unweighted average of six dimensions of institutional quality based on the data from the International Country Risk Guide (ICRG), which is published by the Political Risk Service Group. These dimensions are 'law and order' (from 0 to 6, where a higher number indicates better institutions), 'democratic accountability' (from 0 to 6), 'political corruption' (0 to 6), 'internal conflict' (from 0 to 12), 'bureaucracy quality' (0 to 4), and 'investment profile' (from 0 to 12). Higher scores of the index imply a better quality of economic and political institutions.

In their theoretical and empirical analysis, Dizaji et al. (2016) show that positive developments in the quality of democratic institutions go along with a more generous allocation of resources to education and with lower military spending. Corruption together with a weaker rule of law distorts the allocation of public budgets; public funds are channeled to areas that have higher return from bribes and lower risks of detection. These are mostly capital-intensive projects rather than education or health (see Gupta et al. 2001). Internal risk of conflict may also change the priority of the government for budget allocation – away from education toward military spending.

Furthermore, we also control for regional dummies, such as Sub-Saharan Africa, Latin America, East Asia and the Pacific, and Europe and Central Asia. These regional dummies control for the region-specific factors, which affect public spending on education such as the values and attitudes of the people toward education.

Results

The results are presented in Table 1. Models 1.1 to 1.7 show the effects of oil rents dependency and other control variables on (the logarithm of) public spending per student in *secondary* education (PPP adjusted). We follow a specific to general approach by adding control variables to the initial specification. Models 1.8 to 1.14 use the logarithm of public spending on each student in *primary* education. We have no empirical evidence on the under-spending of governments in oil-rich countries for primary and secondary education. Quite the opposite: there is a positive and statistically significant effect of higher oil rents (for the period of 1995-2005) on the education spending per student in primary and secondary education (in the period 2006-2015) in the majority of the models. The size of the effect of oil rents is stronger for the case of spending on the secondary level of schooling. For example, in Model 1.7, an increase in the share of oil rents in GDP by one standard deviation (12.7% between 1995-2005) increases government spending per student in secondary school by 0.12 standard deviation between 2006-

2015. In Model 1.14, a similar increase in oil rents leads to an increase of government spending per student at the primary level by 0.08 standard deviation. Another way of expressing the size of the relationship between oil rents and government spending per student is through an adjusted-squared partial correlation (the so-called partial omega squared). It adjusts for the number of predictors of education spending in our models, giving a more accurate representation of the population value. In the general Model 1.7, the omega-squared for the entire model is 89.3%. Oil rents explain 6.7% of the variance in public spending per student at the secondary level. GDP per capita explains 52.7%. The second most important variable is population growth, which explains 7.1% of the variance. Oil rents are the third most important variable in explaining that the government spending on students and its effects is more relevant for explaining secondary school expenditures.[12]

As expected, the logarithm of GDP per capita shows a robust and statistically significant effect on public education spending per student in all models. Higher population growth shows a negative effect on education spending per student at both the primary and the secondary levels. A larger population burden will not only increase the entry rates into schools but also put additional pressures on the government's limited budget for other categories such as health. Quality of institutions shows a positive association with government education spending per student but this positive association is statistically significant only for the case of predicting the spending on students at the secondary level of education (Models 1.3, 1.4, and 1.6).[13] Both

[12] In Model 1.4, the omega-squared for the entire model is 91.7%. Oil rents explain 3.1% of the variance of government spending per students at primary levels while the most important explanatory variable is GDP per capita (59%), followed by population growth rate (8%).

[13] This lack of statistical significance may be due to the correlation between GDP per capita and the quality of institutions in our sample (correlation coefficient of 0.78). For example, if we omit the GDP per capita in Model 1.7, the positive effect of institutions becomes significant at the 99% confidence interval (CI), and its coefficient increases from 0.168 to 0.868. It also increases the statistical significance of oil rents from 95% CI to 99% CI and its size from 0.02 to 0.05. By omitting the GDP per capita in Model 1.14, the positive effect of institutions on public spending per students at the primary level becomes statistically significant at 99% CI. In addition, the coefficient for political and economic institutions shows a significant increase from 0.10 to 0.81. In other words, inclusion of income per capita absorbs the significant effect of institutional quality on the public spending per student. Inclusion or exclusion of income per capita, however, has no significant effect on the influence of oil rents on public education spending. To check the extent of multicollinearity, we have examined the variance inflation

openness to international trade and investment are important predictors of government spending on education. Being exposed to global markets (intensity of imports and exports) and to international investors may increase the rate of return for education in a country. Open and competitive economies look for skilled manpower, sending strong signals to the government of the need for spending on education.

Our cross-country investigation shows that earlier findings in the resource curse literature (e.g., Gylfason, 2001) that resource-rich countries are under-spending in their educational system are no longer present when using recent data. Our results are in line with findings in case study of the United States by James (2017). Our investigation, however, does not imply that the resource curse has vanished. The interesting question now is whether the high public spending on education at primary and secondary levels in oil-rich countries translates into a high quality of education.

factor (VIF) in our general models of 1.7 and 1.14. The mean VIF is 3.02 in Model 1.7 and 3.08 in Model 1.14. As a rule of thumb, a variable whose VIF values are greater than 10 may merit further investigation. None of our variables in general models have VIF values larger than 10.

Table 1. Resource rents and government spending per student at the primary and secondary levels

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)	(1.7)	(1.8)	(1.9)	(1.10)	(1.11)	(1.12)	(1.13)	(1.14)
	log_ppp_spending_secondary student 2006_15							log_ppp_spending_primary_student 2006_15						
oil rent (% GDP)	-0.001	0.004	0.021***	0.024***	0.021***	0.023***	0.020**	-0.001	0.008**	0.014**	0.016**	0.014*	0.016**	0.012*
	(-0.37)	(0.75)	(2.72)	(3.18)	(2.75)	(3.05)	(2.30)	(-0.18)	(2.28)	(2.00)	(2.30)	(1.82)	(2.06)	(1.80)
log GDP per capita	0.777***	0.754***	0.606***	0.570***	0.628***	0.588***	0.649***	0.814***	0.770***	0.714***	0.683***	0.711***	0.675***	0.646***
	(22.92)	(22.51)	(7.57)	(7.71)	(6.84)	(6.86)	(6.96)	(25.39)	(26.35)	(12.32)	(13.59)	(11.16)	(12.35)	(10.33)
population growth		-0.127***	-0.140***	-0.115**	-0.161***	-0.134***	-0.163**		-0.224***	-0.217***	-0.194***	-0.224***	-0.204***	-0.154***
		(-3.28)	(-2.67)	(-2.40)	(-3.02)	(-2.69)	(-2.28)		(-5.80)	(-4.58)	(-4.32)	(-4.57)	(-4.39)	(-2.76)
ICRG institutional quality			0.221*	0.277**	0.162	0.238**	0.168			0.081	0.143	0.063	0.138	0.103
			(1.80)	(2.63)	(1.23)	(2.08)	(1.25)			(0.75)	(1.60)	(0.57)	(1.50)	(0.97)
FDI (% GDP)				0.015***		0.004	0.002				0.005		-0.006	-0.004
				(3.51)		(0.58)	(0.24)				(1.35)		(-1.08)	(-0.49)
trade (% GDP)					0.002***	0.002**	0.002**					0.001**	0.002**	0.002
					(3.25)	(2.32)	(2.13)					(2.18)	(2.19)	(1.65)
Sub-Sahara							0.187							-0.481***
							(0.84)							(-2.69)
Latin							-0.265							-0.242*
							(-1.47)							(-1.67)
East Asia							-0.191							-0.056
							(-1.11)							(-0.28)
EU & Central Asia							-0.071							-0.005
							(-0.34)							(-0.03)
Countries	104	104	94	93	93	92	92	104	104	94	93	93	92	92
R-sq	0.85	0.87	0.87	0.89	0.87	0.90	0.91	0.87	0.90	0.90	0.92	0.90	0.92	0.93

