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# Is there a subnational resource curse? Evidence from households in the Niger Delta region of Nigeria

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ABSTRACT

Previous evidence suggests that mining-based extractive sectors have a net positive effect on local economies, further improving the local population's living standards. In contrast to artisanal mining, we argue that hydrocarbon-based industries can have ambiguous implications on demand in sectors that will enhance local welfare. Using annual household data from the Niger Delta between 2010 and 2016, we utilize a combination of fixed effects and difference-in-differences, triple—differences (DDD), and treatment boundaries in oil production and households' locations to produce unbiased estimates. Estimating at a subnational level allows us to exploit variation within a country, control for more potential sources of estimation bias, and measure the impact of compositional changes on households' expenditures. We find that costs of living are higher by proximity to oil fields, but the mechanism is via the vicinity preferences for education. We find inconclusive evidence on other welfare indicators; limited employment opportunities and rent-seeking environment may explain the weak backward linkages and potential positive spillovers.

## 1. Introduction

Across many countries, natural resource extraction projects are capital and labor-intensive activities that have contributed to the economic and social livelihood of people where the extraction occurs. However, there are indications in policy debates, for instance, with reference to the oil-producing Niger Delta region of Nigeria, of pollution (Helbert and O'Brien, 2020; Gaughran, 2009) and militancy (Onuoha, 2016). These issues support an earlier UN report that notes an increase in poverty and changes in its nature in the region (UNDP, 2006). However, in addition to recognized channels of environmental degradation and pollution, variations in higher costs of living stemming from spatial differences in incentives, prices, and products are possible channels that can exacerbate poverty in the Niger Delta region of Nigeria. Understanding these relatively unexplored channels through which living standards improve or deteriorate could promote a multi-stakeholder approach that encourages an open and accountable natural resource management in the region.

This paper asks an important question: Do people living in communities where oil extraction takes place experience better living standards? Are local communities around oil extraction indifferent in their demand for consumption bundles, e.g., human capital (education) and other consumer commodities (e.g., services and food)? We study the local effect of oil and gas extraction activities on economic outcomes using microdata from a sample of Nigerian households in the Niger Delta oil-producing region. We investigate if households' living standards increase by proximity to oil-producing fields. We examine if the aggregate increase reflects a compositional change in expenditure, suggesting a greater preference for education over other consumption bundles. A central result is that opportunities and locality-specific factors drive the preference for investment in education, leading to a compositional change in expenditure pattern (Handbury, 2021; Black et al., 2009) and an insignificant effect for other consumption expenditure categories.

The Niger Delta comprises nine (9) oil-producing states (Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Ondo, Imo, and Rivers) and 185 Local Government Areas (LGAs) in Nigeria (UNDP, 2006; Nwilo and Badejo, 2006). We discuss the institutional settings of states comprising this region in Section 2. For our empirical analysis in Section 3, we extract information on households in the nine states of the Niger Delta region from the Nigerian General Household survey from 2010 to 2016. We also use geo-referenced oil fields by oil and gas industries from the Nigerian National Petroleum Corporation (NNPC) statistical bulletins. A major obstacle to accurately estimating the impact of hydrocarbon

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development is the presence of correlated unobservable that may confound identification. Social and environmental effects may also arise from the economic "boom town" phenomenon (Muehlenbachs et al., 2015). Like Muehlenbachs et al. (2015), we combine fixed effects and difference-in-differences, triple–differences (DDD), and treatment boundary techniques to produce unbiased estimates. Estimating at a subnational level allows us to exploit variation within a country, control for more potential sources of estimation bias, and measure several impact categories via the vicinity and adjacency effect of hydrocarbon extractive activities.

We define the vicinity effect as reflecting the benefits of hydrocarbon extraction among households in the LGAs where production occurs (within a 20 km radius of oil fields). The adjacency effect reflects the environmental and social costs to households in oil-producing LGAs that reduce the value of public goods compared to non-oil LGAs in the Niger Delta. The proximity effect reflects the combined impacts (both positive and negative) of being in the Niger Delta region. We further identify the vicinity and adjacency effects through changes in the compositional consumption bundles reflecting the demand for education and local employment opportunities. The compositional effect refers to the disaggregated impact of oil production on consumption bundles that shows an increased demand for education through higher education-related expenditure that varies by vicinity and proximity to oil fields.

The vicinity, adjacency, and proximity effects of oil extraction on aggregate and disaggregated households' consumption bundles are shown in Section 4. We find evidence of a positive net effect (vicinity plus adjacency effects) by proximity to oil production on aggregate household spending for households. These estimates are robust to alternative specifications and a different proxy for distance to oil fields. Disaggregating consumption into several components, we find that a 10 percent increase in oil production conditional on oil field (vicinity effect) is associated with a 0.46 percent increase in households' expenditure on education. As predicted, the effect is insignificant for other consumption expenditure categories, plausibly implying that households within the vicinity of oil production trade off expenditure on other goods for education.

To develop an intuition for why our results make sense, we propose a fairly reasonable theory of educational demand and talent misallocation under an unproductive rent-seeking environment in Section 5. One approach views the decision to enroll in an institution of higher education as an investment decision (Buera and Kaboski, 2012; Acemoglu and Guerrieri, 2008), while the other views it as a current consumption decision (Campbell and Siegel, 1967). Combining this with the talent misallocation framework of Murphy et al. (1991) and Acemoglu (1995), we generate an equilibrium that predicts a weak backward integration and an ambiguous effect of spillovers from the demand for education.

**Contributions and related literature**. Our paper is related to many papers in two distinct literature. An extensive literature has investigated the local effect of mining activities by investigating the standard of living of economies and communities around mining-based (Aragón and Rud, 2016; Kotsadam and Tolonen, 2016; Loayza et al., 2013). Consistent with the effects of a local shock in housing supply and labor mobility, this explanation sees extractive industries strongly influencing real wages and labor outcomes, such as participation rate and the number of hours worked. Less attention has been paid to the generalizability of these results across sectors, for instance, whether similar outcomes are applicable in hydrocarbon-based sectors. In contrast to mining, Caselli and Michaels (2013) show that the local economic effect of oil field expansion on household income is negligible. Similarly, Brollo et al. (2013) show that oil revenues are most likely used to fund patronage and encourage the corruption of political officers.

A useful distinction between the two sectors is important. Unlike mining, hydrocarbon-based extractive industries are intensive in capital and high-skill labor requirement; benefits may not flow to residents if they lack the needed skills for employment (Jacobsen et al., 2021; Gittings and Roach, 2020). Subsequently, demand for consumption bundles, e.g., education, which improves skills (talents), could improve employment potentials in the oil sector. Therefore, preferences for skills will increase the relative price of education, and consumption bundles will no longer be demanded in the same proportions. However, positive spillover to the local economy may not materialize because post-educational opportunities are non-existent due to the poorly diversified local economies or rent-seeking environments that endogenously assign talent rewards.

Similarly, research on the extractive sector and the premium for local labor to upskill by investing in education have been well studied independently. Yet, findings are mixed (Kumar, 2017; Polgreen and Silos, 2009; Keane and Prasad, 1996). For one, if the resource boom due to hydrocarbon activities is biased toward high-skilled workers, it could encourage investment in education (Aragón et al., 2015). On the other hand, if the increase in wages of low-skilled workers increases the opportunity cost of education, it would discourage expenditure on education and have adverse effects on school enrolments (Kumar, 2017; Atkin, 2016; Keane and Prasad, 1996). Building on Black et al. (2009), we illustrate the implication of skill-intensive hydrocarbon activities to justify households' inter-temporal investment in education.

Also, our empirical identification contributes to the literature on isolating the resource curse at the subnational level. Although empirical evidence using cross-country evidence is elusive (Van der Ploeg, 2011), shifting evidence to people using a within-country-subnational analysis is helpful (Jacobsen et al., 2021; Cust and Viale, 2016; Aragón et al., 2015). While there are ample studies on the subnational analysis of the resource curse within developed countries (e.g., Allcott and Keniston, 2018; Fleming and Measham, 2015; Marchand, 2012; Michaels, 2011; Black et al., 2009), there are limited contributions from less developed countries in Africa.[1] We contribute to the literature by identifying the impact of petroleum-extraction-related activities on household consumption in Nigeria's Niger Delta region.

