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IZA DP No. 15265

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ABSTRACT

Mother Africa's Exceptionalism? Income and Fertility Redux[1]

We revisit the effect of long run income growth on population fertility in some of the poorest countries in the world. Causal inference is enabled through proxying income windfalls by oil price shocks in oil rich versus oil poor provinces. Using various fertility measures as outcomes, we find that long run income growth significantly and robustly reduces fertility. Further analysis suggests that young women's fertility is particularly affected and that women's education; age of marriage, and the age of first birth, but not the use of contraceptives, are among the important mechanisms.

JEL Classification: I15, J113, O15, O47

Keywords: economic development, population fertility, Africa

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1. Introduction

The world's population growth rate peaked in 1965-70 with more than 2 percent on average annually, and since then it has halved to around 1 percent globally on average in recent years, and is projected to further fall (United Nations' Population Division, 2019). While most of the world is expected to experience a population growth slowdown – and ever more countries even a negative growth - Sub-Saharan Africa is projected to account for most of global population growth in the near future, seen to become the most populous region in the world by around 2060.[2] This is just one illustration of the highly uneven population growth across the world, whereby many regions have reached the point of demographic transition, whereas other countries, many in Africa, experience booming population.[3] Whereas Malthusian concerns have been alleviated for much of the world, the rapidly growing population in Africa is sometimes perceived as presenting environmental, socio-political, and economic challenges. Sub-Saharan Africa has by far the highest fertility among the world's regions, raising immediate concerns about the ability to provide adequate health care for infants and longer term concerns about human capital accumulation, the environment, and, ultimately, economic growth and political stability.

Economic theory (e.g., Galor, 2011, Galor and Weil, 2000, Hansen and Prescott, 2002) provides several useful guidelines as to the mutual feedback relationship between population and economic growth. It projects a reduction in fertility as a country develops and demand for human capital increases, sometimes at the expense of the demand for land; and it documents an inverse relationship between fertility and income per capita, both across countries and in the course of countries' historical development (see, e.g., Coale and Watkins, 1986).

Given that Africa stands out in terms of its population growth and fertility patterns, the question is whether these insights are categorical imperatives, or can there be exceptions? For example, whereas modern economic growth that began in Europe in the aftermath of the Industrial Revolution, serves as a standard paradigm for the unified growth theory, it could be argued that its

[2] According to some projections, Africa's population may triple by that year.
[3] To put this in historical perspective, this is a relatively new phenomenon; prior to 1950 Africa's population was growing very slowly.

circumstances were special and not directly universally applicable to other places and times.[4] Thus, while modern economic growth was due to technological progress, much of development in African countries stems from natural resources, which begs the question whether the source of economic development matters for demographic transition. Indeed, technological process naturally induces demand for human capital – standard engine of economic growth - which is less obvious the case for income growth driven by natural resource windfalls. Further, Africa's fertility patterns exhibit large variations, not only across countries, but also regional variations within countries; thus, in Nigeria, the most populous country in the continent, fertility is relatively low (slightly exceeding 4 children per household on average) in the South, but much higher (almost 7 children per household on average) in North-West. This regional variation naturally begs the question as to its link to regional economic development.

In this paper, therefore, we empirically address the question of potential "Africa's exceptionalism" in regard to the effect of economic growth on fertility. Whereas countries' per capita incomes and their population growth are negatively correlated (see Chatterjee and Vogl, 2018), disentangling causality is challenging. For one, it may go from population growth to incomes (see Ashraf et al., 2013), as articulated at least since Malthus' times. Then omitted factors, such as countries' cultural and institutional features, for example, could potentially affect both population and economic growth in various ways.

We, therefore, proceed by collecting detailed data from the IPUMS-DHS, a rich source of information that reports harmonized representative samples, on administrative regions within African countries well-endowed with a main source of growth there, oil resources. We utilize oil price shocks (OPS) as a proxy for region-specific income shocks, distinguishing between oil rich and oil poor regions, to document long term effect of income growth on fertility. As in some of the relevant literature cited below, we conceive of income evolution over prior 20-year period as a proxy for long term economic development, to explore its effects on population fertility.[5] More specifically, we employ two complementary approaches to estimate population fertility, that could be labelled flow and stock. In the former approach, we look at the number of children conceived or born in a region in a given year in our entire sample, sometimes referred to as natality; in the

[4] Coale and Watkins, 1986, is a useful account of Europe's historical fertility experience.

[5] While we do not purport to directly test any specific theory linking economic development and fertility, our results are consistent with the long run perspective of Chatterjee and Vogl's, 2018, framework.

latter approach we target women total number of children, limiting the sample to sufficiently mature women.[6] Under both approaches, we find that controlling for region's fixed effects as well as additional characteristics, an increase in income windfall generated by oil price fluctuations over past 20 year period causes a decrease in current fertility. These results are statistically and economically significant. For example, the doubling of oil price over preceding 20 year period reduces the subsequent number of conceived children by approximately one child on average – or by almost 10 percent of the average number of children in the sample; and the tripling of oil price over preceding 20 year period reduces the subsequent average number of children in a family by the same number. Slicing the results up by age cohorts, we find that younger women (especially those aged 20-24) significantly reduce their birth rate in response to income windfalls; the effect for older women, perhaps not surprisingly, is insignificant. These findings are robust with respect to a battery of tests that include changes in the sample of countries; demographic composition; time period; and potential confounders.

Our dataset enables us to uncover some mechanisms behind these results. In particular, we find that women education is one channel. Controlling for its level, the effect of income windfalls in the average regional birth rate turns insignificant; in contrast, the tripling of oil price over preceding 20 year period causes an increase of about 1.5 years of schooling (or, by more than a third) among women. Additional consequences of such windfalls include a significant delay in the average age of marriage, and the average age at which first births take place. On the other hand, we do not detect a significant change in the use of contraceptives.

Conceptual background and related literature*:* As dire Malthusian predictions (Malthus, 1978) have been refuted by the experience of developed countries in the aftermath of the Industrial Revolution, theories of modern economic growth suggest that technological progress upsets Malthusian tenets. To put it in simple terms, economic development entails income effect – growing per capita incomes – but also substitution effects. The latter embody tradeoffs, such as between quality and quantity of children, or the allocation of women time between child rearing and acquiring human capital.[7] The income effect does imply a positive effect of economic development on fertility; but the substitution effect leads to the opposite conclusion (Becker, 1960,

[6] A more standard terminology typically used by demographers would be "period" and "cohort", respectively; the one we adopt, we believe, is more suitable for economists.
[7] Empirical analyses in developing settings lend support to this view, e.g., Rosenzweig and Zhang, 2009.

1965, Galor, 2011). This basic idea has been developed and elaborated upon in influential body of work that tackles the causes and consequences of modern economic growth in its relationship to population growth (e.g., Brezis and Dos Santos Ferreira, 2015, Cervellati and Sunde, 2015, De la Croix and Doepke, 2003, Galor and Moav, 2002, Galor and Weil, 2000, Hanson and Prescott, 2002, Moav, 2005). Empirical analyses of the effect of income windfalls on fertility in the short to medium run typically indicate a positive relationship – children "is a normal good", see Black et al., 2013, Brueckner and Schwandt, 2015, Dausal et al., 2021. Taking a broader temporal perspective, Chatterjee and Vogl, 2018, correlate current fertility rates with national income changes carefully distinguishing between short run and long run effects. The authors find that, whereas in the short run, consistent with children "being normal", the relationship is positive, this conclusion is reversed in the long run, over 20 year period.

This study contributes to this work in the following manner. Our approach complements Chatterjee and Vogl, 2018, in enabling causal inference in regard to the effect of economic development on fertility. Whereas Chatterjee and Vogl, 2018, presents correlational evidence, our use of exogenous variation in international oil prices as a major source of regional incomes, depending on regions' oil endowments, suggests causality. Our results, therefore, can be viewed as reinforcing Chatterjee and Vogl's, 2018, findings regarding the long run effect of economic development on reduced fertility. The paper is also related to Brueckner and Schwandt, 2015, which makes use of exogenous variation in international oil prices for identification purposes, as we do. While Brueckner and Schwandt, 2015, do so in the cross-country world sample context, we focus on regional variation within a group of similar to each other geopolitically and more homogeneous developing African countries. Unlike Brueckner and Schwandt, 2015, our main finding is that (regional) income growth reduces fertility. In addition to the geographical units, another reason for the disparity in results could be that we focus on a long-term perspective, whereas Brueckner and Schwandt, 2015, which detects procyclicality of fertility, are interested in a shorter span of 5 to 10 year lag. A long-term perspective is likely to encompass, in addition to the income effect, a substitution effect as well. Specifically, it may well affect a young woman's time allocation between investment in human capital through schooling on one hand and children conception and rearing on the other hand. We, in fact, find clear support for this mechanism in identifying the positive effect of past income windfalls on women education; age of marriage; and age of first birth.[8] Methodologically, surprisingly perhaps, existing work on fertility in developing countries that purports to explore causal evidence of rising incomes has not focused on within-country variations, in stark contrast to the counterpart in developed world, e.g., Black et al., 2013, Dausal et al., 2021, Fox et al., 2019.[9]

2. Data and empirical strategy

2.1. Sample

The fertility data, regional and individual characteristics come from the individual census records conducted by Demographic and Health Survey (DHS) program. The data is retrieved from Integrated Public Use Microdata Series (IPUMS) International that reports harmonized representative samples. Our analysis is restricted to country survey waves providing GPS information on the location of the surveyed households. This is because the geocoded data allows us to assign individuals to their respective oil and non-oil producing regions allocated as explained below. To have a more homogenous sample, we focus on countries reporting at least one oil-producing region. This leaves us with 44 surveys over the period 1990-2018 for 15 countries: Angola, Cameroon, Democratic Republic of Congo, Ivory Coast, Benin, Ethiopia, Ghana, Madagascar, Namibia, Mozambique, Nigeria, Niger, Senegal, Tanzania, and Egypt.[10]

The sampled countries had a population of 757 million people in 2016 representing 62%percent of Africa's population. In assigning oil locations and consequently households, we choose to work on coarser administrative units (ADM 1 or provinces) rather than finer levels (ADM 2 or district). The advantage of this approach is twofold. First, higher administrative levels allow for reducing the measurement error associated with the allocation of oil fields. Second, focusing on provinces can mitigate migration concerns, a common phenomenon in periods of high oil prices.[11] Even though migrating from one province to another is possible, it is less frequent relative to migration across districts, especially in the presence of delimited ethnic and tribal

[8] This is consistent with Maurer and Potlogea, 2021, which explores oil shocks to study female labor participation and documents their mildly positive effect.