Robust *t statistics* are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals. All explanatory variables are averages of 1995-2005.

4. The quality of education and resource rents

Our second question aims at examining the effectiveness of government spending on primary and secondary education in oil-rich countries compared to other countries. Can we trace a higher quality of education in oil-rich economies? To answer Q2, we use the following specification:

$$education\ quality_i = cons + \beta_1 \cdot rent\_gdp_i + \beta_2 \cdot Z_i + \varepsilon_i \quad (2)$$

Data

In Eq. (2), our dependent variable measures the quality of education. We use two different indicators – one measure of objective quality and one of perceived quality. Our main proxy to measure quality is a new (objective) index introduced by Kaarsen (2014). In his study on "cross-country differences in the quality of schooling", education quality is defined as the "increase in cognitive skills obtained from an additional year of schooling". He converts the Trends in Math and Science Study (TIMSS) test scores to an index of education quality.[14] His index captures "the effectiveness of one year of schooling in country *i* relative to one year of schooling in the U.S.". The lowest education quality score in our sample is for Yemen with 0.250, and the highest one is for Singapore with 1.363. This index complements the traditional measures of quantity of schooling by the quality of learning, allowing for a more comprehensive view of the potential of human capital formation in a country. Note that the Kaarsen index captures the effectiveness of an education system as it measures the annual progress of students in key competencies. In contrast, the commonly used literacy rates just capture a necessary but by no means sufficient competency for acquiring human capital in a modern economy. In addition, alternative measures such as enrollment ratios or completion rates capture education *de jure* but

[14] Kaarsen (2014) uses data from various TIMSS rounds from 1995, 1999, 2003, 2007 and 2011. Some countries such as the United States have participated in all rounds and some others only in a few of them. The downside of using this data is that we cannot conduct a panel-data analysis, as the Kaarsen index is available only as a cross section.

not *de facto* as the large variation in Kaarsen's data impressively shows. Figure A1 in the Appendix shows global cross-country variation in education quality (for available countries) based on Kaarsen (2014) calculations

In addition to the objective measure of education quality (Kaarsen, 2014) and for robustness checks, we also use the perceived quality of education systems from the Global Competitiveness Reports of the World Economic Forum (WEF).[15] The subjective measure of perceived quality is based on information gathered through executive opinion surveys. Several questions address the quality of education across countries. We use the following survey question: "*How well does the educational system in your country meet the needs of a competitive economy?"* The scores are from 1 (not well at all) to 7 (very well). These data are available from 2006 to 2014. We take the average of the scores for this question from 2006-2014 as a dependent variable. This alternative index of education quality will reflect the opinion of executives on the effectiveness of the education system in fulfilling the job market demands. Figure A2 in the Appendix shows a cross-country variation of this index worldwide.

What are the determinants of cross-country differences in education quality? In addition to the oil rents dependency and other controls used in Section 3, we consider a set of additional variables that might affect the incentives to acquire or provide a high quality of education:

Youth unemployment rate: Youth unemployment refers to the share of the labor force aged 15-24 without work but available for and seeking employment. Higher levels of youth unemployment in an economy can send negative signals to both parents and children about the economic values of demanding high quality education.

Logarithm of government spending on each student in primary (and secondary) education (PPP adjusted): The budgets for primary and secondary education (per student) may matter for the

[15] http://reports.weforum.org/global-competitiveness-report-2015-2016/

quality of educational infrastructure. We have focused on primary and secondary spending since the Kaarsen education quality is based on the performance of students at these levels of education (rather than tertiary education). When we use the WEF education quality (perception based on business managers' opinion on quality of overall education system), we use the total public spending on education (percentage of GDP). We expect to observe a positive association between education spending per student and the quality of education.

Student to teacher ratio at primary and secondary levels of education: A high ratio means that less teaching and supervising capacity is available per student. Particularly with very large classes, this may reduce the quality of learning. Classes with many students are not a fertile environment for significant interaction, practice and effective learning. However, there is little evidence on the significant negative effect of class size on the educational performance of students (Colclough, 1982). Some studies such as Woessmann and West (2006) have found mixed effects of class size on education quality. They argue that the effect depends on the institutional details of the school system and differs across countries. Therefore, the effect of this variable on education quality is ambiguous.

Quality of institutions: The quality of economic and political institutions may affect the incentives of families and children for effective participation in the educational system. Good institutions provide an incentive to acquire soft skills and knowledge for future careers. Better quality of political institutions may also improve education quality through the free flow of information, the improvement in the content of textbooks, reflecting the real needs of society rather than ideologically or politically motivated topics in schools.

Results on the Objective Measure of Education Quality

The results for the determinants of education quality across countries – based on the Kaarsen measure – are shown in Table 2. We examine how the past degree of economic dependence on oil rents affects the quality of education. We follow a specific to general approach, in which oil rents in Model 2.1 are the only explanatory variable of education quality. In Models 2.2 to 2.9, we add other possible determinants of education quality. Model 2.9 is the general specification where we have included a full set of other controls and regional dummies.

The variance inflation factor (VIF) for Model 2.9 indicates some concerns on possible multicollineirty between government spending per student at the primary and secondary levels and GDP per capita.[16] In Model 2.10, we address the multicollineirty concern by excluding insignificant spending per student (at the primary and secondary levels). This leads to a reduction of the VIF for each of the included variables below the critical level of 10. We also exclude the statistically insignificant drivers of education quality in Model 2.11.

In all models (2.1-2.11), we observe a consistent negative and statistically significant effect of oil rents on quality of education.[17] This negative effect is robust to inclusion of other control variables. It shows that dependency on oil rents has a dampening effect on education quality reflected in the performance of students at (lower) secondary levels on international mathematics and science tests. We will discuss the possible channels for this "resource curse" effect in Section 5 in detail.

[16] The mean VIF for Model 2.9 is under the critical level of 10 (8.97). However, the VIF for the logarithm of government spending per student at the secondary level and at the primary level and the logarithm of GDP per capita show VIF of above 10 (24.35, 41.10, and 18.53, respectively).

