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## From wells to wealth? Government transfers and human capital

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# From Wells to Wealth? Government Transfers and Human Capital

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Inter-American Development Bank  
Infrastructure and Energy Sector

May 2022

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# From Wells to Wealth? Government Transfers and Human Capital\*

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## Abstract

To study the causal impact of oil royalties on human capital, we exploit quasi-experimental variation arising from a law in Ecuador that transfers resources to municipalities regardless of their oil-producing status. We find that royalties increase the likelihood of students completing primary and secondary education. Students reaching high school are also more likely to pass and excel on the exit exam. Furthermore, schools are more likely to remain open, increase their size, and become more road-accessible. However, the likelihood of students pursuing higher education decreases as they face steeper opportunity costs when labor demand increases.

**Keywords:** natural resources, oil royalties, transfers, human capital, Ecuador

**JEL:** I25, O13, O15, Q32, Q35

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# 1 Introduction

Oil is an economically important commodity in Ecuador, with petroleum rents having accounted for 11.26 percent of the country’s GDP, on average, between 2000 and 2019 ([The World Bank, 2022](#)).<sup>1</sup> With oil having been first discovered in the country in 1911, questions arise regarding this natural resource’s long-term impact. In particular, whether or not investments in the sector managed to ignite long-term growth in the country. Given the magnitude and economic importance of the oil industry, it is crucial to understand the impact of oil windfalls and, more generally, government royalties, especially in areas that can promote long-term growth and improve living standards, such as human capital accumulation ([Barro, 2001](#); [Kurtz and Brooks, 2011](#); [Venables, 2016](#)).

In this article, we study the causal effect of oil royalties on human capital in Ecuador using quasi-experimental variation arising from Law 010 –hereafter referred to in Spanish as Ley 010. This law has assigned resources to municipalities regardless of their oil-producing status since 1992. Local governments cannot manipulate the resources they receive, and the distribution rule is anchored to predetermined indicators that, in some cases, date back to the last decade. In particular, the total value of royalties captured by the local government depends on the total number of barrels produced at the national level and a fixed tax per barrel with fixed yearly increments as stated in the law. As for the distribution of the royalties, they will be assigned partially to municipalities in the Amazonian region based on the latest census population data.<sup>2</sup> Furthermore, the law imposes restrictions on how local authorities may employ the funds. For example, no more than 20% of the resources can be used to improve education quality and at least 80% have to

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<sup>1</sup>There is not a consensus about the total crude oil reserves but Ecuador reported in 2019 total reserves equivalent to 2.2 billion barrels of oil ([MERNNR, 2019](#)), while the latest estimate for 2021 is 8.3 billion barrels of oil ([EIA, 2021](#)). This places Ecuador’s oil reserves as the third largest in Latin America, after Venezuela and Brazil ([EIA, 2021](#)). At the current production level, this means that Ecuador would have 42 years of oil left.

<sup>2</sup>The details are explained in Section 2

be invested in transport and environmental protection infrastructure.<sup>3</sup> Although Ley 010 has been reformed a few times, the latest and most extensive modification happened in 2008. The reform almost doubled the tax per barrel.

Exploiting the exogenous variation built into Ley 010, we construct an instrumental variable (IV) to predict municipality-level royalties. We show that the identification strategy is robust to excluding oil-producing municipalities, to excluding individuals working for the oil sectors, to accounting for differential trends in municipalities that receive royalties, to considering compositional changes caused by the law, and to estimating an empirical strategy that compares municipalities that are geographically proximate. Nonetheless, we implement a random assignment test that shows that our IV cannot predict the key outcomes before Ley 010 was implemented.

In the first part of the analysis, we use individual-level data from Ecuador’s labor force survey (INEC, 2018) to estimate the effects of royalties on human capital accumulation in different cohorts which have been heterogeneously exposed to education investments from Ley 010. We find that royalties have a nonmonotonic impact on educational attainment in younger cohorts – the chances of completing primary school and obtaining at least some secondary education increase with royalties. However, there is an inflection point, and the sign reverts at the college level. In particular, we observe a negative effect on the probability of acquiring college education. In line with this finding, we observe a negative effect of royalties on the probability that older cohorts attend school.

These shifts in educational attainment are limited to cohorts exposed to the benefits of investment projects financed by the royalties in their municipalities. The reduced educational attainment among individuals old enough to start working

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<sup>3</sup>Environmental protection infrastructure includes water management infrastructure such as access to drinking water and appropriate disposal of sewage water, solid waste management infrastructure, and investments in programs for prevention, preservation, and conservation of the environment, protected natural areas, and, in general, management of ecosystemic goods and services.

suggests changes in the opportunity costs of staying in school. To explore this channel, we estimate the effects of royalties on the probability of being employed, which are positive for all cohorts and do not depend on the individual’s industry. Complementary to this analysis, we turn our attention to employment outcomes at the firm level. Using panel data from the enterprises and establishments census (INEC and SENPLADES, 2020), we can observe the structure of all businesses in Ecuador for the 2006–2019 period. Our estimates indicate a positive and significant effect on employment at the firm level. Of particular importance is the finding that medium and large-sized enterprises are hiring more teenagers ages 15–17.<sup>4</sup> Positions in these firms tend to be of higher quality as they may offer higher wages, better benefits, and a higher ratio of workers covered by social security.<sup>5</sup> The royalty-induced jobs are created outside the oil industry, suggesting that they could provide long-term employment and development. Thus, the evidence shows that high school-aged individuals face steeper opportunity costs to stay in school, discouraging them from pursuing higher education.

Having considered the extensive margin of education, we explore the effects of royalties on the intensive margin using the scores of the high school standardized test, Ser Bachiller. High school students have to pass Ser Bachiller to graduate and to access public post-secondary education. We observe positive effects in mathematics, language, science, and social studies for individuals that have been exposed to royalties from Ley 010. Hence, royalties increase the probability of a student passing and excelling in the exam. Consistent with oil royalties being a source of public financing, we find that the effects are limited to students from public schools. In contrast, students in private institutions do not experience any

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<sup>4</sup>A medium-sized establishment employs between 10 to 49 workers and receives annual revenues between USD 100,000 and USD 1,000,000. On the other hand, large-sized establishments cover enterprises employing 50 to 200 workers with revenues between USD 1,000,000 and USD 5,000,000.

<sup>5</sup>Only 25% of workers belonged to the formal sector in Ecuador in 2017 (INEC, 2018) Meanwhile, the informal sector is less regulated, pays lower salaries, and offers little job security and no benefits.



change. For clarity, this analysis is restricted to those individuals who stay in the education system and take the test. However, we do not find evidence supporting selection or significant compositional changes as drivers of these results. Instead, as shown in our previous findings, the inflection point happens after the completion of high school, which is likely exacerbated by the inelastic college supply in the exposed region.

To understand the impacts of royalties across the entire general educational system, we draw on administrative panel data from the Ecuadorian Ministry of Education for all the country’s institutions and evaluate the effects on key outcomes and resources at the school level. We find that the impact on pass and dropout rates follows the same pattern as observed previously. Students in elementary and middle school have higher pass rates without changes in dropout rates. This shows that people in municipalities that receive oil royalties are more likely to complete their primary general education. In contrast, pass rates do not change among students in the final two years of high school, nor do we observe statistically significant increases in dropout rates. We also do not find that the student-teacher ratio changes since Ley 010 prohibits municipalities from using royalties to hire workers or pay salaries. However, we do not rule out the possibility that municipalities are investing in better assets –such as books, laboratories, computers, or other educational resources, because our data do not allow us to observe those investments.

Nonetheless, we provide evidence on royalties inducing a shift in school attributes and composition. We estimate the impact of royalties on school characteristics and the probability that schools remain open. Schools that survive the entire study period tend to increase in size, implying that they accommodate more students. In addition, these schools are more likely to have land access, which is associated with better road infrastructure. Royalties also increased the chances of survival for less connected, rural schools that owned their buildings and offered bilingual

education at the beginning of 2010.<sup>6</sup> Finally, the data on school closures suggests that students are moving from smaller, less-connected, distance education to more-established schools of higher quality and with more resources. Although we do not observe the specific destination of disbursements from local governments, the investment might be biased toward schools with better financial and academic performances, which could be driving the closure of lower quality and poorly managed institutions.

We contribute to the literature by studying how natural resources can affect development and human capital.<sup>7</sup> Although the literature is not conclusive about the net benefits, some evidence suggests that natural resource windfalls increase public spending on education, increase enrollment, and high school completion, while not slowing wage growth or the accumulation of human capital (Bonilla, 2020; Caselli and Michaels, 2013; Domenech, 2008; Hajkowicz et al., 2011; Mamo et al., 2019). We add to this literature by showing that the quality of education, proxied by high-stake high school test scores, can improve. Moreover, we show that school quality improves as oil royalties change their attributes.

While public spending on education, and high school completion tend to have positive impacts on economic development, natural resources might negatively affect development by increasing the benefits of corruption, diverting public investment from education, and decreasing educational attainment as consequence (Ebeke et al., 2015; Gylfason, 2001; Mamo et al., 2019; Papyrakis and Gerlagh, 2007; Tornell and Lane, 1999; Torvik, 2002). In developing countries, oil windfalls may increase spending on public goods but not necessarily as efficiently (Bonet-Morón et al., 2020; Monteiro and Ferraz, 2010). The existence of these inefficiencies can be partially attributed to the strength of institutions (Boschini et al., 2013;

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<sup>6</sup>The term bilingual refers to Spanish and local indigenous languages

<sup>7</sup>See Mousavi and Edmund Clark (2021) for a broader literature review on the field.

Robinson et al., 2006; Van der Ploeg, 2011).<sup>89</sup> Moreover, the quality of institutions can increase the effect of the allocation of resources and reduce corruption levels (Cabrales and Hauk, 2011; Ebeke et al., 2015; Mehlum et al., 2006). Thus, human capital dynamics in developing countries vary with circumstances, and an increase in public resources will not necessarily improve education outcomes homogeneously (Aragón and Rud, 2013; Balza et al., 2021; Bonilla, 2020; Caselli and Michaels, 2013). Our findings suggest that at least part of the royalties are invested and generate positive outcomes. Some features of Ley 010, such as the inability to use royalties to pay for current expenditures, salaries or daily allowances, help rationalize these outcomes.

The trade-off between employment and education emerges as wages and labor demand increase, opportunity costs change and education becomes more costly for certain groups of the population (Ahlerup et al., 2020; Black et al., 2005; Douglas and Walker, 2017; Ebeke et al., 2015; Kumar, 2017; Marchand and Weber, 2020; Michaels, 2011; Mosquera, 2022).<sup>10</sup> We add to this literature by showing that the royalty-induced jobs can be of high quality, in terms of salary and benefits. Additionally, these jobs do not have to be transitory and can be generated outside the resource extraction sector.

Finally, a key contribution of this paper is proposing a new empirical strategy that exploits features of Ley 010 that strengthen the causal interpretation of our

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<sup>8</sup>The type of resource can also influence the outcome (Isham et al., 2005), as can the likelihood of politicians remaining in power, conditional on existing institutions, where corruption can affect the impact on growth (Bhattacharyya and Hodler, 2010; Libman, 2013).

<sup>9</sup>There are complementary explanations of why resource windfalls might generate bad outcomes: resource windfalls appreciate the exchange rate, shrink the traded sector, expand the non-traded sector, and increase volatility –see Van der Ploeg (2011) for a detailed discussion and Sachs and Warner (1995) for a foundational study in this topic. Crucially, good institutions play an important role in the extent to which natural resource windfalls affect public investment such as transport and communication infrastructure, and financial development (Bhattacharyya and Collier, 2014; Bhattacharyya and Hodler, 2014).

<sup>10</sup>See Neyt et al. (2019) for a literature review in alternative contexts.

results. From a policy perspective, the impacts of the examined policy can provide valuable insights for other resource-rich developing countries and, more generally, add to the literature on government transfers and its distribution (e.g. [Bardhan \(2002\)](#)). In particular, we go beyond an estimation of the direct effect of transfers linked to oil windfalls and shed light on the mechanisms that generate the results by examining outcomes at the school, individual, and firm levels. Our findings suggest that multi-goal policies that aim to improve infrastructure, grow local businesses, and increase education can be attainable. However, such policies have built-in features that inevitably favor low-skill jobs and increase the opportunity cost of higher education. Ley 010 in Ecuador offers an opportunity to contribute to the study of the impact of redistributing oil royalties.

The paper is organized as follows. Section 2 presents a brief background of Ecuador's industry and specifically how oil royalties regulations have changed throughout the years. Section 3 presents the data and some initial summary statistics that help to introduce our empirical strategy. Section 4 describes the identification strategy used to understand the impact of oil royalties on education and labor outcomes, and we present the results in Section 5. Section 6 discusses a few additional robustness tests that confirm our main results, and Section 7 concludes.

## **2 Ley 010 and the oil industry in Ecuador**

Oil was first discovered in Ecuador in 1911 in the province of Santa Elena, with a second reserve being discovered in the Amazonian region in 1967. Initially, extraction activities were managed by foreign companies and the state's share of the windfall was limited. However, in 1971, the government declared that the country's oil wealth was the inalienable patrimony of the state. State-owned companies were created to help manage and develop oil resources. Although the country briefly implemented an oil policy oriented to allow higher private participation during the

mid-1990s to the mid-2000s (Balza and Espinasa, 2015), the overarching theme of the history of oil extraction in Ecuador has been one of increased participation by the state.

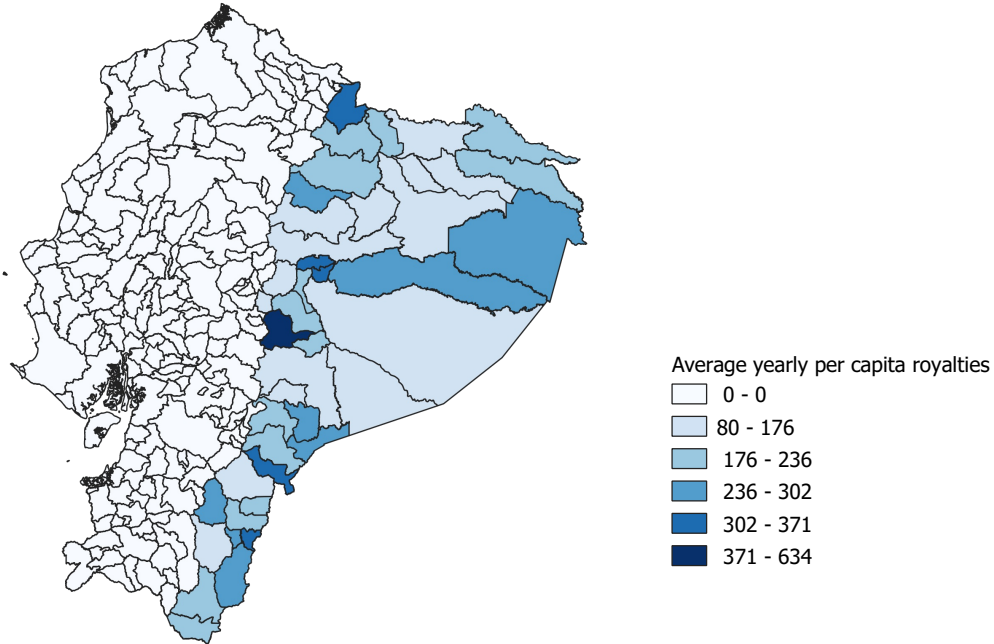
The passage of Ley 010 in 1992 ensured a constant stream of oil-dependent resources to the Amazonian region. Initially, the law established a tax of USD 0.06 per barrel of oil, which would increase by USD 0.01 each year until it reached USD 0.10. The law changed again in 1997: starting in 1998, the tax would increase by USD 0.05 each year until it reached USD 0.50. In addition to the overall distribution, between 1992 and 2008 funds were to be distributed according to the following rule:<sup>11</sup> 55% distributed equally, with the remaining 45% distributed proportionally to the municipality's population in the latest census. Ley 010 further stipulates that all funds must be invested in the Amazonian region. Only 20% of total royalties are available for investment in education, with a focus on improving quality, coverage, and higher education scholarships. The remaining 80% is to be invested in improving environmental quality, promoting local businesses, infrastructure, and transport infrastructures such as ports and roads. However, the law does not specify how these funds should be allocated among these competing objectives.

