A Blessing or a Curse? The Long-term Effect of Resource Booms on Human Capital and Living Conditions

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Abstract

Is natural resource abundance a blessing or a curse for a country? Unintended side effects can come with resource-driven growth. I use proprietary individual-level data to study long-term effects of exposure to the 1970s oil boom on human capital accumulation in the context of a developing country. I exploit variation in the timing of the shock to estimate the effect of exposure to the oil boom before turning 18 on educational attainment and wealth. I find that exposure to the oil boom before turning 18 decreased college completion in the more affected regions of the country. Consequently, exposure to the boom increased the likelihood of working in low-skill occupations 40 years after the boom. I find no significant effect on home and vehicle ownership, suggesting that the affected cohorts did not fare worse in life in terms of wealth accumulation.
JEL codes: O12, O13, O15, H30, H75

1 Introduction

Is resource abundance a blessing or a curse for a country? A priori, we would expect that natural resources boost economic development, but there is correlational evidence that suggests that countries that possess an abundance of natural resources tend to underperform regarding growth (Sachs and Warner, 1999, 2001; Gylfason, 2001; Torvik, 2002; Papyrakis and Gerlagh, 2004, 2007; James and Aadland, 2011; van der Ploeg, 2011).[1] Moreover, even if resource abundance translates into a higher GDP, this does not necessarily imply a uniform improvement of living conditions and welfare throughout a country because unintended side effects can come with resource-driven economic growth. Resource-driven growth may increase corruption (Caselli and Michaels, 2013), increase crime (Bartik et al., 2017), and decrease human capital accumulation.

Resource booms can affect human capital accumulation by decreasing educational attainment.[2] Booms are the product of a combination of discoveries, technological changes and demand shocks that affect prices. These changes may affect labor market conditions favoring low-skill occupations.[3] Standard human capital accumulation models (Becker, 1964; Black et al., 2005b; Charles et al., 2015) show that an increase in productivity in low-skill occupations increases the opportunity cost of going to college and decreases the returns of education. Thus, during a resource boom, it might be optimal for some individuals to drop from high school/college and enter the workforce.

However, economic theory does not predict whether these effects are temporary or permanent. On the one hand, if individuals anticipate that the resource boom is temporary, they could plan to return to school at a later date. On the other hand, as time passes, events such as marriage or having children impose costs on returning to school. Also, the time horizon for the returns of education to realize decreases. These two factors make it less likely for individuals to resume their education. Hence, the decrease of human capital of people affected by natural resource shocks could be permanent.

[1] See van der Ploeg (2011) for a review of this literature. More recent evidence suggests that the apparent negative correlation between resources and economic growth was the product of endogenous measures of resource abundance (Stijns, 2006; Smith, 2015).

[2] There is country-level evidence that natural resource abundance is negatively correlated with educational attainment (Gylfason, 2001; Papyrakis and Gerlagh, 2004, 2007), although these results are sensitive to different measures of resource abundance (Stijns, 2006).

[3] There is evidence that labor demand shocks from "fracking" favor the less educated (Bartik et al., 2017; Kearney and Wilson, 2017). In cases where the state owns mineral rights, government policies can facilitate the development of low-skill, labor-intensive occupations (De La Torre et al., 2015).

A long-term reduction in human capital accumulation could be one of the most concerning effects of natural resources booms. Having less education may lower lifetime wealth accumulation affecting living conditions for retirement. Moreover, even if there is no long-term effect on wealth, lower human capital levels may: (i) constraint the development of high-skill industries (Becker et al., 2011; Becker and Woessmann, 2010) ; (ii) decrease social capital and civic engagement (McMahon, 2010; Dee, 2004; Milligan et al., 2004; Huang et al., 2009); (iii) have negative effects on health (Silles, 2009; Brunello et al., 2016); (iv) affect safety in the country (Lochner and Moretti, 2004; Groot and van den Brink, 2010; Buonanno and Leonida, 2009); and (v) negatively affect the well-being of the next generation (Behrman and Rosenzweig, 2002; Currie and Moretti, 2003; Mine Güneş, 2015). These factors can constrain a country's long-term growth potential.

In this paper, I use proprietary individual-level data to estimate the causal long-term effect of the 1970s' oil boom on educational attainment in the context of a developing country. In 1973, Ecuador found oil at the same time that its price skyrocketed due to the Arab embargo. In Ecuador, as in many countries, the state owns all mineral rights, so the government received a large influx of funds that it targeted to infrastructure spending and subsidies. Productivity in low-skill occupations increased 93 percent because subsidies and price controls lowered the cost of starting small businesses related to commerce and construction in the entire country (World Bank, 1979a). I estimate the reduced form effects of exposure to this shock on education and wealth measured 40 years after the oil boom.

I use an intensity difference-in-differences design that compares changes in outcomes across cohorts of individuals who turned 18 before and after 1973, to changes in outcomes across geographic regions with different costs of college attendance. I focus on cohorts who by 1973 had already decided to go to college or not and compare them to cohorts that were still in high school and thinking about going or not to college. Specifically, I use the cohorts who turned 18 between 1966 and 1979. Differences in costs of attending college across regions stem from the fact that in the 1960s and 1970s universities in Ecuador were located only in five cities of the country, with the two largest cities concentrating college supply.[4] This fact, together with drastic differences in altitude across the country, implies that people born in regions without universities faced higher costs of college attendance than people born in regions with universities. Theoretically, the marginal student from

[4] No new universities opened around the time of the oil boom. I use the terms *college* and *university* interchangeably.

regions without universities should have had higher ability and income than the marginal student from regions with universities. Consequently, college attendance was larger in cities with universities, and the marginal student in these cities was more sensitive to shocks that increase the productivity of low-skill jobs. Thus, the effect of the oil boom on college completion should be larger in regions with a large supply of colleges than in regions without universities.

The aforementioned regional differences in the costs of college attendance define the baseline group for the intensity difference-in-differences design. I use regions without universities as the baseline group, which theoretically should be the least affected by the boom. This design recovers the change in college completion in the regions with universities in excess of the change of college completion in regions without universities.[5] Thus, as long as the oil boom negatively affects college completion in the baseline regions, I recover a lower bound of the true effect implied in Figure 4. I check this assumption using naturalized Ecuadorians as the baseline, who likely lived in other countries during the 1970s and were not affected by the Ecuadorian oil boom. Also, the 1973's oil boom affected the entire country through government's spending. The government built highways, aqueducts and other projects all across the country and other expenditures, such as subsidies and price controls, affected the country uniformly (Acosta, 2006; World Bank, 1979a). Even if some regions concentrated infrastructure spending, Velasco (1988) documents substantial internal migration during the oil boom driven by new low-skill jobs. I control for migration assigning individuals to their region of birth.

I find that in the context of a developing country, exposure to a resource boom negatively affected long-term educational attainment. Previous research analyzed the effect of resource booms on educational attainment in the context of developed countries. These studies find that exposure to resource booms decreased high school enrollment in resource-rich areas in the short-term (Black et al., 2005b; Cascio and Narayan, 2017), but did not affect long-term educational attainment (Emery et al., 2012).[6] In contrast, I find that exposure to the oil boom before turning 18 decreased

[5]Finkelstein (2007) uses a similar region-based approach to estimate the effect of the introduction of Medicare.

[6]There is a larger quasi-experimental literature that considers the effect of natural resource shocks on: (i) non-resource economic activity (Black et al., 2005a; Michaels, 2011; Marchand, 2012; Allcott and Keniston, 2014); (ii) participation in disability programs (Black et al., 2002); (iii) family income and children education (Løken, 2010; Løken et al., 2012), (iv) effect of income on health spending (Acemoglu et al., 2013); and (v) public expenditure and corruption (Caselli and Michaels, 2013). A related literature studies the effects of shocks that increase the productivity of low-skill occupations, such as housing booms (Charles et al., 2015), large infrastructure projects (Carrington, 1996), technological changes (Fetzer, 2014; Bartik et al., 2017; Feyrer et al., 2017), and recessions (Kahn, 2010; Oreopoulos et al., 2012).

college completion in the long-term. Consistent with the previous theoretical predictions, exposure to the oil boom had heterogeneous effects across regions, and the decrease in college completion was driven by the cities that concentrated the majority of universities at the time (*Quito* and *Guayaquil*). In these cities, exposure to the oil boom before turning 18 decreased college completion by 2.9 percentage points, which represents 12.2 percent of baseline college completion for those who turned 18 just before the oil boom. These results are robust to using naturalized Ecuadorians as the baseline group.

The long-term reduction of college completion is consistent with a model of rational individuals who reduce their educational attainment in response to lower returns of education in the long-run. This suggests that the oil boom changed the structure of the Ecuadorian labor market by enhancing the importance of informal low-skill jobs. I provide four pieces of evidence that support this potential mechanism. First, I find that college completion increased in the only region in Ecuador where the oil boom plausibly had a positive effect on jobs with higher skills. All the new oil fields that started production in 1973 are in the *Amazon* region. Hence, the oil boom had a direct positive effect on connectivity and income in this region. This region was sparsely populated before the oil boom, agriculture, commerce, and other low-skill services concentrated 70 percent of employment, and it only had one highway that connected it to the rest of the country. The government built a new highway that connected the *Amazon* region directly to the capital city of *Quito* to access the oil fields. Spillovers from the oil industry into the local economy and direct transfers from the government to municipalities in this region contributed to increasing employment in high-skill occupations from 25 percent in 1962 to 26.8 percent in 1982.[7] Thus, exposure to the oil boom before turning 18 increased college completion by 4.5 percentage points (58.5 percent of the baseline).

Second, as mentioned above low-skill occupations' productivity increased after the oil boom (World Bank, 1979a), changing the employment composition. Employment in commerce, low-skill services (food preparations, repairs, transportation, housekeeping), construction, and other low-skill occupations increased from 22.4 percent in 1962 to 33.44 percent in 1982, while employment in manufacturing industries decreased from 13.6 percent in 1962 to 12.6 percent in 1982. Moreover, this composition change lasted long after the oil boom. In particular, in 1982 the share of non-

[7] By law municipalities in the *Amazon* region receive 10 percent of fiscal revenue from oil.

agriculture low-skill jobs was 39.4 percent and increased to 55.5 percent in 2010.

Third, I find that exposure to the oil boom before turning 18 increased the likelihood of working informally in 2012 by 0.8 percentage points (1.9 percent of the baseline) in the cities with full universities and decreased this probability by 1.7 percentage points (3 percent of the baseline) in the *Amazon* region. While the point estimates are imprecise, these results are consistent with the changes in educational attainment in these regions. The effect for cities with full universities is also consistent and with a labor market oriented to low-skill jobs.

Finally, if the returns of education did not decrease in the long run, the literature on the returns of education (Angrist and Krueger, 1991; Card, 1993; Harmon and Walker, 1995; Card, 1999, 2001; Duflo, 2001; Lemieux and Card, 2001) implies that a reduction in educational attainment should have translated into lower wealth accumulation. However, I find that exposure to the oil boom before turning 18 did not affect two relevant measures of wealth: home ownership in 2010 and vehicle ownership in 2013. The point estimates for home ownership are smaller than 0.6 percentage points in the cities with universities (1 percent of the baseline), and the standard errors rule out effects larger than two percentage points. Similarly, I find that exposure to the oil boom before turning 18 decreased vehicle ownership in the largest cities by 0.5 percentage points (2.8 percent of the baseline rate). Together, these results suggest that negative effects on wealth were limited. This is consistent with a long-term reduction of the returns of education induced by the increase in low-skill productivity after the oil boom.

This paper contributes to the literature that studies the factors that affect the growth potential of developing countries. I show that exposure to the oil boom before turning 18 decreased educational attainment in the long-run. The results suggest that it was optimal for the exposed cohorts to reduce their educational attainment. However, the absence of effect on wealth does not account the positive externalities of education. In particular, the literature on the intergenerational effects of education suggests that the next generation might be worse off. I find that exposure to the oil boom before turning 18 increased the number of children in the largest cities by 0.04 (1.7 percent of the baseline). This estimate, together with no apparent effect on wealth, suggests fewer resources per children that together with less educated parents may have affected their development.

From a macroeconomic perspective, the results indicate that the oil boom decreased Ecuador's stock of human capital and may have affected its capacity to accumulate human capital for the next generation, which constrains the country's long-term growth potential. Ecuador's case suggests that fiscal policy may have a role in the propagation of natural resource shocks in developing countries. In many of these countries, the state owns all mineral rights and is an active participant in the extraction process. Thus, how the government spends funds from natural resources affects the propagation of the shock in the economy, and it could even determine if the shock has positive or negative consequences in the long term.[8] The case of the *Amazon* region suggests that if a government wants a natural resource boom to increase educational attainment, it needs to invest to reduce costs of college attendance.

2 Stylized Facts about the Ecuadorian Oil Boom

In the early 1970s, Ecuador found oil in its *Amazon* region and started major oil production in 1972-1973. At the same time, Ecuador benefited from the rise of oil prices due to the Arab embargo in 1973-1974. We can see the effects of this oil boom in Figure 1. Ecuador's oil output increased from 0 to 28.6 million barrels in 1972.[9] In 1973, output more than doubled to 76.2 million barrels, and it fluctuated around this level in the rest of the decade. Also, in 1974 oil's price raised from $4.20 per barrel to $13 per barrel (a 210 percent increase), and it remained at high levels until 1982.

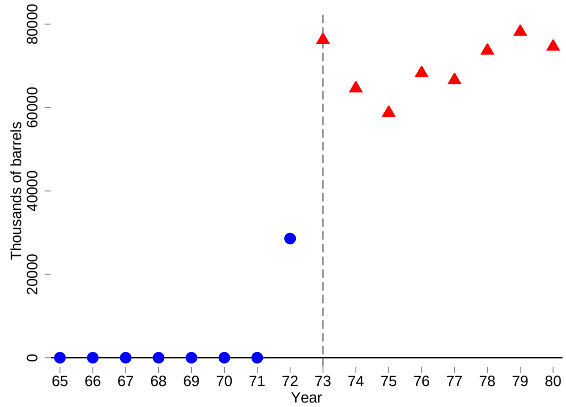
These two shocks had profound implications for Ecuador's economy. GDP per capita increased from $503 in 1972 to $983 in 1974 (Figure 1, Panel e). Oil became a major source of fiscal revenue (Figure 1 Panels c and d) because in Ecuador the state owns all mineral rights and is the main actor in the oil industry. From 1973 to 1980, oil revenue represented 34 percent of total fiscal revenue, up from almost zero in the previous decade. Non-oil tax revenue continued to increase but at a slower rate. The World Bank (1979a) estimates that its share decreased from 14.4 percent of non-oil GDP in 1972 to 12 percent in 1977.

The government channeled these funds to finance an expansion of public expenditures. According to Ecuador's Central Bank, the government's expenditures, mainly personnel expenses, increased

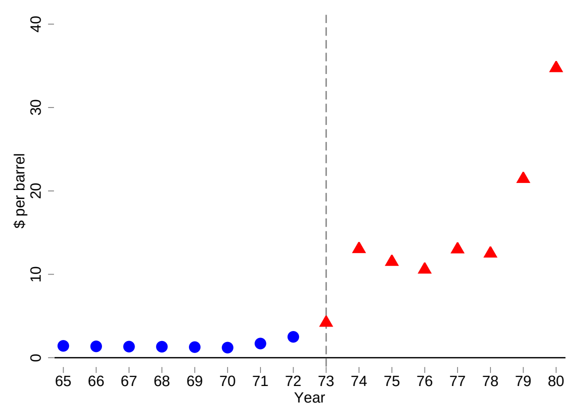
[8] De La Torre et al. (2015) document how fiscal policy can modify how resource shocks affect a country. They find descriptive evidence that low-skill productivity increased in resource-rich Latin American countries during the commodity price boom in the 2000s, driven by public spending policies similar to the ones Ecuador implemented in the 1970s. Caselli and Michaels (2013) find that oil revenue increases budgeted spending for public services in Brazil, but it does not affect living conditions, suggesting that corruption might be a problem.

[9] At the beginning of the twentieth century, Ecuador found small oil deposits in its coast lands. The government leased this field to the Anglo-Ecuadorian Oil Company (now part of British Petroleum), who only paid taxes on its profits. Official statistics do not include output nor revenue from this field.

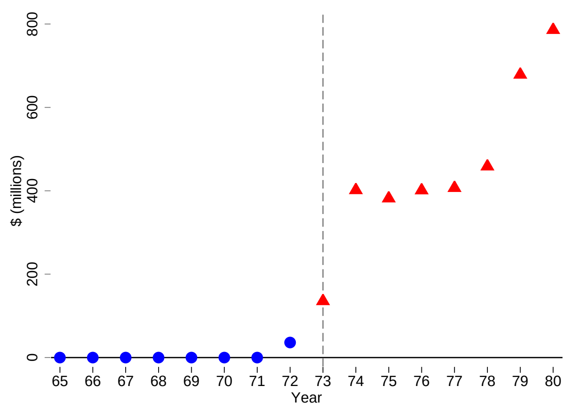
Figure 1: Oil Output and Price



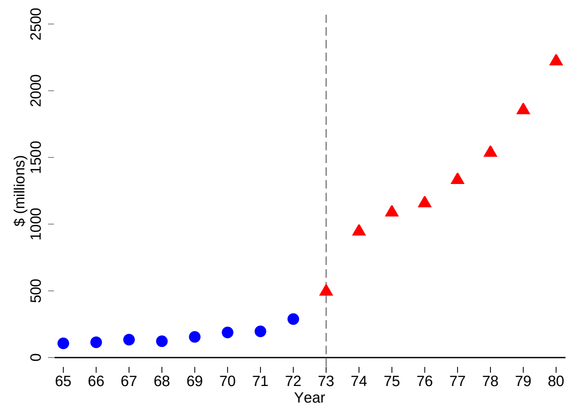
(a) Oil output



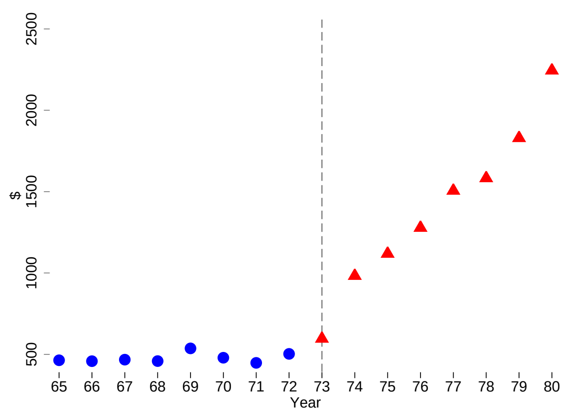
(b) Price ($ per barrel)



(c) Government's Revenue (Millions of $)



(d) Government's Oil Revenue (Millions of $)



(e) GDP per Capita

Notes: This Figure presents the evolution of Ecuador's crude oil output, its price, the government's revenue from oil exports, and GDP per capita from 1965 to 1980. Oil output data, government's oil revenue and GDP per capita is reported by Ecuador's Central Bank. Oil's price from 1965 to 1971 is the average price of OPEC, from 1972 onward it corresponds to the average price of Ecuador's oil exports as reported by Ecuador's Central Bank.

