Access to higher education and Family Formation: Evidence from University Expansion in Nigeria*

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Abstract

How do greater education opportunities impact family formation? Using the rapid university expansion in Nigeria in the 2000s, I examine the influence of higher education on the marriage market, fertility and child development outcomes of women. My empirical analysis combines a self-constructed dataset on the timing and location of university openings with administrative and survey data, and uses a difference-in-differences estimator that exploits the regional and cohort-wise variation in exposure to the university expansion. I find that university openings improved years of schooling and educational attainment among school-aged women. It also delayed the timing of first marriage and childbirth of women. In addition, women had fewer births, and their children were more likely to have better development outcomes. I show suggestive evidence that these outcomes are driven by increased autonomy - women delay sexual activity, and are more likely to work, use contraception and have the final say over important decisions.

Keywords: higher education, marriage, family structure, gender

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1 Introduction

How do greater education opportunities influence family formation in developing countries? Decisions about partnerships and childbearing - if and when to marry, who to marry, and how many children to have, if any - are some of the most important economic choices individuals make during their lifetimes, with far-reaching consequences for income, well-being and mobility (Geruso and Royer, 2018). This is especially true for women in developing countries, given limited female formal labor force participation, the economic significance of marriage markets, and the reliance on kin networks in the absence of formal safety nets (Anukriti and Dasgupta, 2017; Cox and Fafchamps, 2007; Azcona and Bhatt, 2020).

Early theoretical literature in economics emphasized the influence of education on family formation via: assortative mating in marriage markets (Becker, 1991; Chiappori, Iyigun and Weiss, 2009), higher labor market returns and quantity-quality tradeoffs in fertility decisions and child investments (Becker, 1965; Becker and Lewis, 1973; Becker and Tomes, 1976). More recently, empirical studies have found strong causal effects on family formation of policies that extend the duration of compulsory schooling (Lefgren and McIntyre, 2006; McCrary and Royer, 2011; Anderberg and Zhu, 2014), or expand access to schools in developing countries (Breierova and Duflo, 2004; Hahn, Nuzhat and Yang, 2018; Duflo, Dupas and Kremer, 2021). However, we know very little about the impact of post-secondary education. This is an important gap in the literature, given the recent expansion and growing importance of higher education in low and middle-income countries as school completion rates improve, the demand for highly-skilled labor grows, and the returns to college increase (Ilie and Rose, 2016; Marginson, 2016; Atherton, 2016; Psacharopoulos and Patrinos, 2018).

This paper asks whether increased access to higher education leads to improved family formation outcomes for women in developing countries. To do so, I examine the impact of women's exposure to a rapid university expansion in Nigeria on three key aspects of the family formation process - the likelihood and timing of first marriage and birth, their spouses' characteristics, and the quantity and "quality" of any children produced in the marriage. In 1999, the Nigerian federal government embarked on a large-scale university expansion to cater to the rising demand for higher education, and to address the disparities in access to universities across the country. The expansion led to the opening of 153 new universities (57 public and 99 private) between 1999 and 2021.

Enrollment also rose significantly as a result, from 280,000 students in 1998 to over 1.8 million students in 2018. However, like many other developing countries, there are gender

gaps in tertiary enrolment. The female gross tertiary enrollment rate stood at 10 percent in 2018, compared to 14 percent for males.[1] These gender gaps in attendance exist at all levels of schooling, but these gaps begin to widen around age 15, when girls are simultaneously dropping out of school, and getting married almost a decade before their male peers. Gender discrimination and lower demand for higher education no doubt contribute to these trends, but the inadequate supply of institutions is an important constraint. Less than 20 percent of students who apply to Nigerian universities each year are accepted on average, and a third of the states had no university before the expansion.

School construction has been used in many countries to address supply-side constraints to access to education at all levels of schooling, and to close gender gaps (Burde and Linden, 2013; Kazianga et al., 2013; Akresh, Halim and Kleemans, 2018). At the tertiary level, increased proximity to college reduces both the financial and psychic costs of attendance, especially for girls who have higher opportunity costs of attending college away from home due to household and care-giving responsibilities, and restrictive gender norms (Tequame and Tirivayi, 2015). University openings also increase the likelihood of admissions for all students, by increasing the number of places available each year. Future opportunities to access higher education can also increase the perceived returns to investing in girls primary and secondary schooling (Jagnani and Khanna, 2020), and the resulting additional time spent in school may delay or prevent the onset of family formation activities such as early marriage and adolescent pregnancy.

I identify the causal effects of Nigeria's university expansion by exploiting the region and cohort-specific variation in the extent to which women were exposed to university openings. Specifically, I estimate the impact of the first public university opening in a woman's state of residence when she is 18 years or younger, focusing on the 11 (of 36) states in Nigeria had no public or private university before the expansion period.[2] If costs of university attendance are increasing with age, school-aged women would be more likely to update their education investments in response to unanticipated schooling opportunities (Jagnani and Khanna, 2020). I link individuals to the university openings using their current state of residence,which serves as a proxy for place of schooling. I assume that all individuals living in a state are treated by university openings within a state, to account for the possibility that the location of universities within a state is non-random. It is unlikely a significant

[1]Retrieved from The World Bank, World Development Indicators (2021). 64 and 81 girls are enrolled for every 100 boys in Sub-Saharan Africa and Asia (Ilie and Rose, 2016).

[2]While the expansion also led to rapid growth in private universities, my study focuses on the impacts of public university openings, because they comprise 95% of the country's enrollment, and they were the first to be established in each state

proportion of the sample migrated between states to take advantage of university openings, as 67% of the sample had always lived in their current place of residence at the time of the survey, and majority of students attending public university are from the host state.

I implement my identification strategy with a difference-in-differences (DID) estimator that compares the outcomes of cohorts of women who were young enough to benefit from the university expansion in their state to older cohorts, using states where the expansion had not yet taken place as a control group. I use a new DID estimator developed by Borusyak, Jaravel and Spiess (2021) which is robust to treatment effect heterogeneities when the timing of treatment is staggered over time.[3] I assemble a database on the timing of public university openings using data from the Nigerian Universities Commission (NUC) and geo-locate each university using information on university websites and public search engines. I use the 2018 Nigerian Demographic and Health Surveys as the main source of data on women's demographic and reproductive outcomes, and supplement this with the General Household Survey (2006 - 2010), and administrative data on enrolment from several government agencies.[4]

I present five main findings. First, the establishment of the first public university in a state increases women's educational attainment. Women who are exposed to university openings obtain more years of schooling, and are also more likely to complete both primary and secondary schooling. However, there are no significant impacts on the overall likelihood of tertiary attainment. Second, university openings delay the onset of family formation - women postpone both first marriage and childbirth. Third, university openings have no impact on the education, age or likelihood of employment of the sampled women's spouses. Fourth, university openings lead to lower fertility - women have one less birth on average. Fifth, children born to women who were exposed to university openings have better health outcomes overall.

My analysis proceeds in three stages. First, I show that university openings increase educational attainment for women. Women who are exposed to university openings obtain an additional 0.9 years of schooling. They are also more likely to complete both primary and secondary schooling at least, by 8 and 6 percentage points, respectively. This finding

[3]Recent econometric studies have raised concerns that the standard two-way fixed effects DID estimates of a policy with staggered implementation may yield biased estimates when treatment effects are changing over time (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Sun and Abraham, 2021; Goodman-Bacon, 2021)

[4]Data sourced from the General Household Surveys (GHS 2006 - 2010), Joint Admissions and Matriculation Board (JAMB), National Bureau of Statistics(NBS), and the West African Examinations Council(WAEC)

confirms new evidence which finds spillover effects of investments in higher education on lower levels of schooling.[5] The first-stage effects are increasing over time - individuals benefit more from university openings when they are younger, and vary across sub-groups. The impacts on educational attainment are greater for women who are from majority ethnic groups, or living in states which benefit from affirmative action policies.

However, I do not find any significant impacts on the overall likelihood of tertiary attainment. There are some possible explanations for this result. More time may be needed for the effects of university openings to be fully observable in the population, especially given the excess demand that is not being catered to by existing institutions. There may be also be additional unresolved barriers to access, such as financial constraints or perceptions of low returns to education for girls (Sekhri, Hossain and Khosla, 2022). Finally, these average treatment effects of university openings may mask important differences across regions. A sub-group analysis indicates a 2 percent point increase in the probability of obtaining higher education for women living in the Northern region of the country, where 9 of the 11 states where the expansion took place are located.

The second stage of the analysis evaluates the effects of the university expansion on a range of family formation outcomes. First, I show that exposure to the expansion increases the age at first marriage by 0.79 years, and the age at first childbirth by 0.84 years. This delay in both marriage and childbearing roughly corresponds to the additional year of schooling that women obtain as a result of the expansion. If marriage and schooling are mutually exclusive in this context, increasing the time spent in school by women may delay the onset of family formation. Second, there is no evidence of positive assortative mating - university openings have no impact on the education, age or employment of these women's spouses.

Third, university openings lead to a decline in fertility - women have one less birth on average. This impact on fertility is consistent with previous studies in sub-Saharan Africa which also find that increased schooling, albeit at the primary and secondary level, leads to delays and reductions in fertility (Osili and Long, 2008; Ozier, 2018; Keats, 2018). Fourth, I show that this reduction in fertility is accompanied by an increase in the quality of children, as predicted by neoclassical theories of fertility (Becker, 1997; Becker and Lewis, 1973). First-born children of women who were exposed to the university expansion, and who were 5 years or younger at the time of the survey were healthier on average - they are 7 percentage points

[5]The roll-out of elite private colleges and implementation of affirmative action policies in college admissions in India led to increased educational attainment among school-aged children. (Bhattacharjee, 2019; Khanna, 2020; Jagnani and Khanna, 2020)

more likely to be breastfed, 8 percentage points less likely to be stunted, and 5 percentage points less likely to be underweight. I do not find significant effects of university openings on likelihood of being wasted or anemic.

Finally, I exploit the rich DHS data to explore several potential mechanisms which might explain my findings. First, increased schooling for women might impact fertility decisions by increasing their knoledge and use of contraception, increasing earnings which raise the opportunity cost of childbearing, and shifting preferences towards investing more resources into fewer children. The additional time spent in school may also crowd out available time to engage in sexual activities or marriage. (Black, Devereux and Salvanes, 2008; Ferré, 2009; Hahn, Nuzhat and Yang, 2018). I test this by estimating the effect of education on women's sexual behavior and fertility preferences. I find that university openings delay the age at first intercourse by 1.16 years on average, and increase contraceptive use by 9 percentage points, but has no effect on desired fertility. Second, evidence suggests that who are better educated are more likely to marry highly educated partners, which increases household income and potential investments in human capital of any offspring (Behrman and Rosenzweig, 2002; Fernandez, Guner and Knowles, 2005; Anderberg and Zhu, 2014). However, I find no significant effects of university expansion on the husbands' age, education or employment. Third, I examine the effects of university openings on several measures of empowerment, which is correlated with lower fertility and improved inter-generational outcomes (Ashraf et al., 2020). I find that the expansion increases the likelihood that women are currently working (9 p.p) percentage points; and have the final say over large household purchases (2 p.p), spending their own earnings (7 p.p) and accessing healthcare (5 p.p).