Ley 010 guarantees that resources are geographically targeted. Figure 1 displays average yearly per capita oil royalties under the law for the 2001–2017 period. Royalties are distributed mainly in the Amazonian region, with considerable heterogeneity across municipalities. This distribution is linked to the total population in a province and the municipalities within them regardless of whether or not a municipality produces oil. The fact that a portion of the royalties is distributed among 43 municipalities, including the 41 Amazonian municipalities, and another part is distributed evenly among the 6 Amazonian provinces generates additional exogenous variation at the municipality level.

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<sup>11</sup>Codificación de la ley del Fondo para el Ecodesarrollo Regional Amazónico y de Fortalecimiento de sus Organismos. Quito, noviembre 20 de 2003. Oficio No. 851-CLC-CN-03

Figure 1: Average yearly per capita oil royalties between 2001 and 2017.



*Notes:* This figure shows the distribution of the average yearly per capita oil royalties by municipality. The annual average is calculated for the 2001–2017 period. Nominal values have been adjusted to real values using constant 2011 USD. Appendix Table A1 presents the data set, and Appendix Table A2 provides variable definitions.

Starting in 2006, the Ecuadorian government introduced a series of amendments and new laws intended to increase their revenues from the oil sector as oil prices surged. The key changes included the introduction of Law 42-2006 (Ley 42-2006) and an increase in the share of revenues captured by the state under Ley 010. This regulatory shift resulted in all current and future oil income being directed to the central government, with the exception of the portion allocated to the Amazonian Regional Eco-Development Fund (Cueva and Ortiz, 2013). In 2008, the state increased the per-barrel tax under Ley 010 to USD 1.00 and introduced a new assignment rule. The 40% of royalties is to be distributed in equal parts and the remaining 60% of the funds is to be distributed proportionally to the population in each jurisdiction according to the latest census –with this now applying to

provinces, municipalities, and parishes.<sup>12</sup> A further stipulation is that 100% of the funds must be invested and can never be used for current expenditures or to pay for salaries, daily allowances, consumption, or travel expenditures. Nonetheless, two municipalities outside the Amazonian region were included in the municipal distribution in 2008: Penipe in Chimborazo, and Bano de Agua Santa in Tungurahua.

### 3 Data

As our main exposure measure for royalties, we use data from the National Secretariat of Planning<sup>13</sup> (SENPLADES, 2015). Their reports contain nominal yearly transfers in dollars under Ley 010 at the municipality and province level. This helps to characterize changes in oil royalties allocated to municipalities for the 2001–2017 period. We collect data from the central bank and Petroamazonas EP<sup>14</sup> (2021) on the total annual number of barrels of oil produced in Ecuador to estimate total royalties based on the number of barrels.

The National Employment and Unemployment Survey (ENEMDU)<sup>15</sup> provides detailed and nationally representative information on an annual basis related to educational attainment, school attendance, and labor market outcomes for Ecuadorians aged five or older (INEC, 2018).<sup>16</sup> ENEMDU data are produced and published

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<sup>12</sup>See Article 3 of Ley del Fondo para el Ecodesarrollo Regional Amazonico.

<sup>13</sup>Secretaría Nacional de Planificación y Desarrollo, SENPLADES, in Spanish

<sup>14</sup>Petroamazonas EP (PAM EP) is a public company in charge of the state operations in the oil and gas sector. The company is involved in the management, exploration, and exploitation of these resources.

<sup>15</sup>Encuesta Nacional de Empleo, Desempleo y Subempleo, ENEMDU, in Spanish

<sup>16</sup>Educational information is available for some individuals at age four, but the official age to enter the first grade of elementary school in Ecuador is five.

by the National Institute of Statistics (INEC)<sup>17</sup> and cover the 2001–2017 period.<sup>18</sup> Although ENEMDU is not representative at the municipality level, it is still possible to identify people living in municipalities who receive oil royalties. This allows us to track individuals residing in the region so as to estimate the effects of oil royalties on their educational and labor market outcomes. The key outcomes of interest include education, wages, and employment status.

Our analysis restricts the sample to people who were between the ages of 5 and 40 during the study period. We select this range because the minimum age for enrolling in the first grade of elementary school is five years while the upper limit is set at the 99th percentile of the age distribution for the population who attended school in the dataset. This allows us to focus on a subset of the population who is more exposed to the benefits from investing in education while facing the steepest changes in opportunity costs. In addition, for every educational attainment outcome we examine in the empirical analysis, we ensure that the selected sample meets the required age. For example, when exploring the effects on college completion, we make sure everyone in the sample is at least 19 years old.

To investigate the impact of oil royalties on education quality, we use individual scores from the national standardized test, Ser Bachiller. Students in the last year of high school are required to take this test, with their scores representing 30% of the final overall grade needed to graduate. Taking and passing the test gives students the opportunity to study at public postsecondary institutions. The test measures skills in mathematics, language, natural sciences, social studies, and abstract reasoning.<sup>19</sup> Each part is graded on a scale of 10 points. In addition to the scores, the data set includes age, gender, socioeconomic information, and details about the school’s funding. In particular, we observe whether the school is private

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<sup>17</sup>Instituto Nacional de Estadística y Censos, INEC, in Spanish

<sup>18</sup>In fact, the data set covers the years 1990 to 2020, but the 2001–2017 period overlaps with the coverage of our oil royalty data. We use the harmonized data produced by BID (2021), which also include the consumer price index from the World Development Indicators to deflate all nominal values throughout our analysis.

<sup>19</sup>Abstract reasoning is not reported disaggregated from the overall score.



or if it receives funds from the government. The data are produced annually by the National Institute of Educational Evaluation (INEVAL)<sup>20</sup> for the 2015–2019 period.

To study the mechanism driving changes in human capital at the school level, we construct a panel data set using administrative data from the Ministry of Education<sup>21</sup> (INEC, 2020) which covers every year starting from 2009 through 2017. It includes the total number of students, dropouts, promotions, teachers, and schools. These variables can shed light on whether or not resources are being invested in education to further improve human capital.

Labor market outcomes are included to analyze the trade-off between education and employment. We construct a panel data set from the Directory of Enterprises and Establishments of Ecuador (DEE)<sup>22</sup>, which covers the entire structure of self-employment and businesses in Ecuador for the 2006–2019 period. The data were collected by the INEC and SENPLADES (2020) from multiple sources<sup>23</sup> and includes administrative records of the internal tax revenues system, social security records. Our analysis uses data on the size of firms, labor, activity status, and annual wages paid.

Lastly, we use census data from INEC for the years 1964, 1972, 1982, 1990, 2001, and 2010. The data sets for 1990, 2001, and 2010 are produced and published by INEC, and the 10% samples for 1964, 1972 and 1982 are produced by INEC but published by IPUMS-International (Minnesota Population Center, 2020). The data provide individual-level data that we aggregate at the municipality level. The population distribution is of particular interest for our identification strategy, given that this is a key component of how Ley 010 distributes royalties to municipalities.

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<sup>20</sup>Instituto Nacional de Evaluación Educativa, INEVAL, in Spanish

<sup>21</sup>Ministerio de Educación, MINEDUC, in Spanish

<sup>22</sup>Directorio de Empresas y Establecimientos, DEE, in Spanish

<sup>23</sup>In particular, data from MINEDUC and the National Service of Public Procurement in Ecuador.

Table 1: Summary statistics by region according to Ley 010

	Royalties		No royalties		Difference
	Mean	SD	Mean	SD	
<i>Royalties</i>					
Royalties since 2001 (per capita)	6635.25	8529.80	0.00	0.00	6635.25***
Royalties IV since 2001 (per capita)	5668.01	7207.88	0.00	0.00	5668.01***
Royalties (per capita)	221.82	84.86	0.00	0.00	221.82***
Royalties IV (per capita)	217.47	100.78	0.00	0.00	217.47***
<i>Individual characteristics</i>					
Age	29.31	19.36	33.14	20.93	-3.83***
Employed (dummy)	0.53	0.50	0.50	0.50	0.03***
Males (dummy)	0.50	0.50	0.51	0.50	-0.01***
Wage	2.36	4.31	2.07	4.51	0.29***
<i>Education level</i>					
Primary education (dummy)	0.52	0.50	0.49	0.50	0.03***
Some secondary education (dummy)	0.47	0.50	0.45	0.50	0.02***
Secondary education (dummy)	0.25	0.43	0.26	0.44	-0.01***
Some college education (dummy)	0.09	0.29	0.13	0.33	-0.04***
College education (dummy)	0.03	0.18	0.05	0.22	-0.02***
<i>Household characteristics</i>					
Access to water (dummy)	0.75	0.43	0.81	0.39	-0.06***
Access to electricity (dummy)	0.92	0.27	0.97	0.17	-0.05***
Access to toilet or latrine (dummy)	0.84	0.36	0.94	0.24	-0.09***
Dirt floor (dummy)	0.03	0.16	0.07	0.25	-0.04***
Garbage disposal service (dummy)	0.70	0.46	0.70	0.46	0.00*
No schools nearby (dummy)	0.00	0.06	0.00	0.06	0.00**
Rooms in household	3.35	1.49	3.36	1.45	-0.01*
N	134481		1254947		1389428

Notes: This table displays summary statistics for the main variables in our analysis for the years 2001 to 2017. These statistics are calculated at the individual level using the sample from ENEMDU. SD refers to the standard deviation. Appendix Table A1 presents a description of all data sources, and Appendix Table A2 provides variable definitions.

Table 1 displays the summary statistics on oil royalties and aspects covered by ENEMDU. On average, individuals in municipalities that receive royalties tend to be younger and have less education, with lower overall socioeconomic indicators as well. These differences are small but statistically significant. Conversely, wages tend to be higher in municipalities that receive oil royalties. Summary statistics for Ser Bachiller can be found in Appendix Table B1. Students in municipalities that receive oil royalties have lower scores across every area of knowledge tested

in Ser Bachiller. They are slightly older and have lower socioeconomic indicators. Appendix Table B2 displays summary statistics for the Master File of Educational Institutions (AMIE).

## 4 Empirical strategy

To estimate the impact of oil royalties on human capital, we design an IV that exploits the exogenous variation built into Ley 010. According to the law –described in Section 2, royalties are linked to national oil production and distributed to the Amazonian provinces and municipalities.<sup>24</sup> By distributing royalties regardless of local oil production, the design avoids endogeneity issues caused by sample selection bias – municipalities that are better managed may also stimulate local oil production in order to receive extra royalties. A crucial factor for identification is that the tax rate is set regardless of oil prices or future local conditions. Moreover, local and presidential elections occur every four years, which implies that the tax rates are independent of future election results. Another key exogenous feature is that royalties are distributed proportionally to population according to the latest census, which means that incumbent local governments cannot manipulate the amount of royalties they receive. Additional variation is added when new national censuses update population figures and thus the distribution of royalties.

In 1997, oil was taxed at USD 0.10 per barrel, a rate that subsequently increased by USD 0.05 per year until it reached USD 0.50. Municipalities received 60% of these royalties. Of this share, 45% was distributed on a proportional basis by population and 55% was distributed evenly between the 43 municipalities. Before 2008, 30% of the royalties were distributed evenly among the six provinces. Following a modification of Ley 010 in that year, municipalities and provinces began receiving 60% of their funds proportionally, with the remaining 40% evenly distributed.

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<sup>24</sup>As mentioned previously, two municipalities outside the Amazonian region are included in the distribution of the royalties.

The tax per barrel was more than doubled in the same year to USD 1.00. The IV uses national oil production and the allocation rules to predict royalties across municipalities and provinces.

The second stage is given by

$$y_{imt} = \gamma \cdot \text{Royalties}_{mt} + \beta \cdot X_{imt} + \sigma_t + \eta_m + \varepsilon_{imt} \quad (1)$$

The parameter of interest is  $\gamma$ . It captures the impact of USD 1,000 of oil royalties per capita, accumulated at the municipality level since 2001, on an outcome of interest at the individual level,  $y_{imt}$ , such as years of education and education level. The vector  $X_{imt}$  includes a set of controls at the individual level. We also control for municipality and year fixed effects,  $\eta_m$  and  $\sigma_t$ , respectively.