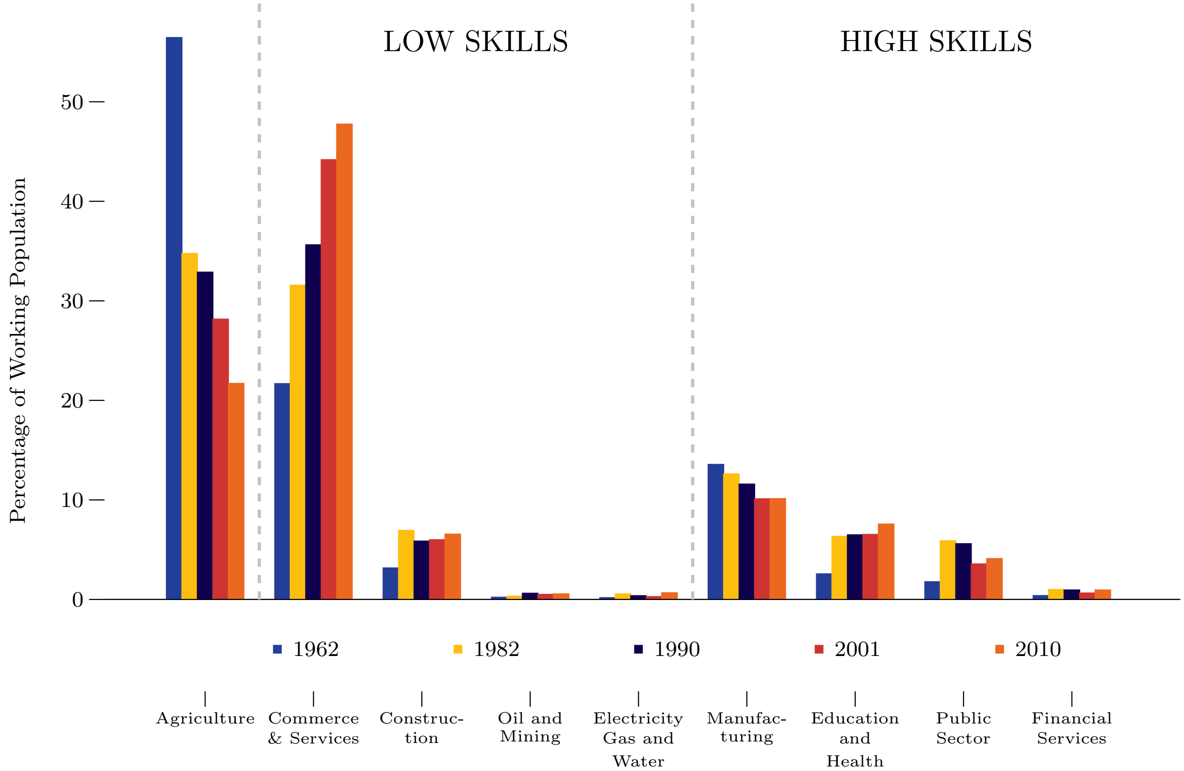
659 percent from 1972 to 1980. Capital expenditures grew 603 percent. These investments were focused on expanding the country's existing highway network and developing new infrastructure for the oil, electricity, agriculture (irrigation and storage), education, and health sectors (World Bank, 1979c). The government also financed interest rate subsidies for certain sectors; price controls on wages and agricultural products; and subsidies on gasoline and other fuels (World Bank, 1979a; Cisneros et al., 1988; Acosta, 2006). Trade policy included tariffs on imports of finished products and subsidized imports of intermediate products and capital goods (Larrea, 1989). All these transfers grew 851 percent from 1972 to 1980. Also, the abundance of oil funds facilitated an implicit transfer in the form of lax tax collection efforts.

Notably, the oil boom did not lead to an increase in the industrial sector's share in the economy. Until 1965, Ecuador's economy relied heavily on agriculture, in particular growing products for export. Ecuador was a major cacao exporter until 1917 and became the world's largest banana exporter since the 1950s (Acosta, 2006). In 1965, the country followed the rest of Latin America and adopted a series of policies to promote growth in the industrial sector by replacing imports of manufactured products with local production. Ecuador maintained these policies throughout the 1970s. However, these policies were not effective at expanding the manufacturing sector weight in the economy. According to the World Bank (1979c), the manufacturing sector's share of real GDP barely increased from 17 percent in 1970 to 18 percent in 1977. At the same time, the share of people working in manufacturing activities fell from 13.6 percent in 1962 to 12.6 percent by 1982 (see Figure 2).[10]

We may think that employment in the manufacturing sector fell due to the adoption of capital-intensive technologies that require fewer but more productive employees. However, the World Bank (1979a) estimates that value added per worker remained practically constant for the industrial sector between 1972 to 1975. At the same time, value added per worker in low-skill non-agricultural sectors increased 93 percent, from $806 to $1,556. Labor productivity of low-skill jobs increased after the oil boom because subsidies and price controls lowered the relative cost of capital in these occupations. For instance, it was cheaper to purchase small machinery (cooking appliances, drink dispensers, sewing machines) and vehicles than before the oil boom. Higher productivity implied higher earnings

[10]In 1965, Ecuador also started an agrarian reform with the objective of redistributing land from large landowners to their workers. According to the World Bank (1979c), this reform was not effective. In 1975, it distributed only 16 percent of the allocated land to 17 percent of the potential beneficiaries.

Figure 2: Employment by Sector Before and After the Oil Boom



Notes: This Figure presents the proportion of the working population employed in each sector of the economy for 1962 and 1982. Data comes from Ecuador's 1962, 1982, 1990, 2001 and 2010 population censuses.

for people who worked in commerce, construction, and low skills services. Consequently, individuals had the incentive to work in occupations with lower skill requirements.

Figure 2 shows that after the oil boom employment shifted from agriculture to other low-skill sectors, consistent with the increase in productivity mentioned above. Employment in agriculture decreased 21.7 percentage points between 1962 and 1982, while employment in low-skill occupations increased by 14.1 percentage points and employment in high-skill jobs increased by only 7.5 percentage points.[11] Commerce and services concentrated labor in the country. These dynamics suggest that, at least in the short-run, some individuals might have chosen to forgo a college education. Moreover, the fact that this change in employment's composition lasted until 2010 would be consistent with a long-term reduction in educational attainment. I study this issue in the rest of the paper.

[11]Employment increased in "high-skill" jobs provided by the government (public administration, education, and health). It is important to note that at that time teachers did not require a college degree, and there were specialized high schools called *normales* that trained teachers.

3 Theoretical Framework

3.1 The Decisions to Drop Out and Return to School

Human capital accumulation models predict that the large increase in productivity of low-skill occupations is likely to cause some individuals to discontinue their education, at least in the short run (Becker, 1964; Black et al., 2005b; Charles et al., 2015). As low skills jobs more become appealing, particularly for young adults, the opportunity cost of finishing high school/going to college increases and the perceived returns of education decrease.

The long run effect of this type of shock is less clear from a theoretical perspective. It is plausible that individuals take advantage of booms to save and return to school in the future. This would imply zero long run effect on educational attainment. However, age imposes costs on the decision to return to school. First, the horizon to receive the earnings premium of education decreases as we get older. Second, the cost of returning to school may increase as time outside school passes. Life events, such as marriage or having children, make it more difficult to go back to school. These costs imply that if the person has been out of school for more than a threshold number of years, then the optimal decision is to keep working. This threshold depends on the gap between high skills and low skills earnings. The smaller the difference, the shorter the period when it is optimal to return to school. Also, if agents expect that the natural resource boom will be a permanent shock, then the likelihood of returning to school decreases. Limited information may induce agents to believe that the shock could last for a long period.

In summary, the presence of long-term effects of natural resource booms on educational attainment is an empirical question that depends on the costs of returning to school, the perceived returns of education, and expectations about the duration of the shock. It is important to note that a negative long-term effect on education should imply a long-term increase in employment in low-skill occupations.

3.2 Heterogeneity across Regions

A homogeneous shock that increases the opportunity cost of education or reduces the returns of education in a country can have heterogeneous effects across its regions if they have different costs of education. This result follows from the human capital accumulation model of Charles et al. (2015), who define a model for young adults who differ in ability θ_i that follows some distribution Φ_θ. In this setup, the authors define the lifetime payoff of going to college in year t as

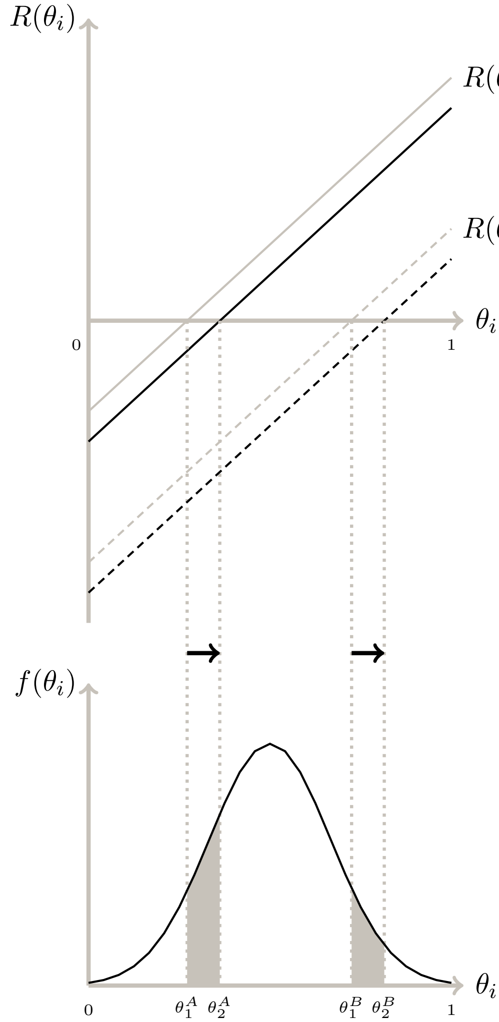
$$R_{it}(\theta_i) = \sum_{k=1}^{L-\alpha_i} E_t[\Pi_{t+k}|\Lambda_t] - (1+b)F - \kappa(1-\theta_i) - Y_t^0 \quad (1)$$

where the first term ($E_t[\Pi_{t+k}|\Lambda_t]$) captures the expected returns of college attendance conditional on all information available Λ_t, the second term ($(1+b)F$) is the direct cost of college attendance (tuition, fees, living costs), the third term ($\kappa(1-\theta_i)$) is the psychological cost of education, and the last term (Y_t^0) is the opportunity cost of college attendance in the form of lost wages. The authors assume that the lifetime value of going to college is increasing in ability. This implies that there is an indifferent individual with ability θ^* such that all individuals with ability $\theta_i \geq \theta^*$ choose to go to college.

With this model, I show that a homogeneous shock that increases the opportunity cost of education or reduces the returns of education in a country can have heterogeneous effects across its regions. Let us suppose that there are two regions in a country, A and B with different direct costs of college attendance, $F^A < F^B$. This difference implies that for any underlying distribution of ability, college attendance is larger in region A than in region B. Now, suppose that both regions are affected by a shock that increases the opportunity cost of college attendance (Y_t^0) or decreases the returns of education ($E_t[\Pi_{t+k}|\Lambda_t]$) homogeneously across regions. College attendance will decrease in both regions, but unless the distribution of ability in the country is uniform, which region is the most affected depends on the magnitude of the difference in costs and the shape of Φ_θ. Fixing the shape of the distribution, the larger the difference in costs, the more likely it is that the cheaper region will be the most affected. Figure 3 presents this result assuming a linear lifetime value of college.

In a developing country, where regions without universities have low base levels of college attendance compared to regions with universities, it is likely that differences in the cost of attendance are large enough such that the marginal student from regions without universities had substantially higher ability and income than the marginal student from regions with universities. Thus, we should expect regions without universities to be the least affected by the shock. I use this result to define the base region to estimate the effects of exposure to the 1973 oil boom with an intensity

Figure 3: Effects of a Decrease in the Return of Education across Regions with Different Costs of College Attendance



Notes: This Figure shows how different in costs between regions can lead to differences in the proportion of the populations that discontinues their education in the presence of a shock that increases the opportunity cost of college attendance and/or decreases the returns of education homogeneously across regions. In both regions the shock shifts the returns $R_{it}(\theta_i)$ to the right by the same proportion, decreasing the fraction of the population that goes to college.

difference-in-differences design.

4 Data

I have access to proprietary historical data from a financial services company that works in Ecuador. This company collects comprehensive demographic data of the adult population in the country to develop credit scoring models.[12] I observe gender, date of birth, marital status, number of children, canton of birth,[13] canton of residence, highest completed education level, type of occupation, income for employees, and car ownership. Also, I use home ownership data from Ecuador's 2010 Population Census.[14] I focus on the cohorts born in Ecuador between 1948 and 1961 to estimate the long-term effects of exposure to the oil boom before turning 18. The main sample consists of 1,711,538 individuals.

Ideally, to fully control for fluctuations from the life-cycle, we would be able to observe these cohorts at different points in time when they have the same age. However, data is only available for single points in time. The demographic information corresponds to 2014, car ownership to 2013, labor market data to 2012, and home ownership to 2010. This concern is not likely to alter the results because the observed outcomes should be determined for these cohorts. For instance, the probability of owning a house should not depend on age, since individuals in the sample were between 49 and 62 years old in 2010. We would expect that the decision of owning a house happened for most individuals before they turn 49. Also, at 62 individuals are young enough to live independently in their own home, even if they decided to downsize. Hence, the home ownership measure should not be affected by age for these cohorts.[15] Similar reasoning applies to the other outcomes measured in Table 1.

Table 1 presents descriptive statistics of the main sample. Women represent 51 percent of these cohorts, and on average, these individuals were 57 years old in 2014. Table 1 also splits the cohorts into two groups: those individuals who turned 18 years old before the oil boom in 1973 (born in 1948-1954) and those individuals who turned 18 after the oil boom (born in 1955-1961). There is no difference in the proportion of women between the two groups. The proportion of people with primary education or less is smaller for those cohorts exposed to the oil boom before turning 18, while the proportion of people with secondary education or more is larger.

[12]Sources include banks, other financial institutions, and web scrapping to fill gaps. Credit applications collect demographic information from Ecuador's national identification cards.

[13]A canton is an administrative division similar to a U.S. county.

[14]The complete census database is publicly available from Ecuador's national statistics agency and it can be downloaded from http://www.ecuadorencifras.gob.ec/base-de-datos-censo-de-poblacion-y-vivienda/. See Rivadeneira and Zumarraga (2011) for the complete description of the Census and the information it collects. I also use 10 percent random samples from Ecuador's population censuses of 1962, 1974 and 1982 to construct labor participation statistics reported in Section 2. These data are reported by Minnesota Population Center (2017), which collected the data from Ecuador's national statistics agency.

[15]Home value could be changing, but this variable is not present in the data.

Table 1: Sample Means

	Full Sample	Born in 1948-1954	Born in 1955-1961
Proportion Women	0.51	0.51	0.51
Age	56.73	60.78	53.84
Proportion No Education	0.15	0.18	0.12
Proportion Primary Education	0.47	0.49	0.45
Proportion Secondary Education	0.26	0.21	0.28
Proportion College Education	0.13	0.12	0.14
Years of education	8.18	7.60	8.59
Proportion Informal Workers in 2012	0.53	0.56	0.51
Proportion Employees in 2012	0.15	0.13	0.17
Proportion Professional Workers in 2012	0.32	0.31	0.33
Monthly Wage for Employees in 2012	974.90	1039.17	939.50
Proportion Vehicle Owners in 2013	0.17	0.16	0.17
Average age of vehicle in 2013	16.09	16.92	15.54
Proportion Home Owners in 2010	0.78	0.81	0.76
Proportion Home Owners with More than 2 Rooms in 2010	0.57	0.59	0.56
Proportion Home Owners with Home above Median Quality in 2010	0.33	0.34	0.32

Notes: this Table presents sample means for a subset of variables that characterize the data used in this research. The data corresponds to 2014 unless otherwise noted. Column 1 presents means for the full sample, that is individuals who were born in Ecuador between 1948 and 1961. Column 2 considers individuals born between 1948 and 1954, that is the cohorts who turned 18 years old before the oil boom in 1973. Column 3 considers individuals born between 1955 and 1961, that is the cohorts who turned 18 years old after the oil boom in 1973. Informal workers are people who work in low skills occupations, often self-employed, and who are not fully declaring taxes. Employees are people who work for a firm and receive a monthly wage. Professional workers are people who work independently and are registered with the Ecuadorian tax office.

Table 1 also presents labor participation indicators as of 2012 to ensure that the majority of the sample is still active in the labor market.[16] The data have three labor participation categories: (i) informal workers, people who work in low skills occupations, often self-employed, and who are not fully declaring taxes; (ii) employees, people who work for a firm and receive a monthly wage; and (iii) professional workers, people who work independently and are registered with the Ecuadorian tax office. More than 50 percent of these cohorts were informal workers in 2012, with a slight drop for those who turned 18 after the oil boom.

I use home and vehicle ownership as proxies of wealth. We can observe that only 17 percent of the individuals born between 1948 and 1961 own at least one vehicle. This proportion is similar for the younger cohorts. Home ownership rate is close to 80 percent. It is important to note that in developing countries the quality of housing is a relevant issue. Hence, home ownership decreases to 57 percent if we consider owning a house with more than two rooms. I also use principal components analysis to combine data from the Census on the type of construction, materials used, water source, type of sewage and garbage disposal into an index of housing quality. Home ownership of houses above the median of the quality index is 33 percent. There are no substantial differences in home

[16] In 2012, those individuals born in 1948 were 64 years old, below the legal threshold for retirement.

ownership between individuals who turned 18 years old before and after the boom.