[17] With the exception of Model 2.8, where oil rents are marginally significant at the 10% level (p-value of 0.106). By excluding the insignificant t variable of spending per student at the primary level and addressing multicollinearity, the statistical significant of oil rents in Model 2.8 increases (p-value of 0.08).

In general, openness to international trade and investment do not show a robust and significant effect on education quality in our analysis sample. In addition, youth unemployment shows no effect on our objective measure of education quality.

The spending on primary education per student shows a positive effect on education quality, which fits the general finding in Colclough's (1982, 167) review article: "*Investment strategies that give primary schooling an important place would be more conducive of growth-with-equity than many alternatives*". However, this positive effect is statistically significant only in Model 2.6.

The negative effect of spending per student at the secondary level on education quality is against our initial expectation. This negative effect may be due to inefficiencies in government spending. The inefficiency of public education spending in oil-rich countries is mentioned in the World Bank study by Le et al. (2010), suggesting that "*public expenditure efficiency is lower in oil-rich countries compared with other developing countries*". They argue that this efficiency deficit is mainly due to "*differences in accountability to citizens of government's spending decisions*". Countries with higher quality of institutions, on average, enjoy a higher degree of transparency in fiscal issues, e.g., addressing public corruption in educational projects more effectively.[18] Nevertheless, the variance inflation factor raises concerns of multicollinearity when we include government education spending per students at both the primary and the secondary levels. When we drop spending per student at the primary level, the negative effect of spending at the secondary level on education quality loses its significance. The ratio of students to teachers in primary and secondary education shows no significant effect on education quality. This is in line with the mixed evidence in studies for OECD countries

[18] The importance of some dimensions of governance such as corruption and the black market premium on foreign exchange (as a proxy for rent seeking) for productive use of schooling and effectiveness of education spending are examined by Rogers (2008).

with more elaborated identification strategies (see, e.g., Altinok and Kingdon 2012 or Woessmann and West 2006).

The effect of economic and political institutions on education quality is captured through the effect of income per capita. In other words, when we exclude income per capita, the positive effect of institutional quality becomes statistically significant at 95% CI.

For the regional dummies, the Sub-Saharan and Latin American regions show a negative effect on education quality. The negative effect of the Sub-Sahara regional dummy on education quality is in line with earlier findings of other studies such as Glewwe et al. (2014). They show that the growth effects of education in Sub-Sahara are lower than in other regions, "*likely due to lower school quality*". By contrast, the regional dummies of East Asia as well as Europe and Central Asia show a positive and significant effect of education quality.

In the general Model of 2.10, the omega-squared for the entire model is 66%. Oil rents explain 10% of the variance in education quality; GDP per capita explains 9.5%.

Table 2. Oil rents and the quality of education (Kaarsen Index)

	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)	(2.9)	(2.10)	(2.11)
	quality_education_kaarsen_1995_2011										
oil rents (% GDP)	-0.012***	-0.011***	-0.011***	-0.011***	-0.011***	-0.015***	-0.013***	-0.010	-0.010*	-0.008***	-0.007***
	(-6.31)	(-5.02)	(-4.77)	(-4.51)	(-4.56)	(-4.66)	(-2.80)	(-1.66)	(-1.94)	(-3.68)	(-3.79)
log GDP per capita		0.113***	0.111***	0.111***	0.110***	0.068	0.096	0.086	0.019	0.078***	0.085***
		(6.88)	(6.86)	(6.71)	(5.40)	(0.86)	(0.91)	(0.88)	(0.21)	(2.90)	(5.89)
trade (% GDP)			0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	
			(1.36)	(1.33)	(1.24)	(1.62)	(1.04)	(1.12)	(0.01)	(1.36)	
FDI (% GDP)				-0.001	-0.001	-0.006	-0.006	-0.007**	-0.001	-0.006*	
				(-0.13)	(-0.13)	(-1.60)	(-1.66)	(-2.26)	(-0.29)	(-1.89)	
youth unemployment					-0.000	-0.001	-0.003	-0.002	-0.001	0.001	
					(-0.14)	(-0.38)	(-0.88)	(-0.56)	(-0.28)	(0.67)	
log PPP spending per secondary stud.						-0.163*	-0.236**	-0.259***	-0.126		
						(-1.79)	(-2.33)	(-2.73)	(-1.26)		
log PPP spending per primary stud.						0.266**	0.230	0.220	0.236		
						(2.08)	(0.97)	(0.93)	(1.23)		
stud_teacher secondary							-0.009	-0.010	-0.008	-0.007	
							(-0.97)	(-1.17)	(-0.80)	(-0.79)	
stud_teacher primary							-0.004	-0.002	0.008	0.004	
							(-0.32)	(-0.20)	(0.68)	(0.51)	
ICRG institutional quality								0.068	-0.002	0.033	
								(1.35)	(-0.03)	(0.82)	
Sub-Sahara									-0.279**	-0.301***	-0.253***
									(-2.40)	(-3.90)	(-4.03)
Latin									-0.136	-0.059	-0.110***
									(-1.06)	(-0.63)	(-2.76)
East Asia & Pacific									0.150	0.187	0.225**
									(1.27)	(1.67)	(2.62)
EU & Central Asia									0.170*	0.162**	0.215***
									(1.92)	(2.39)	(4.82)
Countries	73	72	72	72	72	51	46	46	46	61	72
R-sq	0.17	0.45	0.47	0.47	0.47	0.60	0.64	0.66	0.76	0.73	0.70

Robust *t statistics* are in parenthesis. Independent variables (except for regional dummies) are average values from 1990 to 2000. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals. All explanatory variables are averages of 1995-2005.

Results on the Subjective Measure of Education Quality

We also examine our hypothesis about the negative effect of oil rents on the quality of education by using the subjective index of WEF, which is based on the perception of overall education quality by business executives. Executives have contacts with job seekers and, therefore, may be able to judge the hard and soft skills of the young generation.

Table 3 shows the results using the WEF index of education quality, averaged from 2006 to 2015. The explanatory variables are average values from 1995 to 2005. We include similar control variables as in the previous case. Using the subjective index of education quality does not change our earlier results. Countries with higher dependency on oil rents show a lower education quality as perceived by business executives. The negative association of oil rents with education quality is not sensible to the addition of other control variables.

The education quality of richer countries – based on real GDP per capita – is also perceived to be higher. Countries that are more integrated in global trade show higher perceived education quality as well. In contrast to our earlier results, there is a significant negative effect of past youth unemployment rates on the perceived quality of education by business managers. Higher youth unemployment may be interpreted as a signal for a dysfunctional education system by the business executives. There is a positive and statistically significant effect of spending per student at the secondary level on the perceived quality of education by job providers in business. In Model 2.10, we exclude spending per student at the primary and secondary levels since their existence in the specification shows a high VIF factor, raising concerns of multicollinearity. Excluding spending reduces the VIF factor significantly. We do not observe any significant effect from the ICRG institutional quality index on the education quality. Model 3.11 is a specification, which addresses possible multicollinearity and contains the most significant

variables of earlier models. It explains 64% of the cross-country variation in the quality of education perceptions in our sample.[19]

[19] Note that only a fraction of the 123 countries in Model 3.1 have significant oil rents. Eighty-four countries have non-zero oil rents, and 37 countries exhibit oil-rents-to-GDP ratios of more than 1%.

