HUMAN CAPITAL FORMATION, FERTILITY, AND LABOR FORCE PARTICIPATION IN SUB-SAHARAN AFRICA

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Abstract: My dissertation comprises three chapters. The first chapter examines the effect of childhood immunization. After being in power in Burkina Faso for about a year, a military regime led by Thomas Sankara-within weeks, vaccinated 77% of children between ages one and six against measles, meningitis, and yellow fever. The coverage and the success of this program set it apart from other contemporary vaccination programs, hence providing a policy experiment to test the effects of large immunization programs in the contexts of developing economies. We estimate the impact of increased vaccination on child mortality, primary school outcomes, and adulthood labor market participation.

The second chapter examines the effect of polygamy on fertility; polygamy incidence in Sub-Saharan Africa is the highest in the world. While the relation between polygamy and fertility is well documented, the direction of the causality is still debated. In this paper, I combine census data from five African countries, to test the effect of polygamy on fertility. I exploit the observation that marriages occur within ethnic groups and differences in ethnic populations across regions to construct a novel instrument that allows me to identify the effect of the polygamous union on fertility.

The third chapter examines the role of ethnicity in labor participation in Africa. Does the president's ethnicity favor the youth's formal labor participation in Sub-Saharan Africa? The theory shows no definite conclusion, and analysis from eleven Sub-Saharan African regions substantiate the theory.

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CHAPTER I

PUBLIC HEALTH AND HUMAN CAPITAL FORMATION: THE EFFECT OF NATIONWIDE CHILD IMMUNIZATION OF CHILD MORTALITY, EDUCATION, AND LABOR MARKET OUTCOMES IN BURKINA FASO

1. Introduction

Vaccines are one of the most cost-effective investments to save lives and increase human capital. Vaccines not only benefit the immunized children, but a high vaccination rate also benefits the next generation by lowering the spread of infections and thus lowering the burden of the targeted diseases over time. Yet, one in five children globally in 2020 is not vaccinated for life-threatening infectious diseases (WHO, 2021). The vaccination rate is much lower in many developing nations, ranging from 40% to 70% (WHO, 2020).[1]

In developing countries with relatively weak infrastructure and healthcare systems, an outbreak of an infectious disease places a tremendous burden on the economy and undermines years of development effort. Well-designed and effectively administered vaccination programs could prevent such catastrophic events and increase economic growth by reducing the burden on the health system and improving human capital.

[1] Average vaccination rate for diphtheria-tetanus-pertussis (DTP3) vaccine in low-income countries is 70% in 2020. For the same vaccines the immunization rate in 2020 is 37% in Papua New Guinea, 42% in Central African Republic, 49% in South Sudan, and 52% in Chad (WHO, 2021). Similarly, global measles vaccination rate (among children 12-24 months) in 2020 is 70%; whereas, 46% in Somalia, 47% in Guinea, 51% in Angola, and 54% in Nigeria (World Bank, 2021).

Therefore, an effective vaccination program could potentially be more growth-inducing than other competing public projects.

Rising vaccine hesitancy in developed nations and continued under-investment in vaccines in developing nations, suggests that the impact of vaccines is still not well understood. One potential reason is that there is a limited number of studies evaluating the impact of national- level vaccination programs Uddin et al. (2016), Pezzotti et al. (2018), Sindoni et al. (2021), Nandi et al. (2020); Atwood (2021). Uddin et al. (2016), Pezzotti et al. (2018) and Sindoni et al. (2021) evaluate how national-level vaccination programs affect vaccine coverage and incidence of diseases in Bangladesh and Italy, respectively. To the best of our knowledge, Nandi et al. (2019) and Atwood (2021) are the only ones to evaluate national-level vaccination efforts to study the impact on human capital and labor market outcomes in India and United States. Nandi et al. (2019) use a household fixed-effect estimation to evaluate the effect of the Universal Immunization Program (UIP) in India and find that vaccination leads to higher schooling attainment. Atwood (2021) uses a variation in pre-vaccine measles incidence rates across states in the USA and differential exposure to the vaccine due to birth year to measure the effects of measles vaccination on adulthood earnings and employment. Since there are only a few studies empirically evaluating the positive effect of vaccines, side

effects of vaccines– though limited to brief soreness, occasional rash, and infrequent fever– receive much more attention than the life-altering benefits[2]. In this paper, we add to the growing literature on the returns to immunization program by documenting the effects of a national-level vaccination program on human capital formation and labor market outcomes in a low-income context.