5 The Long-Term Effect of the Oil Boom on Human Capital Accumulation

5.1 Descriptive Analysis

While Table 1 is useful to characterize the sample, it hides the evolution of the different variables across birth cohorts. This variation is important to identify the effect of being exposed to the oil boom before turning 18. Figure 4 presents the evolution of the highest schooling level completed for individuals born in Ecuador between 1940 and 1961.[17] For example, if a person dropped high school, then her highest completed education level is elementary school. The Figure shows that the proportion of people with no education or elementary education was decreasing, while the proportion of individuals with secondary education or college was increasing for those born until 1955.[18] These trends are expected for a developing country.[19]

However, there is a major kink in educational attainment for cohorts who turned 18 after the oil boom. College completion flattens and decreases for the cohorts born between 1955 and 1961 (red triangles in Figure 4). Naively, if we extend the pre-1955 trend, Figure 4 Panel (d) suggests that exposure to the oil boom at the end of high school decreased college completion by around two percentage points. Consequently, the positive trend of secondary education becomes steeper (Panel c), and the negative trend of elementary education flattens (Panel b). These changes suggest that college completion drops due to a mix of people who choose not to enter/complete college and people who choose to drop out of high school.[20]

The abrupt change in the trend of college completion is consistent with the increase in productivity for the traditional, low skills sector of the economy generated by the oil boom. As discussed

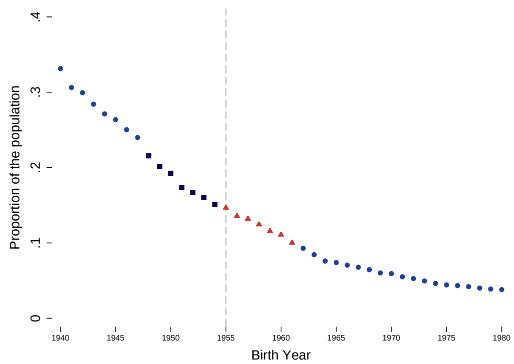
[17] Cohorts born in 1962 and after are affected by a series of additional shocks: a short war in 1981, the oil bust and a declaration of default in 1982, and an earthquake in 1986 that destroyed the only oil pipeline in the country. These shocks confound each other, so I focus on the effect of the oil boom.

[18] Elementary school includes grades 1 to 6, secondary school includes grades 7 to 12.

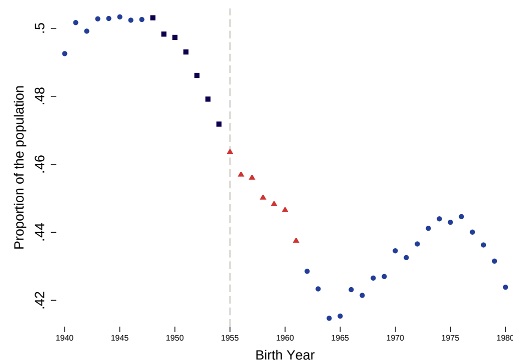
[19] Economic conditions were fairly stable until 1973, and the economy grew at an average annual rate of 5.4 percent from 1960 to 1973. It is important to note that a civilian dictator ruled Ecuador from June 1970 to February 1972, who was replaced by a military dictatorship from February 1972 to August 1979. However, this was a peaceful period in contrast with other dictatorships in Latin America. Also, there are no dips in college completion in 1970, 1971 and 1972 which would have been consistent with repression at the beginning of a dictatorship.

[20] While formal child labor was illegal in Ecuador at that time, children were allowed to work informally in agriculture or other low-skill jobs.

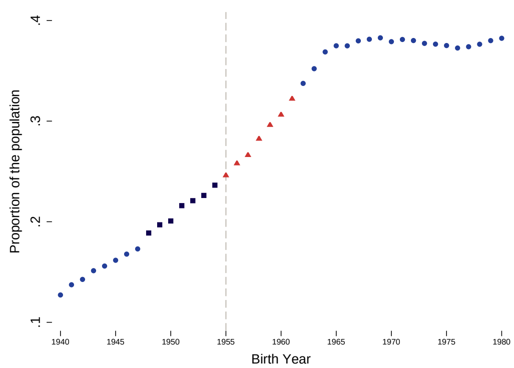
Figure 4: Highest Level of Education Attainment by Birth Cohort



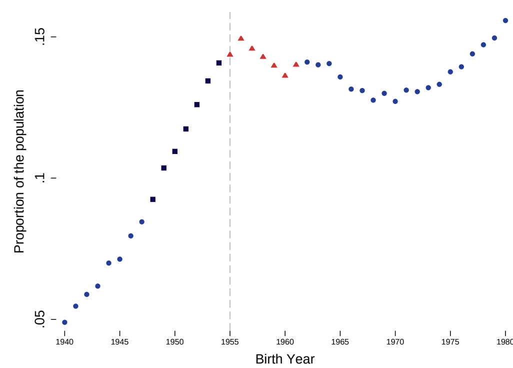
(a) No education



(b) Completed Elementary Education



(c) Completed Secondary Education



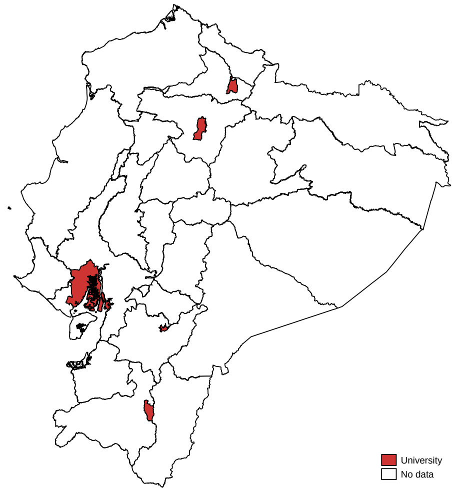
(d) Completed College or More

Notes: This Figure presents the evolution of the highest schooling level completed for the cohorts born in Ecuador between 1940 and 1961. For example, if a person dropped high school before completing 12th grade, then her highest completed education level is elementary school. The cohorts born between 1955 and 1961 (red triangles) turned 18 years old during the oil boom in the 1970s.

in Section 3.1, higher productivity of low skill occupations leads to higher income from these occupations, which increases the opportunity cost of education. A higher opprotunity cost leads to a reduction in high school/college completion in the short term. However, if the returns of education decreased in the long-run, the cost of returning to school were increasing in age, or agents perceived that the increase in productivity of low skill occupations was sufficiently large, then individuals could have chosen not to return to school, leading to the observed drop in college completion in the long run.

Figure 4 provides an additional piece of evidence that supports the idea that exposure to the oil boom before turning 18 decreased college completion. There is no apparent change in the trend of people with no education for the cohorts born between 1948 and 1961. This lack of change suggests that there were no other shocks that affected educational attainment of these cohorts when they

Figure 5: Cities with Universities in Ecuador before the Oil Boom



Notes: This Figure shows the geographical distribution of the cities with universities in Ecuador before the oil boom.

were younger that could explain the reduction in college education. Hence, the only difference for cohorts who turned 18 years old around the time of the oil boom, is that for some people the boom occurred when they were already attending college, while for others it occurred when they were completing high school and thinking about going to college. In the next sections, I develop an empirical strategy to estimate this effect more rigorously.

5.2 Regional Variation in the Costs of College Attendance

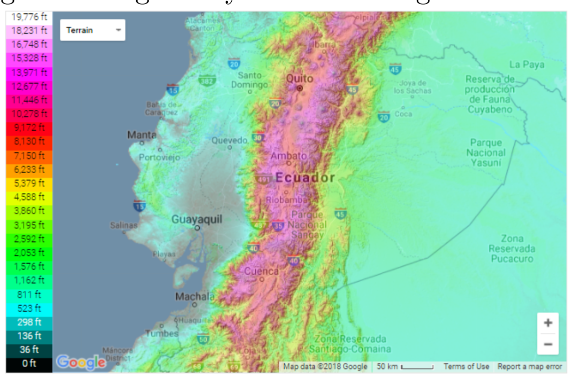
In Section 3.2, I show that if regions in a country have different costs of college attendance, then we should expect heterogeneous effects from a national-level shock that affects low-skill productivity. In Ecuador, geographic differences in these costs stem from the fact that universities in the 1960s and 1970s were located only in five cities of the country with no new openings in that period (Figure 5). Four universities where located in *Quito*, the capital, three in *Guayaquil*, three in *Cuenca*, and one in *Loja* that also had a second campus in the north to the country. Moreover, only universities in *Quito* and *Guayaquil* offered majors in every field of study, the other cities only had access to majors related to law and the humanities (liberal arts). The rest of the country only had agricultural technical schools.[21]

Attending college was cheaper for individuals who lived in the cities with universities due to

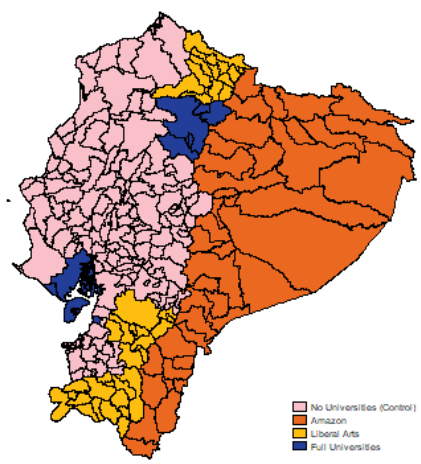
[21] Only one new technical school opened in 1973. These schools are coded as secondary in Figure 4. Appendix Table A2 lists all universities and technical school that functioned until 1989.

lower living, travel, and information costs. In Ecuador, it is very common for young adults to live with their parents until their early 30s, specially while they are still studying.[22] Thus, people born in a city with universities could live with their parents while they studied, significantly lowering the cost of education. These students did not have to rent a place to live (Ecuadorian universities do not offer dorms).

Figure 6: Regions by Cost of College Attendance



(a) Altitude Map



(b) Regions by Cost of College Attendance

Notes: Panel (a) presents an altitude map for Ecuador. Roughly, the country can be divided into 4 regions by the mountain ranges that cross the country. In Panel (b) I combine geographic regions with the location of universities before the oil boom to divide the country in 4 different areas. The country has a fifth region, the Galapagos Islands, which is not shown in the map. These islands where sparsely populated and isolated from the continent at the time of the oil boom.

Altitude-induced transportation costs also contribute to lower the cost of attending college for people who live in the cities with universities. Altitude differences partly determined the geographical distribution of universities in the country. The Andes mountains cross through Ecuador splitting

[22] In 1974, 36.5 percent of all adults between 18 and 30 years old lived with their parents. This share increases to 46.5 percent if we consider people aged 18 to 24. For comparison, Vespa (2017) reports that in 1975, 26 percent of adults aged 18 to 34 lived with their parents or in college dorms in the United States.

the country into four regions, relatively isolated from one another at that time (Figure 6 Panel a). First, there is a small mountain range that runs along the Pacific ocean. Here, altitude raises rapidly from sea level to a maximum of around 3,000 feet above sea level. The second region corresponds to the inland plains, where altitude drops and fluctuates between 0 and 500 feet above sea level. The third region corresponds to the main branch of the Andes. Altitude increases sharply and fluctuates between 6,000 and 16,000 feet above sea level. This region consists of a series of high altitude valleys separated from each other by branches of the mountains. Finally, on the east side of the Andes altitudes drops again and stabilizes between 500 and 1,000 feet above sea level. This region corresponds to the Amazon jungle, which was sparsely populated before the oil boom, had minimal agricultural activities, and had a deficient road network within the region and with the rest of the country (World Bank, 1979b).[23] The sharp differences in altitude increased travel times and costs within relatively short distances. For instance, travel between the two largest cities of the country in the 1970s took half an hour by airplane or 10 hours by car.

Figure 6 Panel (b) combines the location of the universities with the four geographic regions. This way, I define four different areas regarding the cost of college attendance and type of university. Regions without universities had the highest costs of college attendance. Geographically, this region corresponds to the coast lands, excluding the city of *Guayaquil*, and the middle of the highlands. While the *Amazon* region did not have universities at the time, the oil fields were located in this area. The government built a new highway that connected the *Amazon* region directly to the capital city of *Quito* to access the oil fields (Acosta, 2006). Also, spillovers from the oil industry into the local economy and direct transfers from the government to municipalities in this region contributed to increasing employment in high-skill occupations from 25 percent in 1962 to 26.8 percent in 1982. These two factors suggest that the cost of college attendance might have decreased in this region for the cohorts who turned 18 after the oil boom. The third region in Figure 6 Panel (b) corresponds to areas of influence of the cities of Cuenca, Loja, and Ibarra that had access to liberal arts colleges. The last region corresponds to the cities of Quito and Guayaquil that had access to full universities.

[23]Ecuador has an additional region, the Galapagos Islands that lie 1,000 kilometers of its coast. I do not include this region in the analysis because these islands where sparsely populated and isolated from the continent at the time of the oil boom.

5.3 Empirical Strategy

To estimate the effect of exposure to the oil boom before turning 18 on college completion, I use an intensity difference-in-differences design that compares changes in outcomes across cohorts of individuals who turned 18 before and after 1973, to changes in outcomes across geographic regions with different costs of college attendance.

The aforementioned regional differences in the costs of college attendance define the baseline group for the intensity difference-in-differences design. I use regions without universities as the control group. In line with differences in costs discussed in the previous Section, Appendix Figure A2 shows that regions without universities had low base levels of college attendance compared to regions with full universities. Almost seven percent of the cohort born in 1948 in regions without universities completed college, while 16 percent of their peers born in cities achieved this goal. This gap of eight percentage points increased to 12 percentage points for the cohort of 1954. These differences in college completion across regions, together with the theoretical results in Section 3.2, suggest that differences in the cost of attendance are large enough such that the marginal student from regions without universities had substantially higher ability and income than the marginal student from regions with universities. Thus, we should expect regions without universities to be the least affected by the shock.

This design estimates the change in college completion in the regions with universities in excess of the change of college completion in regions without universities.[24] Hence, as long as the oil boom negatively affects college completion in the baseline region (suggested by Appendix Figure A2), I recover a lower bound of the true effect. Specifically, for individual i, born in region r in year t, I estimate

$$college\ completion_{irt} = \alpha_r + \alpha_t + \lambda_r t + \sum_{r \neq NoU} \sum_{t>1948}^{1961} \theta_{rt} region_r \cdot year_t + u_{irt} \quad (2)$$

where I control for region and year of birth fixed effects, α_r and α_t. The coefficients θ_{rt} capture the effect of exposure to the oil boom. We can interpret these estimates as the change in college completion since 1948 in each region in excess of the change observed in the regions without uni-

[24] Finkelstein (2007) uses a similar design to evaluate the effects of the introduction of Medicare comparing highly affected regions in the United States to less affected regions. For other applications of this type of design see Acemoglu et al. (2004), Gregg et al. (2006), Baez (2011), and Felfe et al. (2015).

versities. Finally, I control for differential trends in outcomes for cohorts who turned 18 before the oil boom, $\lambda_r t$.[25] Appendix Figure A2 shows that regions with full universities not only had a higher level of college completion but also had a steeper trend across birth cohorts than regions without universities. These differences in trends are consistent with the fact that regions with full universities had the lowest costs of college attendance and were the richest cities in the country. Also, these trends capture any remaining variation from age differences and the life cycle across cohorts.

The identification assumption is that in the absence of differential effects of the exposure to the oil boom, any difference in college completion across regions would have continued on the same trends. Given this assumption, there are two main concerns to interpreting θ_{rt} as the causal effect of exposure to the oil boom before turning 18. Migration across regions due to the oil boom presents the first threat to identification. Velasco (1988) using data from the 1962, 1974 and 1982 population censuses shows that during the oil boom *Quito* and *Guayaquil* received an influx of immigrants from the rest of the country. The author argues that increased earnings for low-skill occupations drove migration, implying that cities with full univeristies have a larger proportion of people who did not go to college and would not have gone regardless of the oil boom. In this case, using the current place of residence would overestimate the effect. To address this concern, I assign individuals to regions using their canton of birth.

The second identification challenge is that there could be other shocks that have different effects across cohorts or regions. For example, an earlier shock that increases fertility after 1955 in rural areas without universities could increase the proportion of people with no education in this region, which mechanically decreases the proportion of people who completed college. This shock would bias the estimates downwards. Conversly, the estimates would be biased upwards if college educated individuals born in cites with full universities after 1955 are more likely to migrate to other countries than older cohorts. To asses if shocks that affect the population's composition are a concern, I apply a version of McCrary (2008) population density test. This type of shocks would create discontinuities or kinks in the distribution of the population who turned 18 years old around the oil boom. Appendix Figure A1 shows that there are no significant discontinuities nor changes in the

[25]These trends capture the fact that in developing countries younger cohorts are increasingly more educated than their older peers.