This paper makes three primary contributions. First, I contribute to the literature on the relationship between education and marital outcomes for women in developing countries, which examines the impacts of primary and secondary schooling reforms, such as free tuition or large-scale classroom construction programs (Breierova and Duflo, 2004; Duflo, Dupas and Kremer, 2010; Hahn, Nuzhat and Yang, 2018)[6] I extend this literature by presenting one of the first estimates of the impact of post-secondary schooling on family formation in Africa, focusing on the adolescent years when key marriage and education decisions are being made in this context.[7] Nigeria provides an important context to study these questions: it has

[6]Existing studies on higher education focus on developed countries. In the US, Currie and Moretti (2003) shows that local college openings in the 1920s increases years of schooling for women, reduces fertility and improves infant health. In England, Germany and Greece, university expansion delays fertility and reduces the probability of childbirth (James and Vujić, 2019; Kamhöfer and Westphal, 2019; Kountouris, 2020)

[7]My paper is most closely related to two recent studies of college expansions in developing countries. Tequame and Tirivayi (2015) find that a rapid expansion in public universities in Ethiopia increased ed-

some of the highest rates of child marriage on the African continent, and an estimated one in every five of the world's out-of-school children lives in Nigeria.[8] The effects of tertiary education might differ from that of compulsory schooling, given that attendance begins in late adolescence, and the costs are significantly greater, both in terms of tuition and the opportunity costs of time spent in school (Kountouris, 2020).

Second, this paper adds to the literature that examines the non-monetary returns to higher education using university expansions as a source of variation. Many of these studies use the presence of a college or distance to college as an instrument for education, and focus on rapid college expansion in the US that began in the 1960s (Card, 1993; Doyle and Skinner, 2016). I contribute to this literature by generating the first causal estimates of the effects of Nigeria's university expansion, focusing on sub-regions where no university previously existed, in a context where supply constraints are a major barrier to access. I assemble a new dataset of university openings and administrative data on enrolment, and employ a new difference-in-differences estimator to address empirical challenges associated with the staggered roll-out of universities over time that have been highlighted in the recent econometrics literature. Furthermore, while many prior studies explore the differential effects of university openings by economically disadvantaged students, I focus on the impacts of university expansions for women.

Finally, I contribute to the literature that studies the impacts of investments in educational infrastructure in developing countries. School construction is a policy solution commonly used to address supply-side constraints to access to education (Sekhri, Hossain and Khosla, 2022). Previous studies have found that construction of local schools, or capital improvements to existing schools improves educational outcomes for girls (Burde and Linden, 2013; Kazianga et al., 2013; Meller and Litschig, 2016; Adukia, 2017; Akresh, Halim and Kleemans, 2018). I show that university openings also improve educational attainment for girls, in a setting with low baseline educational attainment, and discriminatory laws and norms which restrict girls' rights and access to resources. Additionally, I show that the Nigeria's university expansion increased the rates of primary and secondary school completion for girls, in line with several recent studies in India that find positive spillover effects of college expansion on lower levels of schooling (Bhattacharjee, 2019; Khanna, 2020; Jagnani and Khanna, 2020).

ucational attainment for women, and lowered fertility, and Sekhri, Hossain and Khosla (2022) finds that increased access to college in India increases women's college completion, labor market outcomes and reduces the prevalence of child marriage.

[8] 43% of Nigerian women aged 20-24 who were surveyed in 2018 were married before the legal age of 18 (UN, 2020)

The rest of the paper proceeds as follows. Section 2 describes the setting I study and the university expansion over time. Sections 3 and 4 describe my data sources and empirical strategy. In Section 5 I present the results of my analysis, robustness checks and sub-group heterogeneity in outcomes. I examine potential mechanisms that explain the results in Section 6. Section 7 concludes.

2 Institutional Context

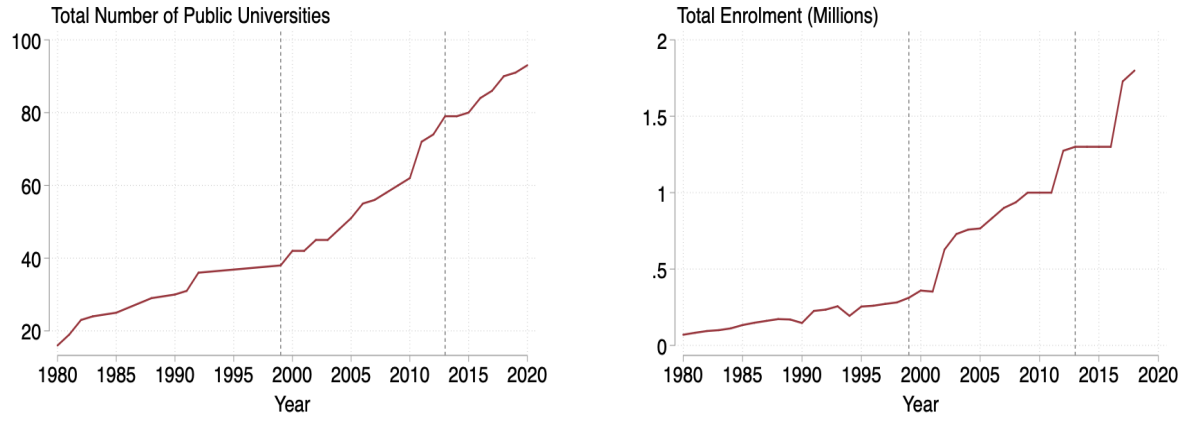
In 1999, the federal government of Nigeria announced plans to expand higher education by twelve times its current size within a decade, through the creation of new public universities, and licensing of private universities (Obadara, 2010; Omomia, Omomia and Babalola, 2014). As in many other developing countries, the demand for higher education was growing, driven by rising rates of secondary school completion as access to and quality of compulsory schooling improved, and the growing demand for a highly- skilled workforce in emerging market economies (Schendel and McCowan, 2016; Darvas et al., 2017).[9]

The aim of the expansion was to cater to the rising demand for higher education, and to address the disparities in access to universities across the country. At the time, there were 32 public universities, disproportionately located in the Southern region of the country (Saint, Hartnett and Strassner, 2003; Nyesiwura, 2014; Ejoigu and Sule, 2012; Okoli, Ogbondah and Ewor, 2016). These universities were poorly funded, and lacked the infrastructure needed to cater to rising enrolment. Between 1970 and 1998, only 16% of students on average who applied to university each year were offered admission, and even fewer numbers enrolled and graduated (see Figure A.2).

The expansion led to the opening of 153 new universities (57 public and 99 private) between 1999 and 2021. By 2021, there were 195 registered universities in total, and Nigeria currently has the largest tertiary education system on the continent, in terms of number of institutions. The expansion was funded by the federal government and did not depend on local economic performance of the state. University openings did not follow a predetermined schedule, but the exact location of the university within a state may have been influenced

[9]Tertiary enrollment in low to middle income countries more than doubled between 2000 and 2020, going from 13% to 35%, compared to an increase from 56% to 79% in high-income countries in the same period (IESALC, 2020). Enrolment in sub-Saharan Africa (SSA) has risen even faster than the rest of the world - the region had a 4.3 per cent annual growth in its tertiary gross enrollment ratio (GER) during 1970-2013 compared to the global average of 2.8 percent.

Figure 1: University Openings and Access over time in Nigeria

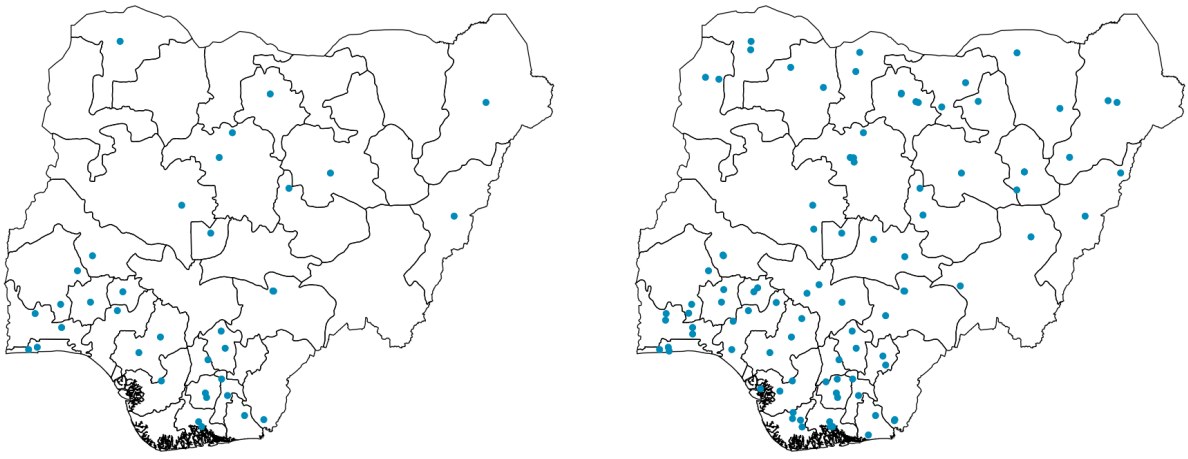


(a) University Openings over time

(b) University Enrolment over time

Figure 1a reports the growth in the number of public universities in Nigeria over time. The university expansion began in 1999. Figure 1b reports total enrolment at public universities, over time. Source: Authors compilation from various government agencies.

Figure 2: Geographical Public University Availability in Nigeria



(a) 1998 (Pre-expansion)

(b) 2020

Figure 2 depicts the expansion in universities across states over tine. The university expansion began in 1999. Source: Nigerian Universities Commission (NUC).

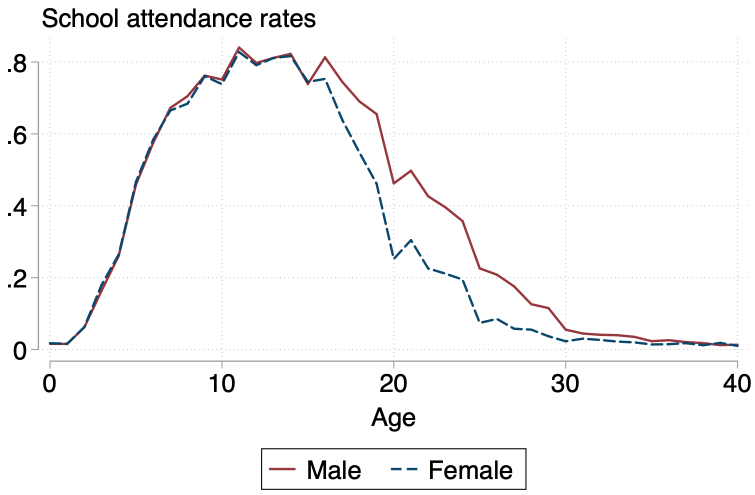
by political factors. By 2013, each of the 36 states in the country had at least one public university. Figure 1 shows the growth in institutions and enrolment and Figure 2 shows the changes in the geographical availability of universities over time.