Table 3. Oil rents and the quality of education (WEF Index)

	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)	(3.8)	(3.9)	(3.10)	(3.11)
						WEF_quality_education 2006_2015					
oil rent (% GDP)	-0.025***	-0.027***	-0.027***	-0.027***	-0.026***	-0.032***	-0.034***	-0.019	-0.033**	-0.035***	-0.030***
	(-2.91)	(-4.41)	(-4.20)	(-4.20)	(-4.32)	(-3.05)	(-3.75)	(-1.42)	(-2.34)	(-3.80)	(-5.23)
log GDP pc		0.399***	0.385***	0.385***	0.376***	0.052	0.119	0.008	0.248	0.349***	0.364***
		(9.75)	(9.12)	(9.08)	(9.54)	(0.28)	(0.62)	(0.04)	(1.27)	(3.28)	(10.42)
trade (% GDP)			0.004***	0.003**	0.003**	0.003	0.004*	0.003	0.004	0.003	0.002*
			(2.86)	(2.18)	(2.08)	(1.31)	(1.82)	(1.45)	(1.63)	(1.62)	(1.97)
FDI (% GDP)				0.005	0.003	0.000	0.001	0.001	-0.005	0.000	
				(0.59)	(0.44)	(0.03)	(0.09)	(0.08)	(-0.39)	(0.03)	
youth unemployment					-0.019***	-0.029***	-0.027***	-0.024***	-0.024***	-0.020***	-0.020***
					(-3.77)	(-4.44)	(-3.65)	(-2.85)	(-2.85)	(-3.01)	(-4.38)
log PPP spending per secondary stud.						0.605***	0.852***	0.950***	0.656**		
						(3.77)	(3.55)	(4.24)	(2.02)		
log PPP spending per primary stud.						-0.126	-0.429	-0.598*	-0.575*		
						(-0.51)	(-1.34)	(-1.84)	(-1.79)		
stud_teacher secondary							0.043**	0.055***	0.047**	0.009	
							(2.12)	(2.92)	(2.42)	(0.59)	
stud_teacher primary							-0.016	-0.026*	-0.021	-0.010	
							(-1.06)	(-1.77)	(-1.37)	(-0.82)	
ICRG institutional quality								0.293	0.199	-0.008	
								(1.50)	(0.84)	(-0.06)	
Sub-Sahara									-0.314	-0.012	
									(-0.67)	(-0.04)	
Latin									-0.754***	-1.023***	-0.771***
									(-2.70)	(-5.17)	(-5.26)
East Asia & Pacific									-0.352	-0.209	
									(-1.18)	(-0.90)	
EU & Central Asia									-0.302	-0.399*	
									(-1.10)	(-1.98)	
Obs.	124	123	122	122	122	79	74	67	67	96	122
R-sq	0.06	0.45	0.49	0.49	0.54	0.60	0.59	0.64	0.68	0.62	0.64

Robust *t statistics* are in parenthesis. Independent variables are average values from 1995 to 2005. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

Robustness checks

Using an international database on human capital quality

For a robustness check, we also re-estimate our previous specifications by using an alternative indicator of human capital introduced and calculated by Altinok and Murseli (2007). In comparison with earlier studies such as Lee and Barro (2001) or Hanushek and Kimko (2000), their index covers a larger number of countries from different income groups while the earlier studies are often focused on high income countries. Altinok and Murseli (2007) use eight international surveys on children's learning achievement, focusing on the most recent data (post-1995) and on the quality of education at the secondary level of schooling (grade 8). In particular, they examine the performance of students at grade 8 in mathematics, science and reading. All surveys are adjusted to a scale from 0 to 100 (maximum performance score).

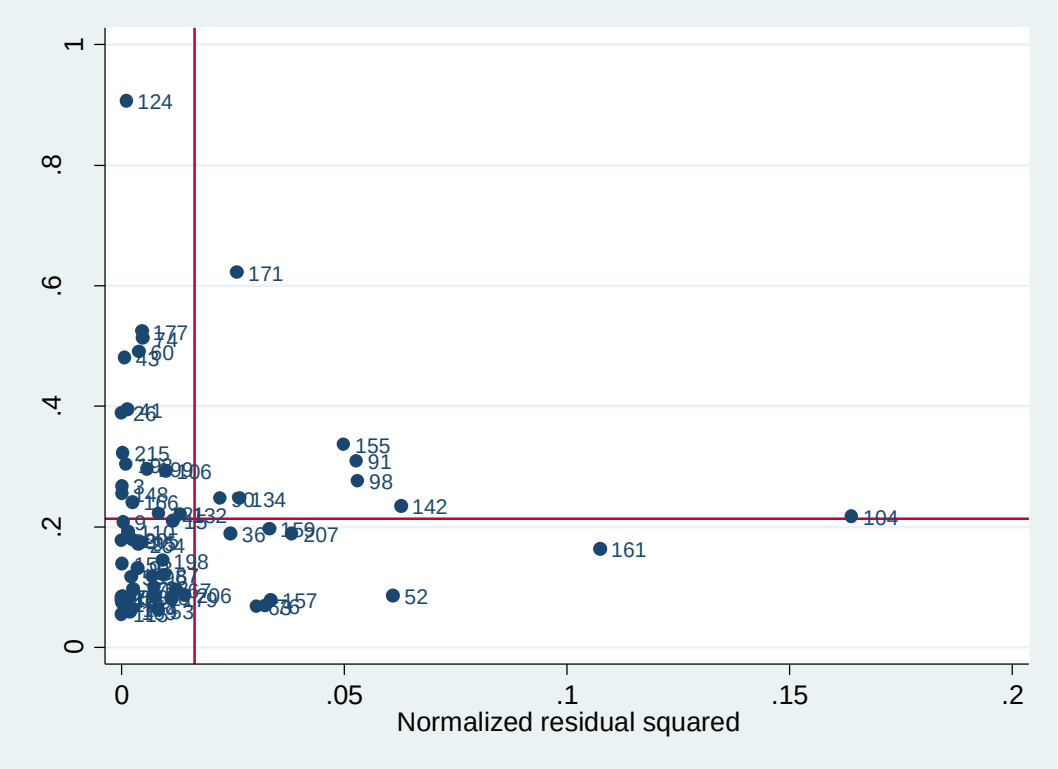
In our robustness test, we replace the Kaarsen education quality index with the Altinok and Murseli index of average student performance in the three dimensions. The results are presented in Table A4 in the Appendix. The results show a consistent negative and statistically robust effect of oil rents dependency on the average quality of education, controlling for other determinants of education quality. GDP per capita and the regional dummies for the Sub-Sahara, Latin America and East Asia and Pacific are often significant drivers of education quality. Class sizes in primary and secondary schools and government spending per student at the primary and secondary levels do not show a significant effect. In some models, trade openness shows a positive and statistically significant impact on the overall quality of the education system. Model 11, which keeps the most relevant variables, explains more than 80% of cross country differences in the overall quality of the educational system in our sample.[20]

Influential observation and outlier tests

To what extent are our main results, which were obtained using the Kaarsen and WEF indicators of education quality, driven by influential observations? Are our main results robust after addressing possible influential observations? For example, we re-examine Model 2.10 from Table 2. The *lvr2plot* is used to create a graph plotting the leverage versus the squared residuals (Figure 1).