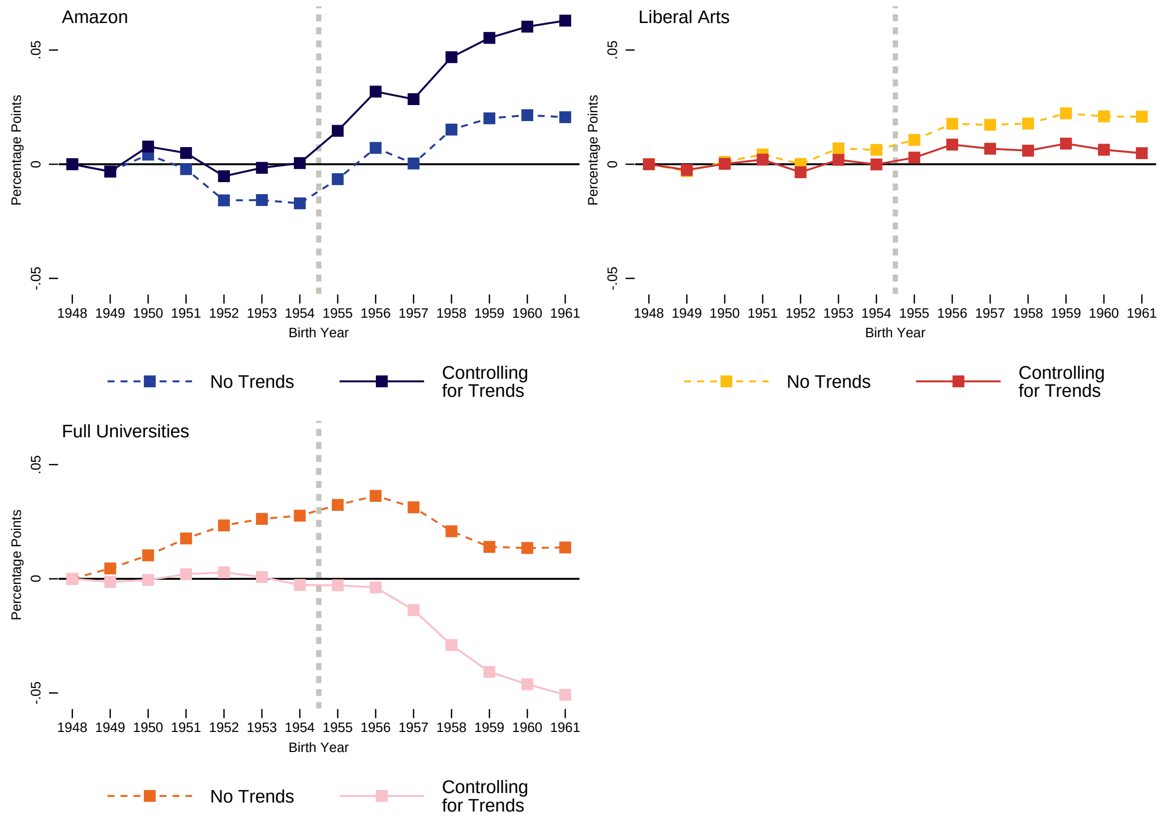
trend of the proportions of the population who turned 18 before the oil boom (born in 1948-1954) and after the oil boom (1955-1961). The trends are almost identical across regions. These results suggest that shocks related to changes in the population (fertility, migration) are not driving the results.

I follow Abadie et al. (2017) to determine the appropriate structure of the variance-covariance matrix. The data in this paper is a cross-section, where the outcomes for the different cohorts are measured at the same point in time. For cross-sections, Abadie et al. (2017) find that with models that include fixed effects we should use cluster robust standard errors if either (i) there is clustering in the sample and there are heterogeneous treatment effects; or (ii) there is clustering in treatment assignment, and there are heterogeneous treatment effects. In this study, we can rule out (i) because the sample consists of the entire population born between 1948 and 1961 in the country. Concerning (ii), Abadie et al. (2017) define that there is clustering in treatment assignment when the probability that individual i is assigned to treatment is correlated with assignment to the treatment of other individuals in the same region. The extreme case would be that all individuals in a region have the same treatment assignment. In this research, treatment is turning 18 after 1973. Thus, in the absence of past regional shocks that affect fertility, as shown in Appendix Figure A1, in any given region the probability that one individual turns 18 after the oil boom is not correlated with other individuals in the region turning 18 before or after the boom. Hence, heteroskedastic robust standard errors should be sufficient since neither (i) nor (ii) hold (Abadie et al., 2017). For robustness, I also report standard errors clustered at the canton level (215 clusters). These standard errors would account for unobserved, local shocks to fertility.

5.4 Results

Figure 7 and Table 2 present the estimates of the effect of exposure to the oil boom before turning 18 on college completion. Figure 7 confirms that college completion had different trends across regions for the cohorts who turned 18 before 1973. Regions with full universities and liberal arts colleges had steeper trends than regions with no universities, and the *Amazon region* had a lower trend than regions with no universities. These differences are consistent with the different costs of college attendance across regions discussed in Section 5.2 and disappear after including linear trends in the regression. Thus, from this point onward, I control for trends in all estimates.

Figure 7: Effects of Exposure to the Oil Boom Before Turning 18 on College Completion



Notes: This Figure presents dynamic difference in difference estimates of the effect of exposure to the oil boom before turning 18 on the probability of graduating from college. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Table 2 presents the point estimates of the effect of exposure to the oil before turning 18. The first seven columns show the coefficients plotted in Figure 7 for the cohorts born between 1955 and 1961, and the last column averages these effect across cohorts weighting the estimates by population. In all regions, the effects get larger for the youngest cohorts in the sample. This pattern is consistent with longer exposure to the oil boom, which gives younger individuals more time to see the shift in the labor market towards low-skill jobs and perceive decreasing returns of education. A longer exposure may also bias their perception regarding the expected duration of the boom. Thus, it is possible that younger individuals were more likely to believe that the boom was a permanent change in the economy.

Table 2 shows that regions with full universities were the most affected by the oil boom, which is consistent with the model in Section 3.2. On average, exposure to the oil boom decreased college

Table 2: Effects of Exposure to the Oil Boom Before Turning 18 on College Completion

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	-0.0028	-0.0038	-0.0137	-0.0290	-0.0408	-0.0461	-0.0508	-0.0286
	(0.0038)	(0.0041)	(0.0045)***	(0.0049)***	(0.0053)***	(0.0057)***	(0.0062)***	(0.0043)***
	(0.0031)	(0.0021)*	(0.0034)***	(0.0043)***	(0.0067)***	(0.0093)***	(0.0079)***	(0.0047)***
Liberal Arts	0.0029	0.0086	0.0068	0.0060	0.0090	0.0063	0.0048	0.0064
	(0.0034)	(0.0037)**	(0.0040)*	(0.0043)	(0.0047)*	(0.0050)	(0.0055)	(0.0037)*
	(0.0027)	(0.0038)**	(0.0049)	(0.0061)	(0.0092)	(0.0095)	(0.0112)	(0.0064)
Amazon Region	0.0146	0.0318	0.0285	0.0469	0.0553	0.0603	0.0629	0.0450
	(0.0083)*	(0.0092)***	(0.0097)***	(0.0107)***	(0.0116)***	(0.0124)***	(0.0134)***	(0.0092)***
	(0.0105)	(0.0095)***	(0.0122)**	(0.0137)***	(0.0127)***	(0.0203)***	(0.0194)***	(0.0133)***

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom before turning 18 on the probability of graduating from college for the cohorts born in 1955-1961. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effect across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors (215 clusters,second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 ($n = 1,711,538$).

completion by 2.9 percentage points for the cohorts born in 1955-1961 in cities with universities. This change represents 12.2 percent of the college completion rate of individuals who turned 18 in 1954.[26] In contrast, college completion did not significantly change for the region with liberal arts colleges.

The estimates in Table 2 also show that exposure to the oil boom increased college completion in the *Amazon* region. On average, exposure to the oil boom increased college completion by 4.5 percentage points for the cohorts born in 1955-1961, which represents 58.5 percent of the college completion rate of individuals who turned 18 before the oil boom in this region. As mentioned above, in 1973, the government built a new road connecting the *Amazon* region with *Quito* as part of the construction of an oil pipeline. This road decreased the cost of attending universities located in the capital, which could explain why education increased for people born in that region. Also, spillovers from the oil industry into the local economy and direct transfers from the government to municipalities in this region contributed to increasing employment in high-skill occupations, which could also explain the increase in college completion, particularly for the younger cohorts.

Appendix Table A3 presents the effect of exposure to the oil boom before turning 18 by gender. The point estimates for both regions with full universities and the *Amazon* region are larger for men than for women, although most of the differences are not statistically significant. On average, for the cohorts born in 1955-1961, exposure to the oil boom decreased college completion by 1.8

[26]Thoughout the paper I will refer to the 1954 cohort as the baseline for all comparisons

percentage points (9.9 percent of the baseline) for women in cities with universities and by 3.9 percentage points for men (13.7 percent of the baseline). Exposure to the oil boom affected women in the younger cohorts (born in 1958 and after), while affected almost all the men who turned 18 after the boom (born in 1956 and after). This difference is consistent with men being affected first by the immediate increase in infrastructure and construction that followed the oil boom, while women were affected by the increase in low-skill productivity that followed. In the *Amazon* region, exposure to the oil boom increased college completion by 3.6 percentage points (56.3 percent of the baseline) for women and by 5.4 percentage points for men (59.9 percent of the baseline). There is no significant effect in the regions with liberal arts colleges for both genders.

5.5 Further Evidence for the Validity of the Research Design

This section reports the results from two additional tests on the validity on the previous results.

5.5.1 Unobserved Shocks on Early Educational Attainment

Other shocks that had different effects across cohorts or regions could be the main threat to identification. In Section 5.3, I present results that suggest that shocks associated with fertility or migration outside Ecuador are not driving the results. However, changes that directly affect early educational attainment could still be a concern. Specifically, two types of shocks would prevent us from interpreting the estimates in Table 2 as the causal effect of exposure to the oil boom before turning 18. First, if for some reason the proportion of people with no education increased more in cities with full universities than in regions with no universities, then the effects in Table 2 would be a consequence of this shock and not of exposure to the oil boom. For instance, in 1965, Ecuador started an agrarian reform to redistribute land from large landowners. In that year the cohorts born in 1955-1961 had ten years or less, and their educational attainment may have stopped if their parents decided to take advantage of this policy. Second, the same interpretation concern would arise if some policy decreased the proportion of people with no education in the *Amazon* region more than in regions with no universities. At that time, missionaries frequently visited the *Amazon* region to improve education.

I check for effects of unobserved shocks on the probability of not completing any educational level for those individuals who turned 18 years old after 1973. Table 3, Appendix Figure A3,

Table 3: Effects on the Probability of Not Completing Any Educational Level

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	-0.0111	-0.0085	-0.0116	-0.0151	-0.0128	-0.0155	-0.0119	-0.0125
	(0.0027)***	(0.0029)***	(0.0032)***	(0.0036)***	(0.0039)***	(0.0043)***	(0.0047)**	(0.0033)***
	(0.0028)***	(0.0030)***	(0.0034)***	(0.0044)***	(0.0048)***	(0.0051)***	(0.0058)**	(0.0039)***
Liberal Arts	-0.0081	0.0009	-0.0028	-0.0028	-0.0002	-0.0077	-0.0036	-0.0035
	(0.0037)**	(0.0040)	(0.0044)	(0.0049)	(0.0053)	(0.0058)	(0.0063)	(0.0044)
	(0.0044)*	(0.0053)	(0.0053)	(0.0056)	(0.0065)	(0.0078)	(0.0086)	(0.0058)
Amazon Region	0.0085	0.0252	0.0263	0.0416	0.0591	0.0813	0.0885	0.0508
	(0.0118)	(0.0128)**	(0.0141)*	(0.0156)***	(0.0172)***	(0.0190)***	(0.0208)***	(0.0147)***
	(0.0149)	(0.0158)	(0.0169)	(0.0213)*	(0.0222)***	(0.0261)***	(0.0316)***	(0.0204)**

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

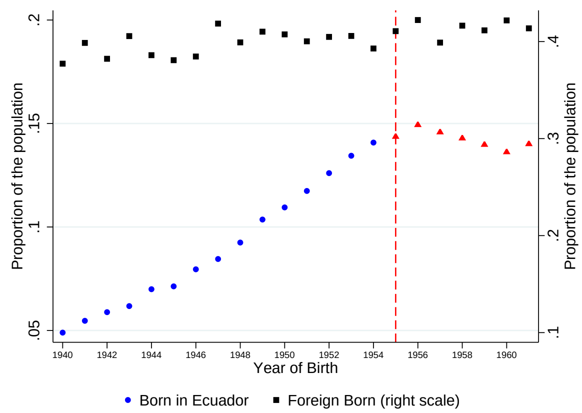
Notes: This Table presents the effects of unobserved shocks on the probability of not completing any educational level for the cohorts born in 1955-1961. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (215 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 ($n = 1,711,538$).

and Appendix Figure A4 show these results. These estimates go in the opposite direction of the hypothesized concerns. Compared to regions without universities, the proportion of people with no education decreased in cities with full universities (1.3 percentage points, 23.4 percent of the baseline) and increased in the *Amazon* region (5.1 percentage points, 26.9 percent of the baseline). Thus, if there is any confounding effect, unobserved shocks that affect early educational attainment are attenuating the effect of exposure to the oil boom before turning 18 on college completion.

5.5.2 Are the Estimates a Lower Bound of the True Effect?

As mentioned above, the results in Section 5.4 are the change in college completion in the different regions in excess of the change of college completion in the regions with no universities region. If exposure to the oil boom before turning 18 had a small, negative effect on educational attainment in these regions, as suggested by Appendix Figure A2, then the estimates are a lower bound of the true effect. However, if exposure to the oil boom had a positive effect on educational attainment in the regions without universities, then the estimates in Section 5.4 would overstate the effect. To address this concern, I re-estimate Equation 2 using people who became Ecuadorian by naturalization as the control group. According to Ecuador's 2010 census, 82.3 percent of these individuals entered Ecuador after they turned 18 and 75.7 percent after they turned 24. While 18 percent of naturalized Ecuadorians could have been exposed to the oil boom, Figure 8 shows that there is no change in the level or trend of college completion between foreign-born individuals who turned 18 years old

Figure 8: College Completion for Native Born and Foreign Born



Notes: This Figure presents the evolution of college completion for individuals born between 1940 and 1961. Blue circles and red triangles represent people born in Ecuador. The cohorts born between 1955 and 1961 (red triangles) turned 18 years old during the oil boom in the 1970s. The black squares represent people born outside of Ecuador, who became Ecuadorians later in life, most likely after the oil boom. It is unlikely that these individuals were in the country when they turned 18 years old.

before and after 1973. Thus, it is likely that for the majority of this group the decision to go to college was not affected by Ecuador's oil boom.[27]

Table 4 presents these results. The estimates follow the same pattern but are two to four times larger than the estimates in Table 2. Cities with full universities are still the most affected region. On average, exposure to the oil boom decreased college completion by 7.7 percentage points for the cohorts born in 1955-1961 in these areas (32.9 percent of the baseline). Additionally, these results indicate that exposure to the oil boom decreased college completion by 4.8 percentage points for the cohorts born in 1955-1961 in regions without universities (42.9 percent of the baseline). This effect is similar to that of regions with liberal arts colleges, where exposure to the oil boom decreased college completion by 4.2 percentage points. The difference in the point estimates between these two regions is not statistically significant for any cohort, consistent with the main results. These results confirm that we can take the main estimates in in Table 2 as a conservative measure of the true effect.

In this specification, exposure to the oil boom did not affect college completion in the *Amazon* region. The fact that in this region there is no effect when compared to foreign-born individuals while there is a positive effect when compared to the other regions without universities in Ecuador

[27]However, it is also possible that these individuals became Ecuadorians because of the oil boom. Thus, it is not valid to use naturalized Ecuadorians as a control for outcomes related to the labor market and wealth.

Table 4: Effects of Exposure to the Oil Boom Before Turning 18 on College Completion using Foreign-Born Ecuadorians as Control

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	-0.0218	-0.0392	-0.0357	-0.0776	-0.0950	-0.1215	-0.1224	-0.0772
	(0.0121)*	(0.0132)***	(0.0144)**	(0.0159)***	(0.0173)***	(0.0189)***	(0.0204)***	(0.0139)***
	(0.0027)***	(0.0010)***	(0.0024)***	(0.0030)***	(0.0058)***	(0.0083)***	(0.0067)***	(0.0038)***
Liberal Arts	-0.0161	-0.0268	-0.0152	-0.0426	-0.0452	-0.0690	-0.0668	-0.0417
	(0.0119)	(0.0131)**	(0.0143)	(0.0157)***	(0.0172)***	(0.0187)***	(0.0202)***	(0.0136)***
	(0.0022)***	(0.0033)***	(0.0043)***	(0.0053)***	(0.0085)***	(0.0085)***	(0.0104)***	(0.0058)***
Amazon Region	-0.0044	-0.0036	0.0065	-0.0017	0.0011	-0.0151	-0.0087	-0.0041
	(0.0141)	(0.0155)	(0.0168)	(0.0185)	(0.0202)	(0.0219)	(0.0236)	(0.0162)
	(0.0104)	(0.0093)	(0.0119)	(0.0134)	(0.0122)	(0.0198)	(0.0189)	(0.0130)
No Universities	-0.0190	-0.0354	-0.0220	-0.0486	-0.0543	-0.0753	-0.0716	-0.0481
	(0.0117)	(0.0128)***	(0.0140)	(0.0154)***	(0.0168)***	(0.0183)***	(0.0198)***	(0.0133)***
	(0.0016)***	(0.0019)***	(0.0024)***	(0.0030)***	(0.0035)***	(0.0042)***	(0.0042)***	(0.0027)***

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom before turning 18 on the probability of graduating from college for the cohorts born in 1955-1961 using Foreign-Born Ecuadorians as control. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (216 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 and naturalized Ecuadorians born in those years ($n = 1,754,059$).

suggests that the presence of the oil industry countered the increase of low-skill productivity that affected the country. As mentioned above, the oil industry may have unintentionally decreased the cost of college attendance in the *Amazon* region by improving connectivity with *Quito* and enhancing the local economy.

In conclusion, the previous results show that exposure to the 1973 oil boom before turning 18 caused a drop in educational attainment on those who turned 18 years old after the oil boom. In the next Section, I discuss the potential mechanisms behind this long-term reduction in human capital.

6 Potential Mechanisms behind the Long-term Reduction in Educational Attainment

The results in Section 5 provide quasi-experimental evidence that a natural resource boom can cause a permanent decrease in long-term educational attainment. However, the theoretical models in Section 3.1 imply that there could be more than one mechanism behind this effect and its long-term consequences on welfare. On the one hand, if the increase of low-skill earnings is large enough, it may compensate for the loss of human capital over a person's lifetime. In the same line, the temporary resource boom could create a permanent shift in the structure of the economy towards low-skill jobs, lowering the long-term returns of education. In these cases, it would be optimal for rational individuals not to return to school, and there would be no long-term effect on wealth. On the other hand, limited information about the resource boom or time inconsistent preferences (Sutter et al., 2013; Castillo et al., 2011; Cadena and Keys, 2015) can lead to a long-run reduction in educational attainment and wealth. Lack of information or present-biased preferences can make individuals overstate the expected duration of the boom. As discussed in Section 3.1, when myopic agents realize that the boom ended, age related costs may prevent them from resuming their education. In this case, we would observe a negative long-term effect on educational attainment, and potentially a decrease in lifetime wealth, creating a "lost generation".