[9] Also related is the work on the effect of medical interventions on mortality and fertility; Ager et al., 2018, for example, find that smallpox vaccinations reduced child mortality, but not the ultimate fertility.

[10] See Table A1 for a list of surveyed countries and waves. The included countries (surveys) represent around 47% (32%) of total surveyed countries (survey waves). As robustness check, we also use the total 137 surveys with geo-coded data for the available 32 countries.

[11] We investigate migration concerns and other regional characteristics in more detail in the robustness checks section.

territories making movement quite restricted. Our sample include 261 provinces with a mean (median) size of 49 (29) thousands km^2. Figure 1 shows a map of the countries included and the locations of oil provinces.

2.2. Outcomes

Fertility. We make use of the DHS-births history survey, which records a complete list of all children the woman has ever given birth to including their date of birth, sex, survival status, age (if alive). Birth histories include all live births, including children who later died, but omit stillbirths, miscarriages, or abortions. The survey covers all women aged 15-49 years old. We construct two types of fertility indicators, one at the individual level and another at the regional level. The first is referred to as the stock measure, which reports both the total number of children ever born and total number of living children born for women. We restrict our sample to women aged 30 years and above at the time of the survey to allow us to capture complete fertility records.[12] This leaves us with a total sample of 283,563 women born between 1941-1988. The second is called the flow measure and it aggregates the number of children born in a given region-survey year by age-cohort.[13] When aggregating individual level data to the regional level, we do not weight by regional population, but instead follow Black et al. (2005) in treating every region as a unit of observation. The flow measure gives us then the age-specific number of births in a given region in a particular survey year for women belonging to one of the 5-year age groups from [15,19] to [45,49].

Other outcomes. For the analysis of individual and regional characteristics, we draw on additional information on women's history, background, and preferences for fertility.

2.3. Independent variables

The main independent variables are an indicator for oil provinces, international oil prices and their interaction.

Oil provinces are allocated based on the map of world oil deposits from PRIO petroleum dataset (Lujala et al., 2007). Onshore oil deposits were assigned to a given province, if the centroid of the

[12] We also tried other age cutoffs for the stock approach by restricting the sample to women over 35, 40 and 45 years old, and the results remain robust (see section 3.2). However, employing a higher age cutoff significantly reduces the sample size creating a tradeoff between the accuracy of measuring completed fertility and preserving a sufficiently large sample size.

[13] When aggregating, we weight individual observations by the person weights provided by the IPUMS in order to improve the representativeness of our sample.

deposit lie within its boundaries. For offshore oil deposits, we first calculated the distance between the centroids of the province and the deposit and assigned the latter to the nearest province. International oil prices are given by the average of Dubai, Brent and Texas prices expressed in real 2010 USD and taken from the World Bank Commodities prices dataset.

Other controls. The surveys contain a set of demographic information for women, which we use to construct age cohorts and control for individual characteristics. These include age, religion, place of residence (i.e. urban vs. rural), marital status, and sex of the household head.

2.4. Descriptive statistics

Table 1 reports descriptive statistics of our main variables of interest both at the individual and regional level, distinguishing between oil and non-oil regions. We note that women residing in oil regions tend to have on average a fewer number of children compared to their peers in non-oil regions, and the difference is statistically significant. The average number of (live) children ever born to women in oil regions is (4) 4.6 children compared to (4.4) 5.3 in non-oil regions. Similarly, the regional number of births for our sampled women records on average 62.3 new births in oil regions, whereas it rises to 82.7 in non-oil regions. Child mortality appears to be also lower in oil regions.

There are substantial differences between regions, women in oil regions being more educated, tending to get married and giving their first birth at a relatively older age. They possess, on average, double the number of years of schooling obtained by women in non-oil regions and tend to get married 1-2 years older. The percentage of population residing in urban areas is also higher in oil regions as well as the percentage of women who have never been married.

2.5. Empirical strategy

Estimation: Our empirical strategy aims at exploring the long-run effect of OPS on women fertility choices. To do so, we employ two levels of analysis: (1) the „stock“ approach investigating, as a proxy for completed fertility, the number of children of women aged 30 years old and above, and (2) the „flow“ approach gauging the targeted effect of annual births for the entire cohort at the regional level. In both cases, the analysis is in the spirit of a difference-in-difference strategy.

For the stock approach, we choose women aged 30 years old and above to match the median age of sampled women and to preserve a sufficiently large sample size. Our baseline specification takes the following form:

$$Y_{ibrct} = \beta\,(OPS_t \times Oil\ Province_r) + X_{ibrct} + \delta_b + \theta_t + \alpha_r + \gamma_c \times \theta_t + \epsilon_{irct} \qquad (1)$$

where Y_{ibrct} is either the total number of children ever born, or the total number of living children born to woman i born in year b residing in province r country c in the survey year t. OPS_t is the logarithm of the lagged 20-year moving average of real oil prices. $Oil\ Province_r$ is a dummy variable that takes a value of 1, if a given province is producing oil. θ_t is survey-year fixed effects to capture time-varying shocks that are common across provinces and α_r is provincial fixed effects to control for time-invariant unobserved heterogeneity at the province level. δ_b is cohort fixed effects and X_{ibrct} is a set of time-varying controls at the individual level including indicators for age, urban residency, marital status, religion, female household head, and month of survey. The $\gamma_c \times \theta_t$ is country-year fixed effects to account for common shocks occurring at the country level that might be correlated with both fertility and oil prices. The coefficient β isolates the long-run effect of OPS on fertility net of year, region, age and individual characteristics specific effects.[14]

For the flow approach, we run the below regression following Chatterjee and Vogl (2018):

$$Y_{arct} = \beta\,(OPS_t \times Oil\ Province_r) + \eta_a + \theta_t + \alpha_r + \gamma_c \times \theta_t + \epsilon_{brct} \qquad (2)$$

where Y_{arct} is the age-specific number of births to woman belonging to age group a in province r country c in the survey year t. We run this specification for each 5-year age-group a, where a ranges from [15,19] to [45,49]. η_b is a single year age effect for each age in the 5-year age group to account for differences in the distribution of single-year ages within age groups across regions and time. The rest of controls are the same as in equation (1). The coefficient β quantifies then the effect of long-run OPS on fertility net of year, region, and age-specific effects. In both equations (1) and (2), the standard errors are clustered at the province level.

Specification: Our identification strategy assumes that oil prices are exogenous, which is plausible because, except for Nigeria and Angola, our sampled countries contribute less than 1% to total world oil production. In Nigeria and Angola, despite being the largest two oil-producing countries

[14] Note that cohort fixed effects exhibit a correlation with age fixed effects of 75%, and of 65% with year fixed effects. Nevertheless, in estimating our equations, we use a multi-way fixed effects estimating technique that corrects for multicollinearity by automatically dropping co-linear variables. Despite the relatively high correlation between the three variables, they are not colinear, and therefore, are not dropped, and it follows that equation (1) can be estimated with the three variable all together with no concern of multicollinearity. To further check that, we have estimated equation (1) while gradually adding year, cohort and age fixed effects and results indicate that the estimated coefficients are quantitatively and qualitatively stable across the 3 models (available upon request).

in Africa, oil production in 2016 accounted for only 2% of world production each.[15] Furthermore, by interacting oil prices with indicators for oil provinces conditional upon provincial and age-interval fixed effects, we are exploiting differential effects of oil price changes depending on access on oil in the spirit of a difference-in-differences strategy.[16]

In addition, our identification strategy requires the satisfaction of two assumptions (1) parallel trends assumption, and (2) the stability of treatment effect between groups and over time. The first assumption requires that oil and non-regions are not systematically different in any other aspect that might affect fertility - hence, in the absence of oil, both groups of regions must witness the same fertility pattern. In other words, our estimates should be unbiased in the absence of pretends or pre-existing factors that might affect fertility in the long run. To ensure that, we make use of geographic, environmental and social info available from DHS surveys at the cluster level to check if oil and non-oil regions differed systematically in these features, which might influence the fertility in the long-term. In this regard, we test whether oil and non-oil regions are comparable in terms of level of vegetation, minimum and maximum temperature, elevation, population density and incidence of malaria. The vegetation and temperature indicators are calculated by taking the median of their monthly values in the 4 years prior to the survey. The population density and malaria index are given for the year 2000. The statistical insignificance of the estimates reported in Table 2 suggest no systematic differences of these features between the types of regions.

The second assumption requires that the number and status of treatment and control groups should be constant over time. Hence, no switch from being treated to being non-treated and vice versa. We unfortunately do not have information on the starting years of production for allocated oil fields. We only have info on the fields' locations, which we then used to allocate to their respective regions. Hence, we are unable to fully investigate whether there has been a changing in the oil production status of oil regions over time. Nevertheless, we believe that working on coarser administrative units (ADM 1 or provinces) rather than finer levels (ADM 2 or district) has the advantage of allowing for reducing the measurement error associated with the allocation of oil fields and with the production status of the regions. Most of our sampled regions contain more

[15] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2241rank.html

[16] Ideally, we would construct oil price shocks utilizing the intensive margin of regional oil production intensity. Unfortunately, the relevant data is nonexistent, which implies that we use an extensive margin differentiating between oil producing and non-producing regions.

than one oil field, and hence, even if we doubt the starting production date of a given field, this should have limited effect on whether the region is an oil producer or not. The larger the number of oil fields contained in a given region, the less doubts we have about the status of the region as an oil producer. Furthermore, having data on the starting dates of oil production at country level can guide a bit on the producing status of the country's respective regions. Following this logic, we conduct several robustness checks on our sample of treated regions and countries as explained below in the robustness checks section (see section 3.2).

3. Baseline findings

3.1. Preliminaries

Before presenting our results, we make sure that some of our fundamental assumptions hold true. To address persistence of oil price shocks, (online) Appendix Table A2 presents the results of formal tests for unit roots for both annual and 20-year average oil prices. In all columns, we fail to reject the null hypothesis of the presence of unit roots.