The second literature is on the positive spillovers from the demand for education and the implications for a skill-biased structural change (Buera et al. forthcoming, Buera and Kaboski, 2012; Acemoglu and Guerrieri, 2008). Notwithstanding this perspective, a weakly diversified economy (Lashitew et al., 2021; Munemo, 2021; Ross, 2019) and the tendency for talent to be misallocated for rent-seeking (Murphy et al., 1991; Gelb et al., 1991) may explain why education can worsen the livelihoods (Leonardi, 2015). A key political economy feature of oil-based economies is rent-seeking. At equilibrium, education (talents) is allocated between rent-seeking and entrepreneurship (Murphy et al., 1991); however, under the resource curse narrative, talent is more likely assigned under rent-seeking (Munemo, 2021). When educated people become entrepreneurs, they innovate and induce a skill-biased technological change, which leads to income growth (Buera and Kaboski, 2012). In contrast, when they become rent-seekers, they absorb labor and other resources from productive sectors and stagnate the economy (Murphy et al., 1991). Similarly, when the public sector attracts rent-seekers, they will use their position to promote patronage and abuse public offices (Jaimovich and Rud, 2014; Brollo et al., 2013). The enormous employment in the public sectors and less entrepreneurship in many resource-rich countries illustrate this effect (Van der Ploeg, 2011; Baumol, 1996; Krueger, 1974).

## 2. Institutional and country settings: Human development in the Nigerian Niger Delta

The Niger Delta extends over about 70,000 km2 (27,000 sq mi), makes up 7.5% of Nigeria's landmass, and comprises of nine oil-producing states (Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo,

[1] Kotsadam and Tolonen (2016) is a notable exception, where the adverse effect of resource abundance on economic development is more profound.

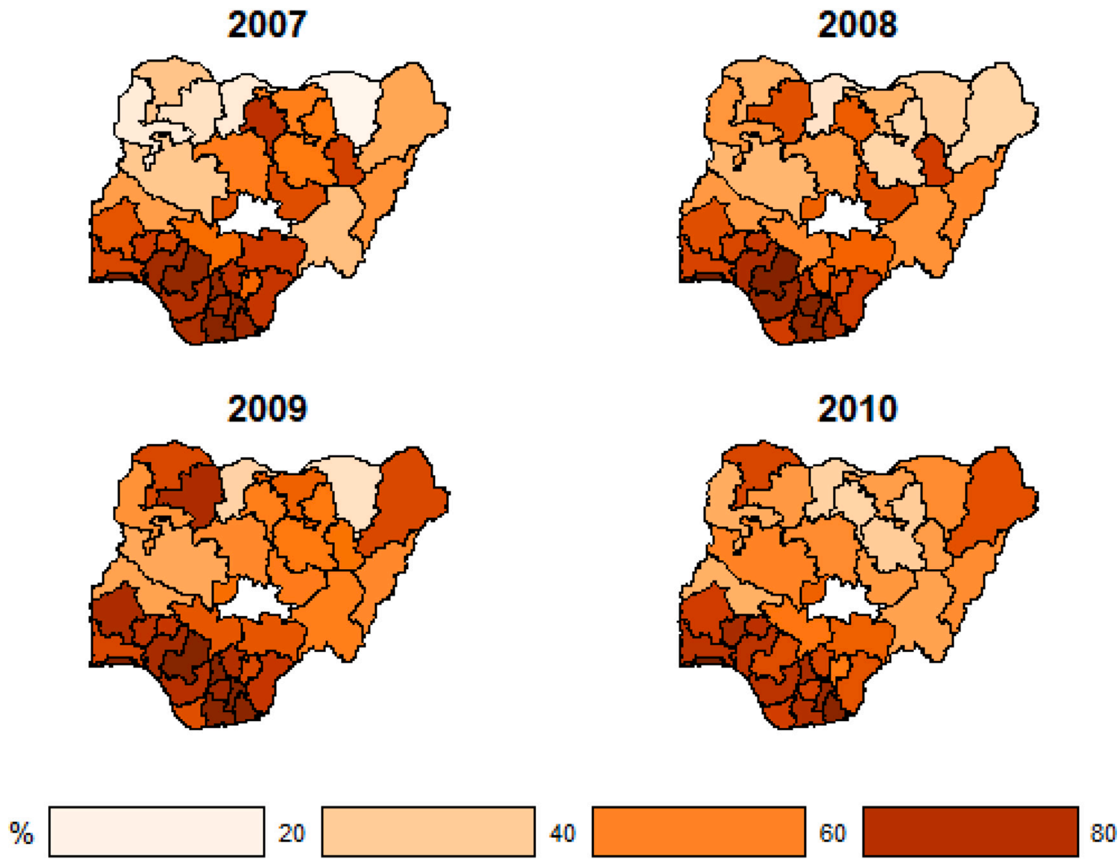


**Fig. 1.** Spatial distribution of literacy rate (%) in Nigeria over time.

Ondo, Imo, and Rivers) and 185 LGAs (UNDP, 2006; Nwilo and Badejo, 2006).[2] Nigeria's Niger Delta region has an extensive network of over 900 oil wells and several petroleum production facilities that cut across 800 communities. The region provides a natural setting to study the local impacts of oil and gas abundance on welfare outcomes under weak institutions (Porter and Watts, 2017).

While the Niger Delta region is heavily invested in the oil and gas industry, economic diversification into non-oil productive activities is limited. At the start of hydrocarbon operations, local people often cannot tap directly into oil industry benefits, including employment, because they lack skills, capital resources, or both (UNDP, 2006). Therefore, in a bid to boost local content, local content capacity policies that mandate the extractive industries to improve the inclusion of local labor in their workforce were enacted. These new laws created opportunities for investment in education and literacy to improve. Available data from the National Literacy Survey (NBS, 2010) conducted by the National Bureau of Statistics in Nigeria show that of the top 10 states with the highest literacy rate, six are within the Niger Delta region: Abia (72.5%), Rivers (72.8%), Akwa-Ibom (75%), Bayelsa (62%), Ondo (66%), Delta (65.7%) and Cross Rivers (62%) (see, Fig. 1 for graphical illustrations).

Paradoxically, the high literacy rates coupled with the abundant wealth from oil and gas appear to have little impact on human development indicators in the region. As of 2006, the region's human development index (HDI) score, an indicator of standard of living, is 0.564, which is low when compared with regions with similar oil and gas resources like Saudi Arabia (0.800), UAE (0.849), Venezuela (0.772), and Indonesia (0.697) (UNDP, 2006). Oil extraction in the Niger Delta is fundamental to economic development of Nigeria, as the revenue from oil accounts for a significant portion of the nation's income (Emediegwu and Okeke, 2017). Similarly, evidence from literature attests to the extremely low standard of living and deplorable environmental situation found within the Niger Delta (Gonzalez, 2016). Petroleum windfalls have also been indicated as one of the main causes of the deterioration of institutional capacities (Oyekola et al., 2024). Transfer of oil rents from the central government to regional administrative units has been linked to corruption, conflict and terrorism, poverty and inequality, and the increase in the risk of HIV and AIDS infection (Gonzalez, 2016).

## 3. Data and model specification

### 3.1. Data description and sources

Our empirical strategy relies on data from three sources. We combine household survey data and satellite imagery with oil activity data to construct a comprehensive dataset containing socio-economic, meteorological, and oil production variables. Our final dataset is panel data consisting of more than 5000 observations spanning from 2010 to 2015.

*Socio-economic dataset*

Our source of household data is the Nigerian General Household Surveys (GHS) that cover the 36 states, and the federal capital territory of Nigeria. The three waves used in this study are chronicled as follows:

[2] The Niger Delta states comprises of all six states in the South-South geopolitical zone of Nigeria (Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers); two states in the South East (Abia and Imo); and one in the South West (Ondo state).