To bring light on the mechanism, in this Section I discuss four pieces of evidence: (i) the effects of college completion in the *Amazon region*, (ii) general shifts in employment from 1962 to 2010, (iii) the effect of exposure to the oil boom of working in low-skill occupations, and (iv) the effect of exposure to the oil boom on wealth.

6.1 College Completion Increased in the *Amazon* Region

In Section 5.4, I find that exposure to the oil boom before turning 18 increased college completion in the *Amazon* region. This region is the only in Ecuador where the oil boom plausibly had a positive effect on jobs that require higher skills. Thus, it is possible that the returns of education increased after the oil boom in this region. If this is the case, rational individuals would increase their educational attainment.

Before the oil boom, the *Amazon* region was sparsely populated before the oil boom and poorly connected with the rest of the country. It only had one highway that connected it to the rest of the country. Agriculture, commerce, and other low-skill services concentrated 70 percent of employment in the region. This situation changed dramatically after the oil boom. The oil boom had a direct positive effect on connectivity and income in the *Amazon* region because all the new oil fields that started production in 1973 are there. Hence, the government built a new highway that connected the *Amazon* region directly to the capital city of *Quito* to access the oil fields. It also passed a new law establishing that municipalities in the *Amazon* region receive 10 percent of fiscal revenue from oil. This transfer plus spillovers from the oil industry into the local economy (Bartik et al., 2017) contributed to increasing employment in high-skill occupations from 25 percent in 1962 to

26.8 percent in 1982, the highest change in the country.

6.2 The Structure of the Labor Market Shifted to Low-skill Occupations

As discussed in Section 2, the oil boom facilitated an increase in productivity of low-skill occupations (93 percent between 1972 and 1975) because oil revenue enabled the government to finance subsidies and price controls that lowered the cost of starting small businesses related to commerce and construction in the entire country (World Bank, 1979a). As a consequence, Figure 2 shows that employment composition in Ecuador changed after the oil boom. Employment in commerce, low-skill services (food preparations, repairs, transportation, housekeeping), construction, and other low-skill occupations increased from 22.4 percent in 1962 to 33.44 percent in 1982, while employment in manufacturing industries decreased from 13.6 percent in 1962 to 12.6 percent in 1982. More generally, Figure 2 shows that after the oil boom employment mainly shifted from agriculture to low-skill services. Employment in agriculture decreased 21.7 percentage points between 1962 and 1982, while employment in low-skill occupations increased by 14.1 percentage points and employment in high-skill jobs increased by only 7.5 percentage points in jobs provided by the government.

This composition change in employment did not revert nor switch to high-skill occupations after the oil boom. Low-skill jobs importance in the economy grew until 2010. Figure 2 shows that agriculture's share in employment decreased until 2010, which is expected for a developing country as it improves living conditions. However, employment shifted to low-skill services and not to occupations that require higher skills. In particular, in 1982 the share of non-agriculture low-skill jobs was 39.4 percent and increased to 55.5 percent in 2010, while the share of high-skill occupations decreased from 25.8 percent to 22.8 percent in the same period. These changes in employment's composition suggest that the oil boom changed the structure of the labor market by enhancing the importance of low-skill jobs. This change would decrease the returns of education in the country in the long-run.

6.3 Are Long-term Labor Market Effects Consistent with the Changes in Educational Attainment?

The theoretical discussion in Section 3 implies that a long-term reduction in educational attainment should come in hand with a long-term increase in the probability of working in low-skill jobs. This

Table 5: Effects of Exposure to the Oil Boom Before Turning 18 on Informal Employment

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	0.0013	0.0042	-0.0020	0.0095	0.0092	0.0163	0.0151	0.0082
	(0.0047)	(0.0052)	(0.0057)	(0.0062)	(0.0068)	(0.0074)**	(0.0081)*	(0.0056)
	(0.0043)	(0.0049)	(0.0056)	(0.0059)	(0.0094)	(0.0178)	(0.0170)	(0.0094)
Liberal Arts	-0.0035	-0.0029	-0.0037	-0.0024	0.0001	0.0037	0.0016	-0.0008
	(0.0051)	(0.0056)	(0.0061)	(0.0067)	(0.0073)	(0.0079)	(0.0086)	(0.0059)
	(0.0043)	(0.0066)	(0.0074)	(0.0078)	(0.0090)	(0.0099)	(0.0117)	(0.0074)
Amazon Region	0.0095	-0.0166	-0.0282	-0.0188	-0.0216	-0.0191	-0.0169	-0.0166
	(0.0149)	(0.0161)	(0.0177)	(0.0193)	(0.0211)	(0.0229)	(0.0249)	(0.0174)
	(0.0165)	(0.0156)	(0.0232)	(0.0239)	(0.0262)	(0.0362)	(0.0351)	(0.0240)

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom on the probability of working informally informally in 2012 for the cohorts born in 1955-1961. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (215 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 ($n = 1,711,538$).

response should be more marked if employment in the country shifted towards these occupations. Ideally, I would estimate the effect of exposure to the oil boom on the probability of working on these jobs, but the available data do not report specific occupations. The data have an aggregate measure that classifies a person as an "informal" worker if at least one of the three following conditions holds: (i) the person works in a low-skill job (as an employee or self-employed); (ii) the person is retired; or (iii) the person has working age but is not registered with the Ecuadorian tax office. I estimate the effect of exposure to the oil boom on this measure of informality in 2012. Given the definition of informality in the data, retired individuals would bias the estimates towards zero because they are classified as informal workers. However, in 2012, the majority of the sample was still active in the labor market. In that year, those individuals born in 1948 were 64 years old, below the legal threshold for retirement.

For the cohorts born in 1955-1961, exposure to the oil boom before turning 18 increased the probability of working informally by 0.8 percentage points (1.9 percent of the baseline) in the cities with full universities and decreased this probability by 1.7 percentage points (3 percent of the baseline) in the *Amazon* region (Table 5, Appendix Figure A5, and Appendix Figure A6). There is no statistically or economically significant change in the probability of working informally in regions with liberal arts colleges, where there is no effect on college completion.[28] Overall, these results

[28] According to Ecuador's Labor Survey of December 2012, informal workers earn on average $195 per month, while formal workers earn on average $470 per month. While there is a gap in earnings, I am not able to estimate the reduced form effect of exposure to the oil boom on income because the labor survey does not report place of birth and the data I use only reports earnings of individuals who work formally as employees in companies. The fact that

are consistent with the changes in educational attainment in these regions and with a labor market oriented to low-skill jobs.

6.4 Long-term Effects of Exposure to the Oil Boom on Wealth

If the returns of education did not decrease in the long run, the literature on the returns of education implies that a reduction in educational attainment should have translated into lower levels of wealth (Angrist and Krueger, 1991; Card, 1993; Harmon and Walker, 1995; Card, 1999, 2001; Duflo, 2001; Lemieux and Card, 2001). However, if wealth is not affected in the long-run, this would be consistent with rational individuals optimally choosing to stop their education. To analyze the long-term effects of exposure to the oil boom, I proxy wealth through home ownership in 2010 and vehicle ownership in 2013. As discussed in Section 4, fluctuations from the life-cycle should not be an important concern, given these individuals' age in 2010 and in 2013.

In Ecuador and other developing countries, the quality of housing is a relevant issue to determine wealth. It is common that poor households split their land to give their children a place to build a small house when they marry. Thus, home ownership rate is close to 80 percent for those born in 1948-1961, but it does not necessarily reflect wealth. To better capture wealth, I follow two approaches. First, I estimate the effect of exposure to the oil boom on the probability of owning a house with more than two rooms. Second, I construct an index of housing quality combining data on the type of construction; materials used in floors, walls, and ceilings; water source; type of sewage; and garbage disposal. In Ecuador, brick and mortar houses are of higher quality than wood houses, and the type of water source (tap/well/creek) and the type of waste disposal (sewage/septic tank/open) also signal higher wealth.

Exposure to the oil boom did not affect home ownership in the regions with full universities (Table 6 and Appendix Figures A7, A8, A9, and A10). Panel (a) shows that for the cohorts born in 1955-1961, exposure to the oil boom decreased the probability of owning a home with more than two room by 0.4 percentage points (0.7 percent of the baseline), insignificant at conventional levels. The standard errors rule out effects larger than two percentage points in any direction. In the

exposure to the oil boom increases the probability of working informally in some regions implies that I would need to account for sample selection to estimate the effect of the oil boom on earnings of employees. However, the fact that informal employment decreases for the *Amazon* region violates monotonicity across regions. Hence, I cannot use bounding procedures as in Lee (2009) to account for selection in the sample.

Table 6: Effects of Exposure to the Oil Boom Before Turning 18 on Home Ownership

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
	a. Owning a house with more than two rooms							
Full Universities	-0.0109	-0.0010	-0.0059	-0.0051	-0.0063	0.0033	-0.0072	-0.0045
	(0.0053)**	(0.0058)	(0.0064)	(0.0071)	(0.0077)	(0.0083)	(0.0091)	(0.0062)
	(0.0037)***	(0.0045)	(0.0042)	(0.0040)	(0.0052)	(0.0078)	(0.0058)	(0.0039)
Liberal Arts	-0.0036	-0.0058	-0.0086	-0.0022	0.00003	-0.0015	-0.0037	-0.0036
	(0.0057)	(0.0063)	(0.0069)	(0.0076)	(0.0083)	(0.0089)	(0.0097)	(0.0065)
	(0.0054)	(0.0061)	(0.0063)	(0.0066)	(0.0074)	(0.0083)	(0.0096)	(0.0060)
Amazon Region	0.0039	0.0208	0.0069	0.0120	0.0001	0.0268	-0.0004	0.0101
	(0.0162)	(0.0178)	(0.0196)	(0.0215)	(0.0236)	(0.0254)	(0.0278)	(0.0192)
	(0.0149)	(0.0126)*	(0.0148)	(0.0175)	(0.0211)	(0.0219)	(0.0226)	(0.0155)
	b. Owning a house of quality above the median of the quality index							
Full Universities	-0.0032	-0.0033	-0.0062	-0.0042	-0.0027	-0.0013	-0.0066	-0.0039
	(0.0053)	(0.0058)	(0.0063)	(0.0070)	(0.0076)	(0.0082)	(0.0090)	(0.0062)
	(0.0038)	(0.0053)	(0.0029)**	(0.0040)	(0.0047)	(0.0068)	(0.0049)	(0.0035)
Liberal Arts	-0.0014	-0.0014	-0.0078	-0.0041	0.0050	-0.0089	-0.0096	-0.0043
	(0.0055)	(0.0061)	(0.0066)	(0.0073)	(0.0080)	(0.0085)	(0.0093)	(0.0063)
	(0.0053)	(0.0057)	(0.0053)	(0.0072)	(0.0078)	(0.0077)	(0.0104)	(0.0061)
Amazon Region	0.0012	0.0289	0.0140	0.0324	0.0391	0.0611	0.0433	0.0332
	(0.0128)	(0.0144)**	(0.0155)	(0.0172)*	(0.0189)**	(0.0204)***	(0.0222)*	(0.0154)**
	(0.0154)	(0.0162)*	(0.0168)	(0.0212)	(0.0209)*	(0.0273)**	(0.0281)	(0.0198)*

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom on the probability of owning a home with more than two rooms (Panel a) and on the probability of owning a home of quality above the median of the quality index for the cohorts born in 1955-1961. Home ownership is measure in the 2010 census. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (215 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 ($n = 1,711,538$).

Amazon region, where college completion increased, exposure to the oil boom before turning 18 increased the likelihood of owning a house with more than two rooms by one percentage point (1.8 percent of the baseline). The points estimates are imprecise and fluctuate across cohorts. There is no significant effect on the region with liberal arts colleges.

Panel (b) in Table 6 presents the effect of exposure to the oil boom on the probability of owning a house of quality above the median of the quality index. Again, exposure to the oil boom did not affect home ownership in the regions with full universities and liberal arts colleges. The point estimates have similar magnitudes to those in Panel (a). For the *Amazon* region, exposure to the oil boom before turning 18 increased the probability of owning a house of quality above the median by 3.3 percentage points (17 percent of the baseline). This result is consistent with the increase in educational attainment in this region.

Table 7: Effects of Exposure to the Oil Boom Before Turning 18 on Vehicle Ownership

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	-0.0011	0.0010	0.0003	-0.0111	-0.0120	-0.0075	-0.0059	-0.0055
	(0.0037)	(0.0040)	(0.0044)	(0.0049)**	(0.0053)**	(0.0058)	(0.0063)	(0.0043)
	(0.0020)	(0.0025)	(0.0035)	(0.0024)***	(0.0038)***	(0.0048)	(0.0055)	(0.0032)*
Liberal Arts	0.0010	0.0048	0.0067	-0.0010	0.0091	0.0061	0.0045	0.0046
	(0.0040)	(0.0044)	(0.0048)	(0.0052)	(0.0057)	(0.0062)	(0.0067)	(0.0046)
	(0.0038)	(0.0046)	(0.0048)	(0.0056)	(0.0068)	(0.0065)	(0.0076)	(0.0052)
Amazon Region	0.0044	0.0148	0.0121	0.0195	0.0289	0.0327	0.0260	0.0209
	(0.0096)	(0.0105)	(0.0114)	(0.0125)	(0.0137)**	(0.0148)**	(0.0160)	(0.0111)*
	(0.0125)	(0.0112)	(0.0163)	(0.0133)	(0.0177)	(0.0228)	(0.0207)	(0.0156)

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom on the probability of owning at least one vehicle in 2013 for the cohorts born in 1955-1961 The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (215 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 ($n = 1,711,538$).

Table 7, Appendix Figure A11, and Appendix Figure A12 show that exposure to the oil boom before turning 18 did not affect on the probability of owning at least one vehicle in cities with full universities. For the cohorts born in 1955-1961, exposure to the oil boom decreased the probability of owning a vehicle by 0.5 percentage points (2.8 percent of the baseline). The point estimates are small and statistically indistinguishable from zero. For the *Amazon* region, the point estimates are imprecise but indicate that exposure to the oil boom before turning 18 increased the likelihood of owning a car by 2.1 percentage points (17.8 percent of the baseline), which goes in line with the effects on educational attainment.

In summary, the four pieces of evidence together suggest that the long-term reduction in educational attainment is consistent with a model of rational individuals who reduce their educational attainment in response to lower returns of education in the long-run. The long-term reduction in human capital together with no significant change in wealth is consistent with the hypothesis that the oil boom changed the structure of the Ecuadorian labor market by enhancing the importance of informal low-skill jobs. Results go in the opposite direction, in the *Amazon* region, where exposure to the oil boom increased educational attainment.

7 Discussion

By analyzing the Ecuadorian oil boom of the 1970s, this paper provides some ground work for understanding how natural resource boom can affect human capital accumulation in developing countries. The results indicate that educational attainment decreased without affecting wealth accumulation. This finding is consistent with a model of fully informed rational individuals who reduce their educational attainment in response to a shock that decreases the returns of education by increasing the productivity of low skill jobs. Thus, that rather than a "lost generation", the cohorts exposed to the oil boom before turning 18 were just busy at work.

The results suggest that fiscal policy has an important role in the propagation of natural resource shocks in developing countries, in particular in cases where the state owns resource rights. The long-term reduction in educational attainment in Ecuador is consistent with policies that increased low-skills productivity at the time and were applied again in Latin America in the last resource boom in the 2000s (De La Torre et al., 2015). How the government spends the extra money can influence the effects of the natural resource shock on the economy, particularly in the long term. The case of the *Amazon* region suggests that if a government wants a natural resource boom to increase educational attainment, it needs to invest to reduce costs of college attendance.

Also, it is plausible that policies that increase productivity in high-skill occupations produce a different effect. The case of Indonesia, another oil producing developing country, gives suggestive evidence in this direction. During the 1960s and 1970s, the Indonesian government started promoting industrialization to increase exports of manufactured goods (Elias et al., 2011). Appendix Figure A15 shows that there is no drop in college completion after the oil boom. There is an increase in the trend for those individuals who turned 18 years old after the oil boom. More studies are needed to fully understand how fiscal spending can determine the effects of natural resource booms. Evaluating the counterfactual of what would have happened if the exposed cohorts completed more education and received the effects of the oil boom is an important question for future research.

Given these results, can we tell if natural resources a blessing or a curse? The estimates suggest that those individuals who turned 18 years old after the oil boom did not fare worse than their older peers regarding wealth accumulation. However, the drop in educational attainment caused by the oil boom could decrease social capital and civic engagement (McMahon, 2010; Dee, 2004;

Milligan et al., 2004; Huang et al., 2009); have negative effects on health (Silles, 2009; Brunello et al., 2016); affect safety in the country (Lochner and Moretti, 2004; Groot and van den Brink, 2010; Buonanno and Leonida, 2009); and negatively affect the well-being of the next generation (Behrman and Rosenzweig, 2002; Currie and Moretti, 2003; Mine Güneş, 2015). These factors can constrain a country's long-term growth potential. To preview these potential negative consequences, Appendix Table A4, Appendix Figure A13 and Appendix Figure A14 present the effect of exposure to the oil boom on the number of children per person.[29] Exposure to the oil boom increased the number of children by 1.7 percent of the baseline in cities with full universities. This result an the fact that wealth did not decrease may imply fewer resources per children, which may lower their educational attainment and other future outcomes. In the *Amazon* region, exposure to the oil boom decreased the number of children by 4.5 percent of the baseline.

From a macroeconomic perspective, the results indicate that the oil boom decreased Ecuador's stock of human capital and may have affected its capacity to accumulate human capital for the next generation, which constrains the country's long-term growth potential. There is evidence that the drop in educational attainment can constraint the development of high-skill industries (Becker et al., 2011; Becker and Woessmann, 2010). Hence, a resource boom may not be a curse regarding individual wealth, but it can be a curse for society regarding the next generation's outcomes and lost growth potential.

[29]There is no effect on the extensive margin of having children nor on the probability of never marrying.