The first stage, depicted in Figure 2, is

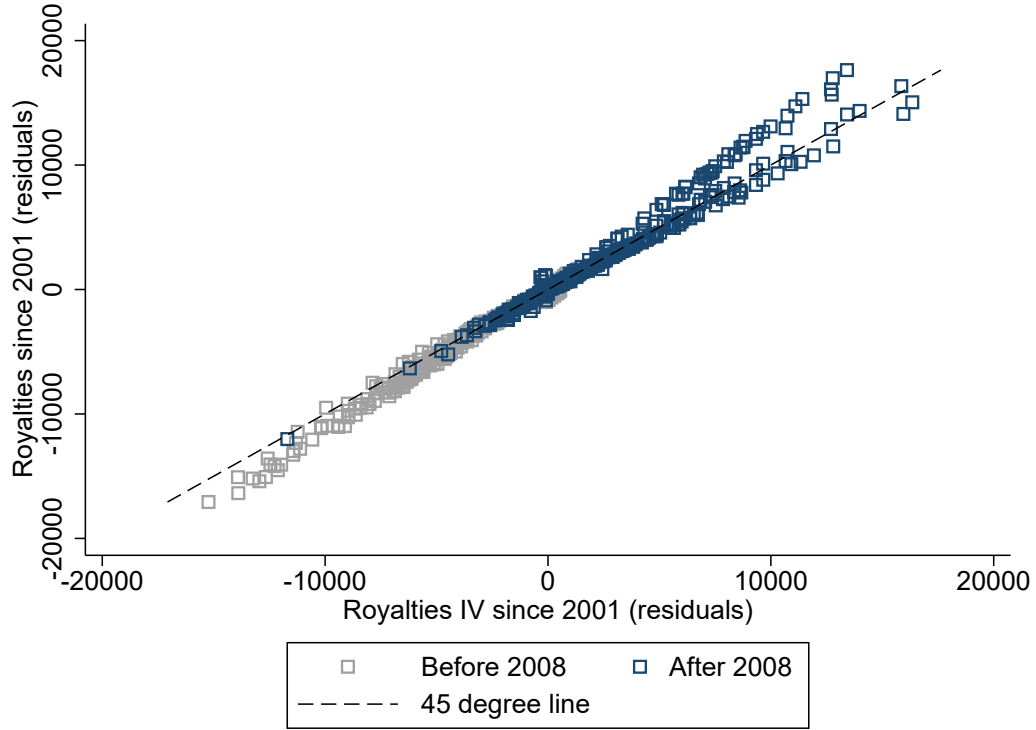
$$\text{Royalties}_{mt} = \alpha \cdot \text{Royalties IV}_{mt} + \theta \cdot X_{imt} + \omega_t + \tau_m + \epsilon_{imt} \quad (2)$$

$\text{Royalties}_{mt}$  are cumulative oil royalties per capita received at the municipality level since 2001 in year  $t$ . These include resources from both municipalities and provinces.  $\text{Royalties IV}_{mt}$  is the IV, designed according to Ley 010. The matrix  $X_{imt}$  includes a set of control variables at the individual level. The model also controls for year and municipality fixed effects,  $\omega_t$  and  $\tau_m$ , respectively.

Figure 2 displays the first-stage relationship between the total per capita royalties since 2001 and the total predicted royalties. Notice that the prediction is not perfect according to the 45-degree line shown in Figure A1. Therefore, despite the rigid framework built into Ley 010, in practice there is a small degree of discretion. This is why we rely on our instrumental variable to predict royalties in order to capture the exogenous variation.

The fact that royalties are geographically targeted, as shown in Figure 1, and the observed socioeconomic differences between the municipalities that receive oil

Figure 2: Average yearly per capita oil royalties between 2001 and 2017.

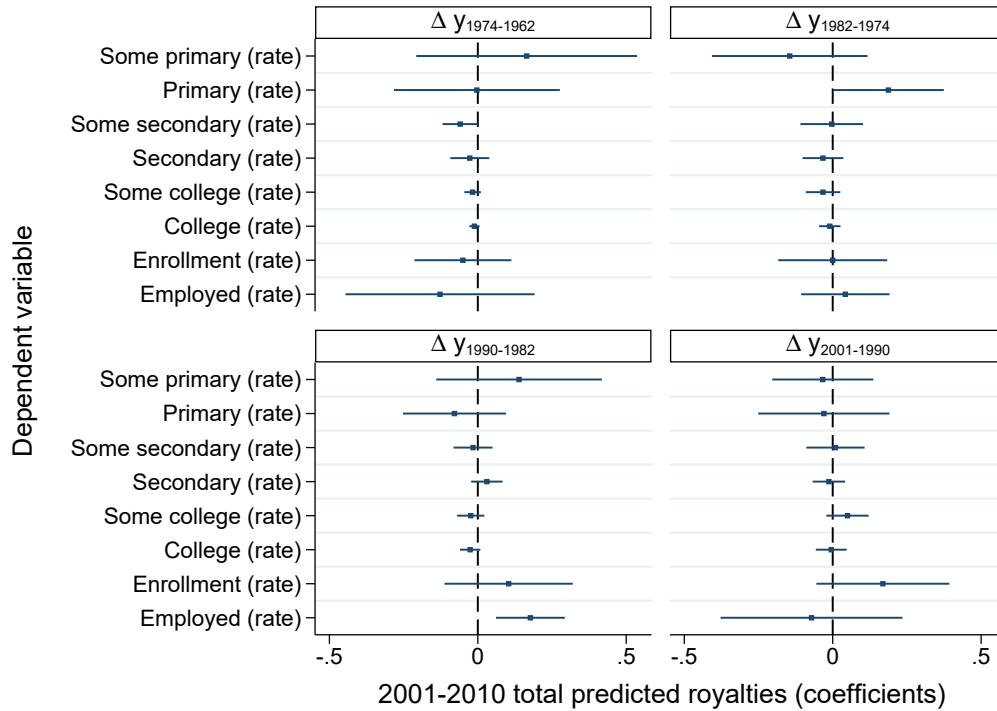


*Notes:* This figure presents a scatter plot between the residuals of royalties since 2011 and the residuals of royalties IV since 2001. We add the 45-degree line for reference. The figure splits the observations into two periods, before and after 2008, because of the change in Ley 010 in that year. Appendix Table A2 provides variable definitions with additional details about how the residuals are calculated.

royalties and those that do not, displayed in Table 1, raise the concern that the IV is correlated with unobservables that could undermine the validity of the research design. To determine whether these differences are an issue, we implement a random assignment test. Intuitively, the IV should have no effect on the outcomes of interest before 2000 because royalties only became a significant source of funding from that year. Indeed, we observe that the IV is unrelated to the outcomes of interest for every decade for which census data are available. Figure 3 shows the results of regressing the long difference between 1974 and 1962 ( $\Delta y_{1974-1962}$ ) on key outcomes of interest, such as the percentage of the population with a college education at the municipality level, on the total cumulative royalties received at the municipality level between 2001 and 2010 predicted by the IV. We repeated

the same exercise for the long differences between  $\Delta y_{1982-1974}$ ,  $\Delta y_{1990-1982}$ , and  $\Delta y_{2001-1990}$ . The IV is unrelated to the outcomes of interest before the period of study. This exercise strongly suggests that there are no long-term, time-varying unobservables that could be driving the results.

Figure 3: Random assignment test



*Notes:* This figure presents the result of estimating Equation 1 using municipality level data before Ley 010 was implemented in Ecuador. The full set of results and statistics is available in Appendix Table B3. Appendix Table A2 provides variable definitions.

## 5 Results

### 5.1 Effects on education and the labor market

We begin our analysis by estimating the impact of oil royalties between 2001 and 2017. Table 2 displays the effects of cumulative royalties since 2001 on educational

outcomes. The coefficient indicates the effect of USD 1,000 of oil royalties per capita. Columns 1 and 2 of panel A display the OLS and IV estimates of royalties on primary education completion, indicating a negative, but not statistically significant, effect. Interestingly, this effect turns positive for cohorts born in or after 1990, though the effect remains insignificant. Meanwhile, the effect is positive and statistically significant for those born in 1995 or later, with USD 1,000 in cumulative per capita royalties increasing the probability of completing primary education by 0.28 percentage points (pp). Columns 3 and 4 display the effect of acquiring at least some secondary education. This effect is negative and insignificant for the population born after 1977, which is unsurprising, as this population includes people over 20 years of age when their municipalities began receiving economically meaningful royalties. The effect on cohorts born in 1990 or later is positive and insignificant, though royalties have marginally significant effects when the population is restricted to those born in 1995 or later. Since oil revenues were first disbursed in 1993, the latter population is the most likely to have fully benefited from the royalties throughout their entire time in school.

The estimated increase in students receiving some secondary school education is 0.17 pp for every USD 1,000 in cumulative per capita revenues. Turning to columns 5 and 6, we observe that the effects of royalties turn negative for the younger cohorts. These results indicate a 0.55 pp decrease in the likelihood of completing secondary school among those born after 1990, while the effect for individuals born after 1995 is similar in magnitude but not significant. The effect of oil royalties on completing some college (columns 7 and 8) and graduating from college (columns 9 and 10) are negative and statistically significant. For example, there is a 0.28 pp drop in the likelihood of completing some college among individuals born after 1977. These effects increase monotonically as we restrict the sample to populations with longer and stronger exposure to royalties. For instance, the decrease in the likelihood of completing some college is even higher, 0.94 pp, among those born in 1995 or later. We observe a similar pattern in the probability of completing college.

Table 2: Main results: educational outcomes

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00059 (0.0008)	-0.00020 (0.0009)	-0.0012 (0.0009)	-0.00068 (0.0009)	-0.0015 (0.001)	-0.00085 (0.001)	-0.0029*** (0.001)	-0.0028*** (0.001)	-0.0016** (0.0007)	-0.0018** (0.0007)
N	596727	596727	567243	567243	412743	412743	381799	381799	294354	294354
Mean of Dep. Var.	0.66	0.66	0.62	0.62	0.41	0.41	0.20	0.20	0.078	0.078
First-stage F-stat		4042.9		3996.5		3617.6		3427.4		2850.7
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0011 (0.0008)	0.0012 (0.0008)	0.00033 (0.0009)	0.00074 (0.0009)	-0.0051*** (0.002)	-0.0055*** (0.002)	-0.0071*** (0.001)	-0.0081*** (0.002)	-0.0039*** (0.0009)	-0.0044*** (0.0009)
N	336258	336258	306774	306774	159056	159056	133533	133533	72121	72121
Mean of Dep Var	0.64	0.64	0.58	0.58	0.35	0.35	0.14	0.14	0.037	0.037
First-stage F-stat		2700.5		2497.0		1226.4		933.5		460.3
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0034*** (0.0008)	0.0028*** (0.0008)	0.0017* (0.0009)	0.0017* (0.0010)	-0.0027 (0.002)	-0.0032 (0.002)	-0.0088*** (0.002)	-0.0094*** (0.002)	-0.00059*** (0.0002)	-0.00098*** (0.0003)
N	206544	206544	180858	180858	73308	73308	56389	56389	18723	18723
Mean of Dep Var	0.60	0.60	0.54	0.54	0.25	0.25	0.063	0.063	0.0030	0.0030
First-stage F-stat		1093.7		935.8		458.8		729.3		6521.7

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



The effects on higher education are expected for these municipalities, given that tertiary education institutions are concentrated in the non–Amazonian region (SENESCYT, 2020). Moreover, Ley 010 dictates that royalties must be used to promote local businesses, which may deter individuals at the margin from acquiring higher education.

The results in Table 2 suggest trade-offs at higher levels of education. To explore this possibility, Table 3 displays the effects of oil royalties on related labor market outcomes.

Table 3: Main results: other outcomes

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0015** (0.0007)	-0.0015** (0.0007)	-0.0057 (0.01)	-0.0078 (0.01)	0.0035*** (0.001)	0.0034*** (0.001)
N	709693	709693	185896	185896	709715	709715
Mean of Dep. Var.	0.59	0.59	1.87	1.87	0.36	0.36
First stage F-stat		4587.4		2768.2		4587.8
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0017** (0.0008)	-0.0019** (0.0008)	-0.037* (0.02)	-0.039 (0.02)	0.0049*** (0.001)	0.0048*** (0.001)
N	448652	448652	43920	43920	448664	448664
Mean of Dep. Var.	0.81	0.81	1.61	1.61	0.19	0.19
First stage F-stat		3624.6		661.8		3624.6
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.00065 (0.0007)	-0.00086 (0.0007)	-0.025* (0.01)	-0.027** (0.01)	0.0069*** (0.002)	0.0071*** (0.002)
N	315422	315422	11671	11671	315426	315426
Mean of Dep. Var.	0.89	0.89	1.42	1.42	0.11	0.11
First stage F-stat		2298.3		596.8		2298.4

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

For the full sample in panel A, we see a negative effect on school attendance, suggesting that people in municipalities receiving royalties are leaving school early and are less likely to go back. For every USD 1,000 per capita in royalties, the likelihood of individuals born after 1977 being enrolled in school decreases by 0.15 pp. The effect among those born in 1990 (panel B) or later is -0.19 pp, though the effect is reduced by half among the youngest cohort (panel C) and is not statistically significant. The effects on wages are only significant for those born after 1995, with the latter group seeing a 2.7 pp reduction for every USD 1,000. However, the considerable reduction in the sample size of individuals reporting positive wages suggests the need to be cautious in interpreting the results. Lastly, in columns 5 and 6 we find positive effects on the likelihood of being employed. For the population born after 1977, royalties increase the probability of being employed by 0.34 pp. The effects are more pronounced among younger cohorts, rising to 0.71 pp among those born in 1995 or later. This is consistent with the lower likelihoods of completing high school or attending or completing college observed in Table 2. People in municipalities receiving royalties thus seem to face a trade-off between continuing their education and obtaining employment. These employment effects are the same whether we exclude individuals exposed to the oil sector because of geography or connection through the labor market –see Appendix Tables B14, B15, B20 and B21.

## 5.2 Labor market outcomes from the firm side

The results from section 5.1 display a clear trade-off between staying in school and moving into the labor market. To understand the kinds of opportunities that drive these results, we study labor market outcomes from the firm perspective using the DEE. The DEE is a panel that approximates the entire structure of businesses in Ecuador and covers the 2006–2019 period. Specifically, we estimate equation 3 below. The outcomes are given at the firm level and the model controls for firm and year fixed effects.

$$y_{fmt} = \gamma_1(\text{Oil royalties})_{mt} + \beta_1 \cdot X_{fmt} + \sigma_t + \eta_f + \varepsilon_{fmt} \quad (3)$$

Appendix Table B4 shows the results. We focus on the effect of royalties on employment at the firm level and group firms according to their size and revenue. Panel A displays the results for microenterprises, defined as those with 1–9 workers and/or that earn revenues below USD 100,000, which accounts for nearly 90% of all firms in Ecuador. There is an overall positive effect on employment across all age groups (column 1). The coefficient implies that firms in municipalities that receive royalties, on average, hire 0.001 additional workers for every additional USD 1,000 per capita in royalties. These effects are positive and significant for every age group, including workers ages 15–17. In the case of small enterprises (panel B), we find similar overall positive patterns in labor demand. Across all age groups, the results imply 0.079 additional workers for a similar jump in royalties. The results are only significant for workers ages 18–29 and 30–44.

Oil royalties have a positive effect on employment in medium-sized enterprises, which are considered high-quality firms that provide high-quality jobs. Because these firms employ at least 10 workers and have annual revenues of at least USD 100,000, they are by definition part of the formal sector. In Ecuador, only 25.5% of workers belonged to the formal sector in 2017.<sup>25</sup> The formal sector is associated with higher wages, social security, paid leave, and several other benefits. In contrast, the informal sector offers lower wages, low job security, and does not provide non-salary benefits. Panel C of Table B4 displays the results for “type A” medium-sized enterprises. These are enterprises with 10–49 workers and annual revenues between USD 100,000 and USD 1,000,000. Interestingly, the effects of oil royalties are positive and statistically significant for workers in the 15–17 age group (column 2). These are teenagers who should be attending high school or starting tertiary education. For every USD 1,000 in royalties, these firms hire 0.004 more

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<sup>25</sup>Based on authors’ calculations from the 2017 ENEMDU.

workers in the 15–17 age group. The effects are positive for workers in other age groups, but only marginally significant for those in the 45–64 age group. Panel D displays the results for “type B” medium-sized enterprises, which are firms with 50–199 workers and annual revenues from 2 to 5 million dollars. In column 1 we see that these firms hire an additional worker for every USD 1,000 in royalties. The effects are positive and significant for workers in the 15–17 age range, implying 0.01 additional workers per USD 1,000. The effects are also positive and significant for other age groups. Finally, we find that oil royalties have no effect on hiring by large enterprises, which represent less than 1% of all firms. Large enterprises have over 200 workers and earn at least USD 5,000,000 in annual revenue. These enterprises have enough resources to provide some of their own infrastructure and are less likely to be affected by royalties.