Another key issue is regarding the construction of long-run oil price shocks. Our baseline measure for oil prices shocks uses the 20-years average of oil prices, similar to Chatterjee and Vogl, 2018. To test whether this presents a good approximation, we estimate equations (1) and (2) using a range of different average cut-offs from 10 to 25 years (in the latter case for each 5-year age group). Figure 2 plots the estimates of these coefficients against the average cut-offs. All the estimated coefficients have negative signs and exhibit a downward pattern with the increase in the average cut-off. In Panel B, four age groups report their minimum estimated coefficients at the 20-average and the rest at the 23-average. The corresponding estimated coefficients and their level of precisions, presented in Appendix Tables A3a and A3b, have negative signs and exhibit a downward pattern with the increase in the average cutoff. Hence, we can conclude that the 20-average is a reasonable proxy for long-run shocks. We also provide a correlation matrix between the different oil price shocks in Table A4, and it shows an average level of 95.7%. In all cases, the correlation coefficients are statistically significant at the 1% significance level.

Then we test whether oil price changes can be interpreted as income changes at a provincial level in our sample. As there is no reliable data on the latter, we resort to Lessmann and Seidel's (2017) estimates of provincial income obtained using nighttime light as a proxy. The data is computed based on nighttime lights collected from satellite data provided by the National Oceanic and Atmospheric Administration (NOAA) and is available for the period 1992-2012. Correlating oil prices with these estimates in Figure 3 reassure that, indeed, oil price changes can be interpreted as provincial income change. This is further illustrated in Appendix Table A5 where we report the estimated coefficients of regressing the (log) regional GDP on oil price shocks at different lag points. These coefficients grow in magnitude and remain statistically significant until the lagged 10-year average beyond which the estimates become smaller and insignificant, suggesting that variations in the oil price have long-rum effects on the level of GDP per capita. To further investigate the issue at the household level, we employ the World Bank's General Household Survey for Nigeria in years 2010, 2012, 2015 and 2018. Using detailed data on all sources of earnings received by a household, we manage to construct total household income per capita and aggregate that to provincial level. Total household income per capita is defined as the sum of all labor and non-labor income (i.e., savings, remittances, rents, property income, etc.), divided by the number of household members. All monetary values are expressed in real 2018 values, with nominal values deflated by the Nigerian CPI. Appendix Table A6 shows a strong positive correlation between provincial income and different lags for OPS in oil producing provinces, with the effect becoming stronger in magnitude and statistical significance the longer the lag before it turns insignificant at the lagged 10-year average as previously found with regional GDP.

3.2. "Stock" analysis

Main Findings. We begin by presenting, in Table 3, the estimation results using our "stock" approach. We consider outcomes that have a bearing on completed fertility of mature women, children ever born and children born alive. One can see that the results are highly statistically significant for both outcomes and it appears, therefore, that fertility decreases in response to income windfalls generated through OPS. The effect is economically substantial: the indicated in columns 1 and 2 coefficients imply that the tripling of oil price over preceding 20-year period reduces subsequent number of children born in a family by approximately one child on average. As the average number of children is slightly above 5, this constitutes roughly 20 percent.

Robustness checks. We conduct several robustness checks that are reported in Appendix B. First, we change in various ways the set of explored countries and treated regions. Thus, we: add countries that are not considered oil producing; in contrast, we drop countries with just one oil producing region; restrict to countries that has been producing throughout the whole sample period; and we consider two largest oil producing countries, Angola and Nigeria. As is indicated Appendix Table B1.1, the results little change relative to the baseline analysis. We, further, change the sample demographics, in two ways. First, we increase the women age threshold from 30 to 35, 40 and 45 years old. Second, we explore the role of migration in driving the results by including an interaction term between the oil price shock and indicator for being a migrant.[17] Tables B1.2 and B1.3 indicate that these alternative samples do not have any effect on the results; and fertility responses to oil price shocks among migrants and non-migrants do not differ statistically. As the results in columns 1 and 2 in Table B1.3 show, the interaction term, while negative, is statistically insignificant, meaning that there is no difference of the impact of oil price shocks on fertility behavior between migrants and non-migrants. Furthermore, we examined whether oil price shocks had an impact of migration, by regressing our indicator for migrants on oil price shocks in column 3. Indeed, 20 years is a long period which could allow people to move and adjust across regions. However, the estimated coefficients show that oil price has no statistically significant positive impact on migration; if anything, the negative sign of the coefficient indicate that shocks may have reduced migration. We also looked at the impact of oil price shocks on the percentage of people living in urban areas, as a proxy for migration in column 4 and found no statistically significant effect of oil price shocks on urbanization.

Instead of using a fixed window for calculating the moving average for all ages, we allowed this window to increase in woman's age to include all the years of the woman's lifecycles. The estimated coefficients presented in columns 1 and 2 of Table B1.4, using this flexible lagged oil price shock, are still negative and statistically significant for our both outcome variables (children ever born and children born alive). This flexible lagged oil price shock has also a highly statistically significant correlation coefficient with our baseline lagged 20-year average oil price shock of around 94% - which reinforces the strategy used throughout. Africa's continent being rich with minerals, one potential concern is that our results might be driven by fluctuations in the

[17] We should first note that DHS surveys provide limited information about migration based on one question that asks the respondent how long she has been residing in her current place of resident (which refers to the respondent's DHS cluster- an administrative level equivalent to a village). Hence, it is a bit unclear whether the respondent has just moved from one village to another within the same region or has indeed migrated from one region to another. Despite this limitation, we considered an indicator for migrants that takes the value of 1 if the respondent has replied that she had not been always residing in her current place of resident, and zero otherwise. Because this question is not available in all surveys and suffers from missing values, including this indicator led to a drop in the sample size by almost 38%.

prices of those minerals instead of that of oil. To alleviate this concern about potential confounders, we introduce in our baseline regression as an additional control variable the prices of other minerals interacted with their respective producing regions, specifically focusing on gold, silver, aluminum, copper, lead, nickel, zinc and tin. These minerals are of at least some importance for at least one country in our sample; and yet their producing countries are not major world producers of the minerals - so unable to affect its price. We then construct our variable of interest, mineral price shock, as follows by selecting, for each region in our sample, the main mineral produced based on the frequency of its production across different mines which is cross-checked by the main minerals that the country is producing.[18] This enables us to construct a dummy variable for each region indicating presence of lack thereof of a main mineral. Multiplying this variable by the mineral's price yields mineral price shock index, which is then constructed similar to the oil price shock. Again, as can be seen from Table B1.4, columns 3 and 4, this does not change the estimated coefficients of OPS.

Since oil prices experienced a significant and steep spike after 1973, we explore in columns 5 and 6 whether confining the sample to the post 1973 period make any change and find that it does not. As a placebo test, we randomly reshuffle oil producing and non-oil producing provinces in columns 7 and 8 and find that this results in oil price shocks having an insignificant effect on fertility, reassuring that our findings are not random.

Furthermore, to mitigate the concern regarding the presence of fertility trends, we multiply the oil price shock with year dummy for each survey year in our sample, thus allowing the effect of oil price shocks on fertility to change over time; hence, if there are indeed different trends in fertility among different regions, for instance due to differential regional policies, this interaction term should control for that. As the results in Table B1.5 indicate, this leaves no impact on the estimated coefficient which remain negative and statistically significant at the 1% significance level. Most of the interaction terms are negative, confirming the previous results of a negative impact of oil prices shocks on fertility in oil producing regions compared to non-oil producing regions; and the few positive interaction terms are statistically insignificant. Finally, in Table B1.6, we run further robustness checks including reestimating our model with the dependent variable

[18] Minerals are allocated to regions using the Mineral Resources Data System (MRDS) from U.S. Geological Survey (USGS) (https://mrdata.usgs.gov/mrds/).

being the average number of children born at the cluster level, dropping regions with only offshore fields, and look at the impact of oil price on regional conflict. Throughout all the models, our baseline results are robust in sign and statistical significance, and we find no statistically significant effect of long-run oil price shocks on incidence of conflict.

Mechanisms. We next explore some of the mechanisms that could mediate the basic effects. To do so, we replace in the main regressions, our primary outcome of interest with variables that could potentially affect fertility. From Table 4, panel A, we observe that income windfalls in prior 20 year periods increases women education, their age at first marriage, and their age at first birth. These effects are economically large. Thus, the tripling of oil price over preceding 20 year period increases the number of years of women education by approximately 1.5 years on average; and postpones age at first marriage and their age at first birth by about a year and more than two years, respectively. Women's employment has negatively responded to OPS. However, by breaking down the different types of work activities, we notice a structural shift in sectoral employment from self-employment in agriculture sector towards domestic work and service sectors (Table B1.8 in Appendix B).[19] Child mortality shows insignificant response to OPS, and so is husband's or partner's employment status and education. Intrahousehold equality in earnings seems to be reinforced by income windfalls, as can be seen from columns (7)-(9) of Table 4. We then explore how the use of contraceptives might have been affected by income windfalls. Here (see Table B1.7 in Appendix B) we do not detect statistically significant changes.

The DHS contain also information on fertility preferences, reporting the total number of children the woman would hypothetically like to have in her whole life, regardless of her actual childbearing. We then run a regression as above whereby the left hand side is the answer to the question. As evident from the results, presented in Table 4, panel B, income windfalls caused by oil prices decrease the preference for large families (number of desired kids more than five); further, they reinforce women preference (albeit statistically weakly significantly) for the ideal family size with either 3 or 4 kids. Further, while in general women have preference for larger

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[19] Unfortunately, absence of detailed data prevents us from exploring the effect on women wages, which was found in earlier work to positively react to economic development, Schultz, 1985, although the increase in educational attainment is consistent with this result. Reduction in employment could be consistent with it, because of sectoral employment changes or increase in leisure; and it is also consistent with the U-shaped curve of female employment in the course of development due to the sectoral shift away from agriculture and toward household and service sectors, as argued in Goldin, 1985. See also Kotsadam and Tolonen, 2016, for recent evidence in Africa.

families than men in developing countries, especially so in poor African countries (see Doepke and Tertilt, 2018) this disparity gets moderated as a result of oil price increase. These results are also consistent with the Doepke and Kindermann's, 2019, findings for developed countries.