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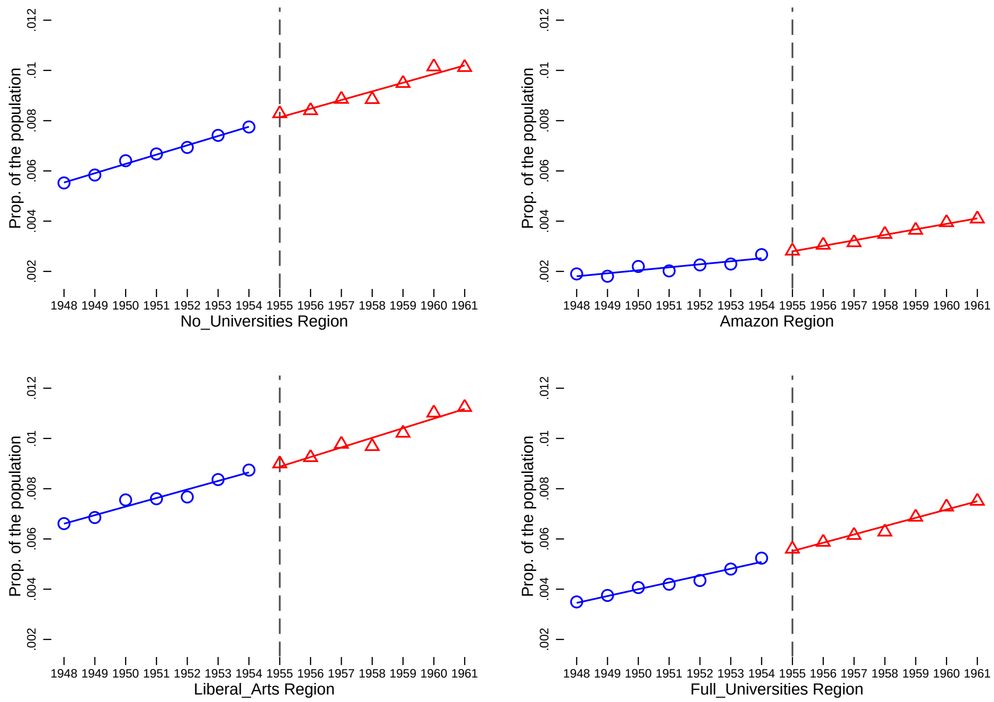
A Design tests

Figure A1: Population Distribution by Birth Cohort and Region



Notes: This Figure presents the distribution of the population in Ecuador for the cohorts born between 1948 and 1961 by region of birth. The cohorts born between 1955 and 1961 (red triangles) experienced the effects of the exploitation of oil in the Amazon region.

B Universities an Colleges during the 1970s

Table A1: Young Adults Living with their Parents in Ecuador

	18-30 years old	18-24 years old
1962	33.8%	45.4%
1974	36.5%	46.5%
1982	37.4%	48.3%
1990	39.4%	51.0%
2001	40.6%	51.0%
2010	40.7%	51.5%

This Table presents the proportion of young adults who live with their parents according to Ecuador's population censuses of 1962, 1974, 1982, 1990, 2001 and 2010.

Table A2: Universities and Colleges in Ecuador during the 1970s

	Open since	Province
Universidad de Cuenca	1867	Azuay
Universidad del Azuay	1968	Azuay
Universidad Católica de Cuenca	1970	Azuay
ESPOCH*	1973	Chimborazo
Universidad Técnica de Machala*	1969	El Oro
Universidad Técnica Luís Vargas Torres de Esmeraldas*	1970	Esmeraldas
Universidad de Guayaquil	1883	Guayas
Escuela Superior Politécnica del Litoral	1958	Guayas
Universidad Laica Vicente Rocafuerte de Guayaquil	1966	Guayas
Universidad Nacional de Loja+	1943	Loja
Universidad Tecnica Particular de Loja*	1971	Loja
Universidad Técnica de Babahoyo*	1971	Los Rios
Universidad Tecnica de Manabi*	1959	Manabi
Universidad Central del Ecuador	1621	Pichincha
Escuela Politécnica Nacional	1869	Pichincha
Escuela Politécnica del Ejercito	1922	Pichincha
Pontificia Universidad Católica del Ecuador	1946	Pichincha
Universidad Tecnica de Ambato*	1969	Tungurahua

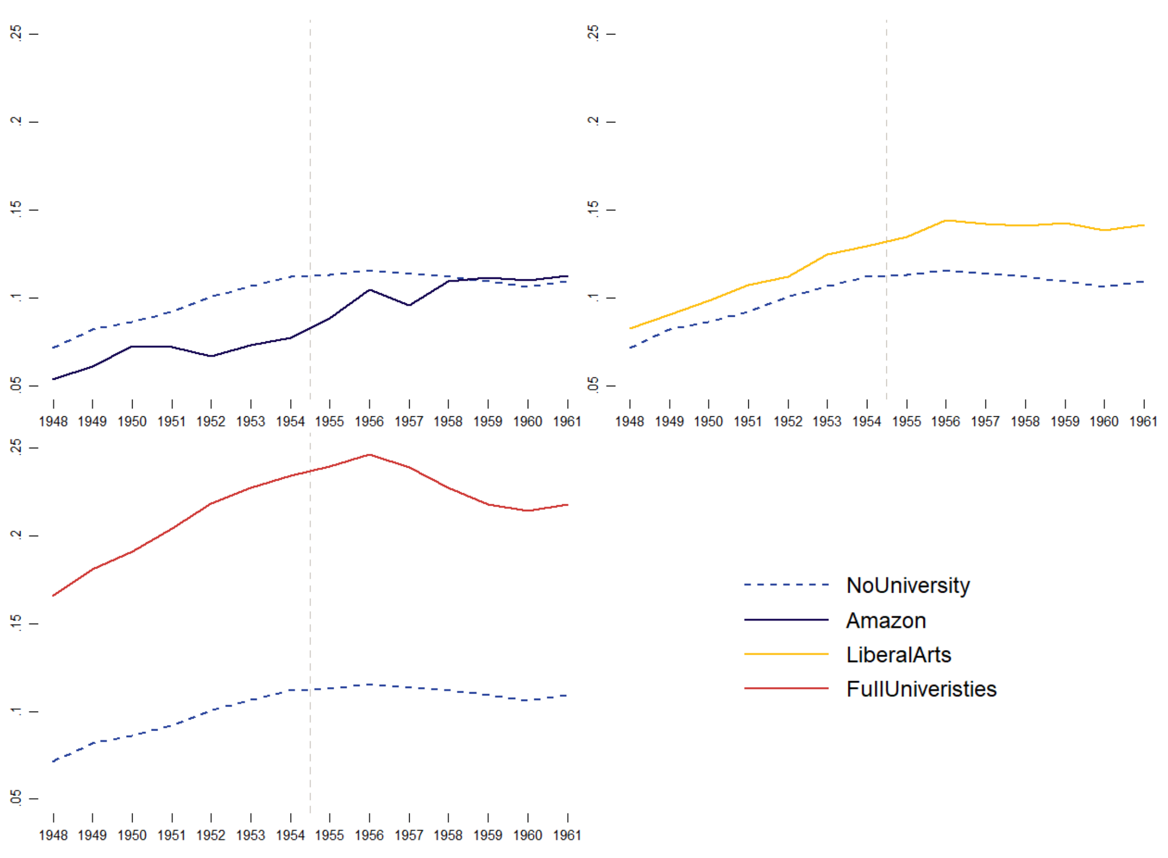
*Technical school focused on agriculture during the 1970s

+ Had a second campus in the Imbabura province in the north of the country

This Table presents list of universities and technical colleges that functioned in Ecuador during the 1970s. Technical colleges focused on agriculture at that time. The Table lists the institution's name, its opening date and the province where it is located.

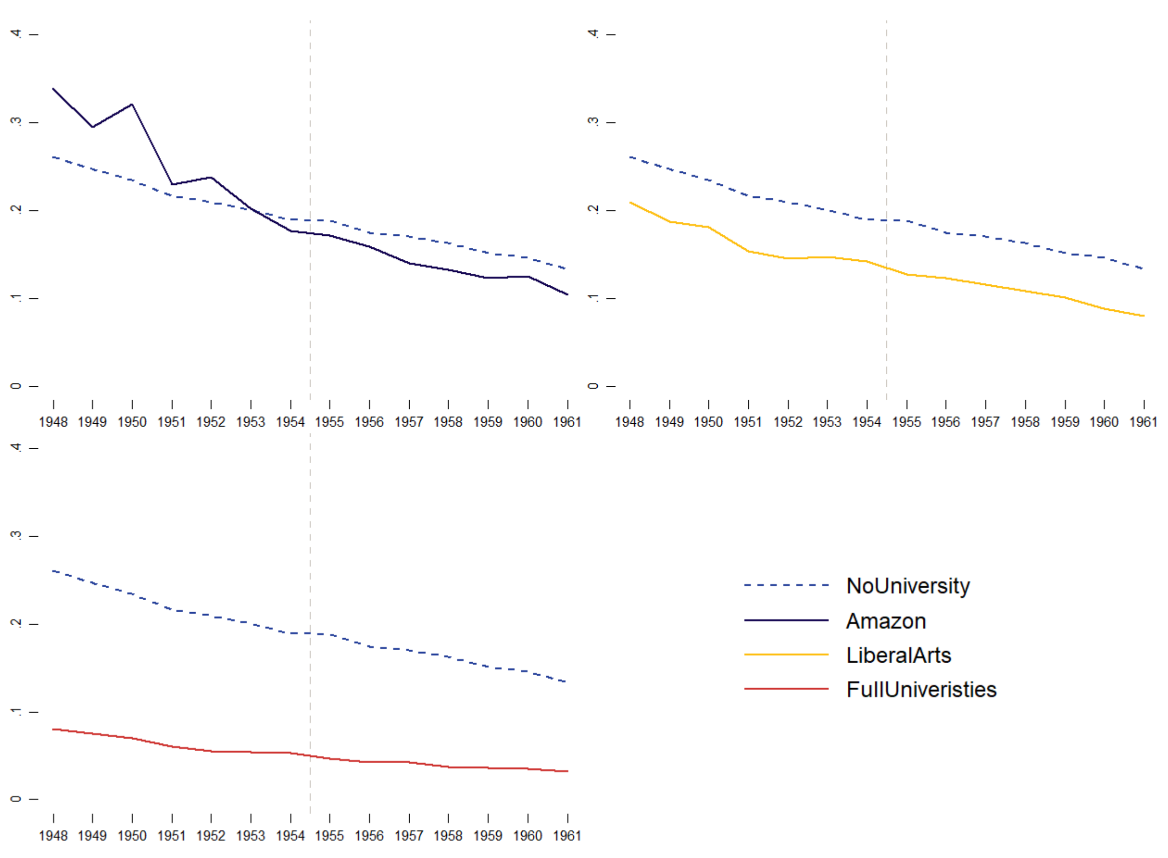
C Additional Graphs and Tables

Figure A2: College Completion by Birth Cohort



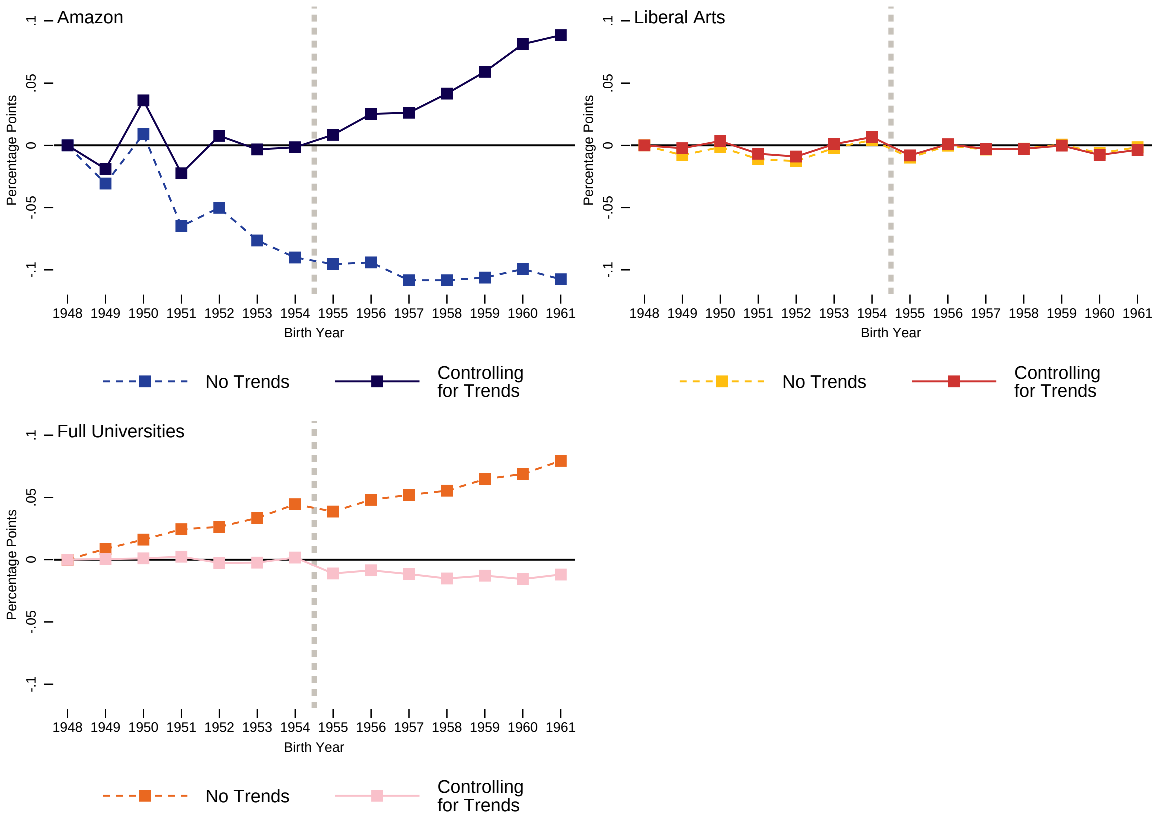
Notes: This Figure presents the evolution of the proportion of the population who graduated from college in Ecuador for the cohorts born between 1948 and 1961. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A3: Population with no Completed Education by Birth Cohort



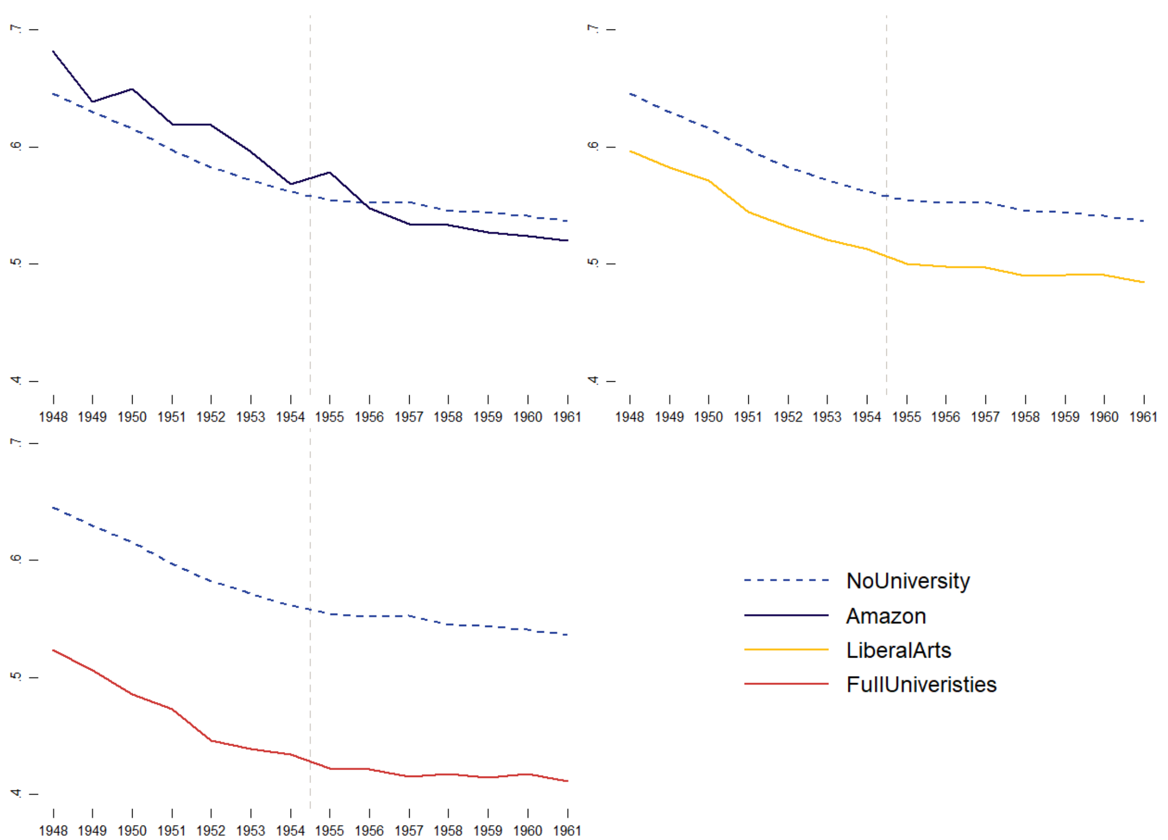
Notes: This Figure presents the evolution of the proportion of the population with no completed education in Ecuador for the cohorts born between 1948 and 1961. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A4: Effects on the Probability of Not Completing Any Educational Level