University enrolment increased substantially over the expansion period from 280,000 in 1998 to 1.8 million in 2018. Although the private sector also expanded significantly in the same period, enrolment at private institutions comprises less than 5% of total enrollment, due to high tuition fees. By comparison, public universities are heavily subsidized by the government. There are gender gaps in access to higher education in Nigeria. The female gross tertiary enrollment rate stood at 10 percent in 2018, compared to 14 percent for males.[10] These disparities begin before students enrol at university, while they are attending primary and secondary school. Analsis of household survey data shows that the gap in school attendance begins to widen in secondary school (see Figure 3a), and fewer girls take the secondary school exit exams required for university admission each year compared to boys(see Figure A.1). Figure 3b suggests that early family formation at least partially explains lower attendance for girls: girls marry much earlier than boys. At age 17, less than 1% of boys are married, compared to 20% of girls.

[10]Retrieved from The World Bank, World Development Indicators (2021). 64 and 81 girls are enrolled for every 100 boys in Sub-Saharan Africa and Asia (Ilie and Rose, 2016).

Figure 3: Gender Gaps in School Attendance and Marriage Rates by Age

(a) School attendance rates by age



(b) Marriage rates by age

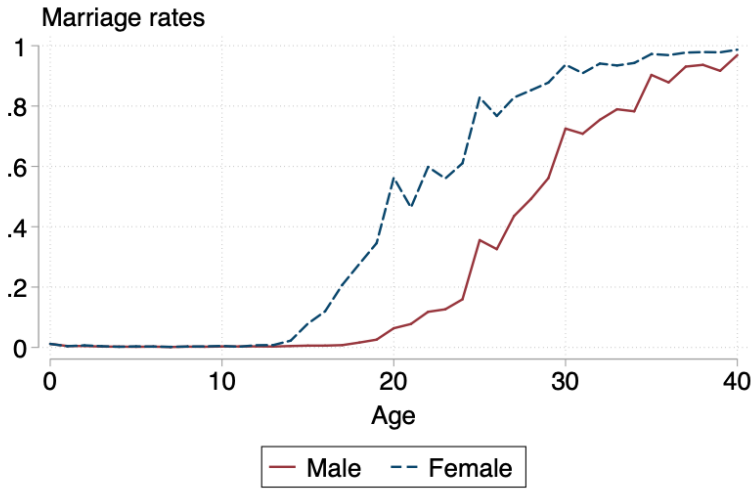


Figure 3a reports the proportion of sampled respondents currently attending school, by age and gender. Figure 3b reports the proportion of sampled respondents who are currently or were previously married, by age group and gender. Both figures show that in their late teens, girls are less likely to be attending school than boys of the same age, but more likely to be married than boys of the same age, and this gap persists for several decades. Source: General Household Survey (2006-2010).

3 Data

My empirical analysis draws on administrative and household survey from multiple sources.

Adult Outcomes. I obtain data on education, marriage, fertility and child health outcomes from the 2018 Nigerian Demographic and Health Surveys (NDHS), a nationally representative sample survey of randomly selected women aged 15-49 and members of their households on various population and health topics. I access this data via the IPUMS-DHS (Integrated Public Use Micro-data Series - Demographic and Health Surveys, using the extracts for women, husbands and children (Boyle, King and Sobek, 2017). I measure education both in terms of years of schooling and levels of education attained - at least completed primary, at least completed secondary, and higher education. To measure family formation, I include variables for the age at first intercourse, marriage and childbirth, as well as desired and total fertility. I measure women's empowerment in terms of the likelihood of labor force participation, decision-making, and contraceptive use. [11]

Child Outcomes. I obtain data on child health outcomes from the IPUMS-DHS child extract. I consider both inputs to child health such as the duration of breastfeeding, as well as child health outcomes, including stunting, wasting and being underweight or anemic.[12]. I follow World Health Organization (WHO) conventions in my definition of these child health indicators. Stunting is defined as a height-for-age z-score less than -2. Wasting is defined as a weight-for-height z-score less than -2. Being underweight is defined as defined as weight-for-age z-score less than -2 (Le and Nguyen, 2020).

University Openings and Enrolment. For data on the timing and location of university openings, I manually compile data on the years of establishment and ownership types of all existing universities from the records of the Nigerian National Universities Commission

[11]The 2018 Nigeria Demographic and Health Survey (2018 NDHS) is funded by the United States Agency for International Development (USAID) and other international donor organisations, and implemented by the Nigerian National Population Commission (NPC) in collaboration with the National Malaria Elimination Programme (NMEP) of the Federal Ministry of Health, Nigeria. Six waves of the survey data are available – for 1990, 1999, 2003, 2008, 2013 and 2018. The choice of the 2018 wave is motivated by the requirements for implementing the identification strategy. The first three waves do not provide information on the respondents state of residence (only region) which is required for estimating the geographical variation in exposure. The 2008 and 2013 waves do not include enough samples of the younger birth cohorts who were exposed to the university expansion.

[12]Stunted growth refers to when a child's height is too low for their age. Wasting refers to too low weight for height, typically resulting from muscle and fat tissue wasting away due to acute food shortage or disease. Being underweight refers to when a child's weight is too low for their height. Anemia is a condition of low levels of hemoglobin in the blood caused mainly by poor nutrition, or prolonged exposure to malaria (Keats, 2018; Nakajima, Hasan and Rangel, 2020)

(NUC).[13] I then geo-locate each university using information provided on university websites and public search engines. Eleven of the 57 new public universities established during the study period were the first to be established in their respective host states, otherwise referred to as expansion states. Figure 4 highlights the states which received their first universities between 1999 and 2013. Majority of these states are located in the Northern geo-political region of Nigeria, which historically has lower levels of educational attainment. Finally, I obtain administrative education records from the statistical bulletins and database records of multiple government agencies, including the National Bureau of Statistics (NBS), West African Examination Council (WAEC), Joint Admissions and Matriculation Board (JAMB) and Nigerian Universities Commission (NUC). These include university application, admissions and enrolment data, as well as secondary school examination records.

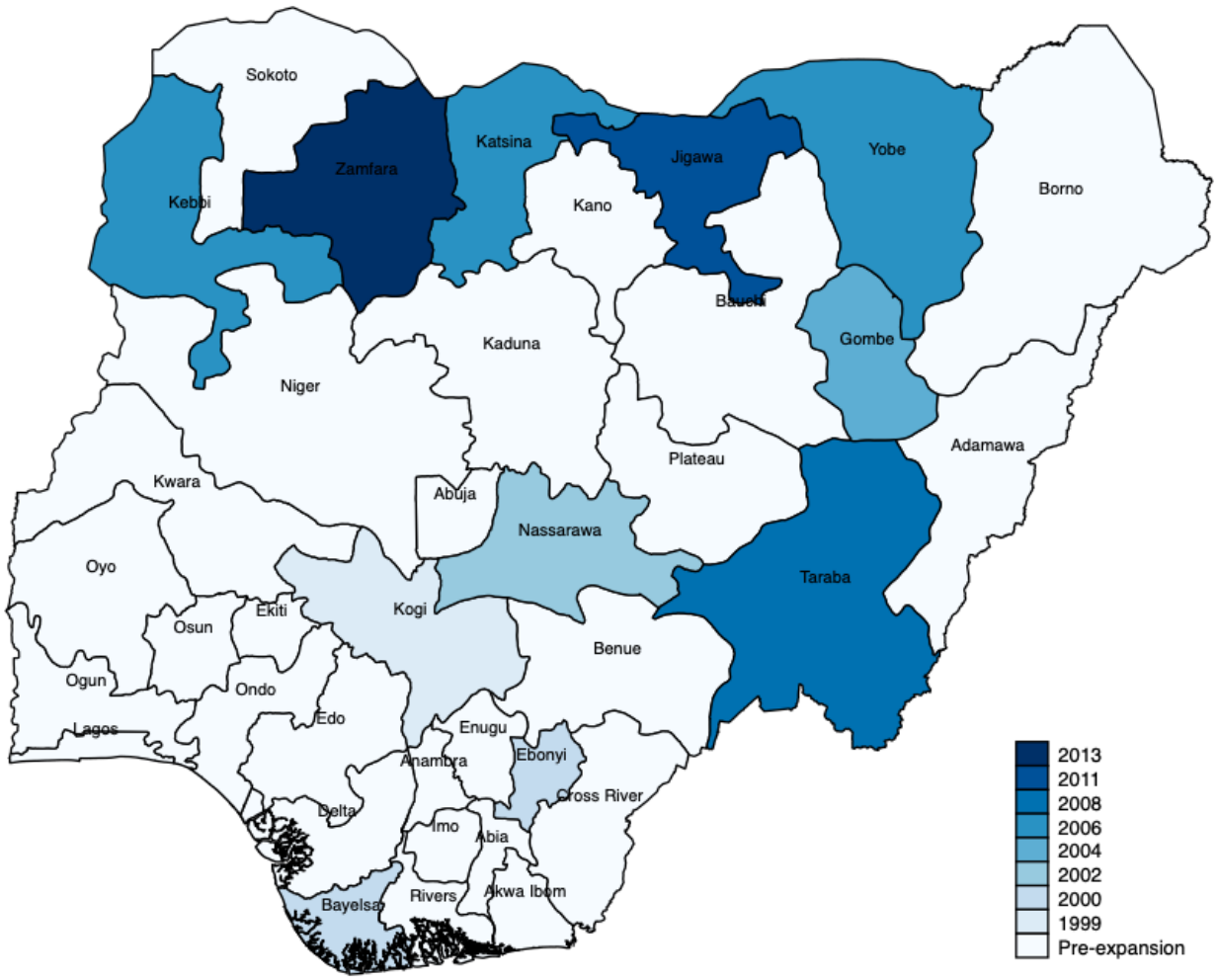
I merge this administrative data with my NDHS sample by matching respondents to the first university established in their current state of residence. Information is not available on the individual's state of residence at birth or at the time of university entry, a common limitation of household survey data. The NDHS does ask about how long respondents have lived at their current address - 68% of my sample have never moved. Previous studies in this context also note that internal migration is mostly intra-state and often between rural and urban areas (Osili and Long, 2008), (Larreguy and Marshall, 2017). I address potential selection bias due to migration in sub-section 5.4.

Sample Restrictions and Summary Statistics. The minimum completion time for a bachelor's degree is four years, so I restrict my analysis to public university openings between 1999 and 2013, to allow at least 5 years between the opening of the last university and the year of the survey data collection, i.e 2018. I focus on the first public university openings in a state. For my analysis of education outcomes, I further restrict my sample to women who are 30 years or older at the time of the survey and so likely to have completed their schooling, based on the official ages of school entry and typical attendance patterns in this context (See figure 3a). To study child health outcomes, I focus on first-born children who are aged 5 or younger. I do not restrict the sample for the analysis of marriage and fertility outcomes.

Table 1 presents descriptive statistics for the sample. Women have 6 years of schooling on average, and 10% of women have attained higher education. Women have lower levels of educational attainment than their husbands, and are 12 years younger on average. This

[13]This information is available on the National Universities Commission (NUC) website - https://www.nuc.edu.ng/

Figure 4: First university openings by state (1999 - 2013)



Notes: This figure highlights the 11 states which received their first public university during the expansion period (1999 - 2013). The remaining 26 states designated "pre-expansion" already had at least one university by 1999.