3.3. "Flow" analysis

We now extend our analysis using the „flow" approach. There are two main differences between the two approaches: the flow approach focuses on the number of births as opposed to the number of children under the stock approach; and it uses regional level as opposed to individual level data. Hence, the two approaches complement each other.

Main findings. Table 3, panel A, presents the estimation results using the aggregated regional number of births as our fertility proxy. [20] Columns 1-7 run our analysis separately for various age cohorts and column 8 contains the results for the total effect. To this end, a cohort is defined by a five-year interval, which generates seven such intervals. In general, income windfalls as a result of oil price changes generates a countercyclical long run effect of reducing the average regional number of births. The result indicates that oil price increases cause a statistically significant reduction in the birth rate of the youngest three cohorts, ages 15-29, whereas the coefficients for older cohorts, while negative, are statistically insignificant. These results help shed light on important differences across the age cohorts. Particularly noteworthy is the large effect on the 20-24 age cohort, whereby the obtained coefficient implies that a doubling of oil prices over 20-year period results in about 12 births less on average in oil provinces. For the total effect, the doubling of oil price reduces the average number of births in oil rich provinces by roughly 29 children, which is around 2.4 times the effect reported by the 20-24 age cohort. Whereas total number of births is what matters for the demography of population size changes, the breakdown by age cohorts and the display of the conception patterns of younger women is arguably more informative for our main goal of exploring the effect of economic development on fertility.

In Table 3, panel B, we supplement our main specification with additional covariates. These are the mean years of education, share of working women, mean number of children who were reported to have died, share of urban population, share of currently and formerly married. The results show little change, with the exception of the mean years of education. Once this variable

[20] Note that we do not use a more commonly reported statistics of fertility rates, such as the number of births per woman or per population. The reason for that is that regional fixed effects that we employ are colinear with regional population measures.

is introduced as a covariate, the effect of oil prices on average number of births, while still negative, becomes either smaller in magnitude or statistically insignificant or both. For instance, the magnitude of the estimated coefficient for the total effect shrinks by 61 percent and becomes statistically insignificant. This reinforces the suggestion that women education is one mechanism that mediates our main effect.

Robustness checks and regional characteristics. Similar to the stock approach, we perform a series of robustness checks. As indicated in Appendix Tables C1, our main results remain robust in sign and statistical significance; and the placebo test indicates that OPS are relevant for oil producing provinces.

Fertility choices can be correlated with regional changes that followed oil price shocks. To investigate that, Appendix Tables C2 explore how regional characteristics for women status (mean years of schooling, percentage of employed, marital status, percentage of urban residents, percentage of male children, mean number of reported dead children, age at first birth and marriage, the usage of contraceptives, percentage of migrants, and change in composition of age cohorts) have responded to shocks. The mean years of schooling for women have increased on average, and so have the mean age of marriage and the age at which the first child is born. This implies that more educated women tend to marry and give birth at an older age. Quantitatively, this means that a doubling of oil prices over 20-year period results in an increase in mean years of schooling by roughly 1 year in oil-rich provinces. Other regional characteristics generally show insignificant response.

Short run analysis and difference specification. To explore the short run effect of income windfalls on regional births, we replace in equation (2) OPS_t as the logarithm of the lagged 3-year moving average of real oil prices (instead of the original 20-year one).[21] As can be seen from Appendix Table C2.4, the results turn out to be statistically insignificant, in other words, short run income windfalls do not appear to have an effect on regional births, even for young women. We, therefore, do not detect a procyclicality that typifies fertility responses to short run income fluctuations in developed countries (Black et al., 2013, Dausal et al., 2021, Sobotka et al., 2011). Along with our main results above, this suggests that the substitution of women pursuit of education and away from child rearing occurs over a time span that exceeds a couple of years.

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[21] Results do not change if this is modified to be a 2-year or a 4-year lag.

We have also explored using the difference in the regional number of children rather the levels – which results in a drop of sample size (already being small, less than 1000 observations, compared to the stock approach, which uses the number of individuals instead of regions as the unit of analysis). Since not are regions are covered in multiple surveys, the required availability of at least 2 observations per region restricts the sample. Still, as shown in Appendix Table C2.5, the results remain relatively robust for most age groups despite the drop in sample size.

4. Concluding remarks

In this paper we revisit the relationship between income and fertility, using a sample of Africa's countries for which population growth is an important and challenging issue. The broad question is whether economic development should result in reduced fertility in the long run – as it has repeatedly in various parts of the world in the context of modern economic growth. To address this question we exploit exogenous income shocks generated through international oil price fluctuations in oil rich Africa's regions. Using several fertility measures, in particular, those pertaining to cumulative and instantaneous fertility patterns, we find that income windfalls do reduce fertility over the long run (defined as a 20 year period). Our results are statistically significant; economically substantial; and are robust with respect to a range of specifications. We also find that the main effect operates on young women; and that education and changing family planning are some of the major mechanisms at play. In particular, income windfalls induce acquisition of more schooling; delay of the age of marriage; and delay of the birth of the first child. On the other hand, we do not detect their effect on the use of contraceptives. These findings indicate that Africa is no exception and, as economic development there takes holding, population growth slows down. The mechanisms provide support for the view that economic development causes human capital acquisition by women, with the associated increase in the opportunity cost of children bearing and rearing, as implied by the modern economic growth theory.

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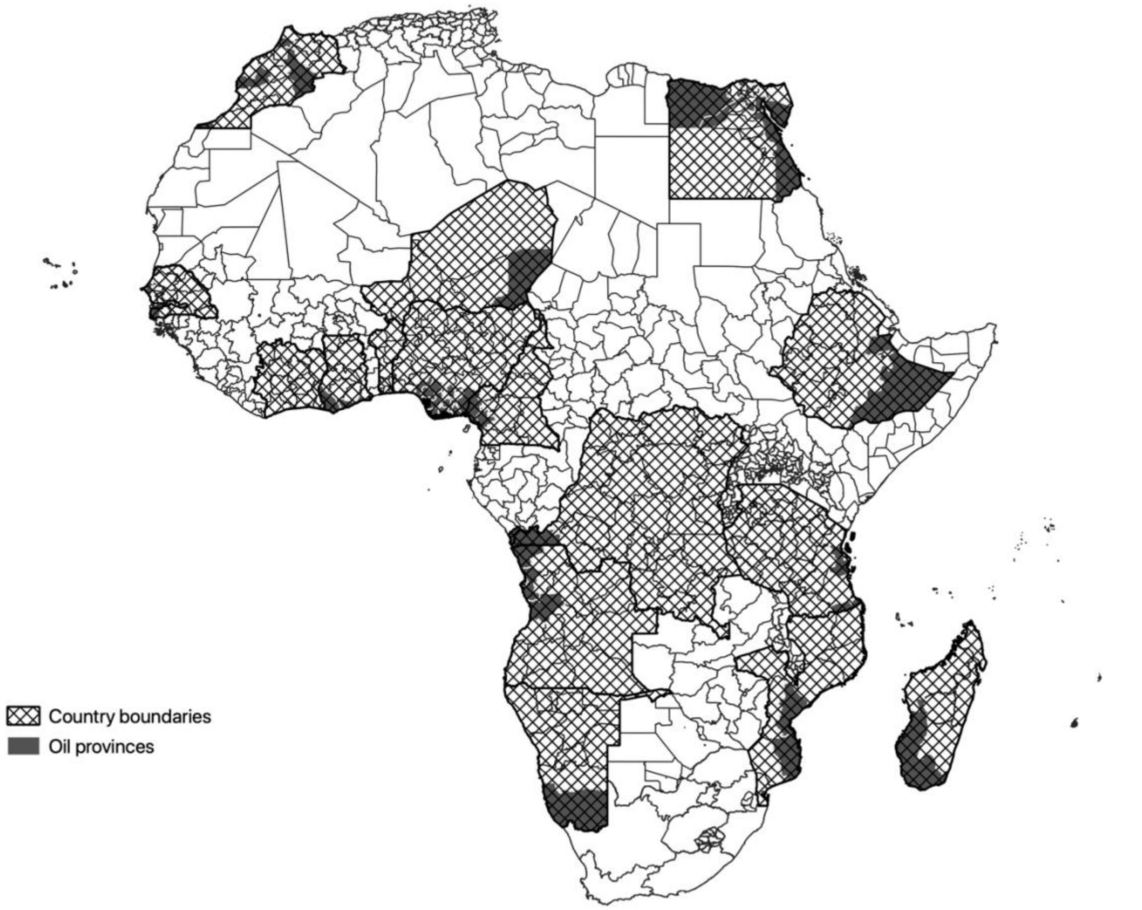
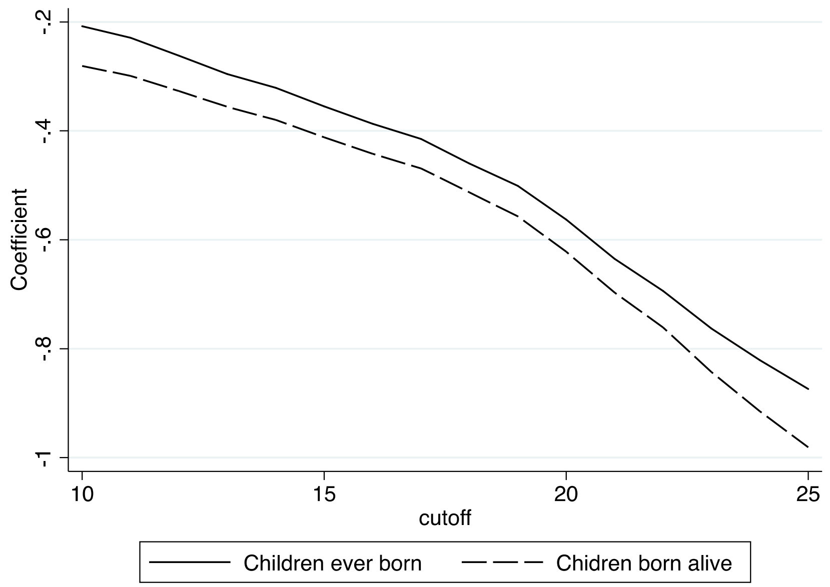
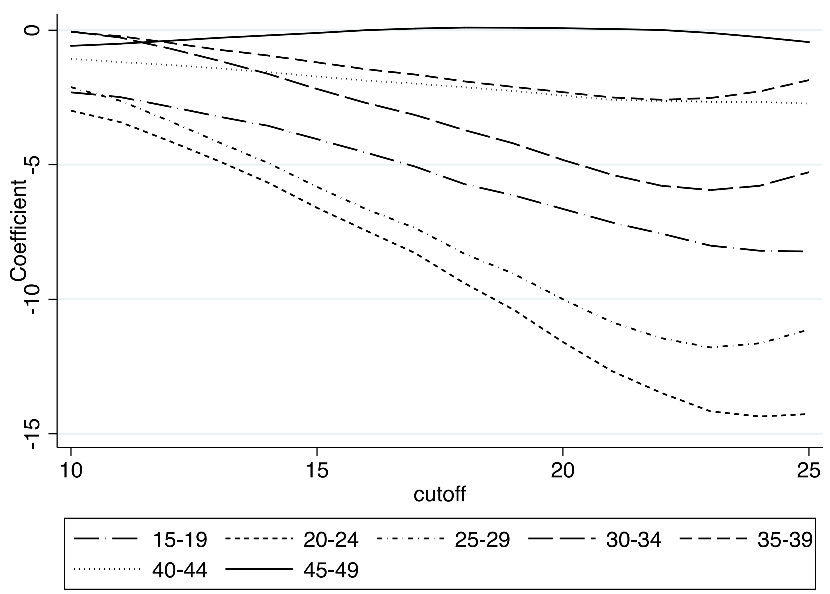