[20] We have also used the average test score in math and science (primary through the end of secondary school, all years, 1964-2003), which is used in Hanushek and Woessmann (2013), as our index of education quality. The negative effect of oil rents remains robust in most specifications (in 7 of 11 models).

Figure 1. Leverage versus squared residuals in Model 2.11



Countries 171 (Singapore) and 104 (Korea, Rep.) have either high leverage or large residuals. Next, we calculate Cook's D and identify the observations with relatively large values of Cook's D. One conventional cut-off value for Cook' D is 4/n, where n is the number of observations in the estimated model (n=61 in Model 2.10). A few countries have Cook's D larger than the cut-off value of 4/61= 0.06. These are countries 91 (Iran with Cook's D of 0.12), 98 (Japan with Cook's D of 0.10), 104 (Korea with Cook's D of 0.21), 124 (Malta with Cook's D of 0.41), 142 (New Zealand with Cook's D of 0.92), 155 (the Philippines with Cook's D of 0.14), 161 (Russia with Cook's D of 0.09) and 171 (Singapore with Cook's D of 0.41). Since none of these countries have Cook's D larger than 1, the robust regression analysis will not exclude them from estimations by assigning the missing weight to them. The robust regression gives different weights to each observation depending on how well-behaved the observations are.[21] We presented the results of the robust regression in Table A5 in the Appendix. The robust regression estimation, which addresses observations with high leverage or residual, is consistent with the OLS estimation of Model 2.10. It confirms our earlier findings on the negative and significant effect of oil rents on education quality.

[21] For more details on robust regressions, see http://stats.idre.ucla.edu/stata/dae/robust-regression/

We also examine the WEF education quality estimations of Table 3 for possible outliers or influential observations using the abovementioned procedure. Countries that have Cook's D larger than the cut-off value of (4/96=0.04) in Model 3.10 (as an example) are South Africa, Mongolia, Luxembourg, Singapore, and Malta. However, none of these countries have Cook's D of larger than 1. The results of the robust regression for Model 3.10 are shown in Table A6. Here, the estimations of the robust regression also confirm our earlier results on the negative and statistically significant effect of oil rents on the subjective index of education quality.

5. Transmission channels between resource rents and education quality

Why do we observe such a robust and negative association between oil rents dependency and education quality across countries? Demand-side as well as supply-side channels may explain the nexus.

Demand for high-quality education

The demand for high-quality education may be low in resource-rich economies simply because parents are less reluctant in accepting low quality schools. This might be the case when disadvantages of poor education are cushioned by the redistribution of resource rents. If this were the case, we should observe parents being less worried about their children's education in resource-rich economies. The World Value Survey (wave 6, 2010-2014)[22] contains the question "*To what degree are you worried about the following situations? Not being able to give my children a good education. 1 = very much … 4 = not at all*". As parents might be more concerned about insufficient education when the school system is working poorly, we control for educational quality and income per capita:

$$WVS\_worry\_good\_education_i = cons + \beta_1 \cdot oilrent\_GDP_i + \beta_2 \cdot eduquality_i + \beta_3 \cdot GDP\ per\ capita_i + \varepsilon_i \quad (3)$$

As dependent variables, we use the percentage of parents who have shown very much or a great deal of worry about the provision of good education for their children. If β_1 is negative and significant, parents in oil-rich countries care less for a given quality of the school system and for a given income per capita. We estimate Eq. (3) with OLS and robust standard errors. The estimated effect of oil rents (β_1) is *positive* (0.47) with robust *t* statistics of 2.06 (significant at 95% CI). Hence, parents in oil-rich countries are more worried (not less) about the quality of

[22] World Values Survey (Wave 6 2010-2014) Official aggregate v.20150418. World Values Survey Association (www.worldvaluessurvey.org).

the education of their children. The low quality of education requires explanations other than parents' attitudes or norms.

A straightforward explanation for lower human capital formation in resource-rich economies might be the Dutch disease, which leads to an increase in the size of the non-tradable sector. The non-tradable sector employs less skilled labor and does not require high levels of human capital.[23] However, university enrollment in resource-rich economies is often above the world average, which suggests that the overall demand for high-quality education is not distorted downwards by the large sector of non-tradables.

Another explanation focuses on the public sector. The public sector in resource-rich countries plays an important role for the employment of graduates while private businesses are marginalized in rent-based economies (Farzanegan, 2014). Studies show that public sector employment is used by governments as a redistributive tool and mostly for patronage purposes, increasing their chances of re-election (Alesina et al., 1998; Auty, 2001; Robinson et al., 2006) or buying political stability (Bjorvatn and Farzanegan, 2015). In the Gulf countries, over 60% of the national labor force is employed in the public sector; in Kuwait and Qatar, this number is even close to 90% (Baldwin-Edwards, 2011). Given the patronage purposes of public employment, particularly in oil-rich countries, these jobs are often entirely unproductive (Bjorvatn and Farzanegan, 2013). Although the government *de jure* may set a certain qualification as a prerequisite for entering public employment, the jobs *de facto* do not require a high-quality education. In such a situation, the demand side for educational quality is distorted. In a recent study, Ebeke et al. (2015) show that, when institutions are weak, resource abundance (oil) leads to a misallocation of talent. A larger share of students opt for professions with access to rents (business, law). They explain enrollment in law, business and social sciences with oil rents (as a percentage of GDP) and institutional quality (governance). They also control for the interaction between oil and governance. The misallocation of talent in tertiary education may be one important reason for the inferior growth performance in resource-rich economies.[24]

The explanations we have discussed so far focus mostly on tertiary education. However, the effect of resources on the low quality of schooling, which we are interested in, can hardly be explained by the distortion of talent at the university level. The low quality of education might emerge, if pupils put less effort into schooling because they anticipate that hard skills will not

[23] Because of this effect, the literature suggests that higher resource rents can reduce the income gap between the rich and the poor in the short term (Howie and Atakhanova, 2014; Goderis and Malone, 2011).
[24] Farzanegan (2014) also shows that rent dependency leads to a low prevalence of entrepreneurship.

be needed later in life, e.g., when studying business or law. The insufficient incentive for high learning efforts is further exacerbated by labor market regulations. Several oil-rich countries have implemented nationalization policies requiring firms to fulfill a fixed quota of domestic employees. For instance, the Nitaqat program in Saudi Arabia aims at increasing the number of Saudis employed in the private sector by sanctioning firms that do not fulfill the quota (Koyame-Marsh 2016). In addition, the U.A.E. have implemented an Emiratization program, which has increased employment of domestic workers, but it has also led to ghost employees who are on the payroll without delivering any productive services. Al Riyami et al. (2015) estimate that in the U.A.E., "over 80% of nationals currently employed in the private sector are considered ghost employees". As ghost employment is not linked to human capital, there is little incentive to excel in educational tournaments.