Table 1: Summary Statistics - Analytical Sample

	N	Mean	Std. Dev.	Min	Max
Marriage and Childbearing					
Age at first marriage	31,152	18.53	5.10	7	48
Age at first birth	29,992	19.69	4.50	11	48
Age at first intercourse	41,781	14.21	6.89	0	45
Total children ever born	41,821	3.05	2.96	0	17
Empowerment					
Currently working	41,821	0.65	0.48	0	1
Ever used contraception	41,821	0.26	0.44	0	1
Final say on large household purchases	41,821	0.04	0.20	0	1
Final say on her own earnings	41,821	0.29	0.46	0	1
Final say on her own healthcare	41,821	0.07	0.26	0	1
SES					
Age	41,821	29.16	9.71	15	49
Year of birth	41,821	1988.74	9.71	1968	2003
Years of Schooling	41,821	6.69	5.58	0	20
Higher education	41,821	0.10	0.31	0	1
Husband's SES					
Age (Husband)	28,870	42.26	11.13	15	94
Year of birth (Husband)	28,870	1975.74	11.13	1924	2003
Years of Schooling (Husband)	28,303	7.29	6.03	0	20
Higher education (Husband)	41,821	0.11	0.31	0	1
Controls					
Urban Resident	41,821	0.41	0.49	0	1
Always Resident	41,821	0.58	0.49	0	1
Number of universities in the State	41,821	2.53	0.83	1	4
Opening year of first university in the State	41,821	1985.36	16.32	1948	2013
Child Health					
Breastfed at least 6 months	41,821	0.41	0.49	0	1
Stunting	5,695	0.19	0.40	0	1
Wasting	5,695	0.27	0.44	0	1
Underweight	5,695	0.26	0.44	0	1
Anemia	5,695	0.26	0.44	0	1

Notes: Source: Nigeria IPUMS-DHS 2018

suggests that university openings may have differential impacts on women cohorts compared to their husbands. Early marriage and childbearing is prevalent - the average age at first marriage for women is 18 years old and the average age at first birth is 19. Women have 3 children on average. 65% of women are currently working but only 29% have a say over how their earnings are spent. Only 26% of the sample has ever used contraception, and less than 10% of women make the final decision on large household purchases or their own healthcare. On average, 41% were likely to be breastfed for 6 months or less, and only a quarter of the population is stunted (27%), wasted (8%), anemic (26 %) or underweight (26%) The sample consists predominantly of rural dwellers (59%), and 67% of respondents have always lived in their current location. Every state has at least one public university, and two public universities on average.

4 Empirical Strategy

I estimate the causal effect of university expansion in Nigeria on educational attainment and marriage market outcomes using a difference-in-differences (DID) design. I exploit exogenous variation in access to higher education across cohorts and states following a wave of public university openings in Nigeria from 1999 to 2013. Exposure to the expansion is jointly determined by individuals' year of birth and state of residence. I categorize individuals are treated if they were 18 or younger at the time when the first university was opened in their state of residence. I use age 18 as the cutoff for eligibility because the official secondary school leaving age in Nigeria is 18 years, and survey data indicates a sharp drop in school attendance around that age (see Figure 3a).

I focus on states which did not have any universities before the expansion began - 11 of the 36 states are in this category (See Figure 4). I measure state-level variation in binary terms - all age-eligible individuals resident in the state are considered 'treated" by the first university openings within that state. I choose to classify exposure at the state level because states represent distinct geographical and administrative boundaries with implications for governance, economic activity and university admissions in Nigeria. Majority of students attending public university are from the host state, and 55% of admissions to public universities are determined by affirmative action quotas based on state.

A common critique of studies that use college proximity as a instrument for education is that there are likely non-random differences in ability, preferences or family background

between students who live closer to colleges than those who don't, which could bias estimates of the effects of college openings (Card, 1993; Currie and Moretti, 2003; Suhonen and Karhunen, 2019). In this context, the precise location of universities within a state might be influenced by economic or political factors which could concurrently drive education or marriage decisions. My approach - assigning all individuals living in a state as treated by university openings in those states rather than using a spatially sensitive measure of distance to the nearest university - accounts for the likelihood that the precise location of universities within each state is non-random.

I begin the analysis by estimating the following two-way fixed effects DID specification:

$$Y_{isc} = \beta_0 + \beta_1 first_{sc}^{18} + +\theta_s + \mu_c + \beta_2 X_{isc} + \varepsilon_{isc} \tag{1}$$

Y_{isc} is the education or marriage outcome of individual i, born in state s and cohort c. $first_{sc}^{18}$ is an indicator of treatment equal to one if a premier university is opened in a respondents state of residence between 1999 and 2013 on or before they turn 18. β_1 thus measures the effects for the group of individuals living in a state with a premier opening and aged 18 or younger at the time of opening, compared to everyone else in the sample. θ_s and μ_c are state and cohort fixed effects, respectively. State fixed effects control for time-invariant unobserved characteristics of states that might be correlated with opening of universities as well as marriage outcomes. Cohort fixed effects account for unobserved characteristics common to states but differing between individual cohorts. X_{isc} is a vector of individual and state-level covariates including ethnicity, urban residence, and number of public universities in each state. I cluster standard errors at the state level to account for auto correlation in error estimates.

This DID strategy relies on the standard assumption of parallel trends - in this case, that the trends in education outcomes of both the treated and control groups would not have varied in the absence of the university openings. This assumption is plausible because university openings were primarily influenced by the government's need to meet the nation-wide excess demand for higher education, while ensuring a balanced distribution of universities across all states of the country. Furthermore, these first university openings were typically targeted at educationally disadvantaged states which would lead to me to underestimate the effects of the expansion.

Recent econometric studies have raised concerns that two-way fixed effects DID esti-

mates of a policy with staggered implementation may yield biased estimates when treatment effects are changing over time (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2020; Sun and Abraham, 2021; Goodman-Bacon, 2021). In my study context, university openings might impact students cohorts in different ways over time, as access to university or social norms around higher education change (Boelmann, 2021). If so, the standard two-way fixed effects DID estimator may estimate a weighted average treatment effect with negative weights, by leveraging 'forbidden comparisons' between earlier treated states and later treated states, which could result in biased results or sign reversal (Borusyak, Jaravel and Spiess, 2021). Similarly, testing for pre-trends using a fully dynamic two-way fixed effects model may result in biased estimates if treatment effects are heterogeneous.

To address these concerns, I test for dynamic treatment effects using an imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) or the BJS estimator, which allows for dynamic treatment effects β_{sc} that vary by state and cohort (see Equation 2). The imputation estimator is constructed in three steps. First it estimates the state and cohort fixed effects using the control group consisting of not-yet treated observations only. Next, the fitted values from that regression are used to impute untreated potential outcomes and obtain an estimated treatment effect for each treated observation. The final step estimates an average of these imputed treatment effects estimates.

$$Y_{isc} = \beta_0 + \beta_{sc} first_{sc}^{18} + +\theta_s + \mu_c + \beta_2 X_{isc} + \rho_{isc} \tag{2}$$

I also use the BJS imputation estimator to test for pre-trends by estimating Equation 3, using observations from the not-yet treated states as the control group. I include state fixed effects to account for differences in levels of outcomes between states, and cluster standard errors by state. I plot estimates of β_1 and perform an F-test of joint significance of estimates $\beta_1 = 0$.

$$e_{isc} = \beta_0 + \sum_{T=-20}^{-1} \beta_1 \left(year18_c - first_s = \tau\right) + \beta_2 no\_unis_s + \theta_s + \mu_c + \varepsilon_{isc} \tag{3}$$

τ measures the time relative to the occurrence of the event as given by the number of years between when the individual turned 18 and when the first public university was established in their current state of residence. Therefore $\tau < 0$, $\tau = 0$, and $\tau > 0$ represent event-time indicators for individuals who turned 18 before, in the same year as, or after the

Figure 5: Event study graph: Effect of first public university openings on women's years of schooling

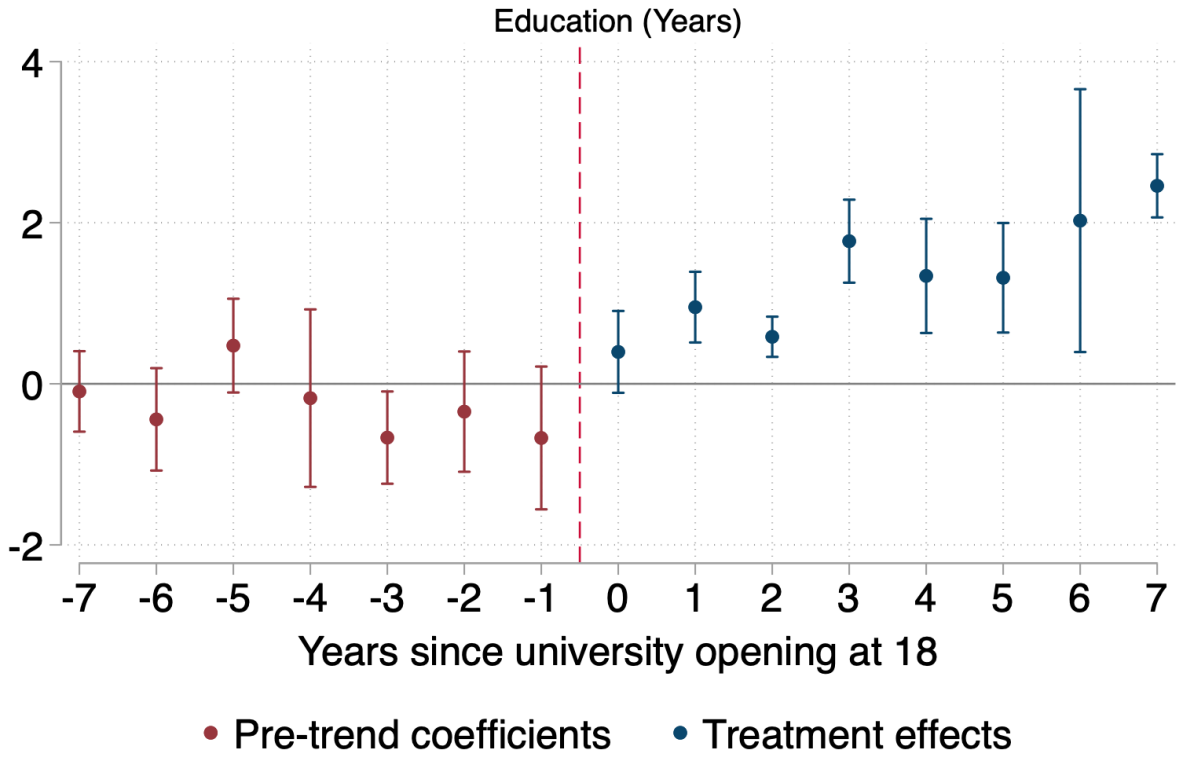


Figure 5 displays the coefficient estimates and corresponding confidence intervals from estimating the dynamic effects of first university openings in a state on average years of schooling of women using equation 3, controlling for state and birth cohort fixed effects, and clustering standard errors at the state level. Time zero is when the opening of the first public university in the state occurs in the year when the respondent is 18 years old. The sample is a cross-section of women aged 30 or older. The study focuses on first university openings that occurred between 1999 and 2013. Data is from IPUMS-DHS 2018 extract.

first university in their state was established, respectively. The coefficients on the event-year dummies β_1 are estimates of the average treatment effects of first public university openings relative to the year just before the the individual turned 18, i.e. $\tau = -1$.