The overall effect on workers’ wages is mixed, as shown in column 6 of Table B4. Indeed, the effects are only significant for microenterprises and type B medium-sized enterprises, both of which see a negative effect on wages. This is consistent with two facts we have already discussed: greater employment across all age groups, and more hiring of younger workers. In general, younger and less-experienced workers command lower wages, explaining the downward wage trend as more young workers enter the workforce. This occurs even if younger workers receive relatively high wages. The effect for microenterprises is a USD 9.34 reduction per worker, while medium-sized enterprises see wages drop by USD 146.6 per worker.

We further explore the effect of royalties on the probability that firms survive. We classify firms according to their characteristics in the latest active period. As such, if a microenterprise grows to become a small- or medium-sized one when it becomes active again, we classify it as a microenterprise during the inactive periods. Column 7 of Table B4 shows increased firm survivorship across all firm sizes. Microenterprises are 5 pp more likely to survive at least one more year for every USD 1,000 increase in per capita royalties. The effects decrease monotonically with firm size, with large enterprises gaining 0.89 pp.

The overall picture that emerges is that royalties influence firms' expansion and survival. We find that teenagers in the 15–17 age range from municipalities receiving oil royalties tend to find employment in greater numbers, especially in firms offering high-quality jobs. This is consistent with the lower rates of college completion reported in Table 2. More generally, employment effects are positive across all age groups, pointing to the trade-offs faced by working-age individuals in oil-revenue-receiving municipalities and helping to explain why they are less likely to graduate from high school or obtain higher education. Moreover, these new jobs are created outside the oil industry, suggesting the possibility of long-term employment and local development.

### 5.3 Intensive margin and quality of education

For this part of the analysis, we use data from the Ser Bachiller dataset. The sample includes high school students enrolled between 2015 and 2019—that is, those students in the sample who have been exposed to oil royalties since they began attending school. We capture here the cumulative impact that oil royalties have on different areas of knowledge, conditional on reaching high school. To explore these effects, we estimate equation 1 at the individual level. The outcomes are the results in the different areas of knowledge evaluated in the Ser Bachiller. The set of controls in this model include age, gender, fixed effects for mother's and father's educational attainment, a standardized socioeconomic index, and fixed effects for the school's source of funding.<sup>26</sup> We see in Table 4 the statistically significant and positive effect of oil royalties across all areas of the test except for social studies. For instance, an additional USD 1,000 of cumulative per capita oil revenue results in an increase of 7.8% of a standard deviation in overall scores (column 1) This translates into an increase of 7.7% of a standard deviation for every USD 1,000. The effect on mathematics is particularly important, because

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<sup>26</sup>Publicly funded schools might be financed by the central government, the province, municipality, or they might be privately owned schools that receive public funding.

the average (without standardization) on this section of the test is below the passing grade of 7 in municipalities that receive oil royalties. Languages also see a gain of 6.4% of a standard deviation. Interestingly, language outcomes display the largest achievement gap between students in municipalities that receive royalties and their peers in control municipalities. One explanation for the initial gaps is that students in most municipalities that receive royalties are more likely to be native speakers of one of the seven indigenous languages of the Ecuadorian Amazonian region. The effects on science are also positive, increasing by 6.1% of a standard deviation.

Table 4: Effect of royalties on *Ser Bachiller* results

Dependent variable:	<i>Ser Bachiller</i> Scores (standardized value)					<i>Ser Bachiller</i> Scores (dummy)	
	Overall	Mathe- matics	Language	Science	Social studies	Pass	Excel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Royalties since 2001	0.078*** (0.03)	0.077*** (0.02)	0.064** (0.02)	0.061** (0.03)	0.038 (0.02)	0.035*** (0.01)	0.017*** (0.01)
N	1337396	1337396	1337396	1337396	1337396	1337396	1337396
First-stage F-stat	11653.3	11653.3	11653.3	11653.3	11653.3	11653.3	11653.3
Mean of dep. var.						0.74	0.097

Notes: This table displays the effect of the sum of total royalties per capita since 2001 on *Ser Bachiller*, a multiple purpose test needed to graduate high school. The scores correspond to the standardized value in each year for columns 1-5, while columns 6-7 use dummies to capture the impact on the probability of passing or excelling the test. The model controls for age, gender, mother's education, father's education, a socioeconomic index, fixed effects for whether the school is publicly financed, municipality and year fixed effects. The sample covers the 2015-2019 period, which is the time frame available for *Ser Bachiller*. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

The chances of passing or excelling on the *Ser Bachiller* increase by at least 1.7 pp per USD 1,000, according to the results displayed in Table 4. In practice, this means that royalties are closing the gap for the students in royalty receiving municipalities. In addition to the positive effects on the intensive margin, these effects are economically important because of the increased likelihood of graduating from high school and excelling on the exit exam. The students will therefore also have a greater chance of being admitted to public postsecondary institutions.

We also show in Appendix Table B5 that our results at the individual level are consistent with the results at the municipality level. Specifically, we test whether we find effects of royalties on high school enrollment at the municipality level using the enrollment data from the Ser Bachiller dataset. In Column 1, we find that for every USD 1,000, the number of students in high school decreases by 23.3. Additionally, if we split our sample by the school’s source of funding, Column 2 shows that there is no impact on enrollment in private institutions. This result is expected, because only public institutions receive additional funding from Ley 010, and students in private schools are unlikely to be susceptible to new labor market opportunities. Column 3 confirms that the bulk of the effect is concentrated in public schools.

## 5.4 School-level outcomes

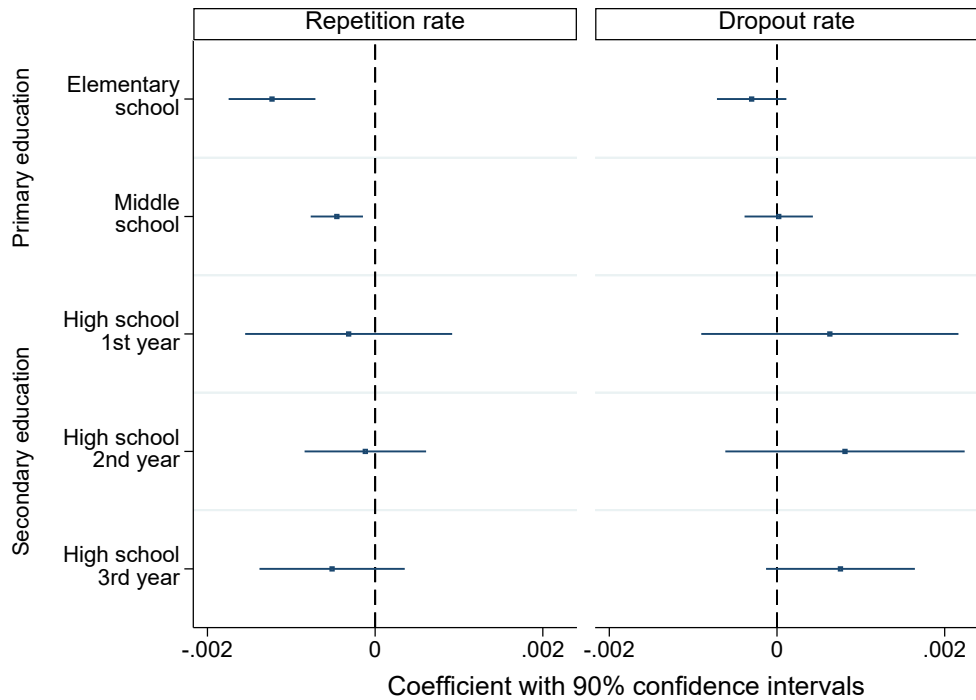
We track school-level impacts using administrative records from the Ecuadorian Ministry of Education. The main specification is given by equation 4, where  $s$  indexes schools. The model controls for school fixed effects, fixed effects by funding source (public or private), and year fixed effects.

$$y_{smt} = \gamma(\text{Oil royalties})_{mt} + \beta \cdot X_{smt} + \sigma_t + \eta_s + \varepsilon_{smt} \quad (4)$$

Figure 4 presents the impact of royalties on repeating grades and dropout probabilities. We find a negative effect on the probability of repeating grades 1–5 and 6–10. This result is in line with the positive effect on schooling up to some secondary in Table 2. Across students in grades 1 to 5, every USD 1,000 decreases the repetition share by 0.0014. Given an average repetition share of roughly 0.018, the effect translates to a 7.7 pp reduction, a figure that drops slightly to 4.3 pp for grades 6–10. There is a small decrease in dropout shares for grades 1–5, which translates to a 1.3 pp reduction relative to the mean. The effects for grades 6–10 are not statistically different from zero. In practice, the evidence is consistent

with additional resources being channeled to schools, with improvements to the schooling of students not yet old enough to experience the labor market effects.

Figure 4: Effect of royalties on pass and dropout rates at the school level



*Notes:* This figure displays the effect of royalties on pass and dropout rates at the school level using Equation 4. The model controls for the number of students, teachers, and administrative employees. In addition, we use school and year fixed effects. Repetition and dropout rates are disaggregated by education level, which is specified on the y-axis. The sample only includes schools with public funding. The full set of results and statistics is available in Appendix Table B6. Data for the figure come from administrative records available in AMIE—see Appendix Table A1 for more details about the data set. Appendix Table A2 provides variable definitions.

There are no effects on repetition rates for high school students.<sup>27</sup> At the school level, the data do not suggest any specific mechanisms that could push students to leave. However, high school students are susceptible to labor market shocks. In this regard, Figure 4 depicts a clear positive trend for students in grades 11–13; consistent with the evidence from Table 2. While these effects are not statistically significant, they do suggest effects that will carry over to higher education because

<sup>27</sup>High school includes grades 11 to 13.



these students can enroll in college. Similarly, the dropout shares are consistent with the increased likelihood of being employed and the decreased likelihood of attending school for working-age individuals shown in Table 3.

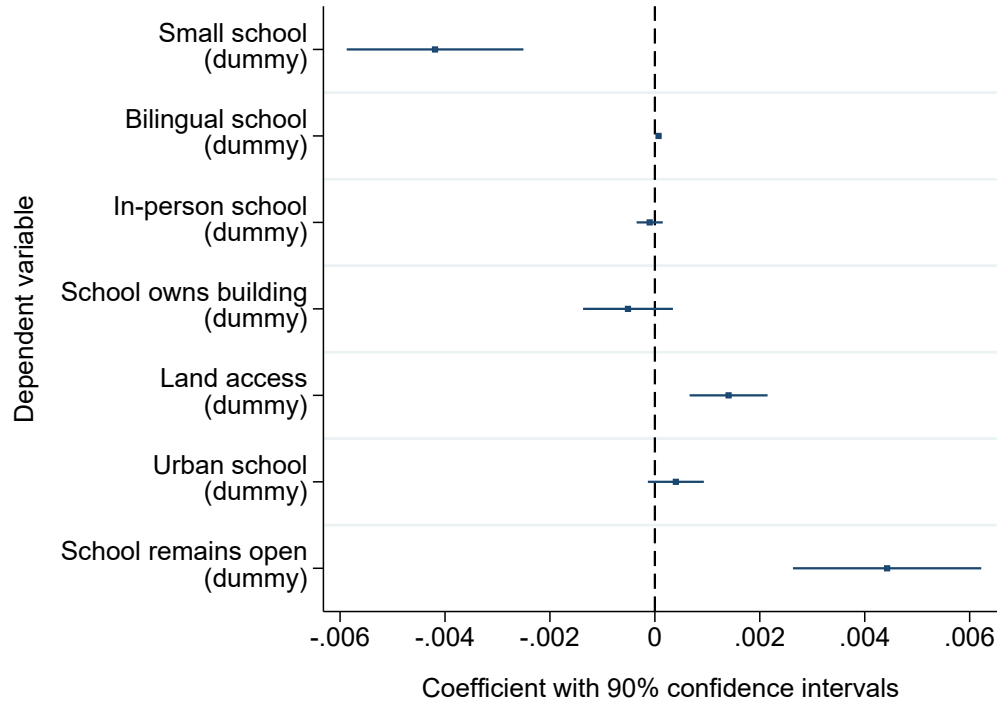
## 5.5 Changes in school composition

In the previous section, we focused our analysis on schools that survived throughout the entire period of analysis, because we cannot observe outcomes for schools that close. However, the panel structure of AMIE does allow us to detect school closures via to the school’s disappearance from the data set. With this insight, we construct a balanced panel with an indicator for whether a school was still open in a year. We can observe a series of characteristics in the years prior to closure, such as the size of the school, whether it offered bilingual education, or if it offered in-person or online classes, etc. In what follows, we estimate regressions based on equation 4. We first explore the impact of royalties on the characteristics of schools that survived throughout the entire period. Then, we assess the impact of royalties on the probability that schools with certain characteristics remained open.

Figure 5 displays the effect of royalties on schools that remain open. Specifically, it shows the likelihood that a school with a certain characteristic retains that characteristic throughout the study period. Hence, there is a 0.34 pp reduction in the likelihood that a small school remains small, defined as having 20 students or less. Because these are schools that remain open, we can surmise that these schools are receiving more students. While greater numbers of students can lead to unfavorable student-teacher ratios, royalties do not appear to affect the ratio (see Appendix Table B7). Surviving schools have a greater probability of offering bilingual education, while there is no change in their likelihood of offering online education, owning their building, or being reclassified as urban schools. Meanwhile, schools that remain open see a 0.14 pp increase in their land accessibility for every USD 1,000 of royalties. Land access is related to roads and better connectivity infrastructure. For students and the general population, this translates into shorter

commuting times and the possibility of studying in schools that were previously unreachable. Royalties increase the likelihood that a school remains open by close to 0.5 pp, regardless of their initial characteristics.