**Table 1**
Distribution of samples by households and oil endowments across states and LGA.

| Niger Delta State | Number of sampled LGA per state | Number of oil fields per state | Sampled households per state |
|---|---|---|---|
| Abia | 9 | 2 | 110 |
| Akwa Ibom | 10 | 9 | 120 |
| Bayelsa | 6 | 34 | 70 |
| Cross River | 12 | 3 | 120 |
| Delta | 11 | 52 | 140 |
| Edo | 8 | 10 | 100 |
| Imo | 15 | 8 | 170 |
| Ondo | 10 | 5 | 130 |
| Rivers | 17 | 30 | 210 |
| **Total** | **98** | **153** | **1170** |

wave 1 (2010–2011), wave 2 (2012–2013), and wave 3 (2015–2016).[3] In each wave, households are interviewed twice – in the post-planting period (August to November) and the post-harvesting period (February to April). The Nigerian GHS was sourced from the World Bank Microdata library that houses household survey data for several countries.[4] The surveys, which are part of the World Bank Living Standards Measurement Study Integrated Surveys on Agriculture (LSMS-ISA) project, were implemented by the National Bureau of Statistics (NBS) with support from various national and international partners.[5]

From this nationally representative sample, we select households that fall within the nine oil-producing Niger Delta states of Nigeria - Abia, Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Ondo, Imo, and Rivers. The distribution of local government areas (LGAs), oil fields, and sampled households are shown in Table 1. The main dependent variable is the consumption expenditure per capita measured at the household level. The survey asks household members to report the amount spent on different food and non-food items (e.g., education expenditure) in the last seven days. We use this information to construct measures of household consumption. Besides, the GHS includes other relevant household variables such as the age, sex, marital status of the household head, whether the house is owned or rented, and household distance to market and border (in km), respectively.

*Weather data*

Our temperature and precipitation data are sourced from CRU TS v4.05 of the Climate Research Unit (CRU) of the University of East Anglia. This dataset (released 16th March 2021) provides gridded time series data for several monthly weather measures, including annual average temperature (°C) and total precipitation (mm) for all land areas in the world (excluding Antarctica) at 0.5° resolution (approx. 56 km × 56 km across the equator) for the period January 1901 to December 2020.[6]

We use these gridded datasets to construct LGA-level weather information. To link the weather information to the relevant LGAs, we overlay a polygon of the Niger Delta region on the rasters containing average temperature and total precipitation, and take the simple average across all grid cells per LGA using geospatial software.[7]

*Oil field and oil production data*

Location of oil fields in Nigeria and the respective volume of oil production from the fields come from the various annual statistical bulletin (ASB) of the Nigerian National Petroleum Corporation (NNPC). The NNPC is the oil corporation through which the federal government of Nigeria regulates and participates in the country's petroleum industry. The ASB of the NNPC documents the monthly oil and gas production activities of all oil companies operating within Nigeria.[8] We utilize data from 33 oil companies operating within Nigeria, omitting few whose production locations cannot be geo-referenced.[9] It is important to state that most of these oil companies have production presence in more than one state in the Niger Delta, hence our approach does identify total production by oil field rather than by company.[10,11]

To align each oil field with the appropriate LGA, we obtain the geo-coordinates of each oil field using spatial analysis software (ArcGIS). Thereafter, we calculate the distances from each oil field to the centroids of the LGAs using the *distHaversine* function in R.[12] Fig. 2 shows the distribution of (onshore) oil fields across the Niger Delta. The reason for exploring onshore oil fields only will be made clear shortly.

For our main analysis, we follow Aragón and Rud (2016), by identifying activities in oil fields that are within 20 km radius from any LGA as shown in Fig. 3. Technically, we assign the aggregate oil production in the oil field if it is within 20 km of an LGA and zero otherwise.[13] The implication of this assignment is that LGAs with oil fields within 20 km radius are regarded as the treatment group while those without oil fields within the buffer location are seen as the control group. One important point from Fig. 3 is that all the offshore oil fields in our sample are not within 20 km of any LGAs. Hence, the reason we consider only onshore oil fields for our analysis. Also given that oil production forms the highest form of revenues and GDP contributor for the Nigerian government, we do not consider other mineral resources such as iron found in Delta state, gold found in Edo state, etc.

Table 2 describes the variables used in the study. Specifically, the table illustrates a consistent upward trend in aggregate consumption in Nigeria over the observed period. Specifically, aggregate consumption increased by 1.39% between Wave 1 and Wave 2 and further accelerated with a 3.61% growth between Wave 2 and Wave 3. This pattern may reflect macroeconomic factors such as inflationary pressures, which often correlate with increased aggregate expenditure. Rising inflation can lead to higher nominal consumption figures as households adjust their spending to maintain their standard of living amidst escalating prices. Amongst other information, the table shows that there is an equal distribution of participants in the treatment and control groups over the three waves, which benefits our identification strategy. This distribution is evidenced by the percentage of LGAs within a 20 km radius of oil fields.

### 3.2. Model specification

Our main hypothesis is to investigate the welfare effect of oil production activities. Specifically, for this objective, we wish to examine if households that are exposed to oil production activities have depressed

[3] Year 2014 is missing from the survey. Also, we could not use the 2016 data for our analysis since we lack data for oil production from oil fields for that year.

[4] https://microdata.worldbank.org/index.php/catalog/lsms.

[5] These partners include the Federal Ministry of Agriculture and Rural Development (FMA&RD), the National Food Reserve Agency (NFRA), the Bill and Melinda Gates Foundation (BMGF), and the World Bank.

[6] See Harris et al. (2020) for a complete description of the dataset.

[7] The R package "raster" has sophisticated functions for implementing this exercise.

[8] These activities covers the upstream and downstream segments of the petroleum sector.

[9] Appendix A contains the list of the oil companies considered.

[10] Also, note that more than one company could be involved in oil production activities within an area, hence the importance of adopting this approach, in addition to the argument in Aragón and Rud (2013).

[11] Additionally, we do not make a major distinction between giant and small-scale oil fields. Our assumption, as evident in prior related studies (e.g., Aragón and Rud, 2016; Kotsadam and Tolonen, 2016), is that the volume of oil production will reflect the size of the drilling site.

[12] We dropped oil fields that cannot be geo-referenced.

[13] Here we summed up the oil production of all oil fields within 20 km to a LGA. Oil production is in hundred thousands cubic meter.