5 Results: Effects of University Openings

Event study. Following Borusyak, Jaravel and Spiess (2021), I present graphic evidence on pre-trends using the BJS estimator as shown in Figure 5. The pre-trend coefficient estimates on the left in red come from the estimation of Equation 2 on a sample of individuals aged

Table 2: Years of schooling

	Effect of first public university opening by age 18		
	(1) (TWFE)	(2) TWFE w/ controls	(3) BJS Imputation Estimator w/ FE and controls
Years of Schooling	0.811**	0.835**	0.964***
	(0.356)	(0.340)	(0.213)
Observations	19351	19351	19351
Outcome mean	6.08	6.08	6.08
Outcome SD	5.76	5.76	5.76

Notes: This table reports the effects of first public university openings by age 18 on women's schooling, using the estimated ATT for the DID models described in equation 4. Columns (1) and (2) report the results of estimating the standard two-way fixed effects model specified in 1 without controls, as well as controlling for urban residence, ethnicity and the number of public universities in the state, respectively. Column (3) presents the results of estimating imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) using equation 2. The main outcome is *years of schooling*. Individuals are treated if they were 18 or younger when the first public university in their state was opened. University openings occur between 1999 and 2013. The sample is restricted to individuals aged 30 and older who are likely past schooling age in this context. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

19 and older in the always-treated and not-yet treated control group. Figure 5 shows no evidence of pre-trends in education outcomes for women. This suggests that conditional on pre-expansion differences between states, student cohorts who were above age 18 were equally likely to obtain schooling across states.

The blue coefficient estimates represent average treatment effects for each year after the university opens for individuals aged 18 and younger, which are positive, statistically significant, and increasing over time. The estimates in Figure 5 also indicate dynamic treatment effects - that university openings had greater effects on younger cohorts of women who had more time left in school and could significantly alter their education investment decisions.

5.1 Women's Educational Attainment

Years of Schooling. Table 2 reports the average treatment effects of university openings on years of schooling for women, using the DID specifications described in Equations 1 and 2. The estimates of the standard two-way fixed effects model in column (1) show that the opening of the first public university increases years of schooling for women by 0.8 years. The

Table 3: Educational Attainment

	Effect of first public university opening by age 18			
	(1) Years of schooling	(2) Complete Primary	(3) Complete Secondary	(4) Higher Education
BJS Estimator	0.964***	0.089***	0.060***	-0.003
	(0.213)	(0.026)	(0.012)	(0.008)
Observations	19351	19351	19351	19351
Outcome mean	6.08	0.55	0.31	0.12
Outcome SD	5.76	0.50	0.46	0.33

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2. The dependent variable is the likelihood of educational attainment in levels - at least completed primary and secondary schooling, and higher education as presented in Columns (2) through (4) respectively. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Individuals are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013. The sample is restricted to individuals aged 30 and older who are likely past schooling age in this context. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

results remain fairly stable when controls are added in column (2). The Borusyak, Jaravel and Spiess (2021) estimator in column (3) shows fairly similar results - university openings increase schooling for women by 0.9 years, which suggests that the TWFE model may be underestimating the effects of university openings slightly. I use the Borusyak, Jaravel and Spiess (2021) estimator as the main specification for the rest of the paper.

Educational Attainment Across the Distribution. The effects of university openings might differ across the educational distribution. Table 3 presents the results of estimating the Borusyak, Jaravel and Spiess (2021) estimator specified in Equation 2 on the likelihood that women have attained different levels of education - at least completed primary, at least completed secondary and higher education. I find that university openings increased the probability of at least completing both primary and secondary school by 8 and 6 percentage points, respectively. However, the effects on tertiary attainment are not significant. There are some possible explanations. More time may be needed for the effects of university openings to be fully observable in the population, especially given the excess demand that is not being catered to by existing institutions. There may be also be additional unresolved barriers to access, such as financial constraints or perceptions of low returns to education for girls (Sekhri, Hossain and Khosla, 2022). Finally, these average treatment

effects of university openings may mask important differences across regions. As discussed in sub-section 6, I find a 2 percent point increase in the probability of obtaining higher education for women living in the Northern region of the country, where 9 of the 11 states where the expansion took place are located. Figures A.3 presents corresponding event-study plots for the different levels of educational attainment for women.

5.2 Women's Marriage and Fertility Outcomes

Table 4 presents the results of estimating the effects of the university expansion on the key marriage and fertility outcomes for women. Columns 1 and 2 show that exposure to the expansion increases the age at first marriage by 0.79 years, and increases the age at first childbirth by 0.84 years. The delay in both marriage and childbearing is in keeping with demographic trends for the sample - women have their first child a year after marriage, on average. [14] I also find that university openings lead to a decline in fertility - women between 15 and 49 years have one less birth on average.[15]

These results are consistent with previous studies in sub-Saharan Africa which also find that schooling, albeit at the primary and secondary level delays and reduces fertility. In Nigeria, Osili and Long (2008) find that the introduction of free primary education programs leads to a 16% reduction in births before age 25. In kenya, (Ozier, 2018) finds that secondary schooling reduces teen pregnancy by 12 percentage points. (Keats, 2018) finds that the introduction of free primary education in Uganda decreases the probability of first birth between age 16 and 20 by between 5-20%. In Ghana, (Duflo, Dupas and Kremer, 2021) exploit randomized assignment to secondary school scholarships among youths, and find that scholarships increase educational attainment, and reduce female fertility by 14% (7.0 percentage points) compared to the comparison group, and this effect persists till age 28.

[14]The relationship between education and age at marriage may also be bi-directional. A related study by Field and Ambrus (2008) in Bangladesh finds that each additional year of delayed marriage is associated with 0.22 additional years of additional schooling

[15]The fertility estimates are for a cohort of women who are still in their childbearing years, and may overestimate the true treatment effect. Ideally, I would only study women who were past the maximum age of first birth, but this restriction would exclude most of my sample. The DHS surveys women aged 15 - 49, and the maximum age at first birth for women is 48 for total sample, and 35 for the sample of treated cohorts.

Table 4: Marriage and Fertility

	Effect of first public university opening by age 18		
	(1) Age at 1st marriage	(2) Age at 1st birth	(3) Number of children
BJS Estimator w/ F.E + controls	0.794***	0.835***	-1.000***
	(0.294)	(0.239)	(0.203)
Observations	31152	29992	41821
Outcome mean	18.53	19.69	3.05
Outcome SD	5.10	4.50	2.96

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on the sample of eligible women. The dependent variables are age at marriage, age at first birth, and number of children, as shown in Columns (1) through (3) respectively. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

5.3 Child Health Outcomes

I have shown that increased access to higher education via university openings causes women in the sample to delay marriage and childbearing and to have fewer children. An important question is whether this reduction in fertility is accompanied by an increase in the quality of children, as predicted by neoclassical theories of fertility (Becker, 1997; Becker and Lewis, 1973), and in line with recent studies.[16] I explore these potential inter-generational impacts by estimating the effects of a mothers' exposure to the university expansion on the health outcomes of her children, as presented in Table 5. All estimates are for the sample of first-born children, who were 5 years or younger at the time of the survey.[17]

Table 5 reports the estimates for several indicators of child health - breastfeeding, stunting, wasting, and being underweight and anemia. Controlling for child's age, I find that the expansion increases the probability that a child is breastfed for 6 months or more, by 8

[16]See Keats (2018) for a discussion

[17]My choice of sample is motivated by both econometric and practical reasons. First, given the relatively recent timing of the expansion, the children of women beneficiaries are relatively young and still attending school. Thus any estimates of child schooling which has been used in many previous studies would be premature. Second, the DHS only collects child health indicators for children born in the 5 years prior to the survey. Finally, only studying outcomes of the first born child may partially address potential selection in completed fertility across treated and control groups.

Table 5: Child Health Outcomes

	Effect of first public university opening by age 18 of mother				
	(1) Breastfed for at least 6 months	(2) Stunting	(3) Wasting	(4) Underweight	(5) Anemia
BJS Estimator	0.077***	-0.080***	-0.007	-0.051**	-0.024
	(0.018)	(0.023)	(0.026)	(0.025)	(0.067)
Observations	5949	5949	5949	5949	1771
Outcome mean	0.18	0.28	0.20	0.27	0.64
Outcome SD	0.39	0.45	0.40	0.45	0.48

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on on a sample of first-born children aged 5 or younger, born to women who were 18 or younger when the first public university in their state was opened. The dependent variables are the likelihood of being breastfed for 6 months or longer, stunted, wasted, underweight or anemic, as shown in Columns (1) through (5) respectively. All specifications include controls for child's age, and ethnicity, urban residence and the number of public universities in the state. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

percentage points. First-born children of women exposed to university openings are 8 percentage points less likely to be stunted, and 5 percentage points less likely to be underweight. I also find that university openings reduce the likelihood of being wasted or anemic, but these estimates are not statistically significant.

5.4 Robustness

As a first robustness check, I replicate my analysis to test whether my results are sensitive to different definitions of the treatment age. First I define the age of exposure at 14 or younger, the official age of completion of basic education (junior secondary school, or middle school in the U.S.), and the time when students decide whether or not to continue on to senior secondary school (or high school in the U.S). The effects of the expansion should be greater for this group, since they have more time to update school investment decisions. I also repeat the exercise for the cohort of women who were 25 or younger, or 30 or younger when the expansion happened, and for whom the effects of the expansion should be weaker, given that they are past the traditional ages of university attendance. Table 5.4 presents the results of these estimations. As expected I find greater impacts of university expansion

on education, marriage and fertility when exposure is defined more narrowly (14 years and under), as shown in Panel B. Panels C shows that university openings have no impact when exposure is defined more broadly (30 years or under) who have completed schooling, except for on total fertility, which is 3 percentage points less than the main estimates in Panel B.

Another potential concern is that the results may be biased by selective migration, if families with less education moved to states where universities were opening. I test the robustness of my results to selective migration in two ways. First I exclude from the sample states with high internal-migrant populations. The 2010 Internal Migration Survey conducted by the Nigerian Population Council in 2010 (for Migration Nigeria and Isiugo-Abanihe, 2016) revealed that 23 per cent of the sampled population of Nigerians were migrants, having changed residence within 10 years, and about 60 per cent of internal migrants were residing in the urban areas. According to the survey, the states that host the highest population of migrants are Lagos, Bayelsa, Imo, Anambra, Abia, Delta and Ekiti. I add the nation's capital Abuja (FCT) to this list, and estimate the key results excluding these states. Second, I estimate the results for only the sample of always resident individuals - the proportion of the sample which has never moved. In both cases the estimates are similar in magnitude and significance to the main estimation model, indicating that my results are robust to potential selective migration.