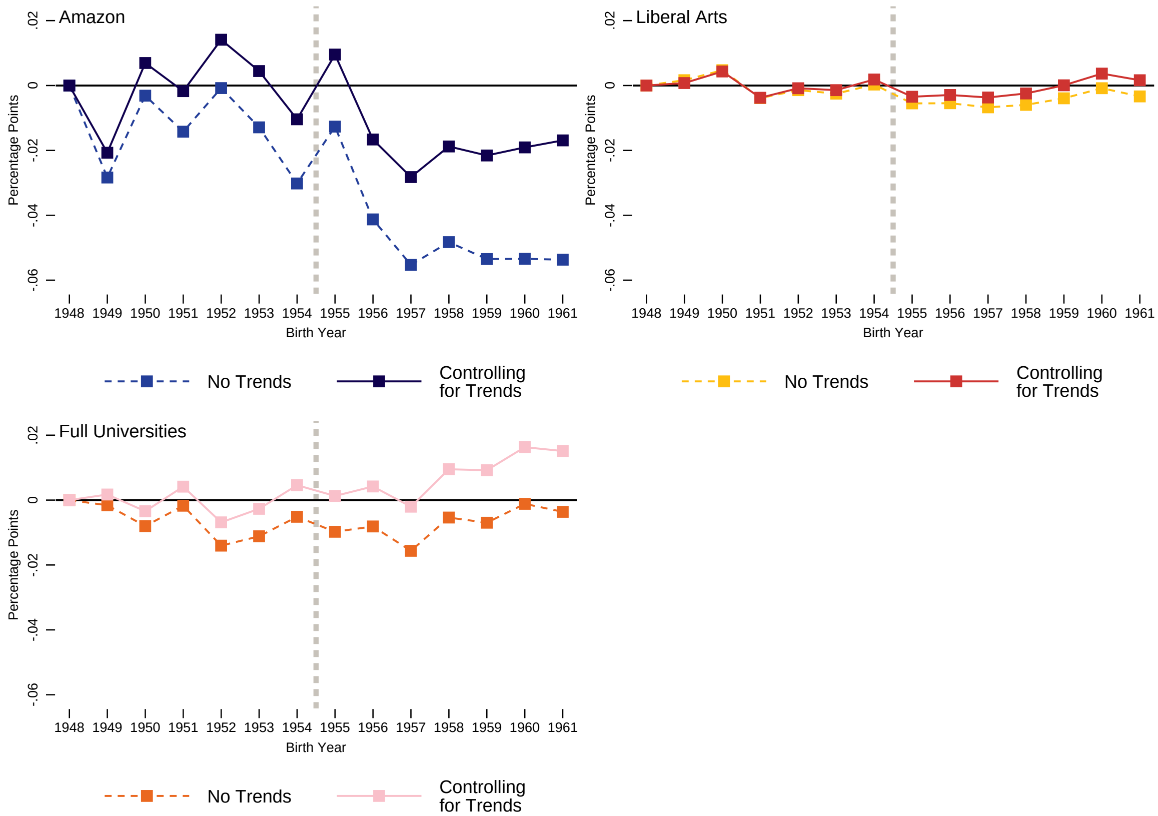
Notes: This Figure presents dynamic difference in difference estimates of the effects of unobserved shocks on the probability of not completing any educational level. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A5: Population Working Informally in 2012 by Birth Cohort



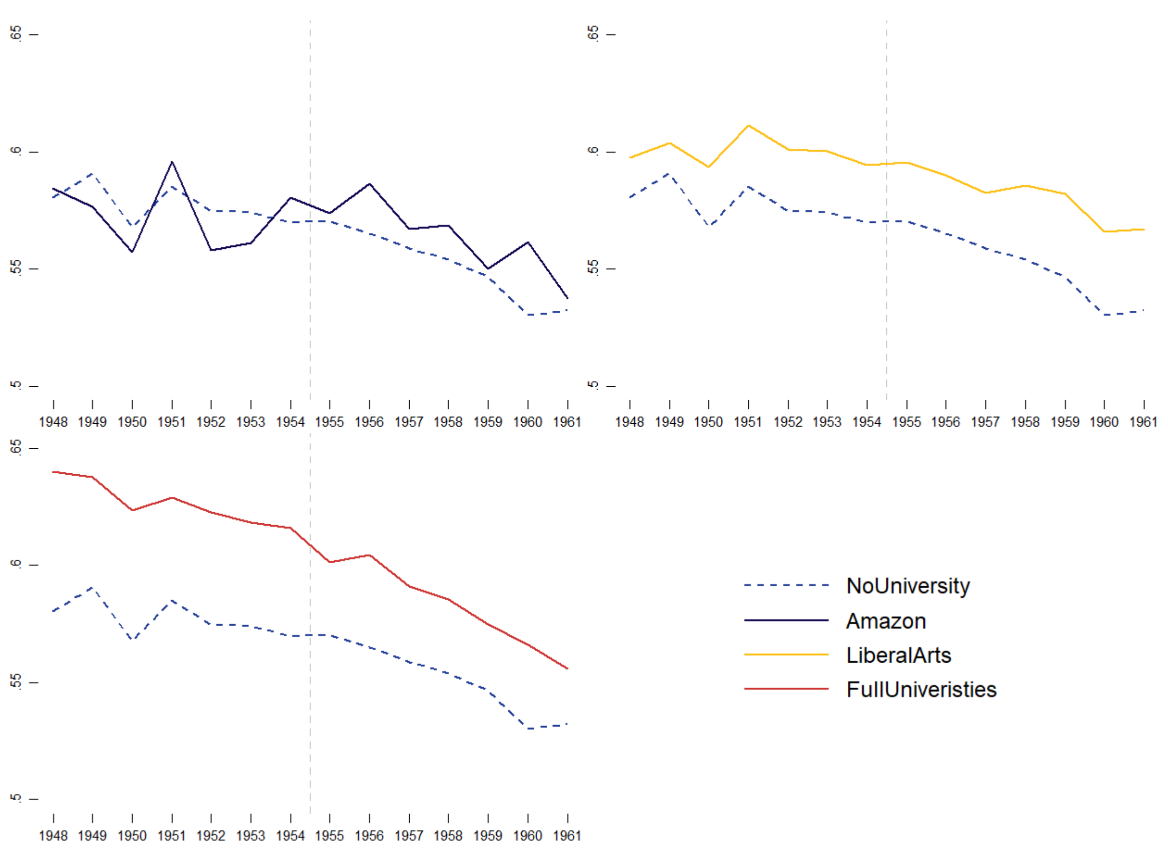
Notes: This Figure presents the evolution of the proportion of the population working informally in Ecuador for the cohorts born between 1948 and 1961. The data correspond to 2012. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A6: Effects of Exposure to the Oil Boom Before Turning 18 on Informal Employment



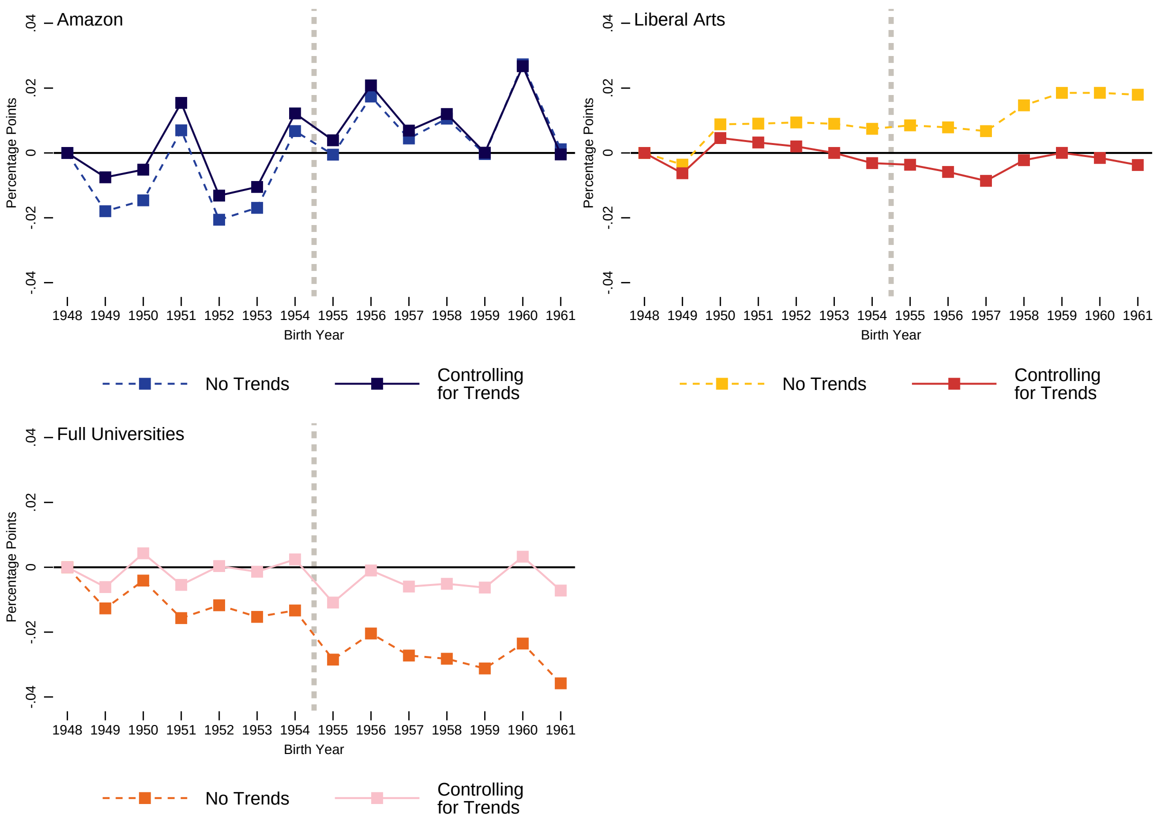
Notes: This Figure presents dynamic difference in difference estimates of the the effect of exposure to the oil boom before turning 18 on the probability of working informally in 2012. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A7: Population Owning a Home with more than two Rooms in 2010 by Birth Cohort



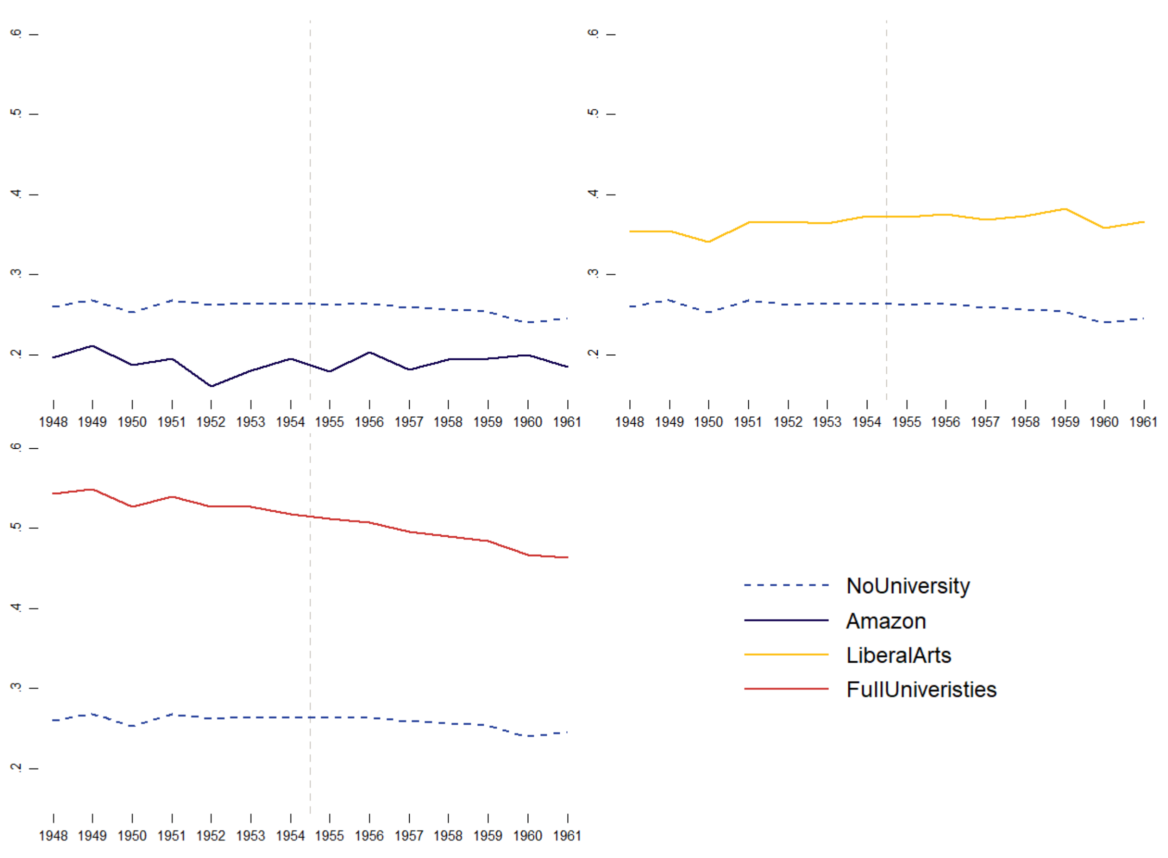
Notes: This Figure presents the evolution of the proportion of the population who owns a home with more than two rooms in Ecuador for the cohorts born between 1948 and 1961. The data correspond to 2010. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A8: Effects of Exposure to the Oil Boom Before Turning 18 on the Probability of Owning a Home with more than two Rooms



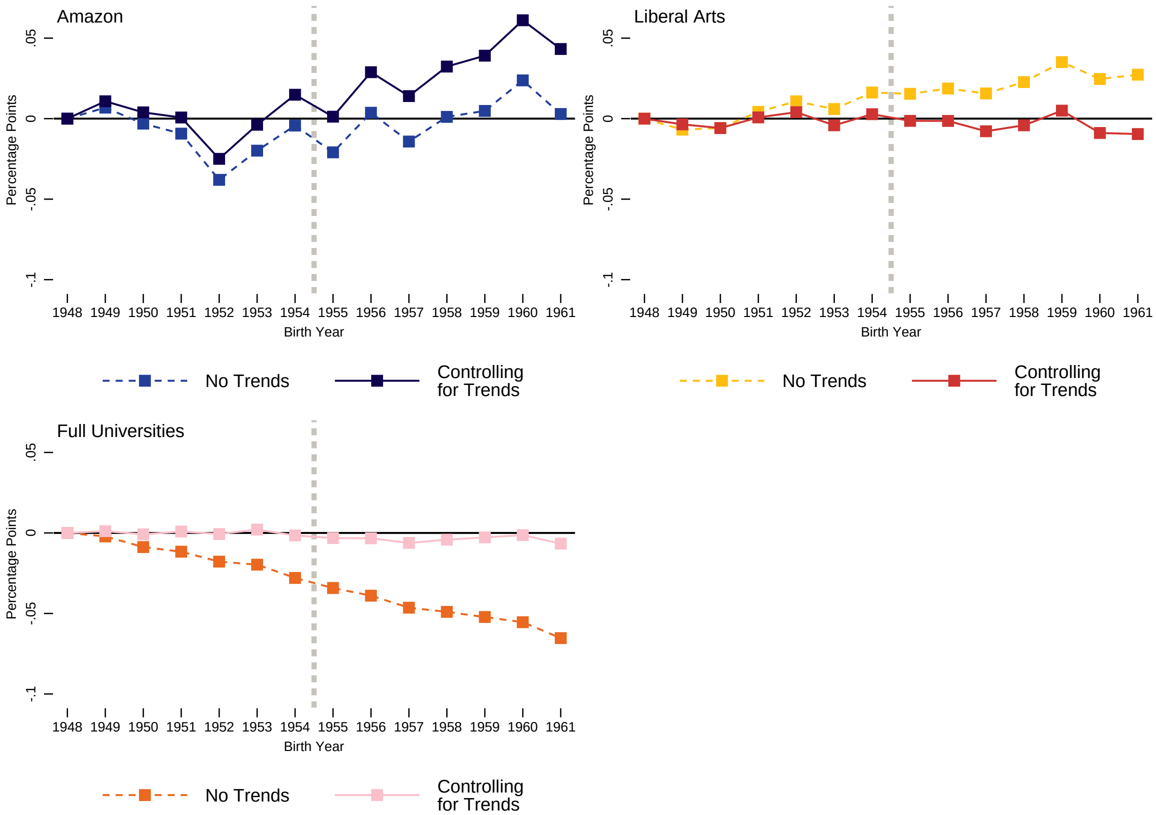
Notes: This Figure presents dynamic difference in difference estimates of the the effect of exposure to the oil boom before turning 18 on the probability of owning a home with more than two rooms in 2010. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A9: Population Owning a Home of Quality above the Median in 2010 by Birth Cohort



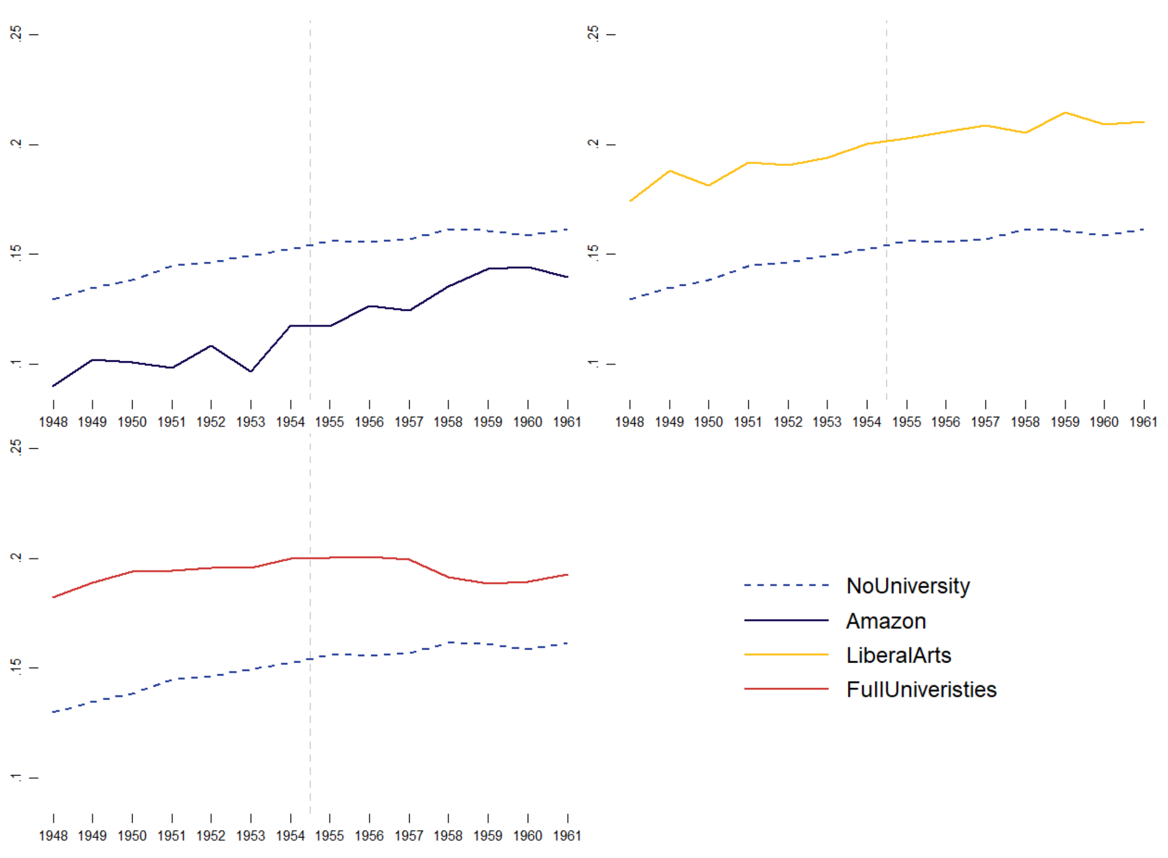
Notes: This Figure presents the evolution of the proportion of the population who owns a home of quality above the median of the quality index in Ecuador for the cohorts born between 1948 and 1961. The data correspond to 2010. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A10: Effects of Exposure to the Oil Boom Before Turning 18 on the Probability of Owning a Home of Quality above the Median