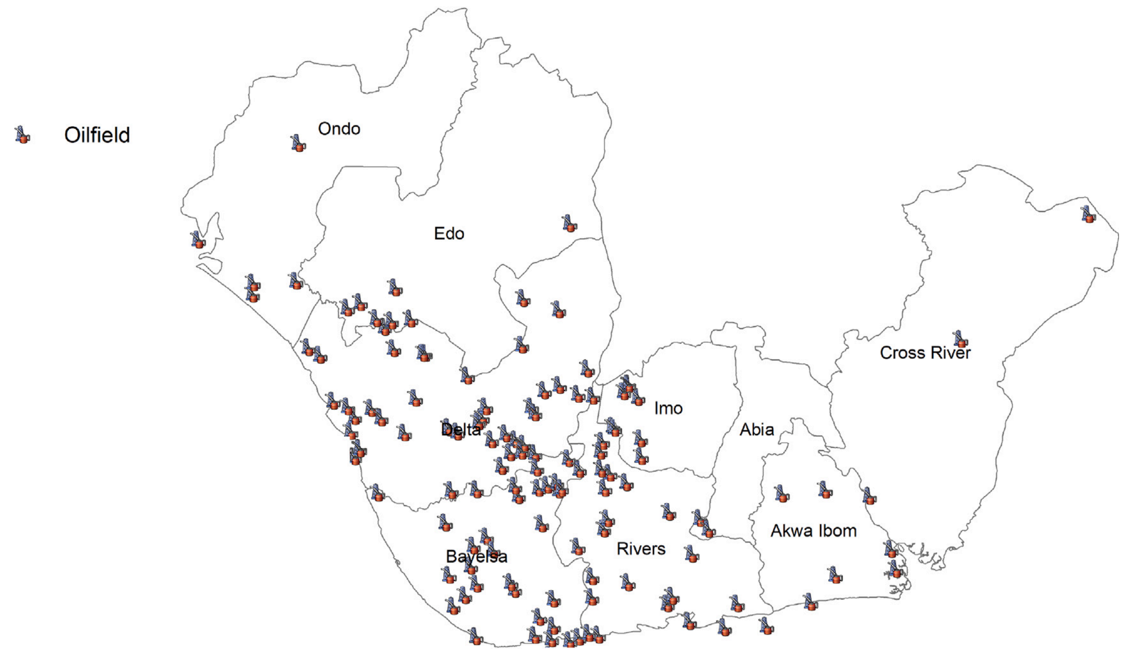


**Fig. 2.** Onshore oil fields across the Niger Delta.

**Table 2**
Descriptive statistics of variables used in the study.

| | Combined waves | | Wave 1 | | Wave 2 | | Wave 3 | |
|---|---|---|---|---|---|---|---|---|
| | Obs. | Mean | Obs. | Mean | Obs. | Mean | Obs. | Mean |
| Log consumption per capita | 5396 | 11.64 | 2281 | 11.47 | 2119 | 11.63 | 996 | 12.05 |
| Oil well within 20 km (dummy variable) | 5396 | 0.53 | 2281 | 0.53 | 2119 | 0.53 | 996 | 0.52 |
| Household (HH) size | 5396 | 5.04 | 2281 | 4.99 | 2119 | 5.18 | 996 | 4.87 |
| Age of HH head | 5396 | 53.88 | 2281 | 52.05 | 2064 | 54.96 | 996 | 55.76 |
| Male HH head (dummy variable) | 5396 | 0.72 | 2281 | 0.73 | 2119 | 0.74 | 996 | 0.68 |
| House ownership (dummy variable) | 5396 | 0.63 | 2281 | 0.60 | 2,119 | 0.64 | 996 | 0.69 |
| Married HH head (dummy variable) | 5396 | 0.59 | 2281 | 0.61 | 2119 | 0.60 | 996 | 0.56 |
| Distance to nearest market (km) | 5395 | 64.91 | 2,281 | 65.91 | 2118 | 64.18 | 996 | 64.20 |
| Distance to border (km) | 5395 | 463.74 | 2,281 | 460.85 | 2118 | 465.57 | 996 | 466.50 |
| Temperature (°C) | 5396 | 26.96 | 2281 | 27.04 | 2119 | 26.82 | 996 | 27.06 |
| Precipitation (mm) | 5396 | 2095.72 | 2281 | 2145.11 | 2119 | 2060.79 | 996 | 2056.90 |

The three waves consist of the following years: wave 1 (2010–2011), wave 2 (2012–2013), and wave 3 (2015–2016)

living standards. This research question is important to support policy recommendations for more sustainable and best exploration practices to improve the livelihoods of people living where oil exploration takes place. A major obstacle to accurately estimating the impact of the proximity of oil fields on the standard of living is the presence of correlated unobservables that may confound identification. For example, people are not located randomly to where oil wells are but are driven by other unobservable characteristics and neighborhood attributes associated with oil field development and expansion. The population of people might increase in response to oil fields, and demand might correlate with prices.

In the spirit of Muehlenbachs et al. (2015), our empirical strategy uses a triple difference (DDD) approach that exploits temporal and spatial variation in 'proximity' to an oil field. To achieve this, we categorize our impact as arising from vicinity effect, i.e, staying within 20 km radius of the oil fields. Then the adjacency effect reflects the environmental and social costs to households in oil-producing LGAs leading to a reduction in the value of public goods compared to non-oil LGAs in the Niger Delta. Finally, the proximity effect estimates the combined impacts (both positive and negative) of being in the Niger Delta region. We further identify the vicinity and adjacency effects through changes in the compositional consumption bundles reflecting the demand for education and local employment opportunities. The compositional effects refer to the disaggregated effects of oil production on consumption bundles, which demonstrate an increased demand for education through increased education-related expenditure that varies by vicinity and proximity to oil fields.

We derive our specification by estimating log of consumption expenditure per capita in household $h$ at time $t$ in LGA $l$ as a function of oil wells, household-specifc ($c_{ht}$) and LGA-specific ($d_{lt}$) time-varying characteristics that may influence household spending, and household ($\alpha_h$), LGA ($\gamma_l$), and time ($\lambda_t$) fixed effects:

$$C_{holt} = \alpha_h + \gamma_l t + \lambda_t + \gamma c_{ht} + \delta d_{lt} + \vartheta P_{ot} Oil_{ho} + \epsilon_{et} \quad (1)$$

where $o$ indexes proximity to an oil field. Eq. (1) is the standard difference-in-difference (DD) approach as we interact proximity to oil field with oil production.

Following Aragón and Rud (2016), we further segregate Eq. (1) by separating households that are within 20 km of an oil field from those outside of 20 km to generate *vicinity effect*:

$$C_{holt} = \alpha_h + \gamma_l t + \lambda_t + \gamma c_{ht} + \delta d_{lt} + \beta_1 k_{ho}(<20\text{ km}) P_{ot} + \omega_1 k_{ho}(>20\text{ km}) P_{ot} + \epsilon_{et} \quad (2)$$

where $Oil_{ho} = \beta_1 k_{ho}(<20\text{ km}) + \omega_1 k_{ho}(>20\text{ km})$; $k_{ho}(<20\text{ km}) = 1$ if an household is located within 20 km radius of an oil field and zero otherwise. The corollary to the preceding definition holds for the term $k_{ho}(>20\text{ km})$. For simplicity, we assume that $\omega_1 = 0$, thereby reducing