Figure 5: Effect of royalties on school characteristics

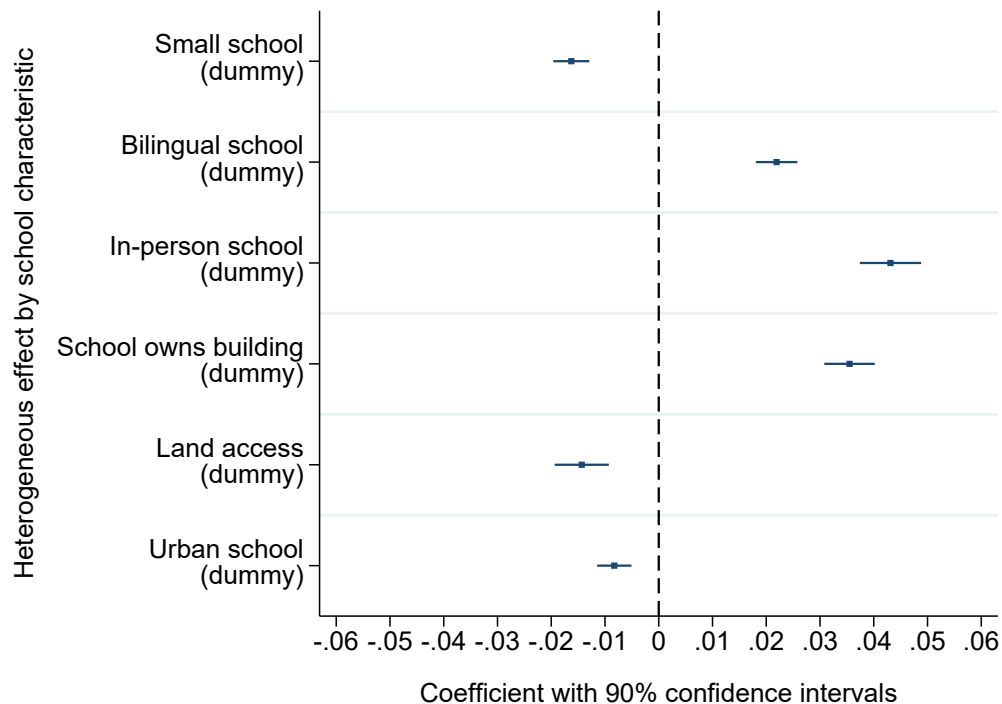


*Notes:* This figure displays the effect of royalties on school characteristics using Equation 4. The model controls for the number of students, teachers, and administrative employees. In addition, we use school and year fixed effects. The sample only includes schools with public funding. Small schools are schools with less than 20 students. Bilingual schools offer education in Spanish and one or more local indigenous languages. Land access is associated with roads; the other possibilities are access by rivers or by air. Confidence levels are given at the 10 percent level. The sample only includes schools with public funding. The full set of results and statistics is available in Appendix Table B7. Data for the figure come from administrative records available in AMIE—see Appendix Table A1 for more details about the data set. Appendix Table A2 provides variable definitions.

The results thus far are limited to schools that remain open throughout the study period. However, royalties can impact the probability of schools' remaining open through the direct effect of additional resources and by changing the connectivity infrastructure. Better connectivity enables students to choose among a larger set of schools. As a consequence, some students might stop attending smaller or un-

derfunded schools. In Figure 6 we estimate the heterogeneous effect of royalties on the probability that certain schools remain open.<sup>28</sup>

Figure 6: Effect of royalties on probability of school remaining open



*Notes:* This figure displays the effect of royalties on the probability that schools remain open with heterogeneous effects by initial school characteristics. Initial school characteristics are defined using the first year that the school appears in the data set. The model is similar to Equation 4, using controls for the number of students, the number of teachers, the number of administrative employees, school fixed effects, and year fixed effects. The difference lies in the inclusion of an interaction between royalties and the initial school characteristic while controlling for the school characteristics in time  $t$ . The sample only includes schools with public funding. Small schools are schools with less than 20 students. Bilingual schools offer education in Spanish and one or more local indigenous languages. Land access is associated with roads; the other possibilities are access by rivers or by air. Confidence levels are given at the 10 percent level. The sample only includes schools with public funding. The full set of results and statistics is available in Appendix Table B8. Data for the figure come from administrative records available in AMIE—see Appendix Table A1 for more details about the data set. Appendix Table A2 provides variable definitions.

We classify them according to their initial characteristics in the year 2010. Interestingly, the impact is statistically significant for every school characteristic chosen, unlike the results for schools that survived in Figure 6. Every USD 1,000 from roy-

<sup>28</sup>The net effects can be calculated from Table B8.

alties reduces the probability that a small school remains open by 1.6 pp. The probability that bilingual schools remain open is significant, increasing by of 4.3 pp per USD 1,000. Royalties increase the likelihood of remaining open for schools with in-person classes (2.2 pp), but reduce it for schools with preexisting land access (-1.4 pp), and urban schools (-0.83 pp). The effect on schools that own their buildings is also negative (-3.6 pp).

In light of the findings on schools that survive and those that close, we can conclude that royalties induce a change in the composition of schools in the region. The evidence suggests that royalties increase the size of schools, connectivity, the likelihood of offering of bilingual education, and the chances of a school's remaining open. Royalties also increase the chances of surviving for schools that at the beginning of 2010 were less-connected, rural schools that owned their buildings and offered bilingual education. However, they decrease the chances of closing for small schools that did not own their buildings.

## 6 Robustness

One possible concern is that our results are spuriously generated by the construction of oil pipelines producing local employment in municipalities that receive oil royalties. This is not, however, possible, because the most recent large-scale pipeline, Pascuales-Cuenca, lies outside the municipalities that receive royalties.<sup>29</sup> We define an alternative exposure measure based on the sum of royalties over an individual's life in a given municipality rather than calculating the cumulative sum of royalties at the municipality level. As such, a person born in the year 2000 and another one born in 2005 would have different levels of exposure to royalties. Appendix Tables B9 and B10 show that similar results are obtained using this alternative exposure measure.

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<sup>29</sup>See the report by the Ministry of Hydrocarbons, *Poliducto Pascuales – Cuenca* (2015).

A related concern regarding the results on the Ser Bachiller is the possibility that migrants to royalty receiving municipalities are driving results. We exclude all migrants from the analysis in Appendix Table B11 and find similar results. Similarly, there exists the possibility that royalties altered the composition of students who take the Ser Bachiller, potentially generating the observed results. To address this concern, we repeat the analysis by excluding every control variable (see Appendix Table B12). If compositional changes are important, then excluding control variable should change point estimates. However, excluding every control variable has no effect on point estimates. In line with these results, Figure 4 shows that repetition and dropouts in high school are not statistically significant, implying a lack of change in the composition of high school students. However, the effects might be so small that we are unable to detect them. These results suggest that compositional changes do not drive the effects. Moreover, the negative impact on post-secondary education concentrates on college enrollment.

We implement an additional battery of robustness. First, we exclude the 2008-2014 period from the analysis. The main reason is that this recent oil boom could have disproportionately affected municipalities that receive oil royalties. Second, we include municipality trends in case royalty receiving municipalities follow different trends during oil booms which could be correlated with royalties. We exclude the two largest cities to ensure the variation originates in more similar municipalities. Finally, to compare geographically proximate and exploit the geographic discontinuity, we restrict the sample to the Amazonian and Sierra regions. The estimates are available in Appendix Tables B13 to B24 and our results hold.

## 7 Conclusions

We study the causal impact of oil royalties on human capital and related labor market outcomes and find that royalties increase the probability of completing general basic education, but reduce the likelihood of completing higher education.

The effects of oil royalties are heterogeneous and vary according to the number of years that cohorts were exposed to royalties. For older cohorts, these effects are limited to high school completion, because they had already completed primary education by the time their municipalities were beginning to receive royalties. In contrast, we see effects at all levels of schooling for younger cohorts. In line with the decreased likelihood of completing or enrolling in college, we observe an increased likelihood of being employed across all cohorts.

Exploring the effects on employment at the firm level helps explain the increased opportunity costs of staying in school, especially for young workers and students who remain in high school. Trade-offs emerge due to the increased likelihood of obtaining high-quality jobs at a young age. These new jobs are created outside the oil industry, suggesting the possibility of long-term employment and local development. However, students who do remain in school have improved educational outcomes in several areas of knowledge. They are also more likely to pass and excel on the high school exit exam. Our findings suggest that this occurs because students shift from smaller, underfunded schools to better-funded establishments in more urbanized areas. Finally, we observe that royalties also increase the tendency of firms to survive.

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# Appendix – For Online Publication

## A Data appendix

Table A1: Dataset descriptions

Dataset	Provided by	Description
Decentralized Autonomous Governments (GAD) Transfer Records	National Secretariat of Planning and Development (SENPLADES)	Municipality level annual data for the 2001-2017 period. The sample covers all the municipalities receiving central government transfers in the Amazonian region.
Directory of Enterprises and Establishments (DEE)	National Institute of Statistics and Census (INEC)	Firm level annual data for the 2006-2019 period. In the 2019 DEE, INEC provides a compiled panel dataset with all the years that the directory has been implemented. The sample covers all formal enterprises and establishments in Ecuador. The data includes self-employment as well.
Ecuadorian Census	Integrated Public Use Microdata Series (IPUMS International), and National Institute of Statistics and Census (INEC)	Individual level annual data for the years 1964, 1972, 1982, 1990, 2001, and 2010. The data is aggregated at the municipality level to calculate the assigned-by-law royalties in each administrative division. For 1964, 1972, and 1982, we use the 10 % sample published by IPUMS-International. For 1990, 2001, and 2010, we use data provided by INEC with the total population aggregates by municipality for all the administrative divisions in Ecuador.
Master File of Educational Institutions (AMIE)	Ministry of Education of Ecuador (MINEDUC)	School level annual data for the 2007-2019 period. Data before 2007 is also available but only at the municipality level. This dataset covers the complete universe of schools in Ecuador.
National Survey on Employment, Unemployment and Underemployment (ENEMDU)	National Institute of Statistics and Census (INEC), and Inter-American Development Bank (IDB)	Individual level annual data for the 2001-2017 period. This survey is representative at the national level but it does not provide individual identifiers to create a panel dataset. We restrict our sample to people who were at least five and at most 40 years old during the period of analysis. This range corresponds to 99% of the population attending school. Furthermore, five years old is the minimum age to enroll in first grade of elementary school.
Oil production	Author's compilation based on Central Bank of Ecuador (BCE) data, and Petroamazonas EP (PAM EP) data.	Municipality level annual data for the 2001-2017 period. The data covers the production of all municipalities in Ecuador. Petroamazonas EP is a public company in charge of the State operations in the oil and gas sector. The company is involved in the management, exploration, and exploitation of the resources.

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Ser Bachiller	National Institute of Educational Evaluation (INEVAL)	Student level annual data for the 2015-2019 period. The dataset includes individual scores from the national standardized test, called <i>Ser Bachiller</i> . This test is required of students in the last year of high school, representing 30% of the final overall grade needed to graduate. Taking and passing the test gives students the opportunity to study at public post-secondary institutions. The test measures skills in mathematics, language, natural sciences, social studies, and abstract reasoning. Each part is graded on a scale of ten points. In addition to the scores, the dataset includes age, gender, socioeconomic information, and details about the school's funding (private or government-funded).
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*Notes:* Abbreviations in parenthesis correspond to the acronym in Spanish. More details about the variables included in the datasets are available in Appendix Table A2.

Table A2: Variable descriptions by dataset

Variable	Description
<i>Decentralized Autonomous Governments (GAD) Transfer Records dataset</i>	
Royalties (per capita)	Ratio between the total value of real transfers in a given year and the population of each municipality. Population from the 2001 Census is used for the observations in the 2001-2009 period, while the 2010 Census is used for the 2010-2017 period.
Royalties since 2001 (per capita)	Ratio between the total value of real transfers since 2001 to date and the population of each municipality. Population in this case refers to the average number of individuals recorded in the 2001 Census and the 2010 census in a given municipality.
Royalties since 2001 (residuals)	Residuals of an ordinary least squares model with <i>Royalties since 2001 (per capita)</i> as the dependent variable controlling for municipality fixed effects, and year fixed effects. Standard errors are clustered by municipality, and residual values out of the 1st and 99th percentile range are removed.
<i>Oil production dataset, and Ecuadorian Census</i>	
Population	Number of individuals in each municipality
Royalties IV (per capita)	Ratio between the total value of real transfers IV in a given year and the population of each municipality. Population from the 2001 Census is used for the observations in the 2001-2009 period, while the 2010 Census is used for the 2010-2017 period.
Royalties IV since 2001 (per capita)	Ratio between the total value of real transfers since 2001 to date and the population of each municipality. Population in this case refers to the average number of individuals recorded in the 2001 Census and the 2010 census in a given municipality.
Royalties IV since 2001 (residuals)	Residuals of an ordinary least squares model with <i>Royalties since 2001 (per capita)</i> as the dependent variable controlling for municipality fixed effects, and year fixed effects. Standard errors are clustered by municipality, and residual values out of the 1st and 99th percentile range are removed.
<i>National Survey on Employment and Unemployment (ENEMDU)</i>	
Access to electricity (dummy)	Dummy variable that assumes value 1 if the individual's household has access to electricity, and 0 otherwise.
Access to toilet or latrine (dummy)	Dummy variable that assumes value 1 if the individual's household has access to a toilet or latrine, and 0 otherwise.
Access to water (dummy)	Dummy variable that assumes value 1 if the individual has access to clean water, and 0 otherwise
Age	Age of the individual
College education (dummy)	Dummy variable that assumes value 1 if the individual has a college degree or a higher level of education, and 0 otherwise.
Cohorts (dummies)	Dummy variables indicating which cohort group individuals belong to. There are 3 different groups, notably: (i) born after 1977, (ii) born after 1990, and (iii) born after 1995.
Dirt floor (dummy)	Dummy variable that assumes value 1 if the individual's dwelling is made from dirt, and 0 otherwise.
Employed (dummy)	Dummy variable that assumes value 1 if the individual is employed, and 0 otherwise.
Enrolled (dummy)	Dummy variable that assumes value 1 if the individual is enrolled with a education institution, and 0 otherwise.
Garbage disposal service (dummy)	Dummy variable that assumes values 1 if the individual's household has access to a garbage disposal service, and 0 otherwise.
Wage	Real hourly wage of the individual. Wage is deflated using the consumer price index with 2011=100.
Male (dummy)	Dummy variable that assumes value 1 if the individual is male, and 0 otherwise.

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No schools nearby (dummy)	Dummy variable that assumes value 1 if the individual's household does not have access to nearby schools, and 0 otherwise.
Primary education (dummy)	Dummy variable that assumes value 1 if the individual has primary education or a higher level of education, and 0 otherwise.
Rooms in household	Number of rooms in the individuals' household.
Secondary education (dummy)	Dummy variable that assumes value 1 if the individual has secondary education or a higher level of education, and 0 otherwise.
Some college education (dummy)	Dummy variable that assumes value 1 if the individual has some years of college or a higher level of education, and 0 otherwise.
Some secondary education (dummy)	Dummy variable that assumes value 1 if the individual has some years of secondary education or a higher level of education, and 0 otherwise.