Figure 1. Location of oil provinces

Panel A: Stock approach

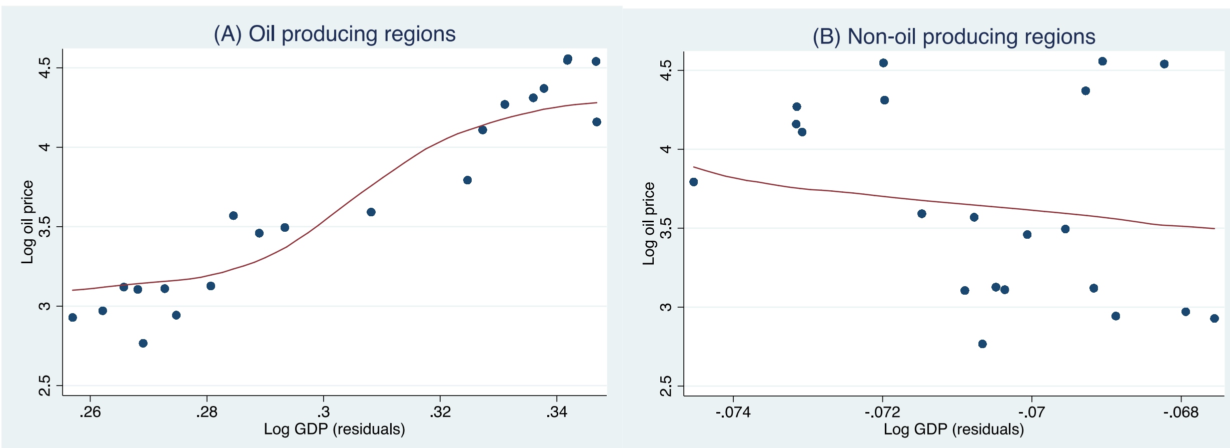


Panel B: Flow approach



Note: The graphs plot the estimated coefficients from running equations (1) and (2) using different average cut-offs for OPS ranging from 10 to 25 years.

Figure 2. Estimated coefficients for different averages of OPS



Note: Both figures are net of province and year fixed effects. The solid line represents the nonparametric local polynomial fit computed using an Epanechnikov kernel.

Figure 3. Log oil prices and average log GDP per capita at the province level

Table 1. Summary statistics

Panel A: women aged 30 years and older

Variable	N	Mean	SD	Min	Max	Difference (oil vs. non-oil)
			Oil regions			
Children ever born	44,478	4.457	2.355	1	18	***a
Children born alive	44,478	3.965	2.018	0	15	***a
Child mortality	44,478	0.492	0.947	0	11	***a
Years of education	44,461	6.400	5.274	0	24	***a
% Urban	44,478	0.567	0.495	0	1	***a
Age at first marriage	43,287	20.292	5.165	7	48	***a
Age at first birth	44,478	21.212	4.851	8	48	***a
% Never married	44,478	0.027	0.161	0	1	***a
% Current marrried	44,478	0.846	0.361	0	1	n.s.
% Former married	44,478	0.127	0.333	0	1	***a
			Non-oil regions			
Children ever born	180,791	5.302	2.613	1	29	
Children born alive	180,791	4.424	2.123	0	16	
Child mortality	180,791	0.878	1.353	0	20	
Years of education	180,714	3.638	4.826	0	24	
% Urban	180,791	0.354	0.478	0	1	
Age at first marriage	176,441	18.483	4.879	4	49	
Age at first birth	180,791	20.006	4.479	6	46	
% Never married	180,791	0.024	0.153	0	1	
% Current marrried	180,791	0.871	0.335	0	1	
% Former married	180,791	0.105	0.307	0	1	
			All sample			
Log(oil price 20-years average)	225,268	3.632	0.264	3.271	4.084	
age	225,268	38.129	5.717	30	49	

Note: the unit of analysis is women aged 30 years old and more. [a] indicates that the difference between oil and non-oil regions samples is statistically significant. n.s. indicates that difference is not statistically significant. Difference is based on nonparametric K-sample test on the equality of medians.

Panel B: regional-survey year level

Variable	N	Mean	SD	Min	Max	Difference (oil vs. non-oil)
			Oil regions			
Number of births	187	62.273	87.276	0.267	816.848	***a
Average number of dead children	188	0.678	0.364	0.068	2.142	***a
Years of education	188	5.274	2.605	0.257	11.054	***a
% Urban	188	0.508	0.310	0	1	***a
Age at first marriage	188	18.773	1.486	14.116	24.247	***a
Age at first birth	188	19.676	1.293	16.616	22.984	***a
% Never married	188	0.025	0.040	0	0.326	***a
% Current marrried	188	0.874	0.066	0.566	1	***a
% Former married	188	0.101	0.044	0	0.216	***a
			Non-oil regions			
Number of births	750	82.735	109.749	0.200	1,046.785	
Average number of dead children	752	0.977	0.519	0.058	2.972	
Average years of education	752	3.197	2.385	0.081	10.442	
% Urban	752	0.294	0.229	0	1	
Average age at first marriage	752	17.630	1.910	11.840	26.056	
Average age at first birth	752	18.781	1.150	15.885	22.976	
% Never married	752	0.026	0.068	0	0.497	
% Current marrried	752	0.888	0.095	0.398	1	
% Former married	752	0.086	0.053	0	0.279	
			All sample			
Log(oil price 20-years average)	937	3.631	0.280	3.271	4.127	

Note: the unit of analysis is region-survey year. [a] indicates that the difference between oil and non-oil regions samples is statistically significant. Difference is based on nonparametric K-sample test on the equality of medians.

Table 2: Oil price shocks and correlations with regional pre-existing factors

	(1)	(2)	(3)	(4)	(5)	(6)
	Vegetation index	**Min temperature**	**Max temperature**	**Malaria index**	**Population density**	**Elevation**
Oil price shock × Oil Province	0.022	0.293	-0.112	-0.840	343.386	-0.025
	(0.018)	(0.213)	(0.238)	(1.960)	(345.779)	(0.034)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	15,616	19,852	19,852	11,277	19,852	21,020
Number of regions	183	220	220	156	220	218
R-squared	0.999	0.934	0.903	0.856	0.715	0.999
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table 3. The effect of OPS on the number of children – stock analysis

	(1)	(2)	(3)	(4)
	Children Ever born	Children born alive	Children Ever born	Children born alive
Oil price shock × Oil Province	-0.609***	-0.677***	-0.563***	-0.622***
	(0.177)	(0.145)	(0.167)	(0.136)
Controls	No	No	Yes	Yes
Number of observations	225,268	225,268	225,268	225,268
Number of regions	247	247	247	247
R-squared	0.274	0.170	0.320	0.213
Cohort FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes

The dependent variable in column 1 is the number of children ever born; and in column 2 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table 4. The effect of OPS on additional outcomes - stock analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Panel A: Socioeconomic outcomes									
	Woman's education	Woman's Age first marriage	Woman's Age at 1st birth	Work	Child mortality	Husband's education	Husband's work	Woman earns more than husband	Woman earns less than husband	Woman earns same as husband
Oil price shock × Oil Province	0.823***	0.585**	1.136***	-0.061**	0.059	0.018	-0.004	0.010	-0.009	0.028***
	(0.245)	(0.256)	(0.267)	(0.027)	(0.067)	(0.279)	(0.008)	(0.007)	(0.028)	(0.011)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	225,174	219,727	225,268	224,937	225,268	206,591	210,248	225,268	225,268	225,268
Number of regions	247	247	247	247	247	217	217	247	247	247
R-squared	0.415	0.890	0.110	0.299	0.211	0.382	0.036	0.033	0.336	0.046
	Panel B: Fertility preferences									
	Women & Husband want same no of kids	Husband Want More kids	Husband Want Fewer kids	Ideal no of kids = 0	Ideal no of kids = 1	Ideal no of kids = 2	Ideal no of kids = 3	Ideal no of kids = 4	Ideal no of kids = 5	Ideal no of kids = 6+
Oil price shock × Oil Province	0.008	-0.148***	0.006	0.003	0.002	-0.011	0.030	0.023	0.001	-0.139***
	(0.029)	(0.031)	(0.012)	(0.010)	(0.003)	(0.013)	(0.020)	(0.021)	(0.015)	(0.048)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	191,208	191,208	191,208	225,269	225,269	225,269	225,269	225,269	225,269	225,269
Number of regions	247	247	247	247	247	247	247	247	247	247
R-squared	0.166	0.108	0.021	0.049	0.020	0.188	0.111	0.081	0.047	0.254
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table 5. Flow analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-6.643***	-11.591***	-10.001**	-4.820	-2.304	-2.431**	0.073	-29.541**
	(1.913)	(3.779)	(4.462)	(2.992)	(2.429)	(1.102)	(0.987)	-13.222
Number of observations	808	875	868	863	832	654	271	894
Number of regions	210	217	216	215	213	194	98	218
R-squared	0.886	0.897	0.896	0.886	0.903	0.862	0.727	0.925
	Add additional covariates							
Oil price shock × Oil Province	-4.875***	-7.836**	-6.950*	-2.589	-1.273	-2.003**	0.335	-18.254
	(1.521)	(3.150)	(4.051)	(2.775)	(2.172)	(1.009)	(0.941)	(11.536)
mean years of schooling	-1.296***	-2.631***	-1.290*	-1.139**	-0.972**	-0.282	0.049	-6.445***
	(0.492)	(0.798)	(0.673)	(0.484)	(0.416)	(0.278)	(0.381)	(2.345)
Work	5.155	8.163*	10.401*	1.246	0.810	0.283	3.301	17.689
	(3.231)	(4.729)	(5.615)	(3.682)	(2.585)	(2.432)	(2.495)	(15.900)
% of urban population	-0.048	-0.196	-0.769	-1.678	3.306	-2.770**	-1.260	-7.469
	(2.295)	(4.877)	(5.073)	(3.281)	(2.395)	(1.375)	(1.409)	(13.993)
Infant mortality	1.567	1.295	1.056	1.918	1.985**	0.746	-0.404	4.026
	(1.116)	(1.723)	(1.919)	(1.333)	(0.885)	(0.689)	(1.052)	(6.336)
% currently married	-10.344	-36.195	25.913	11.219	-15.529	-6.127	7.259	-7.522
	(15.579)	(26.394)	(27.898)	(16.606)	(10.444)	(7.094)	(10.882)	(81.426)
% formerly married	1.185	-40.775	6.346	-12.455	-34.078***	-4.407	7.643	-46.573
	(18.081)	(30.403)	(30.816)	(19.930)	(13.057)	(8.638)	(10.964)	(92.045)
Number of observations	808	875	868	863	832	654	276	894
Number of regions	210	217	216	215	213	194	98	218
R-squared	0.891	0.900	0.897	0.888	0.906	0.864	0.736	0.927
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

APPENDICES

APPENDIX A: Preliminaries and main analysis

Table A1. Sampled countries and survey waves

Country	Year	Country	Year
Angola	2015	Namibia	2000
Cameroon	1991	Namibia	2006
Cameroon	2004	Namibia	2013
Cameroon	2011	Niger	1992
Congo democratic republic	2007	Niger	1998
Congo democratic republic	2013	Nigeria	1990
Benin	1996	Nigeria	2003
Benin	2001	Nigeria	2008
Benin	2011	Nigeria	2013
Ethiopia	2000	Nigeria	2018
Ethiopia	2005	Senegal	2005
Ghana	1993	Senegal	2010
Ghana	1998	Senegal	2012
Ghana	2003	Senegal	2014
Ghana	2008	Senegal	2015
Ghana	2014	Senegal	2016
Cote d'ivoire	1994	Egypt	1992
Cote d'ivoire	1998	Egypt	1995
Cote d'ivoire	2011	Egypt	2005
Madagascar	1997	Egypt	2008
Madagascar	2008	Egypt	2014
Mozambique	2011	Tanzania	1999

Table A2. Unit root testing for oil prices

Variable	Log Oil Prices (Annual)		Log Oil Prices (Lagged 20-year average)	
	without trend	with trend	without trend	with trend
Dickey-Fuller	n.s.	n.s.	n.s.	n.s.
Dickey-Fuller-GLS	n.s.	n.s.	n.s.	n.s.
Philipps-Perron	n.s.	n.s.	n.s.	n.s.

Note: Abbreviation: n.s., not significant at the 10% level.

Table A3a. estimated coefficients for figure 2A

	(1)	(2)
	Children Ever born	**Children born alive**
Oil price shock (10 year) × Oil Province	-0.208**	-0.281***
	(0.093)	(0.074)
Oil price shock (11 year) × Oil Province	-0.229**	-0.299***
	(0.096)	(0.076)
Oil price shock (12 year) × Oil Province	-0.262***	-0.327***
	(0.100)	(0.081)
Oil price shock (13 year) × Oil Province	-0.296***	-0.356***
	(0.106)	(0.086)
Oil price shock (14 year) × Oil Province	-0.321***	-0.380***
	(0.111)	(0.091)
Oil price shock (15 year) × Oil Province	-0.355***	-0.412***
	(0.117)	(0.095)
Oil price shock (16 year) × Oil Province	-0.387***	-0.442***
	(0.123)	(0.100)
Oil price shock (17 year) × Oil Province	-0.415***	-0.469***
	(0.130)	(0.106)
Oil price shock (18 year) × Oil Province	-0.460***	-0.513***
	(0.140)	(0.115)
Oil price shock (19 year) × Oil Province	-0.501***	-0.557***
	(0.152)	(0.124)
Oil price shock (20 year) × Oil Province	-0.563***	-0.622***
	(0.167)	(0.136)
Oil price shock (21 year) × Oil Province	-0.635***	-0.697***
	(0.182)	(0.148)
Oil price shock (22 year) × Oil Province	-0.694***	-0.761***
	(0.198)	(0.159)
Oil price shock (23 year) × Oil Province	-0.763***	-0.843***
	(0.220)	(0.177)
Oil price shock (24 year) × Oil Province	-0.821***	-0.915***
	(0.242)	(0.194)
Oil price shock (25 year) × Oil Province	-0.874***	-0.981***
	(0.261)	(0.209)
Number of observations	225,268	225,268
Number of regions	247	247
Region FE	Yes	Yes
Year FE	Yes	Yes
Single-year age FE	Yes	Yes
Country x Year	Yes	Yes

Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table A3b. estimated coefficients for figure 2B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
Oil price shock (10 year) × Oil Province	-2.311**	-2.991	-2.115	-0.044	-0.060	-1.064	-0.582
	(1.019)	(1.903)	(2.417)	(1.621)	(1.097)	(0.658)	(0.693)
Oil price shock (11 year) × Oil Province	-2.484**	-3.412*	-2.622	-0.274	-0.225	-1.187*	-0.502
	(1.067)	(1.999)	(2.515)	(1.683)	(1.152)	(0.708)	(0.728)
Oil price shock (12 year) × Oil Province	-2.836**	-4.118*	-3.371	-0.676	-0.467	-1.292*	-0.392
	(1.112)	(2.114)	(2.629)	(1.778)	(1.246)	(0.748)	(0.766)
Oil price shock (13 year) × Oil Province	-3.213***	-4.861**	-4.164	-1.128	-0.723	-1.420*	-0.284
	(1.157)	(2.251)	(2.735)	(1.875)	(1.345)	(0.793)	(0.797)
Oil price shock (14 year) × Oil Province	-3.551***	-5.659**	-4.930*	-1.621	-0.941	-1.559*	-0.192
	(1.220)	(2.379)	(2.844)	(1.968)	(1.448)	(0.826)	(0.829)
Oil price shock (15 year) × Oil Province	-4.049***	-6.599**	-5.824*	-2.184	-1.195	-1.724**	-0.098
	(1.309)	(2.551)	(3.013)	(2.117)	(1.583)	(0.859)	(0.867)
Oil price shock (16 year) × Oil Province	-4.549***	-7.450***	-6.652**	-2.705	-1.450	-1.877**	0.004
	(1.406)	(2.739)	(3.217)	(2.269)	(1.719)	(0.904)	(0.905)
Oil price shock (17 year) × Oil Province	-5.075***	-8.292***	-7.357**	-3.152	-1.647	-1.988**	0.064
	(1.497)	(2.899)	(3.412)	(2.402)	(1.859)	(0.936)	(0.916)
Oil price shock (18 year) × Oil Province	-5.725***	-9.407***	-8.310**	-3.713	-1.904	-2.122**	0.102
	(1.636)	(3.189)	(3.748)	(2.611)	(2.056)	(0.998)	(0.935)
Oil price shock (19 year) × Oil Province	-6.141***	-10.394***	-9.056**	-4.211	-2.107	-2.261**	0.095
	(1.766)	(3.455)	(4.076)	(2.776)	(2.219)	(1.054)	(0.956)
Oil price shock (20 year) × Oil Province	-6.643***	-11.591***	-10.001**	-4.820	-2.304	-2.431**	0.073
	(1.913)	(3.779)	(4.462)	(2.992)	(2.429)	(1.102)	(0.987)
Oil price shock (21 year) × Oil Province	-7.151***	-12.676***	-10.856**	-5.377*	-2.498	-2.589**	0.042
	(2.041)	(4.077)	(4.810)	(3.210)	(2.632)	(1.151)	(1.017)
Oil price shock (22 year) × Oil Province	-7.562***	-13.483***	-11.448**	-5.781*	-2.585	-2.625**	0.006
	(2.107)	(4.327)	(5.086)	(3.374)	(2.797)	(1.187)	(1.032)
Oil price shock (23 year) × Oil Province	-8.010***	-14.168***	-11.794**	-5.940	-2.519	-2.660**	-0.100
	(2.200)	(4.619)	(5.414)	(3.628)	(3.015)	(1.239)	(1.081)
Oil price shock (24 year) × Oil Province	-8.195***	-14.359***	-11.639**	-5.781	-2.275	-2.662**	-0.260
	(2.261)	(4.824)	(5.647)	(3.848)	(3.173)	(1.281)	(1.129)
Oil price shock (25 year) × Oil Province	-8.229***	-14.268***	-11.127*	-5.278	-1.853	-2.725**	-0.444
	(2.333)	(4.949)	(5.845)	(4.041)	(3.304)	(1.322)	(1.169)
Number of observations	808	875	868	863	832	654	271
Number of regions	210	217	216	215	213	194	98
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table A4. Correlations between different oil price shocks