[2]Covid-19 vaccine hesitancy has led to severe protests against vaccination mandate in the United States and Australia. Some protesters compare state government to Nazis. Conversely, fearmongering is observed with polio vaccines in the past in India. https://www.nytimes.com/2021/11/10/health/vaccine-mandate-state-lawsuit.html https://www.usnews.com/news/world/articles/2021-11-13/australia-vaccine-mandate-protesters-compare- state-govt-to-nazis-media) https://www.comminit.com/global/content/fear-polio-drops-overcome

The program, locally known as the "vaccination commando (VC) program" was imple- mented in 1984 in Burkina Faso. It provides a unique natural experiment to evaluate the impact of a national-level vaccination program. In 1983 the national vaccination rate was only 17 percent (Unicef et al. (2007); Kessler et al. (1987)). The same year a military regime led by Thomas Sankara came into power after a coup. Observing the colossal failure of the existing expanded program in immunization (EPI), the regime initiated the VC program, which vaccinated over one million children against measles, yellow fever, and meningitis in a two-week campaign. As a result of the VC program, the vaccination rate in Burkina Faso increased from 17 percent to 77 percent in a few months. The success of the VC program was hailed by the World Health Organization (WHO) and presented as a case study of one of the most successful vaccination campaigns (Kessler et al. (1987)).

We utilize the sudden implementation of the VC program through deploying military and without mentionable change in Burkina Faso's health system as a quasi-experiment. This aspect of the VC program helps us to identify the causal effect of a vaccination program on child health and educational outcomes, and labor market outcomes in adulthood. Ideally, we need within-country variation in vaccination rates before and after 1984 to identify the impact of the program. However, we lack data on any within-country variation in vaccination rates. This data limitation leads us to estimate the causal effects (i.e., average treatment effects) with longitudinal data in the context where Burkina Faso is exposed to a binary treatment (i.e., the VC program) in 1984.

Since we do not observe what would have happened in Burkina Faso in the absence of the VC program, we need a suitable method for estimating the counterfactuals– imputing the missing potential control outcomes– to find the average treatment effects. Causal inference literature provides us with three broad approaches– unconfoundedness, synthetic control, and model-based imputation (Athey et al. (2021)). We employ the model-based imputa- tion approach, which takes observations under the treatment condition as missing and uses model-based estimation to impute counterfactuals of treated observations (Liu et al. (2021)). Model-based imputation is more efficient and flexible than the other two approaches. It allows several alternative counterfactual estimation techniques such as fixed effects, iterative fixed effects, and matrix completion.

We use the matrix completion approach in this study and apply the "counterfactual es- timators" proposed by Liu et al. (2021). The counterfactual estimators take observations under the treatment condition as missing and use observations under the control condition to build models and impute the counterfactuals of treated units based on the estimated mod- els. The matrix completion approach nests both unconfoundedness and synthetic control approaches and outperform those approaches.

The identification strategy we employ requires aggregate level data over a long period from a set of countries. We use World Bank's world development indicators to gather data on Sub-Saharan African (SSA) countries from 1972 to 1990. We keep all SSA countries for which we have the required demographic and economic characteristics available for 1972- 1990. That gives us data on 27 countries over 19 years. We focus on child health and education outcomes to measure the short-term impact and labor market outcomes to mea- sure the long-term impact of vaccination. Child health and educational outcome variables also come from World Bank development indicators. For labor market outcomes, we use data from the Demographic and Health Survey (DHS) for 37 SSA countries.

We focus on two child health outcomes– under-five child mortality rate and prevalence of thinness among 5-9 years old. We show that the vaccination leads to a significant decline in child mortality and a lower prevalence of thinness in Burkina

Faso. Using dynamic treatment effect graphs, we show the effect of vaccination increases over time. Clemens et al. (1988) and Koenig et al. (1990) in Bangladesh find similar results that measles vaccination reduces child mortality.Nandi et al. (2019) find measles vaccination leads to better health outcomes in Ethiopia, India, and Vietnam. Contrary to our findings, Bloom et al. (2011) find vaccination has no impact on children's height and weight in the Philippines. Our study is much broader in its scope compared to these studies. We study the impact of national-level vaccine intervention, while these studies use relatively small-scale interventions.

We also explore how vaccination affects children's educational outcomes. We use two indicators of educational attainment– primary school enrollment and completion. We find vaccination leads to a substantial rise in the likelihood of primary school enrollment and completion. Our results confirm those of several studies which find positive effects of vaccination programs on grade attainment in South Africa (Anekwe et al. (2015)), Ethiopia and Vietnam Nandi et al. (2019), and India (Nandi et al. (2020)).