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*Ser Bachiller dataset*

Age	Age of the student.
College education (dummy)	Dummy variable that assumes value 1 if the individual has a college degree or a higher level of education, and 0 otherwise.
Elementary education (dummy)	Dummy variable that assumes value 1 if the individuals has completed elementary education, and 0 otherwise.
Enrollment by municipality	Number of students taking the test at the municipality level
Excel scores (dummy)	Dummy variable that assumes value 1 if the overall score is equal or higher than nine, and 0 otherwise.
Father's education (categorical)	Categorical variable indicating the level of education of the test taker's father.
Female (dummy)	Dummy variable that assumes value 1 if the test taker is female, and 0 otherwise.
High school or technical education (dummy)	Dummy variable that assumes the value 1 if the individuals has completed high school or a degree in technical education, and 0 otherwise.
Language scores (standardized)	Standardized value by year of the score in the social studies area of the test.
Mathematics scores (standardized)	Standardized value by year of the score in the social studies area of the test.
Mother's education (categorical)	Categorical variable indicating the level of education of the test taker's mother.
No education (dummy)	Dummy variable that assumes value 1 if the test taker does not have a formal education level, and 0 otherwise.
Overall scores (standardized)	Standardized value by year of the total score.
Pass scores (dummy)	Dummy variable that assumes value 1 if the overall score is equal or higher than seven, and 0 otherwise.
School's source of funding (categorical)	Dummy variables indicating which funding source receives the test taker's school. There are three main groups, notably: (i) private schools, (ii) public schools, and (iii) mixed funding schools.
Science scores (standardized)	Standardized value by year of the score in the science area of the test.
Social studies scores (standardized)	Standardized value by year of the score in the social studies area of the test.
Socioeconomic index	Index constructed using factorial analysis. The variables include services at the household level, educational attainment of parents, and household goods.

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*Master File of Educational Institutions (AMIE)*

Bilingual school (dummy)	Dummy variable that assumes value 1 if the institution is bilingual, and 0 otherwise.
Dropout rate in elementary school	Share of students not finishing the school year from grades EGB1 to EGB5 grades. In Ecuador, EGB1 to EGB5 correspond to the first 5 grades of elementary education.
Dropout rate in middle school	Share of students not finishing the school year from EGB6 to EGB10 grades. In Ecuador, EGB6 to EGB10 correspond to the following 5 grades of education after a student has finished the EGB5 grade.
Dropout rate in high school	Share of students not finishing from the first grade to the third grade of high school. In Ecuador, students have to graduate from three grades of high school to obtain their high school diploma.
In-person (dummy)	Dummy variable that assumes value 1 if classes are in-person, and 0 otherwise.
Land access (dummy)	Dummy variable that assumes value 1 if the institution can be accessed by land, and 0 otherwise.
Repetition rate in elementary schools	Share of students that will have to repeat the grade next year from EGB1 to EGB5 grades. In Ecuador, EGB1 to EGB5 correspond to the first 5 grades of elementary education.
Repetition rate in middle school	Share of students that will have to repeat the grade next year from EGB6 to EGB10 grades. In Ecuador, EGB6 to EGB10 correspond to the following 5 grades of education after a student has finished the EGB5 grade.
Repetition rate in high school	Share of students that will have to repeat the grade next year from the first grade to the third grade of high school. In Ecuador, students have to graduate from three grades of high school to obtain their high school diploma.
School owns building (dummy)	Dummy variable that assumes value 1 if the school is the owner of the building, and 0 otherwise.
Small school (dummy)	Dummy variable that assumes value 1 if less than 20 students are enrolled in the institution, and 0 otherwise.
Urban school (dummy)	Dummy variable that assumes value 1 if the school is located in an urban area, and 0 otherwise.

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*Directory of Enterprises and Establishments (DEE)*

Size group (categorical)	Categorical variable indicating which size group firms in a given year belong to. There are 5 different groups, notably: (i) micro-enterprises ( $\$0 \text{ USD} \leq \text{revenues} \leq \$100,000 \text{ USD}$ and/or $1 \leq \text{workers} \leq 9$ ), (ii) small enterprises ( $\$100,000 \text{ USD} < \text{Revenues} \leq \$1,000,000 \text{ USD}$ and/or $10 \leq \text{workers} \leq 49$ ), (iii) medium enterprises - type A ( $\$1,000,000 \text{ USD} < \text{Revenues} \leq \$2,000,000 \text{ USD}$ and/or $50 \leq \text{workers} \leq 99$ ), (iv) medium enterprises - type B ( $\$2,000,000 \text{ USD} < \text{Revenues} \leq \$5,000,000 \text{ USD}$ and/or $100 \leq \text{workers} \leq 199$ ), and (v) large enterprises ( $\$5,000,000 \text{ USD} < \text{Revenues}$ and/or $200 \leq \text{workers}$ ). These groups are defined for each year using annual nominal revenues. Similarly, group revenue thresholds correspond to nominal values.
Active (dummy)	Dummy variable that assumes value 1 if the firm appears in the directory, and 0 otherwise. The variable is missing before the first year the firms start appearing in the dataset.
Labor by age group	Number of workers in the firm. Total labor can be disaggregated in the following age groups: (i) 15-17 years, (ii) 18-29 years, (iii) 30-44 years, and (iv) 45-64 years.
Wage per worker	Ratio between the total annual wage bill and the number of workers in the firm. Wages are deflated using the consumer price index with 2011=100.

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*Notes:* Additional details about each dataset and their sample are described in Appendix Table A1.

## B Tables appendix

Table B1: Summary statistics – *Ser Bachiller*

	Royalties		No royalties		Difference
	Mean	SD	Mean	SD	
<i>Royalties</i>					
Royalties since 2001 (per capita)	8449.65	9411.60	0.00	0.00	8449.6***
Royalties IV since 2001 (per capita)	7006.86	7602.49	0.00	0.00	7006.9***
Royalties (per capita)	250.23	56.70	0.00	0.00	250.2***
Royalties IV (per capita)	242.32	67.34	0.00	0.00	242.3***
<i>Ser Bachiller scores</i>					
Overall Score	7.24	0.93	7.68	0.94	-0.4***
Math	7.02	1.11	7.46	1.19	-0.4***
Language	7.33	1.02	7.86	1.03	-0.5***
Science	7.11	1.22	7.54	1.16	-0.4***
Social studies	7.49	1.20	7.86	1.19	-0.4***
Higher education score	667.68	83.75	703.00	97.96	-35.3***
<i>Individual characteristics</i>					
Age	20.09	4.51	19.53	3.98	0.6***
Female (dummy)	0.51	0.50	0.51	0.50	-0.0
Socioeconomic index	-0.49	1.01	0.04	1.02	-0.5***
<i>Education level</i>					
No education (dummy)	0.16	0.36	0.14	0.35	0.0***
Elementary education (dummy)	0.53	0.50	0.46	0.50	0.1***
High school or technical (dummy)	0.21	0.40	0.28	0.45	-0.1***
College (dummy)	0.08	0.27	0.12	0.33	-0.0***
<i>School characteristics</i>					
Public financing	0.64	0.48	0.70	0.46	-0.1***
Private financing	0.07	0.26	0.22	0.41	-0.1***
Mixed financing	0.28	0.45	0.08	0.27	0.2***
N	85609		1285704		1371313

Notes: This table displays summary statistics for the variables included in the *Ser Bachiller* dataset. These statistics are calculated at the individual level. Appendix Table A1 presents a description of all data sources, and Appendix Table A2 provides variable definitions.

Table B2: Summary Statistics – AMIE

	Royalties		No royalties		Difference
	Mean	SD	Mean	SD	
<i>Royalties</i>					
Royalties since 2001 (per capita)	9228.38	9563.04	0.00	0.00	9228.38***
Royalties IV since 2001 (per capita)	7860.93	7914.97	0.00	0.00	7860.93***
<i>Repetition rates</i>					
Elementary school	0.03	0.09	0.02	0.06	0.02***
Middle school	0.02	0.07	0.01	0.05	0.01***
1st year of high school	0.07	0.13	0.05	0.11	0.02***
2nd year of high school	0.04	0.09	0.03	0.08	0.01***
3rd year of high school	0.01	0.06	0.01	0.05	0.00
<i>Dropout rates</i>					
Elementary school	0.04	0.09	0.03	0.07	0.01***
Middle school	0.05	0.10	0.03	0.08	0.01***
1st year of high school	0.14	0.16	0.08	0.12	0.06***
2nd year of high school	0.10	0.13	0.06	0.09	0.04***
3rd year of high school	0.05	0.10	0.03	0.06	0.02***
<i>School characteristics</i>					
Small school (dummy)	0.36	0.48	0.27	0.44	0.10***
Bilingual school (dummy)	0.37	0.48	0.05	0.22	0.31***
In-person (dummy)	0.94	0.23	0.97	0.16	-0.03***
School own building (dummy)	0.83	0.37	0.76	0.43	0.08***
Land access (dummy)	0.87	0.33	0.99	0.11	-0.12***
Urban school (dummy)	0.32	0.47	0.60	0.49	-0.28***
School remains open (dummy)	0.71	0.46	0.67	0.47	0.04***
Teachers	5.51	10.65	9.58	16.95	-4.06***
Administrative employees	0.49	1.62	1.59	4.96	-1.10***
Students	96.02	222.66	192.73	384.60	-96.71***
N	45170		323160		368330

Notes: This table displays summary statistics for the school variables in our analysis for the years 2010 to 2019. These statistics are calculated at the school level using the sample from AMIE. Appendix Table A1 presents a description of all data sources, and Appendix Table A2 provides variable definitions.

Table B3: Random tests

Dependent variable:	Education							Labor
	Some primary (rate)	Primary (rate)	Some sec-ondary (rate)	Secondary (rate)	Some College (rate)	College (rate)	Enroll-ment (rate)	Employed (rate)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel A: <math>\Delta y_{1974-1962}</math></i>								
Royalties IV for 2001-2010	0.16 (0.2)	-0.0031 (0.1)	-0.059* (0.03)	-0.027 (0.03)	-0.018 (0.01)	-0.011 (0.009)	-0.050 (0.08)	-0.13 (0.2)
N	74	74	74	74	74	74	74	74
R-squared	0.27	0.19	0.27	0.25	0.52	0.11	0.27	0.29
<i>Panel B: <math>\Delta y_{1982-1974}</math></i>								
Royalties IV for 2001-2010	-0.14 (0.1)	0.19** (0.09)	-0.0031 (0.05)	-0.033 (0.03)	-0.033 (0.03)	-0.0098 (0.02)	0.000077 (0.09)	0.043 (0.07)
N	74	74	74	74	74	74	74	74
R-squared	0.30	0.56	0.43	0.62	0.36	0.53	0.60	0.70
<i>Panel C: <math>\Delta y_{1990-1982}</math></i>								
Royalties IV for 2001-2010	0.14 (0.1)	-0.079 (0.09)	-0.016 (0.03)	0.031 (0.03)	-0.024 (0.02)	-0.026 (0.02)	0.10 (0.1)	0.18*** (0.06)
N	74	74	74	74	74	74	74	74
R-squared	0.14	0.80	0.52	0.50	0.49	0.62	0.17	0.32
<i>Panel D: <math>\Delta y_{2001-1990}</math></i>								
Royalties IV for 2001-2010	-0.034 (0.09)	-0.030 (0.1)	0.0093 (0.05)	-0.013 (0.03)	0.050 (0.04)	-0.0049 (0.03)	0.17 (0.1)	-0.071 (0.2)
N	74	74	74	74	74	74	74	74
R-squared	0.22	0.50	0.28	0.35	0.27	0.28	0.60	0.21

Notes: This table displays the results of regressing the long differences between 1974-1962, 1982-1974, 1990-1982, and 2001-1990 on key outcomes of interest in education and labor. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for aggregates at the municipality level of age composition, gender composition, total population, population density, housing characteristics to proxy socioeconomic variables, and province fixed effects. Davidson and MacKinnon (1993) standard errors for heteroskedastic models are presented in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B4: Effect of royalties on enterprise performance by firm size

Dependent variable:	Labor by age group					Wage per worker	Active (dummy)
	All	15-17	18-29	30-44	45-64		
	(1)	(2)	(3)	(4)	(5)		
<i>Panel A: Micro-enterprises</i>							
Royalties since 2001	0.0097*** (0.00100)	0.000061* (0.000032)	0.0047*** (0.00045)	0.0066*** (0.00067)	-0.0026*** (0.00038)	-9.34*** (3.18)	0.049*** (0.00046)
N	7113319	7113319	7113319	7113319	7113319	3428707	12790772
First stage F-stat	208727	208727	208727	208727	208727	84211	1719741
Mean of dep. var.	1.410	0.001	0.204	0.353	0.358	3859.522	0.607
<i>Panel B: Small enterprises</i>							
Royalties since 2001	0.079*** (0.021)	0.00013 (0.00052)	0.043*** (0.0095)	0.029** (0.012)	0.0061 (0.0063)	8.03 (17.6)	0.041*** (0.0021)
N	555596	555596	555596	555596	555596	555448	783511
First stage F-stat	16892	16892	16892	16892	16892	16891	37644
Mean of dep. var.	10.009	0.016	3.370	4.161	2.464	5553.579	0.858
<i>Panel C: Medium enterprises - Type A</i>							
Royalties since 2001	0.68 (0.66)	0.0040** (0.0017)	0.15 (0.27)	0.38 (0.32)	0.15* (0.078)	48.3 (44.0)	0.033** (0.016)
N	69041	69041	69041	69041	69041	69037	88598
First stage F-stat	12172	12172	12172	12172	12172	12172	8613
Mean of dep. var.	30.820	0.046	10.119	12.992	7.663	6986.213	0.880
<i>Panel D: Medium enterprises - Type B</i>							
Royalties since 2001	1.09*** (0.23)	0.010** (0.0049)	0.064 (0.10)	0.37*** (0.12)	0.66*** (0.14)	-146.6*** (37.0)	0.017*** (0.0029)
N	50191	50191	50191	50191	50191	50190	58917
First stage F-stat	2160	2160	2160	2160	2160	2160	2212
Mean of dep. var.	59.355	0.073	20.354	25.594	13.334	8170.650	0.905
<i>Panel E: Large enterprises</i>							
Royalties since 2001	-0.69 (0.92)	0.0063 (0.0045)	-0.31 (0.39)	-0.85 (0.52)	0.46 (0.33)	-27.0 (64.9)	0.0089** (0.0042)
N	41219	41219	41219	41219	41219	41219	45005
First stage F-stat	1543	1543	1543	1543	1543	1543	1664
Mean of dep. var.	325.483	0.121	107.920	141.828	75.614	11516.141	0.938

Notes: This table displays the effect of the sum of royalties per capita since 2001 on firm outcomes by firm size. The model controls for firm and year fixed effects. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the firm level in parentheses

Table B5: Municipality level school enrollment by funding source

Dependent variable:	Enrollment by school funding			
	All	Private	Public	Mixed
	(1)	(2)	(3)	(4)
Royalties since 2001	-23.3*** (6.19)	-1.36 (1.77)	-26.5*** (7.38)	-1.01* (0.55)
N	1114	1114	1114	1114
First-stage F-stat	5250.6	9274.4	9274.4	9274.4
Mean of dep. var.	1191.4	246.8	836.0	108.7