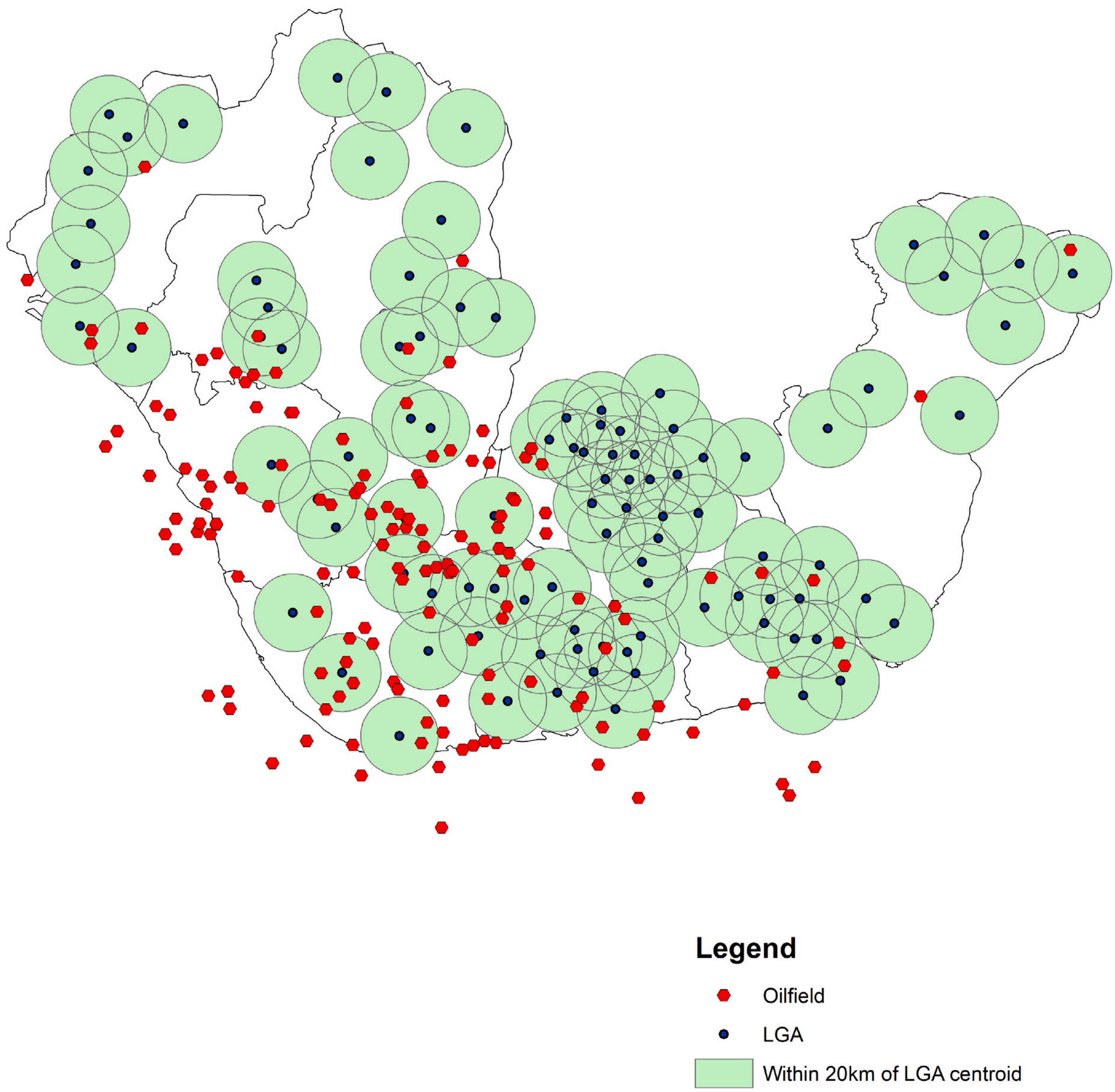


**Fig. 3.** Oil fields within 20 km of LGAs.

Eq. (2) to

$$C_{holt} = \alpha_h + \gamma_l t + \lambda_t + \gamma c_{ht} + \delta d_{lt} + \beta_1 k_{ho}(<20 \text{ km}) P_{ot} + \epsilon_{et} \tag{3}$$

Our choice of 20 km cutoff helps us to have a balanced number of members within the control and treatment group as seen in Table 2. However, we show in Figure A1 in the appendix that our result is robust to several cutoff choices. We also employ an alternative distance measure, *nearest-neighbor,* for sensitivity analysis. There, we replace the "20 km radius" criterium with *3-nearest-neighbor (3-NN)* measure, where we aggregate oil production from the three closest oil field to the centroid of each LGA. This distance proxy ensures that every LGA is associated with oil production activities.

We finally transform Eq. (3) into a triple-difference model by interacting the DD terms with a dummy ($OR_h = 1$) indicating that a household lives in an oil-rich local government area:

$$C_{holt} = \alpha_h + \gamma_l + \lambda_t + \gamma c_{ht} + \delta d_{lt} + \beta_1 k_{ho}(<20 \text{ km}) P_{ot} + \beta_2 OR_h k_{ho} \times (<20 \text{ km}) P_{ot} + \epsilon_{et} \tag{4}$$

Eq. (4) captures two main effects: the difference-in-difference term, $\beta_1$, measures the *vicinity* effect, while $\beta_2$ estimates the triple-difference measure of *adjacency* effect. It is important to add that the net of $\beta_1$ and $\beta_2$ is the *proximity* effect.

Since unobservables affects the effect of oil field presence on household expenditure, we include household ($\alpha_h$), LGA ($\gamma_l$), and time ($\lambda_t$) fixed effects in all our specifications. Besides, $c_{ht}$ and $d_{lt}$ are respective matrices of household- and LGA-specific time-varying characteristics that may influence household spending following Aragón and Rud (2016). These characteristics (controls) are presented in Table 2. We show in Table A1 in the appendix that our results are robust to different permutations of fixed effects. Lastly, $\epsilon_{et}$ are idiosyncratic errors clustered at household-level to account for possible correlation of the standard error terms within households.

To account for heteroskedasticity associated with household sizes, a weighted version of Eq. (1) is estimated where weight is the household weights provided in the surveys. In addition to controlling for heteroskedasticity, population-weighted models allow us to estimate impacts on an average person rather than average household.

## 4. Results

We first present the absolute effects of aggregate oil production on consumption expenditure of households' living within 20 km radius

**Table 3**
Oil production and household consumption.

| | log (total consumption) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\beta_1$ | 0.0087 | 0.0066 | 0.0100 | 0.0083 |
| | (0.0079) | (0.0067) | (0.0078) | (0.0066) |
| $\beta_2$ | −0.0013 | 0.0001 | −0.0000 | 0.0005 |
| | (0.0093) | (0.0082) | (0.0094) | (0.0084) |
| $\beta_1 + \beta_2$ | 0.0074 | 0.0067 | 0.0100** | 0.0089 |
| | (0.0050) | (0.0049) | (0.0051) | (0.0050)* |
| HH controls | NO | YES | NO | YES |
| LGA controls | NO | NO | YES | YES |
| Observations | 2288 | 2239 | 2288 | 2239 |
| $R^2$ | 0.71 | 0.74 | 0.71 | 0.74 |

Standard errors (in parentheses) are clustered at household level. $\beta_1$ = vicinity effect; $\beta_2$ = adjacency effect; $\beta_1 + \beta_2$ = aggregate proximity effect. All specifications include a dummy variable of being within 20 km of an oil field. Household controls include household size, household head's age and its squared term, respective indicators for married and male household heads, an indicator for living in one's house, distance to border (km), distance to nearest market (km). Local government controls include temperature and precipitation, with their quadratic terms. Oil production in measured in hundred thousands of meter cube.
***p < 0.01, **p < 0.05, *p < 0.1.

of an oil field in Section 4.1. Section 4.2 estimates the relative effect by considering expenditure on the disaggregated components of aggregate households' expenditure. Specifically, we estimate the impact on expenditure on education and other disaggregated expenditure components like rents, energy, transport, food, and telecommunications. We find that households' expenditure on education does not significantly increase between those in oil-producing fields and those outside the 20 km radius. This suggests that increasing education expenditure does not stimulate local demand for other goods and services in ways that are different by location to oil fields.

Section 4.3 explores alternative channels that rely on the effect of oil production activities on soil productivity. This is particularly relevant as the industrial-scale expansion of extractive sectors introduces new land uses with unknown repercussions for local communities. In addition, predominantly agricultural households may be affected through this channel due to the deterioration of soil productivity. Accordingly, we estimate the anthropogenic effect on soil characteristics such as nutrient availability, the toxicity of rooting conditions, and disaggregate households by rural and urban locations.

### *4.1. Oil production and households' aggregate expenditure*

Table 3 describes the effect of aggregate oil production within the 20 km radius on household spending. Consistent with Aragón and Rud (2013), results in Table 3 show that oil and gas production is positively correlated with household expenditure. For example, columns 3 and 4 show that a 10 unit increase in oil production is associated with a 0.09 percent increase in household expenditure within the 20 km radius of oil fields.[14] A possible suggestion is that the real income of households related to economic activities has grown, making them more able to increase consumption expenditure. Similarly, because endowments are positively and significantly correlated with population and employment, the oil-abundant region grows faster with a positive effect that spills over to other sectors. The results are also robust to alternative measures of oil production using average oil instead of aggregate oil production as shown in Table A2 of the Appendix.