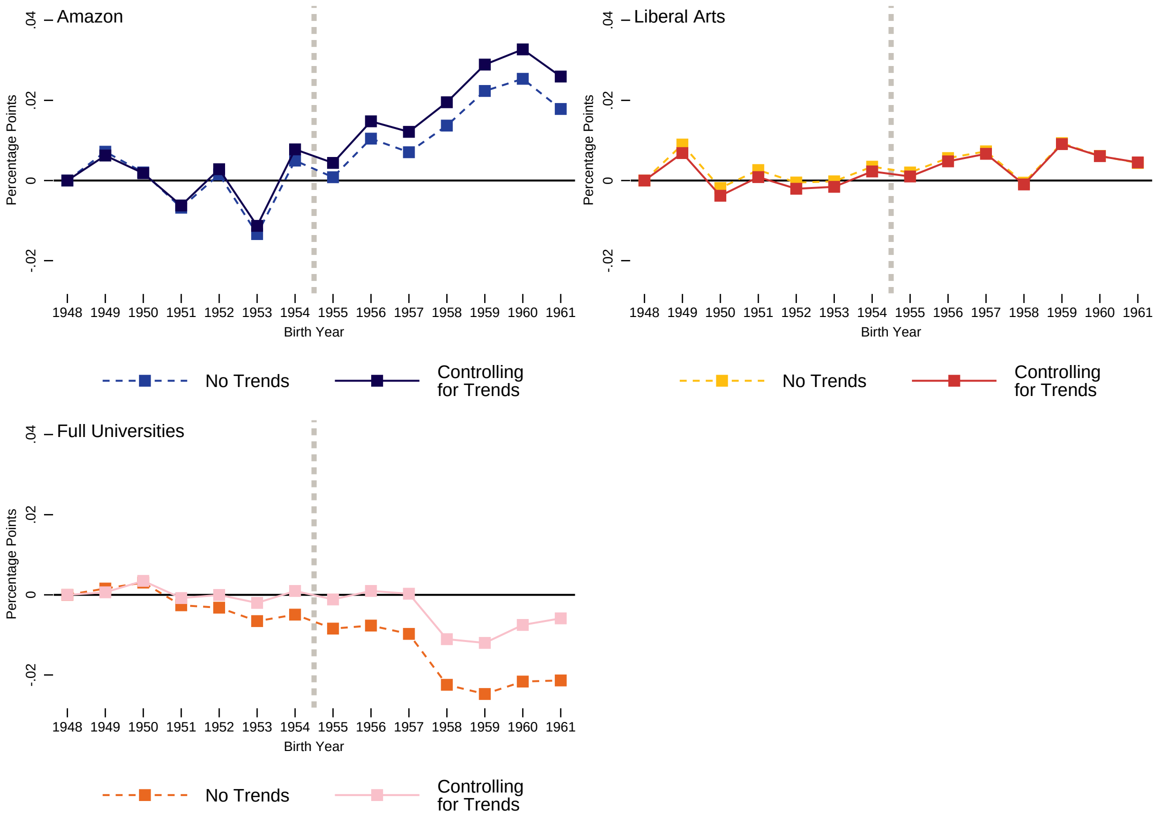
Notes: This Figure presents dynamic difference in difference estimates of the the effect of exposure to the oil boom before turning 18 on the probability of owning a home of quality above the median of the quality index in 2010. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A11: Population Owning a Vehicle in 2013 by Birth Cohort



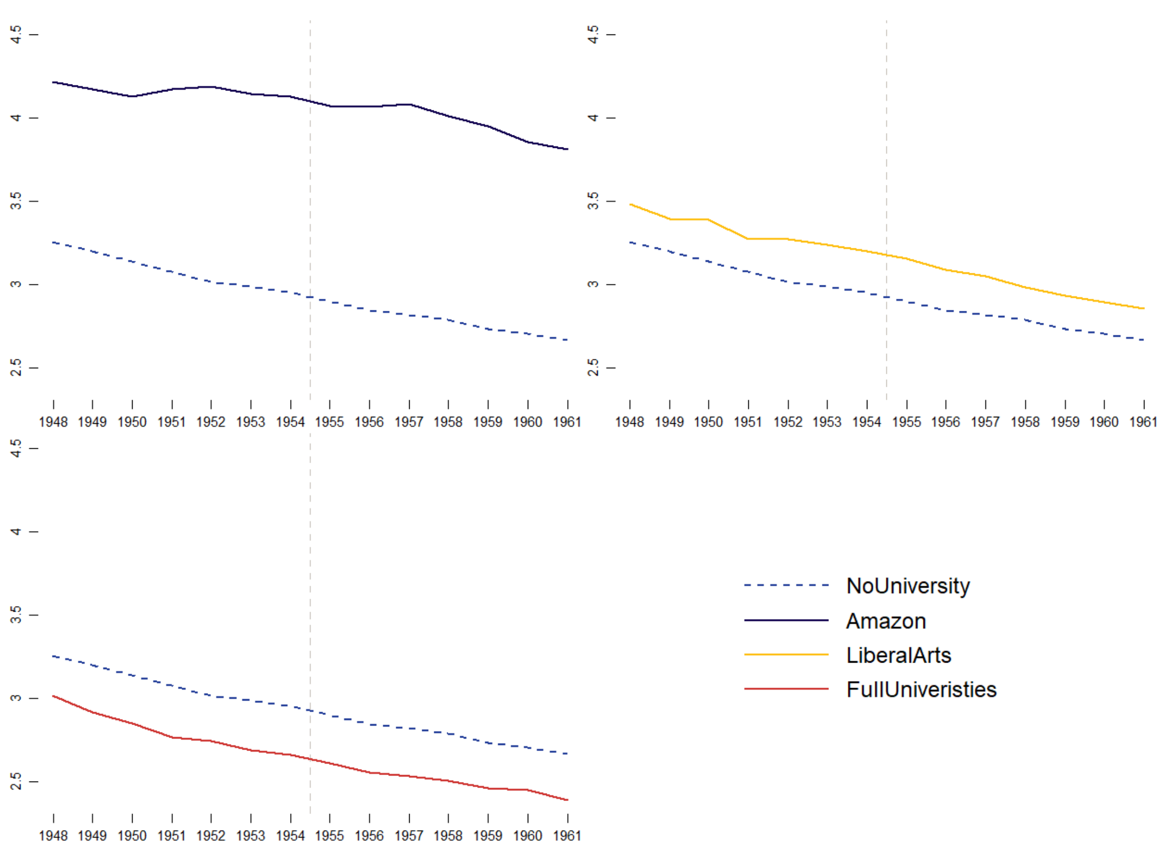
Notes: This Figure presents the evolution of the proportion of the population who owns a vehicle in Ecuador for the cohorts born between 1948 and 1961. The data correspond to 2013. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A12: Effects of Exposure to the Oil Boom Before Turning 18 on the Probability of Owning a Vehicle



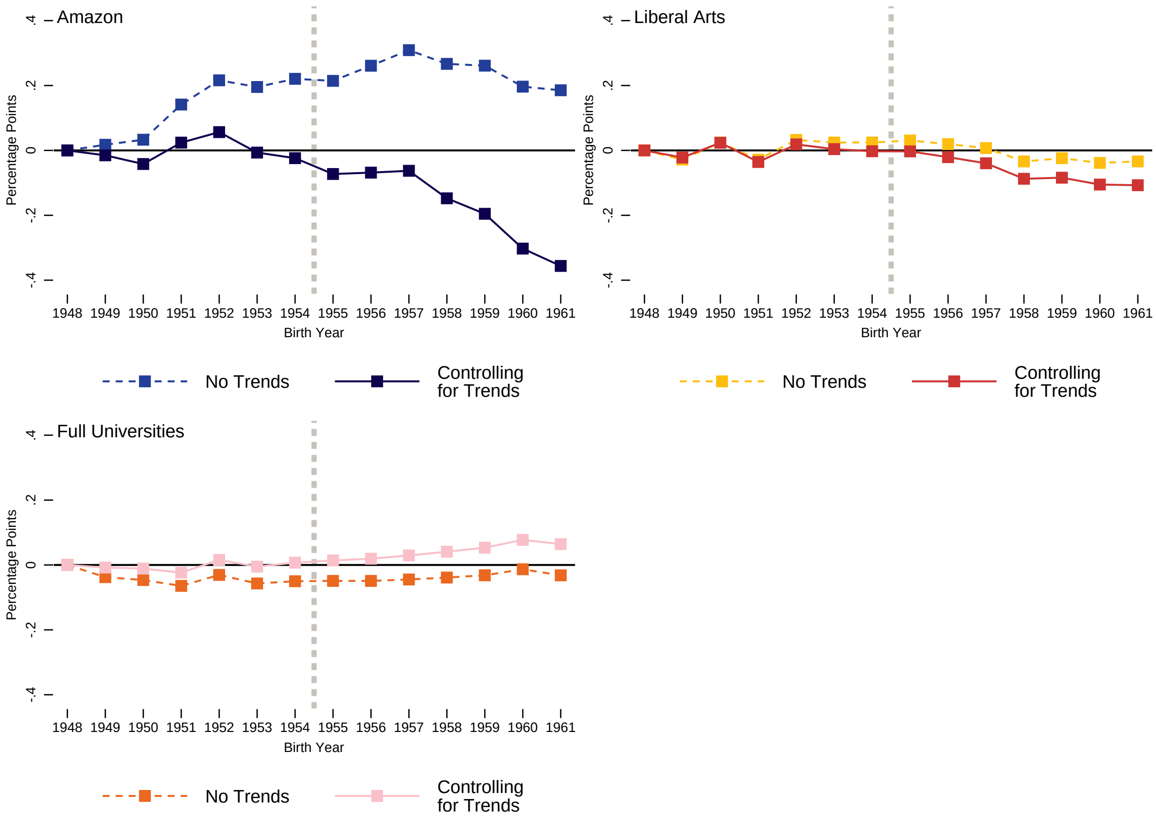
Notes: This Figure presents dynamic difference in difference estimates of the the effect of exposure to the oil boom before turning 18 on the probability of owning a vehicle in 2013. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A13: Number of Children by Birth Cohort



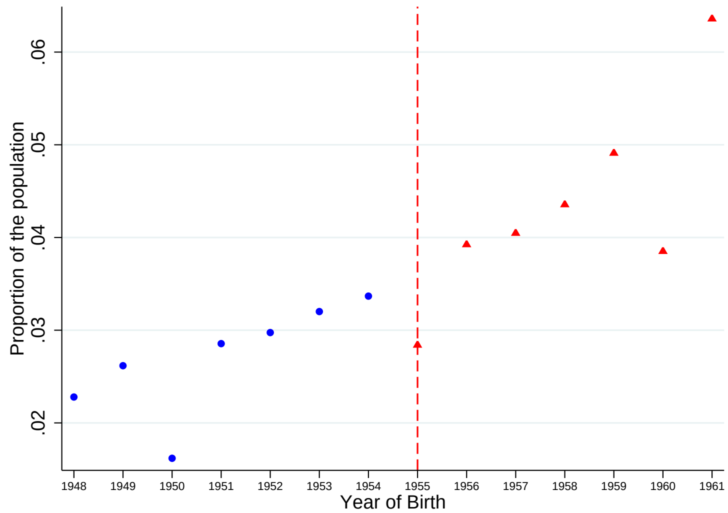
Notes: This Figure presents the evolution of the number of children for the cohorts born between 1948 and 1961. The data correspond to 2014. The horizontal axis plots the year of birth. The country is divided into four regions depending on the geographic location and type of universities before the oil boom. The cohorts born between were exposed to the oil boom before turning 18 years old.

Figure A14: Effects of Exposure to the Oil Boom Before Turning 18 on the Number of Children



Notes: This Figure presents dynamic difference in difference estimates of the the effect of exposure to the oil boom before turning 18 on the number of children in 2014. Dashed lines present conventional difference in difference estimates, and solid lines control for differential trends. These estimates take the the region without universities as the base region.

Figure A15: College Completion by Birth Cohort in Indonesia



Notes: This Figure presents the evolution of college completion for the cohorts born in Indonesia between 1948 and 1961. The cohorts born between 1955 and 1961 (red triangles) turned 18 years old during the oil boom in the 1970s. This Figure uses data from a 10 percent random sample of Indonesia's 2010 population census (Minnesota Population Center, 2017). The drops correspond to birth years that are multiples of five. Apparently, individuals with low education round their age/year of birth to the closest multiple of five. I have found evidence of this rounding in self-reported data sets from other developing countries.

Table A3: Effects of Exposure to the Oil Boom Before Turning 18 on College Completion by Gender

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
				Women				
Full Universities	0.0014	0.0072	-0.0014	-0.0142	-0.0261	-0.0405	-0.0431	-0.0184
	(0.0049)	(0.0054)	(0.0058)	(0.0063)**	(0.0068)***	(0.0073)***	(0.0080)***	(0.0055)***
	(0.0024)	(0.0039)*	(0.0088)	(0.0118)	(0.0137)*	(0.0171)**	(0.0166)***	(0.0107)*
Liberal Arts	0.0011	0.0006	0.0102	0.0092	0.0129	0.0116	0.0078	0.0078
	(0.0043)	(0.0047)	(0.0051)**	(0.0056)	(0.0060)**	(0.0064)*	(0.0070)	(0.0047)*
	(0.0036)	(0.0049)	(0.0056)*	(0.0070)	(0.0105)	(0.0116)	(0.0121)	(0.0073)
Amazon Region	0.0122	0.0159	0.0307	0.0313	0.0544	0.0408	0.0528	0.0357
	(0.0107)	(0.0115)	(0.0127)**	(0.0135)**	(0.0149)***	(0.0157)***	(0.0170)***	(0.0116)***
	(0.0109)	(0.0117)	(0.0116)***	(0.0130)**	(0.0145)***	(0.0187)**	(0.0214)**	(0.0124)***
				Men				
Full Universities	-0.0074	-0.0151	-0.0263	-0.0441	-0.0552	-0.0522	-0.0575	-0.0387
	(0.0057)	(0.0062)**	(0.0067)***	(0.0074)***	(0.0080)***	(0.0087)***	(0.0095)***	(0.0066)***
	(0.0060)	(0.0040)***	(0.0118)**	(0.0097)***	(0.0083)***	(0.0069)***	(0.0098)***	(0.0076)***
Liberal Arts	0.0053	0.0175	0.0034	0.0027	0.0054	0.0011	0.0023	0.0051
	(0.0052)	(0.0057)***	(0.0061)	(0.0066)	(0.0072)	(0.0078)	(0.0084)	(0.0058)
	(0.0036)	(0.0058)***	(0.0068)	(0.0073)	(0.0096)	(0.0099)	(0.0126)	(0.0072)
Amazon Region	0.0172	0.0479	0.0261	0.0631	0.0561	0.0787	0.0744	0.0544
	(0.0127)	(0.0143)***	(0.0148)*	(0.0166)***	(0.0177)***	(0.0193)***	(0.0209)***	(0.0144)***
	(0.0161)	(0.0147)***	(0.0168)	(0.0178)***	(0.0195)***	(0.0255)***	(0.0243)***	(0.0179)***

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom before turning 18 on the probability of graduating from college for the cohorts born in 1955-1961 by gender. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effect across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors (215 clusters,second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 (870,046 women and 841,492 men).

Table A4: Effects of Exposure to the Oil Boom Before Turning 18 on the Number of Children

	Born in 1955	Born in 1956	Born in 1957	Born in 1958	Born in 1959	Born in 1960	Born in 1961	1955-1961
Full Universities	0.0139	0.0195	0.0295	0.0410	0.0533	0.0775	0.0643	0.0446
	(0.0176)	(0.0193)	(0.0214)	(0.0236)*	(0.0259)**	(0.0285)***	(0.0311)**	(0.0216)**
	(0.0116)	(0.0223)	(0.0213)	(0.0348)	(0.0502)	(0.0447)*	(0.0529)	(0.0325)
Liberal Arts	-0.0029	-0.0208	-0.0396	-0.0874	-0.0841	-0.1051	-0.1072	-0.0662
	(0.0211)	(0.0229)	(0.0250)	(0.0277)***	(0.0302)***	(0.0330)***	(0.0359)***	(0.0247)***
	(0.0194)	(0.0224)	(0.0251)	(0.0333)***	(0.0333)**	(0.0410)**	(0.0432)**	(0.0280)**
Amazon Region	-0.0726	-0.0684	-0.0628	-0.1475	-0.1954	-0.3025	-0.3560	-0.1854
	(0.0758)	(0.0812)	(0.0898)	(0.0979)	(0.1077)*	(0.1167)***	(0.1268)***	(0.0890)**
	(0.0613)	(0.0762)	(0.0805)	(0.1019)	(0.1064)*	(0.1255)**	(0.1351)***	(0.0869)**

* $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$

Notes: This Table presents the effect of exposure to the oil boom on the the number of children per adult for the cohorts born in 1955-1961. The number of children is measured in 2014. The first seven columns present the effect for each cohort identified by the column header. The last column shows the average of these effects across cohorts using using population as weights. Standard errors are in parentheses. Following Abadie et al. (2017), in this case heteroskedastic robust standard errors (first row of standard errors) are appropriate because there is no clustering in sampling nor in treatment assignment. For robustness, I also report cluster-robust standard errors at the canton level (215 clusters, second row of standard errors). The estimates control for different trends across regions for the cohorts who turned 18 before 1973. The estimation sample corresponds to all individuals born in Ecuador between 1948 and 1955 with children ($n = 1,366,190$).