	OPS (10 year lagged)	OPS (11 year lagged)	OPS (12 year lagged)	OPS (13 year lagged)	OPS (14 year lagged)	OPS (15 year lagged)	OPS (16 year lagged)	OPS (17 year lagged)	OPS (18 year lagged)	OPS (19 year lagged)	OPS (20 year lagged)	OPS (21 year lagged)	OPS (22 year lagged)	OPS (23 year lagged)	OPS (24 year lagged)	OPS (25 year lagged)	OPS (flexible window)
Oil price shock (10 year lagged)	1																
Oil price shock (11 year lagged)	0.998	1															
Oil price shock (12 year lagged)	0.992	0.998	1														
Oil price shock (13 year lagged)	0.984	0.992	0.998	1													
Oil price shock (14 year lagged)	0.974	0.985	0.993	0.998	1												
Oil price shock (15 year lagged)	0.963	0.976	0.986	0.994	0.998	1											
Oil price shock (16 year lagged)	0.950	0.964	0.977	0.986	0.993	0.998	1										
Oil price shock (17 year lagged)	0.937	0.951	0.965	0.977	0.985	0.993	0.998	1									
Oil price shock (18 year lagged)	0.923	0.939	0.953	0.966	0.975	0.986	0.993	0.998	1								
Oil price shock (19 year lagged)	0.911	0.926	0.940	0.954	0.963	0.975	0.985	0.993	0.998	1							
Oil price shock (20 year lagged)	0.902	0.916	0.929	0.942	0.952	0.965	0.976	0.984	0.992	0.998	1						
Oil price shock (21 year lagged)	0.894	0.906	0.917	0.929	0.938	0.952	0.963	0.972	0.982	0.990	0.997	1					
Oil price shock (22 year lagged)	0.890	0.900	0.909	0.919	0.928	0.940	0.950	0.959	0.969	0.979	0.990	0.997	1				
Oil price shock (23 year lagged)	0.891	0.897	0.903	0.911	0.917	0.927	0.935	0.943	0.953	0.964	0.977	0.988	0.996	1			
Oil price shock (24 year lagged)	0.889	0.891	0.893	0.898	0.901	0.908	0.913	0.919	0.928	0.940	0.956	0.970	0.984	0.996	1		
Oil price shock (25 year lagged)	0.890	0.888	0.886	0.886	0.886	0.890	0.893	0.896	0.903	0.914	0.931	0.948	0.966	0.984	0.995	1	
Oil price shock (flexible window)	0.888	0.896	0.904	0.911	0.916	0.923	0.928	0.932	0.935	0.939	0.941	0.941	0.939	0.934	0.923	0.908	1

Note: All the correlations are statistically significant at the 1% significance level

Table A5. Oil prices and regional GDP

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log (GDP per capita)	**Log (GDP per capita)**	**Log (GDP per capita)**	**Log(GDP per capita)**	**Log (GDP per capita)**	**Log(GDP per capita)**	**Log (GDP per capita)**	**Log (GDP per capita)**
log(oil price), t x oil province	0.052**							
	(0.024)							
log(oil price), t-1 x oil province		0.053**						
		(0.025)						
log(oil price), lag 3-year average x oil province			0.058**					
			(0.028)					
log(oil price), lag 5-year average x oil province				0.060**				
				(0.030)				
log(oil price), lag 7-year average x oil province					0.065*			
					(0.033)			
log(oil price), lag 10-year average x oil province						0.070*		
						(0.038)		
log(oil price), lag 15-year average x oil province							0.050	
							(0.039)	
log(oil price), lag 20-year average x oil province								0.036
								(0.051)
Number of observations	4,830	4,830	4,830	4,830	4,830	4,830	4,830	4,830
Number of regions	230	230	230	230	230	230	230	230
R-squared	0.979	0.979	0.979	0.979	0.979	0.979	0.979	0.979
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the log(GDP per capita) for the period 1992-2012. Oil province is a dummy that takes a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table A6. Oil prices and household income – Nigeria

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Real household income per capita (log)	**Real household income per capita (log)**	**Real household income per capita (log)**	**Real household income per capita (log)**	**Real household income per capita (log)**	**Real household income per capita (log)**	**Real household income per capita (log)**
log(oil price), t x oil province	0.061						
	(0.485)						
log(oil price), t-1 x oil province		1.843*					
		(0.944)					
log(oil price), lag 3-year average x oil province			1.929*				
			(1.000)				
log(oil price), lag 5-year average x oil province				3.627**			
				(1.722)			
log(oil price), lag 7-year average x oil province					1.359		
					(1.384)		
log(oil price), lag 10-year average x oil province						-0.273	
						(1.089)	
log(oil price), lag 15-year average x oil province							-0.814
							(1.011)
Number of observations	136	136	136	136	136	136	136
Number of regions	37	37	37	37	37	37	37
R-squared	0.181	0.215	0.218	0.213	0.185	0.181	0.185
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Appendix B – Robustness and additional mechanisms

Stock analysis

Table B1.1. Sample size

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Add non-oil producing countries		Drop countries with only 1 oil region		Oil producing countries since 1960		Only Angola and Nigeria	
	Children Ever born	Children born alive	Children Ever born	Children born alive	Children Ever born	Children born alive	Children Ever born	Children born alive
Oil price shock × Oil Province	-0.589***	-0.645***	-0.593***	-0.653***	-0.520**	-0.630***	-1.123***	-1.125***
	(0.170)	(0.140)	(0.170)	(0.137)	(0.229)	(0.182)	(0.239)	(0.176)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	404,290	404,290	176,051	176,051	115,398	115,398	58,989	58,989
Number of regions	462	462	177	177	108	108	55	55
R-squared	0.326	0.225	0.316	0.215	0.346	0.230	0.312	0.188
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns 1, 3, 5 and 7 is the number of children ever born; in columns 2, 4, 6 and 8 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.2. Age cutoff

	(1)	(2)	(3)	(4)	(5)	(6)
	Women >= 35 years old		Women >= 40 years old		Women >= 45 years old	
	Children Ever born	Children born alive	Children Ever born	Children born alive	Children Ever born	Children born alive
Oil price shock × Oil Province	-0.627***	-0.676***	-0.780***	-0.782***	-0.702***	-0.700***
	(0.199)	(0.160)	(0.222)	(0.174)	(0.253)	(0.206)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	155,001	155,001	92,637	92,637	42,955	42,955
Number of regions	247	247	247	247	247	247
R-squared	0.270	0.160	0.243	0.136	0.233	0.126
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in coulmns 1, 3, and 5 is the number of children ever born; in columns 2, 4, and 6 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.3. Migration

	(1)	(2)	(3)	(4)
	Children Ever born	**Children born alive**	**Migration**	**Urbanization**
Oil price shock × Oil Province	-1.247***	-1.169***	-0.036	-0.050
	(0.249)	(0.194)	(0.130)	(0.038)
Oil price shock × Oil Province × Migrants	-0.012	-0.004		
	(0.019)	(0.016)		
Controls	Yes	Yes	Yes	Yes
Number of observations	140,526	140,526	140,526	225,268
Number of regions	236	236	236	247
R-squared	0.313	0.203	0.164	0.279
Cohort FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes

The dependent variable in column 1 is the number of children ever born; in column 2 is the number of children born alive; in column 3 is an indicator that takes the value of 1 if the respondent is migrant; and in column 4 is indicator that takes the value of 1 if the respondent lives in urban area, and zero otherwise. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.4. Flexible window, minerals, post 1973, and reshuffling of regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Oil price shock (flexible window)		**Other minerals**		**Post 1973**		**Reshuffle oil regions**	
	Children Ever born	**Children born alive**	**Children Ever born**	**Children born alive**	**Children Ever born**	**Children born alive**	**Children Ever born**	**Children born alive**
Oil price shock × Oil Province	-0.375**	-0.578***	-0.563***	-0.623***	-0.537***	-0.479***		
	(0.156)	(0.131)	(0.168)	(0.137)	(0.142)	(0.099)		
Mineral price shock × Mineral Province			-0.005	0.009				
			(0.014)	(0.011)				
Oil price shock × Reshuffled Oil Province							0.003	0.003
							(0.003)	(0.003)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	225,268	225,268	225,268	225,268	92,631	92,631	225,268	225,268
Number of regions	247	247	247	247	247	247	247	247
R-squared	0.319	0.213	0.320	0.213	0.341	0.250	0.319	0.212
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country specific-time trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable in columns 1, 3, 5 and 7 is the number of children ever born; in columns 2, 4, 6 and 8 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.5. Differential trends – Stock approach

	(1)	(2)
	Children Ever born	Children born alive
Oil price shock × Oil Province	-2.771***	-2.521***
	(0.482)	(0.365)
Oil price shock × Oil Province × 1991	-0.204*	-0.143
	(0.120)	(0.102)
Oil price shock × Oil Province × 1992	-0.399***	-0.274***
	(0.086)	(0.059)
Oil price shock × Oil Province × 1993	-0.229***	-0.195***
	(0.075)	(0.059)
Oil price shock × Oil Province × 1994	-0.220***	-0.190***
	(0.079)	(0.057)
Oil price shock × Oil Province × 1995	-0.365***	-0.268***
	(0.081)	(0.051)
Oil price shock × Oil Province × 1996	-0.474***	-0.268***
	(0.087)	(0.064)
Oil price shock × Oil Province × 1997	-0.400***	-0.336***
	(0.079)	(0.049)
Oil price shock × Oil Province × 1998	-0.273***	-0.227***
	(0.078)	(0.055)
Oil price shock × Oil Province × 2000	-0.418***	-0.375***
	(0.086)	(0.069)
Oil price shock × Oil Province × 2001	-0.597***	-0.427***
	(0.101)	(0.072)
Oil price shock × Oil Province × 2003	-0.411***	-0.356***
	(0.099)	(0.066)
Oil price shock × Oil Province × 2004	-0.606***	-0.512***
	(0.119)	(0.088)
Oil price shock × Oil Province × 2005	-0.527***	-0.443***
	(0.104)	(0.072)
Oil price shock × Oil Province × 2006	-0.580***	-0.513***
	(0.105)	(0.077)
Oil price shock × Oil Province × 2007	-0.397***	-0.350***
	(0.095)	(0.069)
Oil price shock × Oil Province × 2008	-0.302***	-0.264***
	(0.072)	(0.046)
Oil price shock × Oil Province × 2010	-0.229***	-0.170***
	(0.061)	(0.036)
Oil price shock × Oil Province × 2011	-0.252***	-0.209***
	(0.066)	(0.047)
Oil price shock × Oil Province × 2012	-0.116**	-0.089**
	(0.058)	(0.037)
Oil price shock × Oil Province × 2013	-0.020	-0.016
	(0.033)	(0.021)
Oil price shock × Oil Province × 2014	0.064	0.062**
	(0.041)	(0.027)
Oil price shock × Oil Province × 2015	0.038	0.049
	(0.046)	(0.034)
Oil price shock × Oil Province × 2016	0.047	0.064
	(0.057)	(0.047)
Controls	Yes	Yes
Number of observations	225,268	225,268
Number of regions	247	247
R-squared	0.321	0.215
Cohort FE	Yes	Yes
Region FE	Yes	Yes
Year FE	Yes	Yes
Country x Year	Yes	Yes