We further explore several alternative "distance" metrics: First, we replace $P_{ot}$ in Eq. (1) with a simpler variable (within 20 km × Year). Second, we replace the "20 km radius" criterium with *3-nearest-neigbor (3-NN)* measure, where we aggregate oil production from the three closest oil field to the centroid of each LGA. Tables 4 and 5 show that the results of either using a discrete treatment or a uniform distance parameter are qualitatively similar to our baseline estimates: oil production stimulates households' aggregate spending.[15]

**Table 4**
Including time-varying proxy.

| | log (total consumption) | |
|---|---|---|
| | (1) | (2) |
| $\beta_1$ | 0.0102 | 0.0102 |
| | (0.0064) | (0.0064) |
| $\beta_2$ | −0.0013 | −0.0013 |
| | (0.0082) | (0.0064) |
| $\beta_1 + \beta_2$ | 0.0089* | 0.0089* |
| | (0.0050) | (0.0050) |
| Within 20 km × Year | 0.1375*** | 0.1375*** |
| | (0.0086) | (0.0087) |
| Observations | 5286 | 2239 |
| $R^2$ | 0.71 | 0.74 |

Standard errors (in parentheses) are clustered at household level. $\beta_1$ = vicinity effect; $\beta_2$ = adjacency effect; $\beta_1 + \beta_2$ = aggregate proximity effect. All specifications include complete controls and a dummy variable of being within 20 km of an oil field. Oil production in measured in hundred thousands of meter cube. Column 1 includes all households and all years while Column 2 is truncated to include only years when production occurs.
***p < 0.01, **p < 0.05, *p < 0.1.

**Table 5**
Alternative distancing measure: nearest neighbor (NN).

| | log (total consumption) | |
|---|---|---|
| | (1) | (2) |
| $\beta_1$ | 0.0036 | 0.0162*** |
| | (0.0041) | (0.0055) |
| $\beta_2$ | 0.0046 | −0.0142** |
| | (0.0059) | (0.0072) |
| $\beta_1 + \beta_2$ | 0.0082* | 0.0020 |
| | (0.0042) | (0.0043) |
| Observations | 4873 | 2212 |
| $R^2$ | 0.70 | 0.70 |

Standard errors (in parentheses) are clustered at household level. $\beta_1$ = vicinity effect; $\beta_2$ = adjacency effect; $\beta_1 + \beta_2$ = aggregate proximity effect. All specifications include complete controls and a dummy variable of being within 20 km of an oil field. Oil production in measured in hundred thousands of meter cube. Column 1 includes all households and all years while Column 2 is truncated to include only years when production occurs.
***p < 0.01, **p < 0.05, *p < 0.1.

[14] This strategy implicitly assumes that the impact of oil production decays with distance. This implicit assumption is further confirmed in Figure A1 of the Appendix where we compare the evolution of households' response at several proximity cut-off with respect to households farther away from oil fields.

[15] For this analysis, we get similar results irrespective of whether we use the entire sample years or only the years of oil production per oil field

These results are consistent with the effects of a local shock arising from backward integration to improved living standards (Aragón and Rud, 2013; Loayza et al., 2013). In a similar study focusing on Africa, Kotsadam and Tolonen (2016) find that mine openings create new employment opportunities outside agriculture and significant gender-disaggregated structural shifts. As suggested by Aragón and Rud (2013) and Loayza et al. (2013), in this case, local shocks from mining activities can increase real wages through backward integration and stimulate the standard of living (such as poverty, consumption, and literacy) of households in mining-based regions. Earlier findings interpret a positive effect as suggestive evidence that the market mechanism (that is, increase in demand for local inputs) improves local living conditions than the fiscal channel (increase in local governments' revenue and spending).

The studies discussed above have important limitations (Aragón et al., 2015). First, they are not very informative about the effects on other measures of welfare, and difficult to assess how much of the increase simply reflects the higher cost of living or changes in the composition of the local population. Second, they use settings where the extractive sector is based on mining activities. As discussed in the background and shown in Aragón et al. (2015), the economic effects at the local level depend on several factors, such as the degree of economic linkages of extractive activities (which determine the size of the local demand shock), substitutability of labor between industries, and labor mobility. These factors are likely to be very industry and context-specific.

This contrary view is gleaned from Caselli and Michaels (2013), who question the local economic effect of oil-based fiscal windfall in Brazil. Using data at the municipality level, the paper finds no significant improvement in housing quality or quantity, supply of educational or health inputs, or welfare receipts. There is also a negligible effect on household income and population size. The authors interpret these findings as evidence that oil production has not been particularly beneficial to the local population. A possible explanation is that oil production may generate a compositional shift that benefits specific sectors without improving the local economy. We investigate if education benefits from the growth of oil production due to the opportunities for local employment. These factors may offset the increase in living costs associated with the resource boom.

### 4.2. Impact of oil production on compositional shift in households' expenditures

This section investigates if increases in aggregate expenditure are associated with a compositional shift in households' expenditure in favor of items that improve local labor opportunities. Since hydrocarbon-based sectors are high-skill labor-intensive, the premium to skill through investing in education may be greater relative to the proximity to oil production. As a result, further development in these economies increases the relative demand for education without necessarily affecting other items that constitute the aggregate expenditure.

To explore the potential compositional shift accruing from oil production operations, we re-analyzed Eq. (1) with disaggregated consumption expenditures - education, food, telecommunication, rent, energy, and transport - as individual left hand side variables. Table 6 and Figure A2 in the Appendix show the negligible effect of oil production activities on the constituents except for education.[16] Specifically, we find that the main mechanism causing the increase in aggregate expenditure is the household demand for education. For example, a 10 unit increase in oil production is associated with a 0.211 percent increase in expenditure on education. In Table 6, we refer to the vicinity effect as the oil production effect ($\beta_1$), which captures the immediate impact of oil production and direct incentives of locals to invest in education due to some employment benefits. This effect is positive partly in response to local community requirements for local content in directly employing local workers affiliated with oil production. On the other hand, ($\beta_2$) refers to the adjacency effect, which is the oil-rich LGA's effect on households in oil-rich LGAs compared with households in non-oil-rich LGAs. Specifically, in this context, the adjacency effect captures some of the social costs associated with oil-rich LGAs, which, without much apparent benefits in terms of job potential, result in less demand for education. Oil-rich LGAs are associated with higher levels of corruption (Peel, 2005); the distribution of opportunities where corruption is more pronounced could reduce the extent to which investment in skills and knowledge translates into job opportunities.

We find that the overall proximity effect of oil on education spending ($\beta_1 + \beta_2$) is not statistically significant. This loss of significance derives from Gallice and Grillo (2019) model of educational investment under social concerns. Aggregate social demands for educational investments can improve productivity and income gains only in settings characterized by less quid pro quo patronage in exchange for a merit-based talent allocation in the oil sector. Oil proximity may diminish the combined effect of educational investments because oil fosters patronage-based corruption, increasing opportunities for high-skilled potential workers.

This finding has several implications for clarifying the inconsistencies with empirical findings on the local economy effect of oil production. First, it suggests examining the impact of resource booms on disaggregated outcomes can provide a better picture of the effect on livelihoods than simply observing aggregate outcomes. Second, it clarifies the mechanisms and highlights another important channel: opportunities for local employment in the hydrocarbon sector conditional on premium to skill that are different for artisanal mining.

The welfare effect of these compositional shifts towards education is auspicious. Education can encourage skill-biased structural change, leading to higher income and further diversification into non-oil sectors (Emediegwu, 2020; Buera and Kaboski, 2012; Acemoglu and Autor, 2011). In Acemoglu and Autor (2011) for example, a production function that uses high-skilled and low-skilled labor as inputs would increase wage only through a technical change that favors the employment of high-skilled workers. This skill-biased structural change could improve welfare by increasing employment and wages, aggregate output, sectoral factor shares, and the distribution of sectoral value added to more complex commodities.

On the other hand, without the right conditions, such as the size and completeness of the market and the extent of contracts enforcement, education is likely allocated for rent-seekers (Munemo, 2021; Murphy et al., 1991). Moreover, the lack of economic diversification and weak institutions associated with many resource-rich countries suggest that household expenditure on education might be less informative at stimulating welfare. To address this concern, we consider the ambiguous effect of education on income and investigate if this is a channel for improving expenditure on other consumption items in Table 7.