Notes: This table displays the effect of the sum of royalties per capita since 2001 on school enrollment at the municipality level. The model controls for socioeconomic variables, municipality and year fixed effects. The first stage F-stat refers to the [Kleibergen and Paap \(2006\)](#) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B6: Effect of royalties on pass and dropout rates at the school level

Dependent variable:	Repetition rate					Dropout rate				
	Elementary school	Middle school	High school			Elementary school	Middle school	High school		
			1st year	2nd year	3rd year			1st year	2nd year	3rd year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Royalties since 2001	-0.0012*** (0.0003)	-0.00046*** (0.0002)	-0.00032 (0.0006)	-0.00012 (0.0004)	-0.00051 (0.0004)	-0.00030 (0.0002)	0.000021 (0.0002)	0.00063 (0.0008)	0.00081 (0.0007)	0.00076* (0.0005)
N	145943	155767	23490	22428	21114	145943	155767	23490	22428	21114
Mean of dep. var.	0.019	0.013	0.065	0.034	0.0081	0.037	0.036	0.100	0.066	0.028
First-stage F-stat	92323.6	99729.0	5674.0	5713.6	6551.2	92323.6	99729.0	5674.0	5713.6	6551.2

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. The first stage F-stat refers to the [Kleibergen and Paap \(2006\)](#) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B7: Effect of royalties on school characteristics

Dependent variable:	Small school (dummy)	Bilingual school (dummy)	In-person school (dummy)	Building owners (dummy)	Land access (dummy)	Urban school (dummy)	Remains open (dummy)	Student-teacher ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Royalties since 2001	-0.0042*** (0.00086)	0.000071*** (0.000025)	-0.000099 (0.00013)	-0.00051 (0.00044)	0.0014*** (0.00038)	0.00040 (0.00027)	0.0044*** (0.00092)	0.045** (0.021)
N	198419	198419	198419	198419	198419	198419	285970	179294
First-stage F-stat	85486	85486	85486	85486	85486	85486	890794	87138
Mean of dep. var.	0.31	0.11	0.98	0.80	0.97	0.49	0.70	18.83

Notes: This table displays the effect of royalties on school characteristics using Equation 4. The model controls for the number of students, teachers, and administrative employees, additionally we use school and year fixed effects. The sample only includes schools with public funding. Small schools are schools with less than 20 students. Bilingual schools offer education in Spanish and one or more local indigenous languages. Land access is associated with roads; the other possibilities are access by rivers or by air. Confidence levels are given at the ten percent level. The sample only includes schools with public funding. Data for the figure come from administrative records available in the Master File of Educational Institutions (AMIE) – see Appendix Table A1 for more details about the dataset. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B8: Effect of royalties on probability of schools remaining open by initial school characteristics

Dependent variable:	School remains open (dummy)					
Heterogeneous effect $X_0$ :	Small school (dummy)	Bilingual school (dummy)	In-person school (dummy)	Building owners (dummy)	Land access (dummy)	Urban school
	(1)	(2)	(3)	(4)	(5)	(6)
Royalties since 2001	0.013*** (0.0011)	-0.033*** (0.0028)	-0.0021** (0.0011)	-0.023*** (0.0022)	0.018*** (0.0024)	0.0099*** (0.0012)
Royalties since 2001 $\times X_0$	-0.016*** (0.0017)	0.043*** (0.0029)	0.022*** (0.0020)	0.036*** (0.0024)	-0.014*** (0.0026)	-0.0083*** (0.0016)
N	269045	269045	269045	269045	269045	269045
First-stage F-stat	115256.955	23014.469	162067.502	38958.791	290449.558	154032.552
Mean of dep. var	0.74	0.74	0.74	0.74	0.74	0.74

Notes: This table displays the effect of royalties on the probability that schools remain open with heterogeneous effects by initial school characteristics. Initial school characteristics are defined using the first year that the schools appears in the dataset. The model is similar to Equations 4 using controls for the number of students, the number of teachers, the number of administrative employees, school fixed effects, and year fixed effects. The difference lies in including an interaction between royalties and the initial school characteristic while controlling for the school characteristics in time  $t$ . The sample only includes schools with public funding. Small schools are schools with less than 20 students. Bilingual schools offer education in Spanish and one or more local indigenous languages. Land access is associated with roads; the other possibilities are access by rivers or by air. Confidence levels are given at the ten percent level. The sample only includes schools with public funding. Data for the figure come from administrative records available in the Master File of Educational Institutions (AMIE) – see Appendix Table A1 for more details about the dataset. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



Table B9: Robustness: Cumulative effect of royalties on education

Dependent variable:	Educational attainment $\geq$ education level (dummy)				
	Some primary	Primary	Some secondary	Secondary	Some college
	(1)	(2)	(3)	(4)	(5)
Royalties since 2001	0.015*** (0.00)	0.011** (0.00)	-0.027*** (0.01)	-0.018*** (0.00)	-0.00022 (0.00)
N	315223	315223	315223	315223	315223
First-stage F-stat	43474.0	43474.0	43474.0	43474.0	43474.0

Notes: This table displays the effect of the sum of royalties per capita since 2001 on school enrollment. The sum on royalties is age dependent at the municipality level. The sample only includes observations for which we know the total sum of royalties they have been exposed to at the municipality level since they were born. The model controls for socioeconomic variables, municipality and year fixed effects. The first stage F-stat refers to the [Kleibergen and Paap \(2006\)](#) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B10: Robustness: Cumulative royalties on other outcomes

Dependent variable:	Enrolled (dummy)	Real wages	Employed (dummy)
	(1)	(2)	(3)
Royalties since 2001	-0.010* (0.01)	-0.079 (0.06)	0.039*** (0.01)
N	315422	11671	315426
First-stage F-stat	44296.0	678.3	44296.2

Notes: This table displays the effect of the sum of royalties per capita since 2001 on school enrollment. The sum on royalties is age dependent at the municipality level. The sample only includes observations for which we know the total sum of royalties they have been exposed to at the municipality level since they were born. The model controls for socioeconomic variables, municipality and year fixed effects. The first stage F-stat refers to the [Kleibergen and Paap \(2006\)](#) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B11: Effect of municipality cumulative royalties on *Ser Bachiller* robust to migrants

Dependent variable:	<i>Ser Bachiller</i> Scores (standardized value)					<i>Ser Bachiller</i> Scores (dummy)	
	Overall	Mathe- matics	Language	Science	Social studies	Pass	Excel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Royalties since 2001	0.077*** (0.03)	0.074*** (0.02)	0.067*** (0.03)	0.059** (0.03)	0.036 (0.02)	0.035*** (0.01)	0.018*** (0.01)
N	1234279	1234279	1234279	1234279	1234279	1234279	1234279
First-stage F-stat	11619.5	11619.5	11619.5	11619.5	11619.5	11619.5	11619.5
Mean of dep. var.						0.74	0.10

Notes: This table displays the effect of the sum of total royalties per capita since 2001 on *Ser Bachiller*, but excludes migrants from the analysis. The scores correspond to the standardized value in each year for columns 1-5, while columns 6-7 use dummies to capture the impact on the probability of passing or excelling the test. The model controls for age, gender, mother's education, father's education, a socioeconomic index, fixed effects for whether the school is publicly financed, municipality and year fixed effects. The sample covers the 2015-2019 period, which is the time frame available for *Ser Bachiller*. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B12: Effect of municipality cumulative royalties on *Ser Bachiller* robust to controls

Dependent variable:	<i>Ser Bachiller</i> Scores (standardized value)					<i>Ser Bachiller</i> Scores (dummy)	
	Overall	Mathe- matics	Language	Science	Social studies	Pass	Excel
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Royalties since 2001	0.080*** (0.03)	0.077*** (0.02)	0.069*** (0.03)	0.062** (0.03)	0.039 (0.02)	0.036*** (0.01)	0.018*** (0.01)
N	1234279	1234279	1234279	1234279	1234279	1234279	1234279
First-stage F-stat	11417.3	11417.3	11417.3	11417.3	11417.3	11417.3	11417.3
Mean of dep. var.						0.74	0.10

Notes: This table displays the effect of the sum of total royalties per capita since 2001 on *Ser Bachiller*, but excludes every control variable. The scores correspond to the standardized value in each year for columns 1-5, while columns 6-7 use dummies to capture the impact on the probability of passing or excelling the test. The model controls for age, gender, mother's education, father's education, a socioeconomic index, fixed effects for whether the school is publicly financed, municipality and year fixed effects. The sample covers the 2015-2019 period, which is the time frame available for *Ser Bachiller*. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B13: Main results: educational outcomes including municipality trends

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00015 (0.0008)	-0.000059 (0.0009)	-0.00076 (0.0009)	-0.00054 (0.0010)	-0.00066 (0.001)	-0.00055 (0.001)	-0.0026** (0.001)	-0.0027** (0.001)	-0.0017** (0.0008)	-0.0018** (0.0008)
N	351328	351328	333259	333259	240756	240756	222367	222367	170199	170199
Mean of Dep Var	0.64	0.64	0.61	0.61	0.40	0.40	0.19	0.19	0.076	0.076
First-stage F-stat		31261.1		30127.6		30483.0		29182.2		21670.0
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0014 (0.0009)	0.0013 (0.0009)	0.00072 (0.0008)	0.00093 (0.0008)	-0.0039* (0.002)	-0.0053** (0.002)	-0.0075*** (0.001)	-0.0095*** (0.002)	-0.0040** (0.002)	-0.0051** (0.002)
N	185428	185428	167359	167359	81638	81638	68668	68668	42535	42535
Mean of Dep Var	0.62	0.62	0.56	0.56	0.40	0.40	0.16	0.16	0.053	0.053
First-stage F-stat		14183.8		11469.1		1785.1		780.6		4925.3
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0033*** (0.0009)	0.0026*** (0.0009)	0.00056 (0.0010)	0.00030 (0.0010)	0.0054* (0.003)	0.0086** (0.003)	-0.0090*** (0.002)	-0.011*** (0.003)	-0.00091*** (0.0003)	-0.0018** (0.0007)
N	107356	107356	93085	93085	45704	45704	37949	37949	16748	16748
Mean of Dep Var	0.62	0.62	0.59	0.59	0.33	0.33	0.085	0.085	0.0033	0.0033
First-stage F-stat		2248.6		1100.1		33240.3		11939.3		7987.4

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B14: Main results: educational outcomes excluding oil-producing municipalities

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00046 (0.0008)	-0.00011 (0.0009)	-0.0011 (0.0009)	-0.00059 (0.0009)	-0.0015 (0.001)	-0.00086 (0.001)	-0.0028*** (0.0010)	-0.0027*** (0.001)	-0.0016** (0.0007)	-0.0016** (0.0007)
N	593320	593320	563838	563838	409366	409366	378443	378443	291152	291152
Mean of Dep Var	0.66	0.66	0.62	0.62	0.41	0.41	0.20	0.20	0.077	0.077
First-stage F-stat		4089.3		4046.5		3687.5		3491.9		2914.3
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0013 (0.0008)	0.0013* (0.0008)	0.00042 (0.0009)	0.00084 (0.0009)	-0.0053*** (0.002)	-0.0055*** (0.002)	-0.0070*** (0.001)	-0.0080*** (0.002)	-0.0039*** (0.0009)	-0.0043*** (0.0009)
N	335495	335495	306013	306013	158320	158320	132815	132815	71499	71499
Mean of Dep Var	0.64	0.64	0.58	0.58	0.35	0.35	0.14	0.14	0.037	0.037
First-stage F-stat		2716.1		2513.9		1252.7		954.1		456.6
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0035*** (0.0008)	0.0029*** (0.0008)	0.0017* (0.0009)	0.0017* (0.0010)	-0.0034* (0.002)	-0.0038* (0.002)	-0.0088*** (0.002)	-0.0094*** (0.002)	-0.00059*** (0.0002)	-0.00099*** (0.0004)
N	206337	206337	180653	180653	73122	73122	56216	56216	18608	18608
Mean of Dep Var	0.60	0.60	0.54	0.54	0.25	0.25	0.063	0.063	0.0030	0.0030
First-stage F-stat		1099.0		941.2		460.2		732.8		6257.7

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B15: Main results: educational outcomes excluding the Northern Amazonian provinces

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00011 (0.0009)	0.00033 (0.0009)	-0.00055 (0.0009)	0.000014 (0.0010)	-0.0015 (0.001)	-0.0011 (0.001)	-0.0025** (0.001)	-0.0024** (0.001)	-0.00089 (0.0007)	-0.00099 (0.0007)
N	572909	572909	544610	544610	396231	396231	366455	366455	282241	282241
Mean of Dep Var	0.66	0.66	0.62	0.62	0.41	0.41	0.20	0.20	0.080	0.080
First-stage F-stat		5420.4		5303.6		4667.6		4568.8		3414.4
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0012 (0.0009)	0.0011 (0.0009)	0.00048 (0.001)	0.00082 (0.001)	-0.0041** (0.002)	-0.0047** (0.002)	-0.0062*** (0.001)	-0.0071*** (0.002)	-0.0030*** (0.0009)	-0.0034*** (0.0008)
N	321465	321465	293166	293166	151396	151396	126910	126910	68178	68178
Mean of Dep Var	0.64	0.64	0.58	0.58	0.35	0.35	0.14	0.14	0.039	0.039
First-stage F-stat		3425.4		3096.1		1124.2		944.9		404.2
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0031*** (0.0010)	0.0023** (0.0010)	0.0014 (0.0010)	0.0013 (0.001)	-0.0019 (0.002)	-0.0024 (0.002)	-0.0085*** (0.002)	-0.0091*** (0.002)	-0.00056*** (0.0002)	-0.00100*** (0.0004)
N	196105	196105	171491	171491	69008	69008	52956	52956	17498	17498
Mean of Dep Var	0.60	0.60	0.54	0.54	0.26	0.26	0.065	0.065	0.0031	0.0031
First-stage F-stat		1180.5		935.3		616.9		898.6		7833.9

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B16: Main results: educational outcomes restricting the sample to municipalities in the Amazonian border

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	0.000047 (0.0009)	0.00042 (0.0009)	-0.00071 (0.0009)	-0.00022 (0.0010)	-0.0017 (0.001)	-0.0011 (0.001)	-0.0031** (0.001)	-0.0030** (0.001)	-0.0020** (0.0009)	-0.0021** (0.0009)
N	360925	360925	343353	343353	250734	250734	232002	232002	179259	179259
Mean of Dep Var	0.67	0.67	0.63	0.63	0.43	0.43	0.22	0.22	0.088	0.088
First-stage F-stat		3910.4		3869.0		3511.2		3330.5		2775.6
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0017** (0.0008)	0.0018** (0.0008)	0.00050 (0.0009)	0.00085 (0.0009)	-0.0062*** (0.002)	-0.0068*** (0.002)	-0.0084*** (0.002)	-0.0097*** (0.002)	-0.0049*** (0.001)	-0.0055*** (0.001)
N	205743	205743	188171	188171	99419	99419	83799	83799	45918	45918
Mean of Dep Var	0.67	0.67	0.60	0.60	0.37	0.37	0.15	0.15	0.040	0.040
First-stage F-stat		2623.7		2432.4		1206.3		917.0		443.2
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0040*** (0.0008)	0.0034*** (0.0008)	0.0017* (0.0009)	0.0016* (0.0010)	-0.0040** (0.002)	-0.0048** (0.002)	-0.0100*** (0.002)	-0.011*** (0.002)	-0.00064*** (0.0002)	-0.0011*** (0.0004)
N	128089	128089	112642	112642	46942	46942	36340	36340	12372	12372
Mean of Dep Var	0.63	0.63	0.56	0.56	0.27	0.27	0.066	0.066	0.0026	0.0026
First-stage F-stat		1069.2		915.4		436.6		689.0		6593.4