Evidence for the incentive hypothesis is also provided by the huge gender gap in international examinations such as Trends in Mathematics and Sciences Study (TIMSS). In the Gulf countries, girls outperform boys in mathematics and science tests by much more than in other countries (Dyer and Kherfi, 2016). While there is little incentive for boys to acquire math and science skills (see above), girls benefit to some extent from higher skills both in the labor market and in the marriage market. "[E]ducation for women is an investment toward both direct earnings and finding a partner with better job opportunities" (Sayre and Hendy 2016, 73).

Supply of high-quality education

The low quality of education in resource-rich economies could also be driven by supply-side factors. A crucial determinant of educational output is teacher quality. In oil-rich economies, the personnel in educational institutions are often hired in international labor markets. Becoming a teacher is not among the most prestigious jobs in oil-based economies. According to Ridge et al. (2015), the educational system in oil-rich countries in the MENA region has been unable to attract the domestic high-skilled teachers, relying more heavily on migrant teachers. Therefore, a significant fraction of the teaching staff consists of foreigners who are employed on fixed-term contracts. For example, 90% of teachers in boys' public schools in the UAE were expatriate Arabs as of 2010-2011. Similar numbers are reported for the case of Qatar: the share of Arab migrant teachers in public schools was approximately 90% in 2013 (Ridge et al., 2015). In contrast to permanent teaching staff that is rooted in the local community, the incentives for long-term development of educational quality are clearly lower for migrant teachers with fixed-term contracts. Ridge (2010) shows that the majority of male teachers in UAE are mostly from

Syria, Egypt and Jordan, where "[a]s in most Arab countries, teachers tend to be from the lower end of the graduating cohort" [Ridge (2010, 28)]. In contrast to Emirati teachers, the expatriates receive lower wages, have limited contracts (one year) and have very limited training and promotion opportunities. Things are different with female teachers. In girls' schools, 70-100% of the (female) teachers are Emiratis. The higher quality of teachers and their long-term perspective when teaching a class pays off. As mentioned earlier, girls outperform by far their male counterparts, particularly in math and science.

6. Conclusion

We investigated a new transmission channel of the oil curse: education quality (overall and at the lower secondary levels of education). Using updated data on different measures of public spending on education, we show that oil-rich economies are not under-spending in their educational system. However, our results show that higher spending on education (in particular, at the primary and secondary levels per student) has not translated into higher (objective and subjective) measures of education quality. Our results are based on an analysis of more than 70 countries for the period of 1995-2015. In addition to oil rents as our key predictor of education quality, we also control for other drivers of education quality, such as income per capita, economic globalization of countries, the amounts of allocated budgets at different levels of schooling, the class size, quality of political and economic institutions and a set of regional dummies. Our findings are robust to different specifications as well as different measures of education quality. The significant negative effect of oil rents dependency on education quality can be explained by both the demand and supply side channels. On the demand side, we refer to the effects of the Dutch disease on the allocation of resources, the redistribution of rents through unproductive jobs in the public sector and the Emiratization programs generating ghost employment. On the supply side, we note the insufficient incentives of migrant teachers to provide high-quality education.

Future research will have to be devoted to identifying causal links between resource rents and educational quality. We have discussed some supply and demand factors that may be crucial for the inefficient accumulation of human capital in resource-rich countries. Due to the lack of data in this field, we were not able to disentangle the different effects. Quasi-natural experiments, e.g., created by some educational reform, as well as case studies of single countries may be helpful in removing the bottlenecks in producing high educational quality in oil-rich economies.

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Appendix

A. Resource curse in our sample of analysis

The resource curse hypothesis states that countries that are more dependent on resource rents (in most cases, this is oil) experience lower economic growth rates in the long term compared to countries with lower initial dependency on rents. To (re-)test this hypothesis, we consider the effects of oil rents dependency in 1990 on GDP per capita growth rates from 1990 to 2015, controlling for other possible drivers of growth in 1990. These control variables are trade openness ([import+ exports]/GDP); foreign aid (percentage of GNI); domestic capital formation (percentage of GDP) as a proxy for the domestic investment rate; foreign direct investment (FDI, percentage of GDP); the fertility rate and a dummy for the East Asian and Pacific region.[25] All variables are from the World Bank (2017).

We follow a specific to general approach in our specification, starting in Model 1 with oil rents only. There is a negative and significant effect of oil rents in 1990 on the long run growth rates, supporting the resource curse hypothesis. Only in Model 7, when also controlling for fertility, the negative significance of oil rents vanishes. However, the statistical significance of oil rents in growth returns in Model 8 where we exclude the insignificant variables of Model 7.

[25] Other regional dummies turn out to be insignificant when included.

Table A1. The resource curse: oil rents and long run growth rates across countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GDP per capita growth rate (1990-2015)							
oil rent (% GDP) 1990	-0.036***	-0.036***	-0.044***	-0.029**	-0.025*	-0.024*	-0.004	-0.028*
	(-2.85)	(-2.65)	(-3.39)	(-2.08)	(-1.81)	(-1.77)	(-0.21)	(-1.77)
trade (% GDP) 1990		0.001	-0.001	-0.004	-0.004	-0.006*	-0.009**	-0.001
		(0.37)	(-0.41)	(-0.92)	(-1.20)	(-1.75)	(-2.63)	(-0.32)
aid (% GNI) 1990			-0.034	-0.016	-0.016	-0.002	0.040	
			(-1.08)	(-0.60)	(-0.55)	(-0.09)	(1.44)	
investment (% GDP) 1990				0.068**	0.064*	0.033	0.013	
				(2.29)	(1.94)	(1.39)	(0.56)	
FDI (% GDP) 1990					0.051	0.024	0.058**	0.021
					(1.04)	(0.81)	(2.11)	(0.91)
fertility 1990							-0.425***	0.001
							(-2.73)	(0.01)
East Asia & Pacific						2.186***	2.028***	1.678**
						(2.72)	(2.72)	(2.22)
Obs.	116	109	72	71	66	66	66	92
R-sq	0.07	0.07	0.11	0.20	0.20	0.34	0.43	0.18

Robust *t statistics* are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

B. Long run growth, education spending and education quality

We investigate the effects of government spending on education and of education quality [using the measure by Kaarsen (2014)] on long-run growth (Table A.2). There is a positive effect of education quality and a negative effect of education spending on growth.