Table 7 shows that increasing expenditure on education lowers other consumption, but the effect is not significantly different for oil-producing regions. Similarly, we show that increasing expenditure on education does not stimulate demand for energy, transport, rent, food, and telecommunications. It follows that overall changes in premium for education due to oil production does not increase welfare and a similar increase in other expenditure components.

### 4.3. Alternative explanations: anthropogenic effects of oil production

We interpret the previous results as evidence that the local economy does not benefit from oil production. Although the expansion of oil production induces a compositional shift towards education, this is insufficient to stimulate strong backward linkages to other sectors.

[16] A reminder that this is for households within the 20 km radius to an oil field.

**Table 6**
Investigating compositional shifts.

| | Total consumption | Energy | Transport | Rent | Food | Education | Telecommunication |
|---|---|---|---|---|---|---|---|
| $\beta_1$ | **0.0083** | 0.0020 | −0.0018 | 0.0115 | 0.0090 | 0.0466*** | −0.0024 |
| | (0.0066) | (0.0125) | (0.0118) | (0.0108) | (0.0080) | (0.0149) | (0.0092) |
| $\beta_2$ | **0.0005** | −0.0115 | 0.0108 | −0.0070 | −0.0022 | −0.0446** | −0.0059 |
| | (0.0084) | (0.0161) | (0.0162) | (0.0123) | (0.0102) | (0.0210) | (0.0130) |
| $\beta_1 + \beta_2$ | **0.0089** | −0.0094 | 0.0091 | 0.0044 | 0.0068 | 0.0020 | −0.0084 |
| | (0.0050)* | (0.0103) | (0.0111) | (0.0059) | (0.0062) | (0.0146) | (0.0091) |
| HH controls | YES | YES | YES | YES | YES | YES | YES |
| LGA controls | YES | YES | YES | YES | YES | YES | YES |
| Observations | **2239** | 2148 | 1228 | 2239 | 2237 | 1288 | 1772 |
| $R^2$ | **0.74** | 0.66 | 0.62 | 0.80 | 0.70 | 0.77 | 0.62 |

Standard errors (in parentheses) are clustered at household level. $\beta_1$ = vicinity effect; $\beta_2$ = adjacency effect; $\beta_1 + \beta_2$ = aggregate proximity effect. All specifications include a dummy variable of being within 20 km of an oil field. Household controls include household size, household head's age and its squared term, respective indicators for married and male household heads, an indicator for living in one's house, distance to border (km), distance to nearest market (km). Local government controls include temperature and precipitation, with their quadratic terms. Oil production in measured in hundred thousands of meter cube.
***p < 0.01, **p < 0.05, *p < 0.1.

**Table 7**
Investigating the impact of education expenditure.

| | Total consumption less education | Energy | Transport | Rent | Food | Telecommunication |
|---|---|---|---|---|---|---|
| Education | −0.8569*** | 0.0365 | 0.0835 | −0.0382* | 0.0431* | 0.0109 |
| | (0.0180) | (0.0390) | (0.0594) | (0.0228) | (0.0259) | (0.0361) |
| Education*oil dummy | 0.0023 | 0.0312 | −0.0563 | 0.0492* | 0.0134 | 0.0444 |
| | (0.0245) | (0.0528) | (0.0760) | (0.0296) | (0.0326) | (0.0577) |
| HH controls | YES | YES | YES | YES | YES | YES |
| LGA controls | YES | YES | YES | YES | YES | YES |
| Observations | 3045 | 2888 | 1578 | 3045 | 3044 | 2483 |
| $R^2$ | 0.92 | 0.67 | 0.61 | 0.89 | 0.71 | 0.75 |

Standard errors (in parentheses) are clustered at household level. All specifications include a dummy variable of being within 20 km of an oil field. Household controls include household size, household head's age and its squared term, distance to border (km), distance to nearest market (km). Local government controls include temperature and precipitation, with their quadratic terms. Oil production in measured in hundred thousands of meter cube.
***p < 0.01, **p < 0.05, *p < 0.1.

**Table 8**
Anthropogenic effects of oil production.

| | Nutrient availability | Nutrient retention capacity | Rooting Conditions | Oxygen availability | Excess salts | Toxicity | Workability |
|---|---|---|---|---|---|---|---|
| $\beta_1$ | 0.9999 | 1.0001 | 0.9999 | 0.9995 | 0.9997 | 0.9997 | 0.9997 |
| | (0.0001) | (0.0002) | (0.0002) | (0.0003) | (0.0002) | (0.0002) | (0.0002) |
| $\beta_2$ | 0.9985 | 0.9990 | 0.9988 | 1.0012 | 0.9988 | 0.9988 | 0.9988 |
| | (0.0006) | (0.0012) | (0.0022) | (0.0015) | (0.0018) | (0.0022) | (0.0022) |
| $\beta_1 + \beta_2$ | −0.0014** | −0.0008 | −0.0012 | 0.0008 | −0.0013 | −0.0012 | −0.0012 |
| | (0.0007) | (0.0012) | (0.0023) | (0.0015) | (0.0018) | (0.0023) | (0.0023) |
| HH controls | YES | YES | YES | YES | YES | YES | YES |
| LGA controls | YES | YES | YES | YES | YES | YES | YES |
| Observations | 2221 | 2221 | 2221 | 2221 | 2221 | 2221 | 2221 |

Jackknife standard errors (in parentheses). $\beta_1$ = vicinity effect; $\beta_2$ = adjacency effect; $\beta_1 + \beta_2$ = aggregate proximity effect. All specifications include a dummy variable of being within 20 km of an oil field. Household controls include household size, household head's age and its squared term, distance to border (km), distance to nearest market (km). Local government controls include temperature and precipitation, with their quadratic terms. Results are obtained *via* Poisson estimation. Hence, the columns report incidence-rate ratios (IRR). Oil production in measured in hundred thousands of meter cube.
***p < 0.01, **p < 0.05, *p < 0.1.

This subsection explores additional explanations: we investigate the anthropogenic effect of the petroleum extractive sector on the environment and indirectly on households' living standards in the Niger Delta region of Nigeria. Local communities, particularly the poorest households, who do not benefit from work and trade opportunities offered by extractive industries, depend on agriculture for food and income. Two activities— petroleum extraction and its transportation through pipelines – are potential anthropogenic sources of environmental degradation. Exposure to these might further marginalize the poor and constitute a welfare loss to people living in the Nigerian Niger Delta.

Results in Table 8 show the impact of oil production operations on edaphic characteristics in the Niger Delta region of Nigeria. Our analyses do not provide evidence supporting the loss of soil quality of communities in the Niger Delta. Although oil-based activities might constitute soil cover loss, we argue that the impact is less likely to contribute to the degradation of local livelihoods in the Niger Delta.

These results reduce concerns regarding the indirect effect of oil-extraction activities not captured through expenditure and living costs. Moreover, they suggest that education may have been effective at mobilizing social capital for incorporating social responsibility to stimulate local action on enhancing biodiversity support. Education improves public awareness of the importance of ecosystems. As a result, the local community may better organize themselves to address threats imposed by extractive industries. Future studies may establish the relationship between education and the resource curse in the direction of biodiversity conservation and income-generating enterprises for the local populations.

## 5. Discussion

The results concerning preferences for education and why these might unlikely stimulate the local economy are very robust. They follow models of talent allocation under incomplete markets, such as Murphy et al. (1991) and Gelb et al. (1991). Since Schultz (1961), many economists have emphasized the importance of human capital as an integral component of development. Skills and knowledge are a form of capital; deliberate investment in human capital is probably an important factor in the growth of many Western societies. Increasing the relative supply of high-skill workers would spur a skill-biased technical change that diversifies the economic base and increases the relative demand for value-added products (Buera et al. forthcoming, Acemoglu and Guerrieri, 2008).