The dependent variable in column 1 is the number of children ever born; and in column 2 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.6. Dropping off-shore fields; number of children at the cluster level; and conflict

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Drop regions with only off-shore wells		Average number of children at the cluster level		Conflict indicators		
	Children Ever born	Children born alive	Children Ever born	Children born alive	number of battles	number of riots	violence against civiliance
Oil price shock × Oil Province	-0.657***	-0.728***	-0.306***	-0.353***	-0.106	0.105	-0.004
	(0.220)	(0.181)	(0.114)	(0.093)	(0.100)	(0.205)	(0.071)
Controls	Yes	Yes	Yes	Yes	Yes		Yes
Number of observations	210,256	210,256	225,268	225,268	16,858	16,858	16,858
Number of regions	231	231	247	247	220	220	220
R-squared	0.316	0.208	0.507	0.340	0.494	0.607	0.657
Cohort FE	Yes	Yes	Yes	Yes	Yes		Yes
Region FE	Yes	Yes	Yes	Yes	Yes		Yes
Year FE	Yes	Yes	Yes	Yes	Yes		Yes
Country x Year	Yes	Yes	Yes	Yes	Yes		Yes

The dependent variable in columns 1 and 3 is the number of children ever born; in columns 2 and 4 is the number of children born alive. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.7. Other mechanisms - the use of contraceptives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Current contraceptive user	Previous contraceptive user	Never used contraceptive	Current contraceptive user - Traditional	Current contraceptive user - Modern	Previous contraceptive user - Traditional	Previous contraceptive user - Modern
Oil price shock × Oil Province	-0.034	-0.068***	0.102***	-0.005	-0.030*	-0.062***	-0.284***
	(0.022)	(0.023)	(0.035)	(0.012)	(0.018)	(0.015)	(0.047)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	225,269	225,269	225,269	225,269	225,269	225,269	225,269
Number of regions	247	247	247	247	247	247	247
R-squared	0.246	0.075	0.350	0.071	0.241	0.159	0.549
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table B1.8. Other mechanisms – work sectors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	professional	**clerical**	**sales**	**agriculture self-employment**	**agriculture employment**	**Domestic**	**service**	**skilled**	**unskilled**
Oil price shock × Oil Province	0.011	-0.015**	-0.019	-0.053**	0.020	0.009***	0.037***	0.008	-0.004
	(0.011)	(0.006)	(0.033)	(0.025)	(0.013)	(0.004)	(0.012)	(0.009)	(0.009)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	220,532	220,532	220,532	220,532	220,532	220,532	220,532	224,937	220,532
Number of regions	247	247	247	247	217	217	247	247	247
R-squared	0.055	0.035	0.250	0.348	0.238	0.041	0.093	0.052	0.120
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. Controls include mother's age, month of survey, religion, urban residency, marital status and sex of household head. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Appendix C – Flow analysis

C1. Robustness checks

Table C1.1. Add non-oil regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-6.656***	-11.759***	-10.370**	-3.887	-2.300	-2.474**	-0.143	-31.045**
	(1.903)	(3.836)	(4.491)	(3.086)	(2.423)	(1.109)	(0.909)	(13.404)
Number of observations	1,442	1,583	1,557	1,540	1,440	1,101	447	1,637
Number of regions	422	444	440	439	420	359	163	446
R-squared	0.883	0.900	0.905	0.899	0.903	0.864	0.725	0.932
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C1.2. Drop countries with 1 oil region

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-6.765***	-11.488***	-10.042**	-3.053	-2.003	-2.900***	0.058	-27.845**
	(1.893)	(3.572)	(4.459)	(3.123)	(2.482)	(1.080)	(1.062)	(12.461)
Number of observations	620	678	671	670	638	483	201	695
Number of regions	145	148	147	148	145	134	71	148
R-squared	0.858	0.820	0.810	0.802	0.791	0.796	0.713	0.863
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C1.3. Keep countries that have been producing through the whole period

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-7.715***	-17.352***	-14.881**	-7.765*	-3.994	-4.523***	0.036	-40.035**
	(2.903)	(4.432)	(5.701)	(4.017)	(3.312)	(1.368)	(1.280)	(16.032)
Number of observations	348	400	403	393	379	268	108	412
Number of regions	85	89	90	88	89	80	37	90
R-squared	0.715	0.742	0.764	0.740	0.714	0.743	0.683	0.826
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C1.4. Nigeria and Angola

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-13.002***	-24.764***	-22.737***	-10.562*	-6.509	-4.772***	0.300	-49.916**
	(3.681)	(5.522)	(7.381)	(5.806)	(4.510)	(1.526)	(1.416)	(23.948)
Number of observations	159	179	180	176	170	139	89	185
Number of regions	37	37	37	37	37	37	28	37
R-squared	0.710	0.720	0.749	0.732	0.674	0.736	0.670	0.836
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C1.5. Add minerals

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	All
Oil price shock × Oil Province	-6.835***	-11.896***	-10.242**	-4.964	-2.355	-2.458**	0.068	-30.283**
	(1.943)	(3.819)	(4.499)	(3.018)	(2.447)	(1.116)	(1.029)	(13.325)
Mineral region × mineral price	1.361***	2.382***	2.008***	1.175***	0.391	0.186	0.008	6.699***
	(0.320)	(0.535)	(0.577)	(0.425)	(0.320)	(0.148)	(0.089)	(2.283)
Number of observations	808	875	868	863	832	654	276	894
Number of regions	261	261	261	261	261	261	261	261
R-squared	0.887	0.897	0.896	0.886	0.903	0.862	0.727	0.925
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C1.6. Placebo test – reshuffle oil regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	20-24	25-29	30-34	35-39	40-44	45-49	All
Oil price shock × Oil Province	0.152	0.257	-0.001	-0.030	-0.032	-0.169	0.098	-1.309
	(0.190)	(0.346)	(0.298)	(0.191)	(0.147)	(0.104)	(0.088)	(1.019)
Number of observations	808	875	868	863	832	654	276	894
Number of regions	261	261	261	261	261	261	261	261
R-squared	0.884	0.895	0.895	0.885	0.902	0.861	0.729	0.925
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

C2. Regional characteristics and short run – Flow analysis

Table C2.1. Oil price shocks and regional characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Education	**% Work**	**% never married**	**% current married**	**% former married**	**% urban**	**% of migrants**	**Infant mortality**	**% male children**
Oil price shock × Oil Province	1.006***	0.012	0.009	-0.020*	0.011	0.006	-0.113**	0.123	-0.002
	(0.297)	(0.027)	(0.006)	(0.012)	(0.010)	(0.039)	(0.044)	(0.076)	(0.007)
Number of observations	897	897	897	897	897	897	897	897	897
Number of regions	261	261	261	261	261	261	261	261	261
R-squared	0.949	0.938	0.970	0.921	0.801	0.902	0.886	0.850	0.348
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C2.2. Oil price shocks and regional characteristics

	(1)	(2)	(3)	(4)	(5)
	age at 1st marriage	**age at 1st birth**	**% current contraceptive users**	**% former contraceptive users**	**% never contraceptive users**
Oil price shock × Oil Province	0.533**	0.785***	0.006	-0.049**	0.044
	(0.251)	(0.216)	(0.026)	(0.023)	(0.039)
Number of observations	897	897	897	897	897
Number of regions	261	261	261	261	261
R-squared	0.944	0.892	0.937	0.786	0.920
Region FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C2.3. Oil price shocks and regional characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	% 15-19	**% 20-24**	**% 25-29**	**% 30-34**	**% 35-39**	**% 40-44**	**% 45-49**
Oil price shock × Oil Province	0.001	-0.015*	-0.016	0.002	0.014	0.014	-0.001
	(0.005)	(0.009)	(0.010)	(0.009)	(0.011)	(0.011)	(0.008)
Number of observations	897	897	897	897	897	897	897
Number of regions	261	261	261	261	261	261	261
R-squared	0.790	0.694	0.480	0.470	0.484	0.484	0.558
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C2.4. Flow analysis – Short run

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-0.601	0.405	1.623	1.850	1.099	-0.151	-0.870*	4.260
	(0.829)	(1.265)	(1.810)	(1.329)	(0.764)	(0.455)	(0.492)	(5.185)
Number of observations	894	808	875	868	863	832	654	276
Number of regions	210	217	216	215	213	194	98	218
R-squared	0.884	0.895	0.895	0.886	0.903	0.861	0.729	0.925
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the number of live births. Oil price shock is the ln-3 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.

Table C2.5. Flow analysis – differences in the number of regional births

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	15-19	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**All**
Oil price shock × Oil Province	-2.832	-7.581*	-6.886*	-3.056	-2.298	-1.039	-0.004	-12.356
	(2.109)	(3.978)	(4.347)	(3.168)	(2.036)	(1.601)	(0.130)	(12.823)
Number of observations	547	611	601	601	563	387	174	635
Number of regions	159	170	165	168	157	121	96	177
R-squared	0.532	0.597	0.620	0.594	0.607	0.538	0.392	0.712
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Single-year age FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country x Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The dependent variable is the first difference in the number of live births. Oil price shock is the ln-20 years average of oil price for period *t* multiplied by a dummy that take a value of 1 if the region is producing oil. The method of estimation is ordinary least squares with Huber-robust standard errors (reported in parentheses) clustered at the region level. Significantly different from zero at *10% significance, **5% significance level, ***1% significance level.