Table A2. Education spending, education quality and long run growth rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	GDP per capita growth rate_90_2015									
government spending on education (% GDP) 90_95	-0.148***	-0.233***	-0.260***	-0.218***	-0.189***	-0.147**	-0.125*	-0.121*	-0.190***	-0.177**
	(-3.76)	(-3.97)	(-4.86)	(-3.53)	(-3.88)	(-2.81)	(-2.18)	(-2.19)	(-4.11)	(-2.71)
quality of education (Kaarsen) 95_2011		0.570	0.127	1.888**	1.104**	1.263**	1.179**	1.563**	1.060*	0.962
		(0.89)	(0.20)	(2.26)	(2.54)	(2.64)	(2.21)	(2.26)	(2.08)	(1.66)
trade (% GDP) 1990			0.007**	-0.002	-0.001	-0.002	-0.004	-0.000		
			(2.04)	(-0.59)	(-0.20)	(-0.42)	(-0.68)	(-0.02)		
aid (% GNI) 1990				-0.004	-0.004	-0.022	-0.032	-0.051*	-0.004	-0.008
				(-0.09)	(-0.12)	(-1.07)	(-1.34)	(-1.88)	(-0.12)	(-0.19)
investment (% GDP) 1990					0.083***	0.093***	0.079**	0.081**	0.084***	0.084**
					(3.08)	(3.25)	(2.61)	(2.44)	(3.19)	(2.34)
FDI (% GDP) 1990						0.099	0.138	0.142		
						(0.63)	(0.79)	(0.80)		
oil rent (% GDP) 1990							-0.011	-0.015		
							(-0.69)	(-0.98)		
ICRG IQ 90_2000								-0.430		
								(-0.87)		
East Asia & Pacific										0.151
										(0.37)
Latin										0.304
										(0.41)
Sub-Sahara Africa										-0.116
										(-0.25)
Obs.	117	56	51	21	21	19	19	19	21	21
R-sq	0.07	0.14	0.25	0.49	0.72	0.79	0.80	0.81	0.72	0.73

Robust *t statistics* are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

In the following table (Table A.3), we use the logarithm of government spending per student at the secondary level schooling (PPP adjusted) instead of government spending on education (percentage of GDP). The overall results do not change.

Table A3. Education spending per student (secondary level), education quality and long run growth rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	GDP per capita growth 1990_2015									
government spending per student (secondary, log PPP)	-0.207*	-1.140***	-0.949***	-0.778**	-0.723***	-0.720*	-0.453	-0.682	-0.889***	-0.878***
	(-1.68)	(-5.60)	(-5.36)	(-2.74)	(-3.31)	(-2.12)	(-1.17)	(-1.55)	(-3.95)	(-3.51)
quality of education (Kaarsen) 95_2011		2.921***	2.074***	2.803***	2.103**	2.360**	1.928**	1.532*	0.976	1.219
		(3.96)	(2.88)	(3.32)	(2.86)	(2.67)	(2.45)	(2.00)	(0.95)	(1.01)
trade (% GDP) 1990			0.007**	0.002	0.001	-0.003	-0.004	-0.007		
			(2.23)	(0.41)	(0.33)	(-0.28)	(-0.48)	(-0.93)		
aid (% GNI) 1990				-0.036	-0.034	-0.019	-0.031	-0.028		
				(-1.03)	(-0.82)	(-0.32)	(-0.71)	(-0.70)		
investment (% GDP) 1990					0.054**	0.040	0.022	0.018	0.049**	0.061**
					(2.32)	(1.52)	(0.87)	(0.85)	(2.13)	(2.35)
FDI (% GDP) 1990						0.282	0.259	0.217		
						(1.56)	(1.63)	(1.32)		
oil rent (% GDP) 1990							-0.035*	-0.024	-0.003	0.007
							(-1.86)	(-1.36)	(-0.28)	(0.55)
ICRG IQ 90_2000								0.642*	0.211	0.303
								(2.19)	(0.71)	(0.98)
East Asia & Pacific										0.054
										(0.12)
Latin										0.886*
										(1.86)
Sub-Sahara										0.568
										(0.77)
Obs.	111	53	47	21	21	19	19	19	46	46
R-sq	0.03	0.38	0.43	0.52	0.62	0.68	0.76	0.80	0.42	0.45

Robust *t statistics* are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

C. Using International database on human capital quality (Altinok and Murseli, 2007)

Table A4. Education quality and oil rents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	General Index of Qualitative Indicators of Human Capital (Mathematics, Science and Reading) (Grade 8)- Post 1995										
oil rent (% GDP)	-0.507***	-0.536***	-0.528***	-0.501***	-0.500***	-0.507***	-0.382*	-0.484*	-0.547***	-0.418***	-0.408***
	(-3.39)	(-4.54)	(-4.41)	(-4.42)	(-4.42)	(-3.14)	(-1.83)	(-2.02)	(-2.99)	(-2.79)	(-3.56)
log GDP pc		8.761***	8.672***	8.686***	8.702***	5.276	4.771	5.440	1.611	3.202**	3.857***
		(13.36)	(13.33)	(14.01)	(13.78)	(1.56)	(1.43)	(1.63)	(0.48)	(2.33)	(4.91)
trade (% GDP)			0.014	0.005	0.006	0.005	-0.016	0.025	-0.033	0.007	
			(0.69)	(0.21)	(0.22)	(0.11)	(-0.35)	(0.59)	(-0.81)	(0.26)	
FDI (% GDP)				0.343	0.343	1.014**	1.038*	-0.076	0.465	-0.124	
				(0.91)	(0.91)	(2.19)	(1.84)	(-0.15)	(0.86)	(-0.28)	
youth unemployment					0.013	-0.187	-0.256	-0.283*	-0.125	-0.067	
					(0.07)	(-0.98)	(-1.57)	(-1.76)	(-1.30)	(-0.75)	
log PPP spending per secondary stud.						-3.298	1.747	-0.052	0.257		
						(-0.82)	(0.42)	(-0.01)	(0.06)		
log PPP spending per primary stud.						7.230	-0.999	-1.662	4.082		
						(1.44)	(-0.17)	(-0.29)	(0.66)		
stud_teacher secondary							0.053	-0.057	-0.271	-0.337	
							(0.15)	(-0.12)	(-0.67)	(-1.13)	
stud_teacher primary							-0.626*	-0.640	0.221	0.279	
							(-1.98)	(-1.45)	(0.50)	(1.17)	
ICRG instit. quality								1.940	-2.499	1.425	
								(0.94)	(-1.36)	(0.96)	
Sub-Sahara									-20.518***	-21.047***	-18.205***
									(-4.10)	(-4.64)	(-5.64)
Latin									-7.143*	-5.789*	-4.453
									(-1.84)	(-1.96)	(-1.55)
East Asia & Pacific									7.682*	6.391	7.864**
									(1.78)	(1.53)	(2.34)
EU & Central Asia									8.899***	7.421***	8.337***
									(2.91)	(2.70)	(3.35)
Obs.	81	81	81	80	80	63	58	55	55	69	81
R-sq	0.05	0.64	0.65	0.67	0.67	0.72	0.75	0.74	0.87	0.85	0.84