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B17: Main results: educational outcomes excluding largest cities

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00015 (0.0008)	-0.000059 (0.0009)	-0.00076 (0.0009)	-0.00054 (0.0010)	-0.00066 (0.001)	-0.00055 (0.001)	-0.0026** (0.001)	-0.0027** (0.001)	-0.0017** (0.0008)	-0.0018** (0.0008)
N	351328	351328	333259	333259	240756	240756	222367	222367	170199	170199
Mean of Dep Var	0.64	0.64	0.61	0.61	0.40	0.40	0.19	0.19	0.076	0.076
First-stage F-stat		31261.1		30127.6		30483.0		29182.2		21670.0
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0014 (0.0009)	0.0013 (0.0009)	0.00072 (0.0008)	0.00093 (0.0008)	-0.0039* (0.002)	-0.0053** (0.002)	-0.0075*** (0.001)	-0.0095*** (0.002)	-0.0040** (0.002)	-0.0051** (0.002)
N	185428	185428	167359	167359	81638	81638	68668	68668	42535	42535
Mean of Dep Var	0.62	0.62	0.56	0.56	0.40	0.40	0.16	0.16	0.053	0.053
First-stage F-stat		14183.8		11469.1		1785.1		780.6		4925.3
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0033*** (0.0009)	0.0026*** (0.0009)	0.00056 (0.0010)	0.00030 (0.0010)	0.0054* (0.003)	0.0086** (0.003)	-0.0090*** (0.002)	-0.011*** (0.003)	-0.00091*** (0.0003)	-0.0018** (0.0007)
N	107356	107356	93085	93085	45704	45704	37949	37949	16748	16748
Mean of Dep Var	0.62	0.62	0.59	0.59	0.33	0.33	0.085	0.085	0.0033	0.0033
First-stage F-stat		2248.6		1100.1		33240.3		11939.3		7987.4

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B18: Main results: educational outcomes excluding the 2008-2014 period

Dependent variable:	Educational attainment $\geq$ Education level (dummy)									
	Primary		Some Secondary		Secondary		Some college		College	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<i>Panel A: Born after 1977</i>										
Royalties since 2001	-0.00015 (0.0008)	-0.000059 (0.0009)	-0.00076 (0.0009)	-0.00054 (0.0010)	-0.00066 (0.001)	-0.00055 (0.001)	-0.0026** (0.001)	-0.0027** (0.001)	-0.0017** (0.0008)	-0.0018** (0.0008)
N	351328	351328	333259	333259	240756	240756	222367	222367	170199	170199
Mean of Dep Var	0.64	0.64	0.61	0.61	0.40	0.40	0.19	0.19	0.076	0.076
First-stage F-stat		31261.1		30127.6		30483.0		29182.2		21670.0
<i>Panel B: Born after 1990</i>										
Royalties since 2001	0.0014 (0.0009)	0.0013 (0.0009)	0.00072 (0.0008)	0.00093 (0.0008)	-0.0039* (0.002)	-0.0053** (0.002)	-0.0075*** (0.001)	-0.0095*** (0.002)	-0.0040** (0.002)	-0.0051** (0.002)
N	185428	185428	167359	167359	81638	81638	68668	68668	42535	42535
Mean of Dep Var	0.62	0.62	0.56	0.56	0.40	0.40	0.16	0.16	0.053	0.053
First-stage F-stat		14183.8		11469.1		1785.1		780.6		4925.3
<i>Panel C: Born after 1995</i>										
Royalties since 2001	0.0033*** (0.0009)	0.0026*** (0.0009)	0.00056 (0.0010)	0.00030 (0.0010)	0.0054* (0.003)	0.0086** (0.003)	-0.0090*** (0.002)	-0.011*** (0.003)	-0.00091*** (0.0003)	-0.0018** (0.0007)
N	107356	107356	93085	93085	45704	45704	37949	37949	16748	16748
Mean of Dep Var	0.62	0.62	0.59	0.59	0.33	0.33	0.085	0.085	0.0033	0.0033
First-stage F-stat		2248.6		1100.1		33240.3		11939.3		7987.4

Notes: This table displays the effect of the sum of royalties per capita since 2001 on educational attainment. For each educational outcome, the sample is restricted to those individuals who had the minimum required age. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



Table B19: Main results: other outcomes including municipality trends

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0015* (0.0008)	-0.0040 (0.01)	-0.0065 (0.01)	0.0036*** (0.001)	0.0037*** (0.001)
N	422166	422166	109196	109196	422188	422188
Mean of Dep Var	0.59	0.59	1.86	1.86	0.38	0.38
First stage F-stat		36819.8		16552.0		36821.7
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0020** (0.0008)	-0.0022** (0.0009)	-0.054 (0.04)	-0.060 (0.05)	0.0050*** (0.001)	0.0053*** (0.001)
N	255935	255935	24864	24864	255947	255947
Mean of Dep Var	0.80	0.80	1.69	1.69	0.20	0.20
First stage F-stat		24075.6		833.8		24075.9
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0016* (0.0008)	-0.014 (0.02)	-0.023 (0.03)	0.0073*** (0.002)	0.0078*** (0.002)
N	174407	174407	7996	7996	174411	174411
Mean of Dep Var	0.87	0.87	1.50	1.50	0.14	0.14
First stage F-stat		13152.8		83.3		13152.9

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the [Kleibergen and Paap \(2006\)](#) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B20: Main results: other outcomes excluding oil-producing municipalities

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0015** (0.0007)	-0.0015** (0.0007)	-0.0063 (0.01)	-0.0085 (0.01)	0.0035*** (0.001)	0.0034*** (0.001)
N	706275	706275	182684	182684	706297	706297
Mean of Dep Var	0.59	0.59	1.85	1.85	0.36	0.36
First stage F-stat		4629.3		2834.2		4629.7
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0016** (0.0008)	-0.0018** (0.0008)	-0.039* (0.02)	-0.040 (0.02)	0.0048*** (0.001)	0.0047*** (0.001)
N	447881	447881	43231	43231	447893	447893
Mean of Dep Var	0.81	0.81	1.60	1.60	0.19	0.19
First stage F-stat		3638.3		686.7		3638.3
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.00063 (0.0007)	-0.00082 (0.0007)	-0.035*** (0.01)	-0.032** (0.01)	0.0069*** (0.002)	0.0071*** (0.002)
N	315209	315209	11509	11509	315213	315213
Mean of Dep Var	0.89	0.89	1.41	1.41	0.11	0.11
First stage F-stat		2305.8		794.3		2305.8

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B21: Main results: other outcomes excluding the Northern Amazonian provinces

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.00096 (0.0007)	-0.00099 (0.0008)	-0.00093 (0.02)	-0.0048 (0.02)	0.0041*** (0.001)	0.0041*** (0.001)
N	681160	681160	178780	178780	681182	681182
Mean of Dep Var	0.59	0.59	1.86	1.86	0.36	0.36
First stage F-stat		5927.2		2681.3		5927.9
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0011 (0.0008)	-0.0012 (0.0008)	-0.040* (0.02)	-0.048* (0.03)	0.0051*** (0.001)	0.0050*** (0.001)
N	429155	429155	41862	41862	429167	429167
Mean of Dep Var	0.81	0.81	1.60	1.60	0.19	0.19
First stage F-stat		4468.5		576.9		4468.5
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.00020 (0.0007)	-0.00037 (0.0007)	-0.016 (0.01)	-0.022* (0.01)	0.0073*** (0.002)	0.0076*** (0.002)
N	300390	300390	11076	11076	300394	300394
Mean of Dep Var	0.90	0.90	1.41	1.41	0.11	0.11
First stage F-stat		2659.6		498.3		2659.6

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B22: Main results: other outcomes restricting the sample to municipalities in the Amazonian border

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0010 (0.0007)	-0.0010 (0.0007)	-0.013 (0.01)	-0.016 (0.01)	0.0040*** (0.001)	0.0039*** (0.001)
N	427309	427309	112352	112352	427320	427320
Mean of Dep Var	0.60	0.60	1.98	1.98	0.39	0.39
First stage F-stat		4430.0		2690.7		4430.4
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0020** (0.0008)	-0.0023*** (0.0008)	-0.042** (0.02)	-0.044* (0.02)	0.0053*** (0.001)	0.0054*** (0.001)
N	271831	271831	26448	26448	271838	271838
Mean of Dep Var	0.81	0.81	1.66	1.66	0.22	0.22
First stage F-stat		3505.7		653.4		3505.8
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.00089 (0.0008)	-0.0011 (0.0007)	-0.033** (0.01)	-0.039*** (0.01)	0.0067*** (0.002)	0.0070*** (0.002)
N	192259	192259	6961	6961	192263	192263
Mean of Dep Var	0.90	0.90	1.44	1.44	0.14	0.14
First stage F-stat		2233.8		656.2		2233.8

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table B23: Main results: other outcomes excluding largest cities

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0015* (0.0008)	-0.0040 (0.01)	-0.0065 (0.01)	0.0036*** (0.001)	0.0037*** (0.001)
N	422166	422166	109196	109196	422188	422188
Mean of Dep Var	0.59	0.59	1.86	1.86	0.38	0.38
First stage F-stat		36819.8		16552.0		36821.7
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0020** (0.0008)	-0.0022** (0.0009)	-0.054 (0.04)	-0.060 (0.05)	0.0050*** (0.001)	0.0053*** (0.001)
N	255935	255935	24864	24864	255947	255947
Mean of Dep Var	0.80	0.80	1.69	1.69	0.20	0.20
First stage F-stat		24075.6		833.8		24075.9
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0016* (0.0008)	-0.014 (0.02)	-0.023 (0.03)	0.0073*** (0.002)	0.0078*** (0.002)
N	174407	174407	7996	7996	174411	174411
Mean of Dep Var	0.87	0.87	1.50	1.50	0.14	0.14
First stage F-stat		13152.8		83.3		13152.9

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

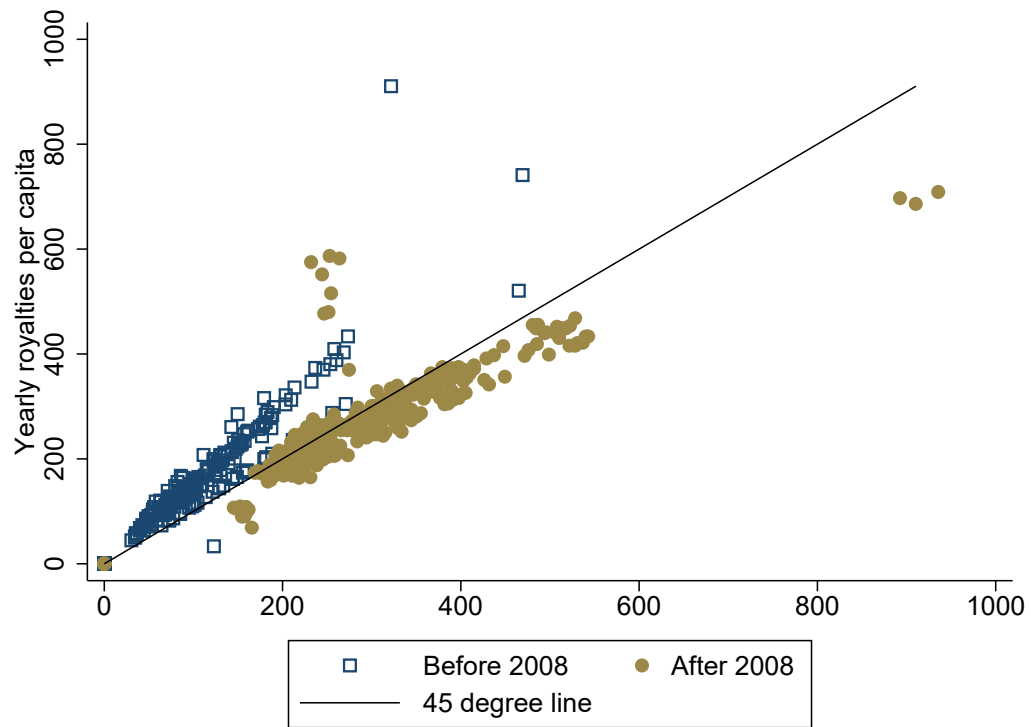
Table B24: Main results: other outcomes excluding the 2008-2014 period

Dependent variable:	Enrolled (dummy)		Real wages		Employed (dummy)	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Born after 1977</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0015* (0.0008)	-0.0040 (0.01)	-0.0065 (0.01)	0.0036*** (0.001)	0.0037*** (0.001)
N	422166	422166	109196	109196	422188	422188
Mean of Dep Var	0.59	0.59	1.86	1.86	0.38	0.38
First stage F-stat		36819.8		16552.0		36821.7
<i>Panel B: Born after 1990</i>						
Royalties since 2001	-0.0020** (0.0008)	-0.0022** (0.0009)	-0.054 (0.04)	-0.060 (0.05)	0.0050*** (0.001)	0.0053*** (0.001)
N	255935	255935	24864	24864	255947	255947
Mean of Dep Var	0.80	0.80	1.69	1.69	0.20	0.20
First stage F-stat		24075.6		833.8		24075.9
<i>Panel C: Born after 1995</i>						
Royalties since 2001	-0.0014* (0.0008)	-0.0016* (0.0008)	-0.014 (0.02)	-0.023 (0.03)	0.0073*** (0.002)	0.0078*** (0.002)
N	174407	174407	7996	7996	174411	174411
Mean of Dep Var	0.87	0.87	1.50	1.50	0.14	0.14
First stage F-stat		13152.8		83.3		13152.9

Notes: This table displays the effect of the sum of royalties per capita since 2001 on labor market outcomes and school attendance. The model controls for age, gender, housing characteristics to proxy socioeconomic variables, municipality and year fixed effects. Appendix Table A2 provides variable definitions. The total sum of royalties per capita for a typical oil receiving municipality between 2001 and 2017 is 753 USD. The first stage F-stat refers to the Kleibergen and Paap (2006) test. Cluster robust standard errors at the municipality level in parenthesis. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## C Figures appendix

Figure A1: First stage



*Notes:* This figure displays the 45-degree line and scatter plot of observed yearly royalties and the IV for the 2001–2017 period. The figure splits the figure into two periods, one before 2008 and one after, because of the change in Ley 010 in that year. Appendix Table A2 provides variable definitions.