However, under an inefficient and poorly organized market, human capital can be misallocated and less effective for the economy. Murphy et al. (1991) consider conditions that encourage the most talented people to choose rent-seeking – a growth-reduction activity – over entrepreneurship. When markets in a country are large, and people can easily organize firms and keep their profits, many talented people become entrepreneurs. On the other hand, rent-seeking occurs when entrepreneurs cannot appropriate the surplus they generate (e.g., due to unclear property rights, lack of patent protection, etc.) or when markets are poorly diversified. Where human capital is efficiently allocated, i.e., talented people become entrepreneurs, they improve the technology and diversify the economy by pursuing economic activities resulting in productivity and income growth.

The remainder of this section formalizes these concepts to see if they align with our results. We start by considering a unit measure of households with identical preferences defined over two commodities. In our empirical analysis, these two commodities can be regarded as one that improves human capital $(C_H)$, we specifically define this type of consumption as direct expenditures on education. The second consumption involves expenditures on other goods and services that cover all purchases to meet day to day needs $(C_Z)$. These include spending on food, clothing, housing (rents), energy, transport, durable goods (notably cars), communication, and many imputed expenditures, such as agricultural products produced for own consumption.

Accordingly, preferences for human capital $(C_H)$ and value-added commodities $(C_Z)$ take the following form:

$$U(C_H, C_Z) = U(H_t, Z_t) \tag{5}$$

Human capital $(H_{t+1})$ is accumulated, given initial stock $(H_t)$ by sending a fraction of the household's school-age children $(e_t)$, to school and by purchasing inputs (e.g., textbooks) $(x_t)$. The allocation of expenditure on human capital evolves according to:

$$H_{t+1} = H_t + \alpha_t G[(x_t, e_t)(1 + \beta_j)] \tag{6}$$

where $G$ is a neoclassical production function and $\alpha_t$ is a learning productivity parameter that reflects school quality as well as child ability and motivation (Glewwe and Jacoby, 2004). We allow for locations to differ in attractiveness in terms of labor opportunities and earnings by introducing a location-induced effect $(1 + \beta_j)$. $\beta_j$ reflects proximity to oil fields, and the expectation is that increasing $\beta_j$ will increase local labor opportunities and preferences for investment in education (Black et al., 2009).[17] Since $0 < \beta_j < 1$, the consequence is that investment in education will differ across locations and reflect non-homotheticity as $\beta_j > 0$.

$Z_{t+1}$ is composed of value-added commodities, whose demand increases the productive utilization of resources that stimulate the local economy. Households generate income $Y_t$ from the allocation of human capital $(H_t)$ either under rent-seeking or entrepreneurship. $K_t$ is the stock of physical capital and together with $Y_t$, determine preference for $Z_t$ as:

$$Z_{t+1} = K_t + Y_t(.) \tag{7}$$

$$Y_t = \phi_t[(1 - H_t(1 + B_j))] \tag{8}$$

where $K_t$ is the capital stock (land and other fixed assets) and $Y_t$ is the wage (income) generated under rent-seeking or entrepreneurship. The parameter $\phi_t$ is a random variable serially uncorrelated and identically distributed over time. It can be considered as a productivity parameter that reflects the state of technology, market coordination, and institutions translating human capital into entrepreneurship. The variable $H_t$ is the talent (human capital). If $H_t > 0$, talent is misallocated under rent-seeking, and this diverts productive resources that otherwise would generate a multiplier effect and stimulate backward linkages. On the other hand, if $H_t = 0$, the talent is allocated under entrepreneurship and adds resources that stimulate productivity. However, rent-seeking is favorable as $\beta_j > 0$, reflecting the greater tendency for misallocation of talent (human capital) and less opportunity to stimulate local productivity as households' proximity to oil fields and production increases.

## 6. Conclusion, policy implications, and future research

This paper investigates the local effects of oil and gas production on people living in the Niger Delta oil-producing region of Nigeria. Specifically, we seek to understand if oil production benefits people living in communities where oil extraction occurs. Although the potential for extractive industries to improve the local economy and living standards of their host communities is strong, evidence points to backward linkages through local labor employment and input demand (Kotsadam and Tolonen, 2016; Aragón and Rud, 2013). However, oil and gas developments (in)ability to impact local poverty and sustainable development in many communities in SSA where extraction takes place have been the focus of the development agenda over the years (UNDP, 2006).

A major obstacle to estimating the impact of hydrocarbon development on households' living standards in the Niger Delta is the presence of correlated unobservables that may confound identification. For example, households do not randomly assign themselves to where they live, but the economic opportunities associated with oil, such as increased wages and unobservable neighborhood attributes, are correlated with proximity and prices. Similarly, the predicted increase in expenditure may only imply nominal changes, reflecting inflation and not providing information on the effect on welfare.

Methodologically, we utilize a combination of fixed effects and difference-in-differences, triple–differences (DDD), and treatment boundaries in oil production and households' locations to produce unbiased estimates. Specifically, in addition to the compositional effect that reflects the priority for education, we delineate the impact categories by proximity to oil fields to net out the social costs and economic benefits of oil development. We label these as the vicinity effect (households in oil LGA and within a 20 km radius of oil fields) and the adjacency effect (households in non-oil LGAs). We call the net effect of these the proximity effect.

We find robust evidence that oil production positively affects the consumption expenditure of households in the Niger Delta. However, after disaggregating expenditure into its components, we find evidence supporting a compositional shift, reflected by the increased demand for education by vicinity alone. Taken as a whole, our findings point to suggestions that under the resource curse, surplus labor rent-seeking could aggravate dynamic social costs (Gelb et al., 1991; Murphy et al., 1991). In this case, demand for education will be insufficient to stimulate the local economy, especially if there are limited alternatives in non-oil economic activities. On the other hand, diversifying the economy into non-oil sectors that use high and low-skilled workers as inputs could stimulate backward linkages and bring about income growth and

[17] Many such models exist in urban economics, e.g., Shapiro (2006), Hanson (2005), Glaeser and Mare (2001) and Roback (1982).

structural transformation.

Our findings fit into the recent policy debates on subnational governance of resource extractives through intentional interventions that engage local actors' human and material resources (Bauer et al., 2016). Economic impacts may arise from the "boom town" phenomenon, where local areas facing hydrocarbon development see increased employment due to increased business activities and government revenues (Muehlenbachs et al., 2015). However, social and environmental costs within a boomtown may aggravate living standards if local skilled labor is underutilized due to the specialized nature of the skill demands in the oil sector. Specifically, market-based interventions encouraging a diversified economy could absorb locals with specialized training in communities where extraction occurs.

Furthermore, incorporating voices from local stakeholders can be used to identify areas that prioritize long-term development objectives over short-term gains. Ultimately, the sustainability of local benefits of resource extraction would depend on policies that tame the likely economic consequence of depleted resources as resource markets get volatile. Because of the volatility of the extraction and resource revenue life cycle, having a long-term development objective helps address the consequences of local recessions, job cuts, and reduced government spending due to depressed demand. Undiversified economies are more likely to be hit during global recessions, resulting in oil production cuts. Management policies can be sustainable only when savings and investment decisions prioritize diverse portfolios and economic sectors less reliant on the oil supply value chains.

Although our findings elucidate some important mechanisms, it is still unclear how extraction affects well-being through other important mechanisms. Because the mechanisms we rely on come from consumption expenditure per household, it is not very informative about the effects on different measures of welfare like housing quality and quantity, drinking quality, child health, health outcomes, and quality of life — these are some channels that could be used in future research to elucidate the welfare implication from a broader perspective.

Our findings suggest that certain aspects of expenditure are influenced by external factors; however, it remains unclear to what extent these changes are driven by rising costs of living and inflation or by shifts in the composition of the local population. Future research could explore the mechanisms and degree to which local benefits are influenced by episodes of political connections, examining how subnational corruption shapes the distribution of opportunities and contributes to economic inequality. Additionally, further investigation is warranted into the economic impacts of civil conflicts over resource control, particularly the ways in which such conflicts erode subnational transparency, accountability, and community cohesion as a result of windfall transfers.

## CRediT authorship contribution statement

**Jubril Animashaun:** Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Lotanna E. Emediegwu:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.resourpol.2025.105464.

## Data availability

Data will be made available on request.

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