Robust *t statistics* are in parentheses. Independent variables are average values from 1995 to 2005. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

D. Robust regression: examining the effect of outliers or influential observations

Table A5. Robust regression: Re-examining Model 2.10 from Table 2

	(1) Model 2.10	(2) Robust regression of Model 2.10
	quality_education_kaarsen_1995_2011	
oil rent (% GDP)	-0.008**	-0.009***
	(-2.56)	(-3.51)
log GDP pc	0.078**	0.038
	(2.48)	(1.60)
trade (% GDP)	0.001*	0.002***
	(1.72)	(5.37)
FDI (% GDP)	-0.006	-0.009**
	(-1.24)	(-2.54)
youth unemployment	0.001	0.002
	(0.51)	(0.99)
stud_teacher secondary	-0.007	-0.001
	(-0.99)	(-0.16)
stud_teacher primary	0.004	-0.006
	(0.56)	(-1.18)
ICRG institutional quality	0.033	0.046
	(0.84)	(1.56)
Sub-Sahara	-0.301**	-0.259***
	(-2.61)	(-2.98)
Latin	-0.059	0.046
	(-0.49)	(0.51)
East Asia & Pacific	0.187**	0.021
	(2.28)	(0.34)
EU & Central Asia	0.162**	0.163***
	(2.54)	(3.38)
Obs.	61	61
R-sq	0.73	0.83

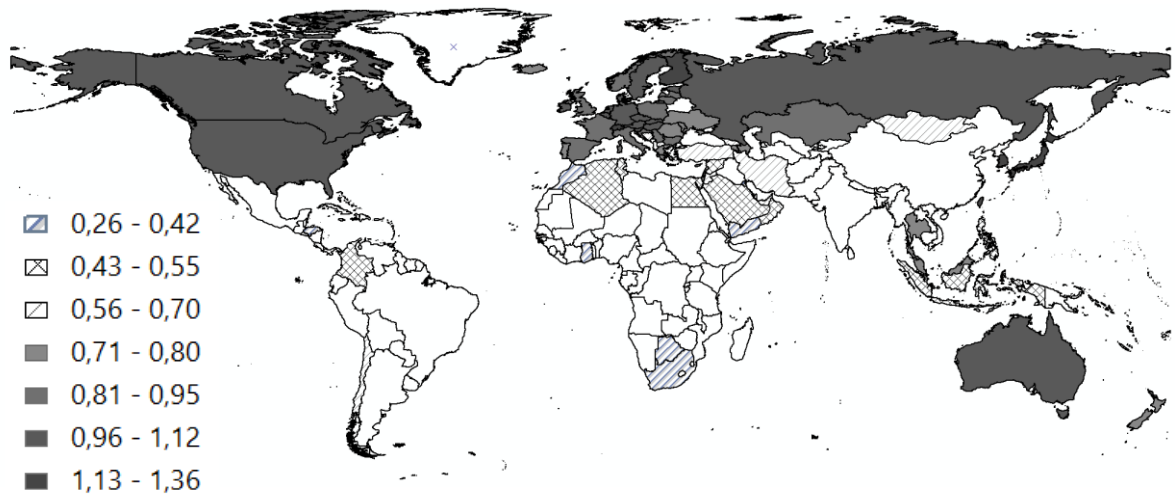
t statistics are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

Table A6. Robust regression: Re-examining Model 3.10 from Table 3

	(1) Model 3.10	(2) Robust regression of Model 3.10
	WEF_quality_education 2006_2015	
oil rent (% GDP)	-0.035***	-0.037***
	(-3.91)	(-3.75)
log GDP pc	0.349***	0.363***
	(3.45)	(3.26)
trade (% GDP)	0.003	0.003*
	(1.58)	(1.68)
FDI (% GDP)	0.000	-0.001
	(0.02)	(-0.05)
youth unemployment	-0.020***	-0.019**
	(-3.02)	(-2.60)
stud_teacher secondary	0.009	0.010
	(0.56)	(0.57)
stud_teacher primary	-0.010	-0.011
	(-0.72)	(-0.74)
ICRG institutional quality	-0.008	-0.040
	(-0.06)	(-0.29)
Sub-Sahara	-0.012	0.019
	(-0.04)	(0.06)
Latin	-1.023***	-1.051***
	(-4.94)	(-4.60)
East Asia & Pacific	-0.209	-0.197
	(-0.89)	(-0.76)
EU & Central Asia	-0.399*	-0.407*
	(-1.94)	(-1.80)
Obs.	96	96
R-sq	0.62	0.58

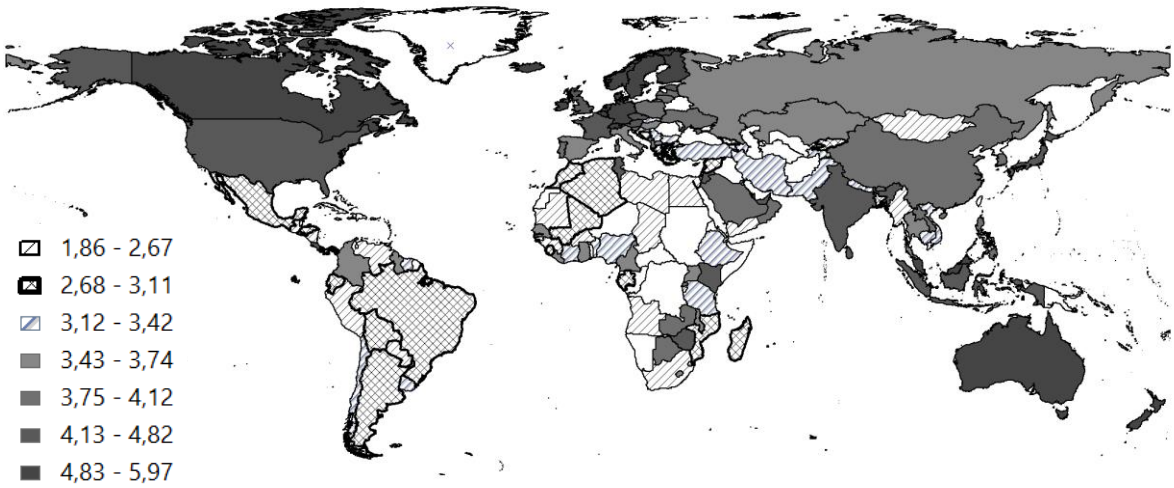
t statistics are in parentheses. ***, **, * refer to statistical significance at the 99%, 95% and 90% confidence intervals.

Figure A1. Global map of education quality (Kaarsen Index)



Source: education quality scores are from Kaarsen (2014) and own work. Countries with no available score are in white color.

Figure A2. Global map of education quality (World Economic Forum)



Note: We use the following survey question: "*How well does the educational system in your country meet the needs of a competitive economy?"* The scores are from 1 (not well at all) to 7 (very well). Countries with no available score are in white color.

Source: http://reports.weforum.org/global-competitiveness-report-2015-2016/ and own work