5.5 Heterogeneity Analyses

This section examines the ways in which the effects of university expansion might vary for women by location or socio-economic characteristics. Women living in states with historically low levels of educational attainment might benefit more from university openings due to affirmative action admissions quotas. Admission to public universities in Nigeria combines merit-based criteria with affirmative action policies based on student's states of origin.[18] 55% are allocated through these state-based quotas.[19] These quotas were designed to ensure equitable representation of students from all parts of the country at public universities, and

[18]State of origin here refers to the paternal ancestral homeland or community rather than place of birth or current residence. It is an important identity marker in Nigeria, and is used to ensure equitable distribution of resources and representation, across school and university admissions, scholarship awards, public sector employment and elected public service

[19]The first 45% of available seats are reserved for students with the highest performance on centralised university entrance exams. 35% is reserved for students from the universities' catchment area, which includes the state where the university is located and the surrounding states in the sub-region. The last 20% are reserved for students from educationally less developed states (ELDS) which have historically lower levels of education. (Adeyemo, 2000)

Table 6: Heterogeneity Analyses

	Effect of first public university opening by age 18				
	(1) Years of Schooling	(2) Higher Education	(3) Age at first marriage	(4) Age at first birth	(5) Total children ever born
Panel A: Full Sample					
BJS Estimate	0.964***	-0.003	0.794***	0.835***	-1.000***
	(0.213)	(0.008)	(0.294)	(0.239)	(0.203)
Observations	19351	19351	31152	29992	41821
Outcome mean	6.08	0.12	18.53	19.69	3.05
Outcome SD	5.76	0.33	5.10	4.50	2.96
Panel B: ELDS States					
BJS Estimate	1.061***	0.013	0.218	0.302	-0.443*
	(0.245)	(0.008)	(0.281)	(0.207)	(0.236)
Observations	12389	12389	21943	20830	28313
Outcome mean	4.08	0.08	17.26	18.71	3.36
Outcome SD	5.32	0.27	4.35	3.90	3.15
Panel C: Majority Ethnic					
BJS Estimate	1.020***	-0.007	1.269***	1.234***	-1.319***
	(0.197)	(0.010)	(0.318)	(0.309)	(0.265)
Observations	12053	12053	19717	18736	25804
Outcome mean	5.94	0.12	18.38	19.70	3.19
Outcome SD	5.88	0.33	5.19	4.57	3.05
Panel D: Northern Region					
BJS Estimate	0.738***	0.020***	0.454*	0.597***	-0.686***
	(0.201)	(0.008)	(0.256)	(0.201)	(0.224)
Observations	10951	10951	20148	18891	25540
Outcome mean	3.50	0.08	16.96	18.48	3.44
Outcome SD	5.19	0.27	4.07	3.70	3.19

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on certain sub-samples of interest for women - from educationally disadvantaged states, majority ethnic groups and from the Northern region. The dependent variables are- years of schooling, age at first marriage and childbirth, and number of children. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. Estimates for years of schooling are restricted to the sample of women aged 30 and older. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

to correct historical imbalances in educational attainment across sub-regions.

Based on these admissions criteria, each public university opening, irrespective of location within the country, should disproportionately increase the chances of admission for students from designated ELDS states. 23 of Nigeria's 36 states are designated as educationally less developed. ELDS states have lower levels of education, and higher rates of early marriage compared to the general population. Table 6 presents the results of estimating the effects of university openings on the main outcomes of interest - years of schooling, timing of marriage and childbirth, and fertility using Equation 2. I find that university openings have slightly higher effects on educational attainment on women from ELDS states compared to the general population of eligible women, but no significant effect on family formation (see Panels A and B of Table 6).

I also explore the possibility that treatment effects differ by ethnicity. In a multi-ethnic state like Nigeria, political power and economic resources are often monopolized by the dominant ethnic groups. I test this by examining the effects of the expansion on education and marriage outcomes of women belonging to the three major ethnic groups - the Igbos, Hausa-Fulanis or Yorubas, which comprise 61% of the sample. Panel C of Table 6 shows that university openings have greater effects on women from majority ethnic groups compared to baseline estimates for most of the key outcomes - they obtain more years of schooling, marry and have children even later, and have even fewer children in total.

Finally, I examine outcomes of women in Northern Nigeria, a predominantly Muslim sub-region of Nigeria. The region has historically had the lowest rates of educational attainment rates for women in the country, due to religious and cultural norms which discourage western education and support child marriage. As reported in of Panel D of Table 6, I find similar effects of the expansion on this sub-group of women compared to the full sample, except for the likelihood of obtaining higher education (Column 2). I find a 2 percentage point increase in their likelihood of attaining higher education, unlike the full sample where I found no significant effects. This may be because 9 of the 11 states where the expansion took place are located in the Northern region.

6 Potential Mechanisms

There are several channels by which education could impact fertility decisions and child health investments and outcomes (Ferré, 2009; McCrary and Royer, 2011; Keats, 2018): pos-

itive assortative mating (Becker and Lewis, 1973; Behrman and Rosenzweig, 2002), knowledge acquisition about family planning, child health and nutrition (Glewwe, 1999), changing gender attitudes towards women and their role in society (Lavy and Zablotsky, 2015), and increased intra-household bargaining power (Jejeebhoy, 1998). In this section, I exploit the richness of the DHS data to examine the relevance of these potential mechanisms for explaining the results on child health in my study context.

6.1 Fertility Behavior

Increased schooling for women might impact fertility decisions in several ways: the "knowledge effect"- where education increases individuals awareness and use of contraceptive options; the "autonomy or empowerment effect"- where women's human capital increases, raising the opportunity cost of childbearing and shifting preferences towards investing more resources into fewer children; and the "incarceration effect" - where the time spent attending school reduces time available to engage in sexual activities or marriage. (Black, Devereux and Salvanes, 2008; Ferré, 2009; Hahn, Nuzhat and Yang, 2018). My results suggest that both the knowledge and incarceration effect might play a role in the fertility outcomes I observe. As shown in Table 7, I find that university openings delay the age at first intercourse, by 1.16 years on average, increase the likelihood of contraceptive use by 9 percentage points, but have no significant effect on women's desired fertility.[20]

6.2 Spousal Characteristics

Women's education may also be related to that of their partners through assortative mating, which can in turn, influence fertility rates and reproductive success (Becker and Lewis, 1973; Lavy and Zablotsky, 2015; Lefgren and McIntyre, 2006). Women who are better educated are more likely to marry highly educated partners, which increases their household income and potential investments in the human capital acquisition of any offspring (Behrman and Rosenzweig, 2002; Fernandez, Guner and Knowles, 2005; Anderberg and Zhu, 2014). I find no significant effects of university expansion on a range of spousal characteristics, including the husbands' age, education or employment, as presented in Table 8. However, women are 4 percentage points less likely to be married to men who have more than one

[20]The NDHS asks about a range of contraceptive methods including the pill, IUD, injection, condom, female sterilisation, male sterilisation, abstinence, withdrawal, implant and other

Table 7: Fertility

	Effect of first public university opening by age 18		
	(1) Age at 1st intercourse	(2) Ever used contraception	(3) Desired children
BJS Estimator w/ F.E + controls	1.163***	0.085***	-0.169
	(0.310)	(0.014)	(0.226)
Observations	41781	41821	41821
Outcome mean	14.21	0.26	7.33
Outcome SD	6.89	0.44	7.73

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on women. The dependent variables are the age at first intercourse, the likelihood that a woman has ever used contraception, and the desired number of children, as shown in Columns (1) through (3) respectively. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

wife. Previous studies have found that education increases the likelihood that women are in a polygamous union, a type of marriage that is negatively correlated with measures of empowerment (Fenske, 2015; Andre and Dupraz, 2017).

6.3 Women's Empowerment

Finally, the increased human capital acquired through education can improve women's labor market outcomes and opportunities outside of the household. This may provide women with independent sources of income, increased bargaining power in the household, and additional knowledge on issues such as contraception (Ashraf et al., 2020; Hahn, Nuzhat and Yang, 2018). I check this by examining the impacts of the expansion on a range of measures of women's empowerment, including labor market participation and decision-making. 65% of women in the sample are currently working. Column 1 of Table 9 shows that the expansion increases the likelihood that women are currently working by 9 percentage points. Columns 2 through 4 show that the expansion slightly increased the probability that women have the final say over large household purchases, spending their own earnings and accessing healthcare, by between 2 and 7 percentage points respectively.

Table 8: Spousal Outcomes

	Effect of first public university opening by age 18			
	(1) Husband's schooling	(2) Age gap	(3) Husband is currently working	(4) Husband has other wives
BJS Estimator w/ F.E + controls	0.316	-0.175	-0.005	-0.060***
	(0.245)	(0.216)	(0.005)	(0.022)
Observations	25404	28868	28781	28758
Outcome mean	7.34	10.37	0.96	0.30
Outcome SD	6.05	7.17	0.19	0.46

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on the sample of women's husbands. The dependent variables are husband's schooling, age, likelihood of currently working and likelihood of being polygamous, as shown in Columns (1) through (4) respectively. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. Estimates for years of schooling are restricted to the sample of husbands aged 30 and older.University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Table 9: Women's Empowerment

	Effect of first public university opening by age 18			
	(1) Currently working	(2) Final say: large household purchases	(3) Final say: own earnings	(4) Final say: own healthcare
BJS Estimator w/ F.E + controls	0.087***	0.022***	0.070***	0.048***
	(0.023)	(0.008)	(0.022)	(0.014)
Observations	41821	41821	41821	41821
Outcome mean	0.65	0.04	0.29	0.07
Outcome SD	0.48	0.20	0.46	0.26

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 on women. The dependent variables are the likelihood that a woman is currently working, has final the final say over household purchases, own earnings and own healthcare, as shown in Columns (1) through (4) respectively. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

7 Conclusion

Women's education has long been cited as an important tool for improving development outcomes for women, their families and society. This paper examines the effects of Nigeria's university expansion on the marriage, fertility and child health outcomes of women who were school-aged when universities opened. I exploit the exogenous variation in access to higher education across cohorts and regions from public university openings at the state level. I find positive effects of education on family formation, in line with recent empirical evidence - university openings increase educational attainment, delay the timing of marriage and childbearing, reduce fertility, and result in healthier children for eligible women. I also present evidence in favor of some potential mechanisms, showing that female schooling increases contraceptive use, bargaining power and labor market participation for women, but has no significant impact on the socioeconomic characteristics of their husbands.

This study contributes new evidence on the effects of public university expansions, a growing trend across developing countries in sub-Saharan Africa, South-East Asia and Latin America. University openings can increase access to education by reducing distance and attendance costs, as well as increasing the chances of admission. Increasing college proximity is particularly important for women, who may face additional barriers due to cultural norms and care responsibilities that limit their ability to leave home to attend university.

However, physical university expansion is capital-intensive, and given the competing needs for funding at lower levels of education, credible evidence of the effectiveness of these expansion reforms is needed to inform policy decisions. I find that Nigeria's university openings increase educational attainment, and these effects are driven by increased completion of secondary schooling, rather than higher education attainment. This evidence of spillover effects of investments in higher education on lower levels of schooling suggests that future, not just current opportunities for schooling can yield returns for women in the marriage market.

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A Appendix

Figure A.1: Gender gaps in Secondary School Completion over time

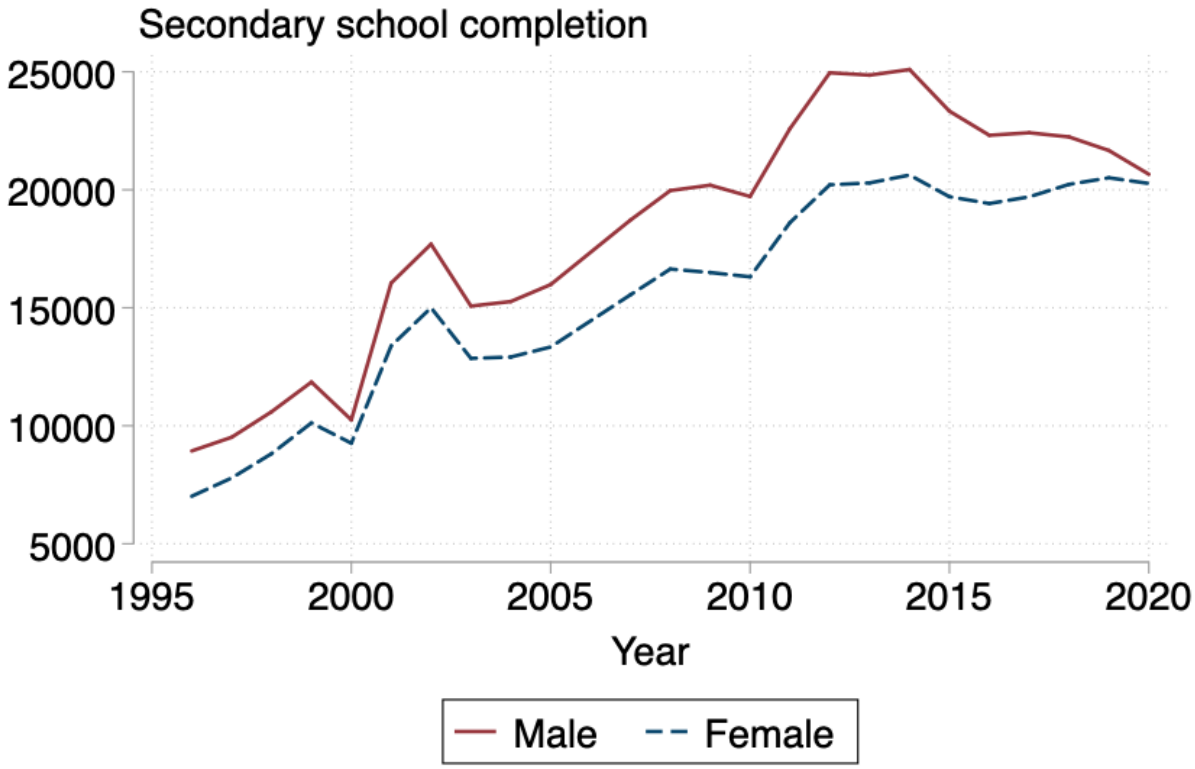
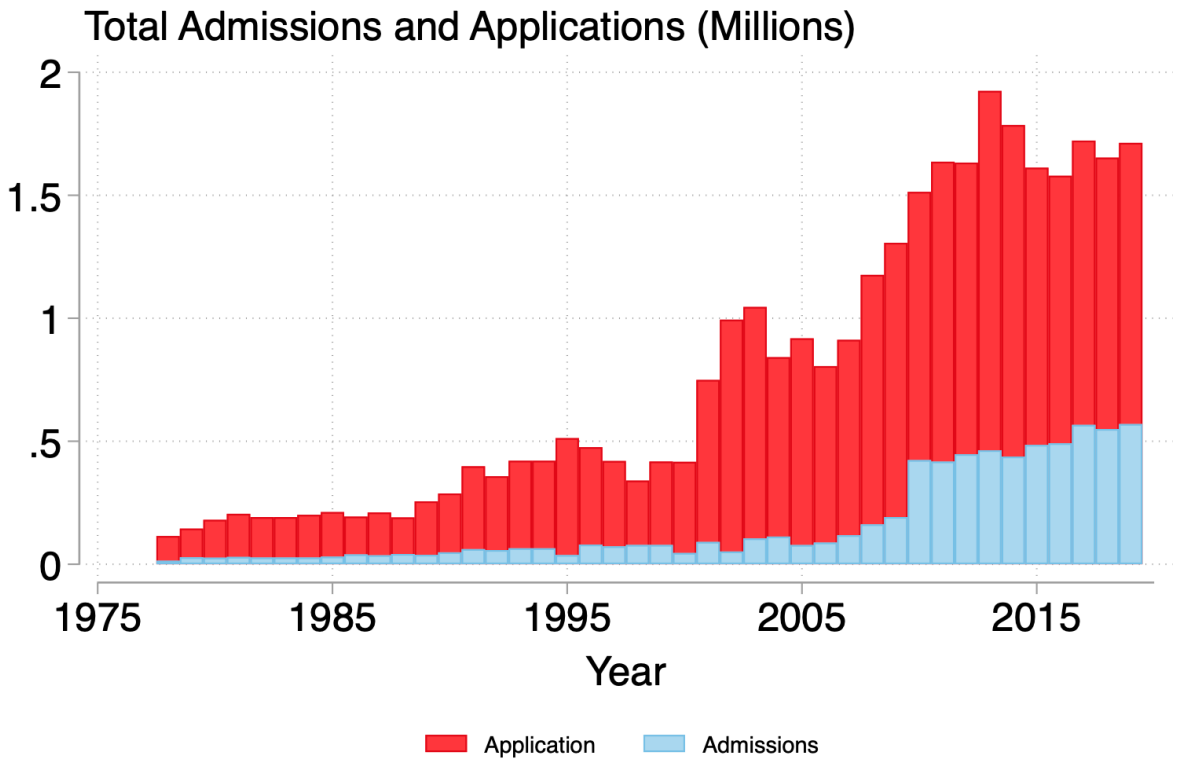


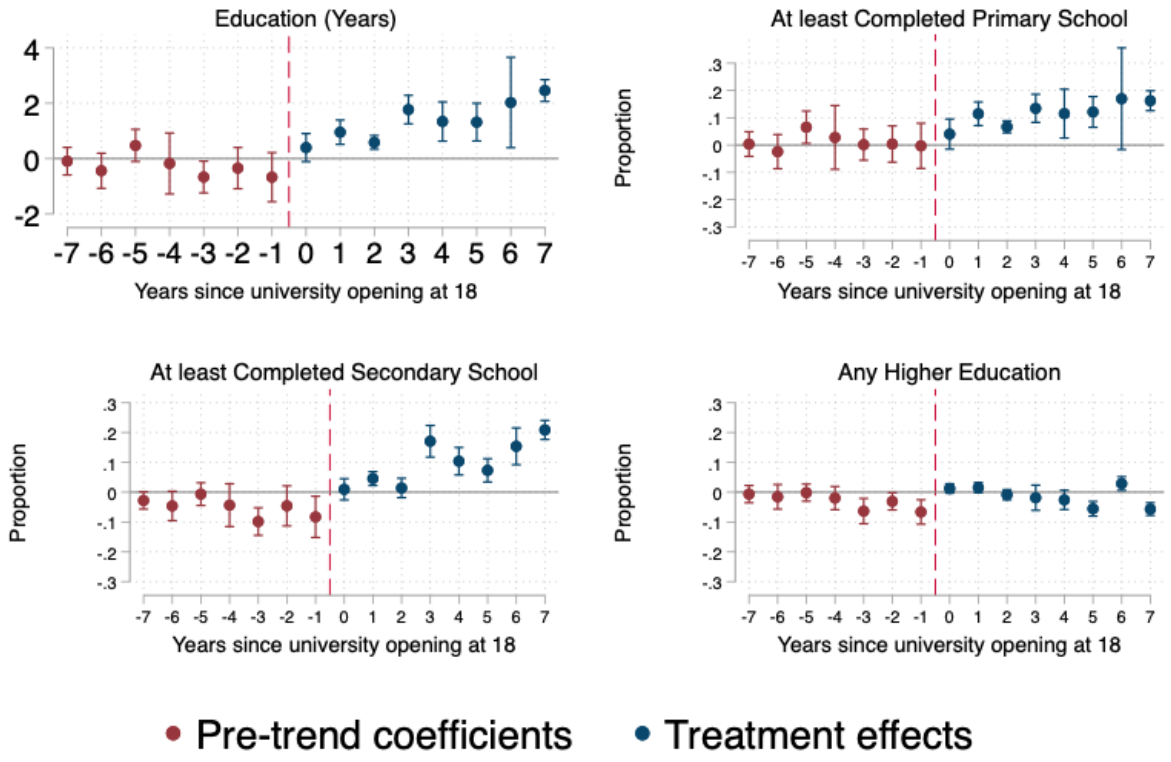
Figure A.1 reports the gender gap in the number of candidates who sat for the West African Senior Secondary School Certificate Examinations (WASSCE), over time. Source: West African Examinations Council (WAEC).

Figure A.2: Admissions rates at Nigerian universities over time



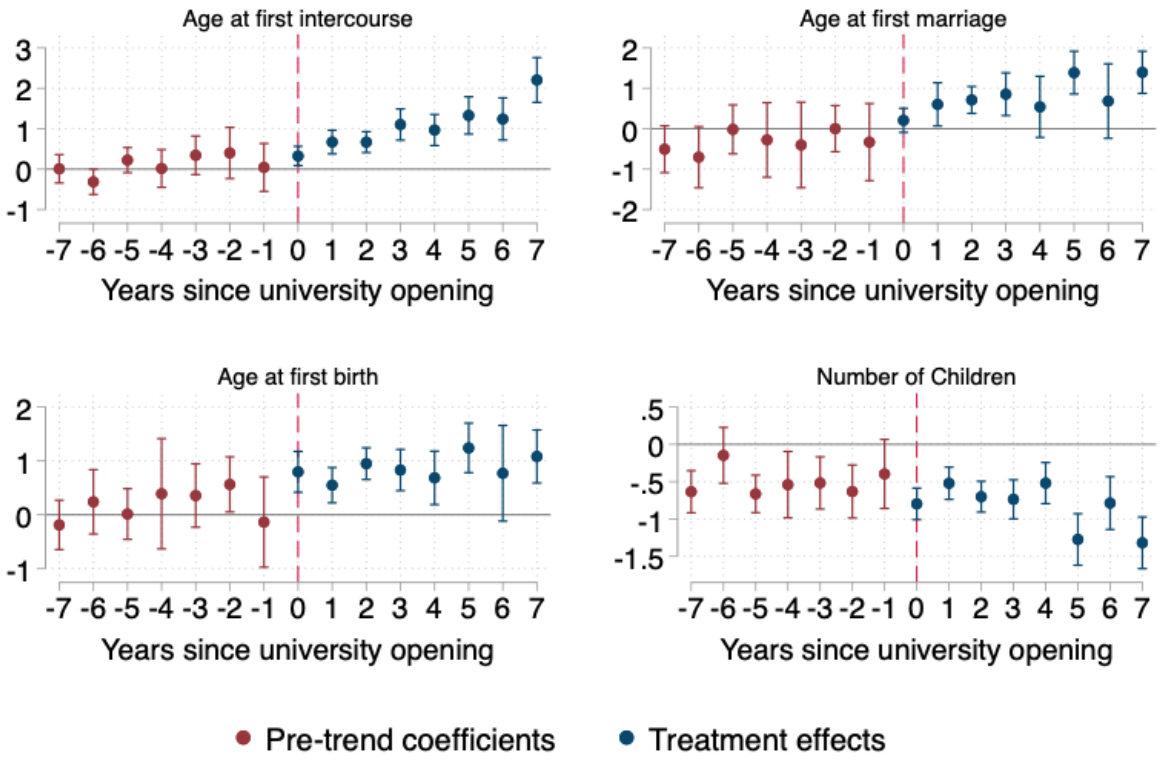
Source: Joint Admissions and Matriculation Board(JAMB), National Universities Commission(NUC)

Figure A.3: DID ATT Estimates: Educational Attainment of Women



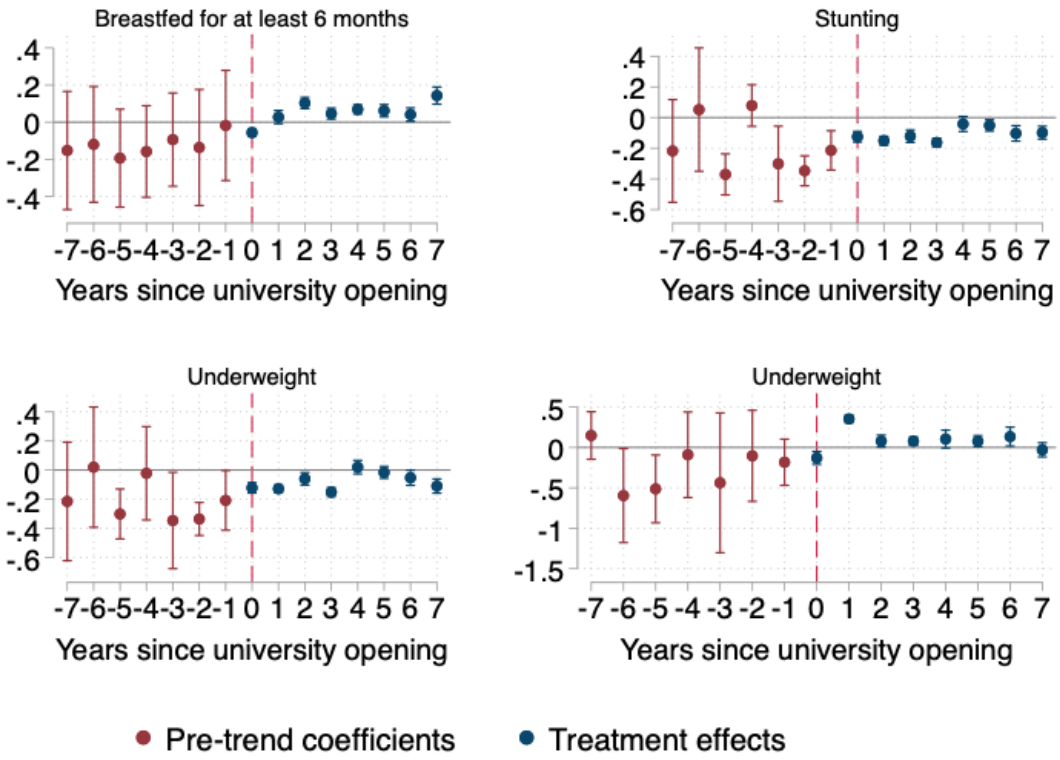
This table shows the estimated ATT for the DID models for women using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in 2. The dependent variables are years of schooling, and educational attainment in levels - at least completed primary, completed secondary and tertiary schooling. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013. The sample is restricted to individuals aged 30 and older who are likely past schooling age in this context. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Figure A.4: DID ATT Estimates: Marriage and Fertility Outcomes



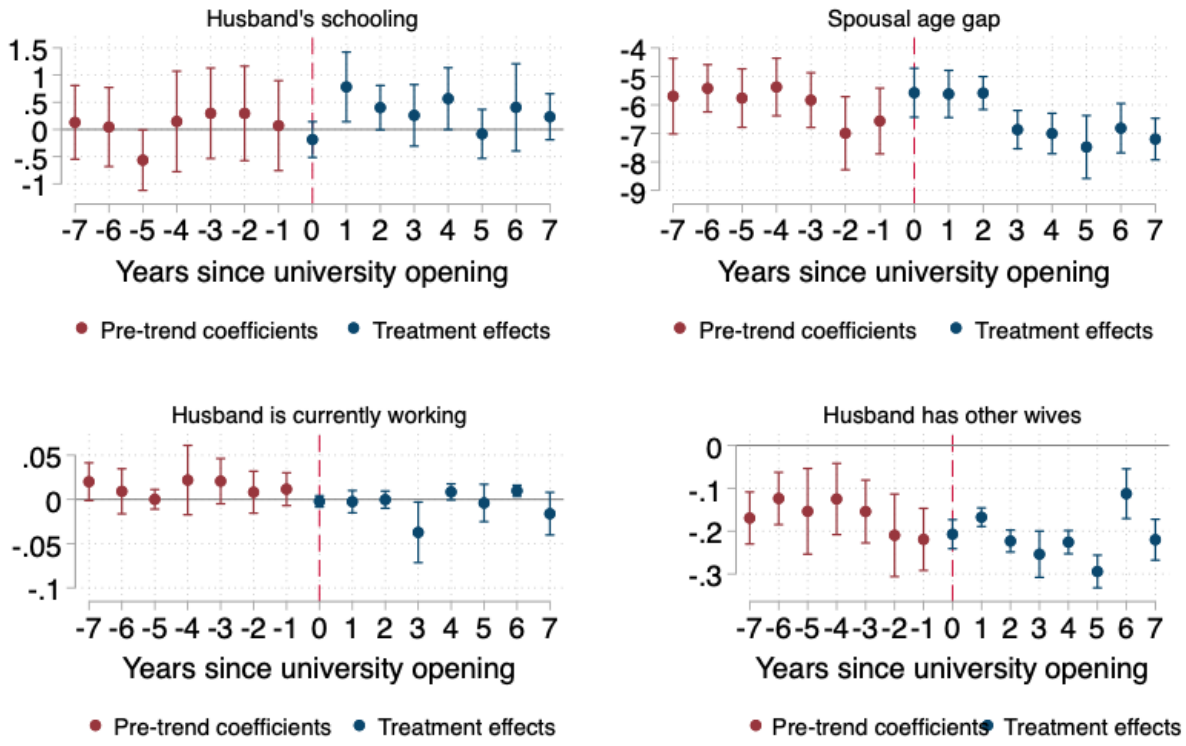
This table shows the estimated ATT for the DID models for women using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in 2. The dependent variables are age at first intercourse, marriage and childbirth, and number of children. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013.State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Figure A.5: DID ATT Estimates: Child Health Outcomes



This table shows the estimated ATT for the DID models for women using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in 2. The dependent variables are age at first intercourse, marriage and childbirth, and number of children. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. University openings are between 1999 and 2013.State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Figure A.6: DID ATT Estimates: Spousal Outcomes



This table shows the estimated ATT for the DID models for women's husbands using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in 2. The dependent variables are husband's schooling, age gap, likelihood of working and polygamy. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first public university in their state was opened. The sample is restricted to individuals aged 30 and older for schooling outcomes. University openings are between 1999 and 2013.State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Table 10: Robustness Checks - Age at University Expansion

	Effect of first public university openings			
	(1) Years of Schooling	(2) Age at first marriage	(3) Age at first birth	(4) Total children ever born
Panel A: 18 or younger				
BJS Estimate	0.964***	0.794***	0.835***	-1.000***
	(0.213)	(0.294)	(0.239)	(0.203)
Observations	19351	31152	29992	41821
Outcome mean	6.08	18.53	19.69	3.05
Outcome SD	5.76	5.10	4.50	2.96
Panel B: 14 or younger				
BJS Estimate	1.215***	0.737***	0.619**	-0.887***
	(0.389)	(0.277)	(0.253)	(0.202)
Observations	19351	31152	29992	41821
Outcome mean	6.08	18.53	19.69	3.05
Outcome SD	5.76	5.10	4.50	2.96
Panel C: 30 or younger				
BJS Estimate	0.010	0.102	0.379**	-0.968***
	(0.247)	(0.203)	(0.178)	(0.251)
Observations	19351	31152	29992	41821
Outcome mean	6.08	18.53	19.69	3.05
Outcome SD	5.76	5.10	4.50	2.96

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 using alternative definitions of treatment age-eligibility - women aged 14 or younger, or women aged 30 or younger - when the first public university in their state was opened in their state. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger . Estimates for years of schooling are restricted to the sample of women aged 30 and older. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.

Table 11: Robustness Checks - Selective Migration

	Effect of first public university opening by age 18			
	(1) Years of Schooling	(2) Age at first marriage	(3) Age at first birth	(4) Total children ever born
Panel A: Full Sample				
BJS Estimate	0.964***	0.794***	0.835***	-1.000***
	(0.213)	(0.294)	(0.239)	(0.203)
Observations	19351	31152	29992	41821
Outcome mean	6.08	18.53	19.69	3.05
Outcome SD	5.76	5.10	4.50	2.96
Panel B: Low Migrant States				
BJS Estimate	1.012***	0.715***	0.717***	-0.907***
	(0.172)	(0.239)	(0.191)	(0.209)
Observations	15117	25620	24463	33607
Outcome mean	4.99	17.84	19.14	3.22
Outcome SD	5.57	4.69	4.15	3.06
Panel C: Always Residents				
BJS Estimate	0.916***	0.763***	0.765***	-1.056***
	(0.228)	(0.281)	(0.255)	(0.239)
Observations	10088	16530	15985	24132
Outcome mean	5.20	17.88	19.23	2.90
Outcome SD	5.64	4.75	4.28	3.05

Notes: This table shows the estimated ATT for the DID models using the imputation estimator proposed by Borusyak, Jaravel and Spiess (2021) as specified in equation 2 using alternative sub-samples - excluding states with high migrant populations, and restricting the sample to women who have never moved away from their states. All specifications include controls for ethnicity, urban residence and the number of public universities in the state. Women are treated if they were 18 or younger when the first university was opened in their state. Estimates for years of schooling are restricted to the sample of women aged 30 and older. University openings are between 1999 and 2013. State-clustered standard errors in parentheses. **** p<0.01, ** p<0.05, * p<0.10. Source: Nigeria IPUMS-DHS 2018.