Finally, we inquire how the vaccination improves human capital (i.e., health and educational outcomes) and affects the treated cohorts' labor market outcome in adulthood. We find that vaccinated cohorts are more likely to be employed in both the informal and the formal labor sectors. Atwood (2021) found a similar result for the measles vaccine in the United States where the labor market is well established. Whether vaccines have an impact on labor market outcomes in developing countries with more frictions in the labor markets remains an open question that we address.

This study makes two major contributions to the literature. First, we evaluate nationwide vaccination programs: while there are several studies on the impacts of vaccination, most fo- cus on local programs (Anekwe et al. (2015)). Studies based on local vaccination programs are very informative, but also likely to mischaracterize the true effect of the program due to failure to capture spillover effects[3]. Our study is part of a fast-growing body of research that focuses on understanding the long-term returns of large health interventions (Atwood (2021); Nandi et al. (2020)). Second, our results demonstrate that vaccines can have a strong and positive effect in the long-run even in environments where the labor market is less than perfect.

2. Program Context

More than half of all deaths of children under five years in Burkina Faso were directly at- tributed to vaccine-preventable diseases (Bellamy (1998)). To improve the situation, Burkina Faso established its Expanded Program on Immunization (EPI) in 1980 to administer vac- cines against measles, meningitis, and yellow fever to infants and children. Only 25,000 of the half a million children under age two were vaccinated in 1981 Bellamy (1998). Lack of vaccines and ineffective transportation of the immunizer personnel were cited for the low coverage. Vaccination Commando (VC) was established in 1984 to address the failure of the EPI. In a 15 days campaign between November 25th and December 10th of 1984, Burkina Faso vaccinated over 1 million children against measles, yellow fever, and meningitis. The VC campaign covered 68-75% of the previous unimmunized children and saw an increase in the national vaccination coverage from 17% to 77%. Consequently, the number of reported measles cases fell sharply after the VC program, except in 1987 when the country went through a political turmoil (See Figure 1).

The vaccination Commando (VC) aimed to vaccinate children between the ages of 9 months to six years against measles and those between the ages of one to fourteen against both meningitis and yellow fever (Kessler et al. (1987)). The government

[3] Specifically, while the spillover effects on disease burden are unquestionably positive in the short-run, the effects on education and labor outcomes can be ambiguous. Improved child health due to vaccination can increase the demand for education. This can result in lower enrollment rates if the supply of educational services does not increase to match the changes in demand. Similar arguments can be made for the formal labor market. These types of frictions are presumably more severe in resource-constrained countries such as Burkina Faso.

took both demand and supply-side initiatives to achieve its objective. The government raised health awareness for vaccination through a nationwide campaign using multiple mediums: radio and television, circulated educational leaflets in several dialects, displayed posters, organized contests, staged theaters, and artists sang special songs to create awareness for the program. The government procured vaccines from the world market with funds from WHO, UNICEF, and several national governments on the supply side. The Ministry of health provided a refresher course for the health workers, temporarily assigned workers to ensure adequate staffing, and issued new vaccination cards. Besides, the government established multi-sectoral vaccination committees in every province to mobilize community support and participation. On top of that, the militaries were deployed to facilitate transportation logistics.

3. Data and Method

3.1. Data

In this study, we want to estimate the average treatment effects with longitudinal data in the context where Burkina Faso was exposed to a binary treatment (i.e., the VC program) in 1984. Since we do not observe what would have happened in Burkina Faso in the ab- sence of a Vaccination Commando program, in this situation, we need a suitable method of counterfactual estimation to find the average treatment effects. The identification strategy we employ requires aggregate (macro) level data over a long period from a set of countries. We use World Bank's world development indicators to gather data on Sub-Saharan African (SSA) counties from 1972 to 1990. We keep all SSA countries for which we have the required demographic and economic characteristics available for 1972- 1990. That gives us data on 27 countries including Burkina Faso. The demographic and economic indicators we use from the world development indicators are population growth rate, percentage of male population, percentage of female population, percentage of age 0-14 population, percentage of rural population, life expectancy at birth, mortality rate for adult females, mortality rate for adult males, percentage of land used in agricultural, crop produc-

tion index, food production index, livestock production index, and gross domestic product (GDP) per capita (see Table 1).

In Table 1, we provide the descriptive statistics of the key variables. We present the statistics for two broad groups: Burkina Faso and other Sub-Saharan countries. Columns 1 and 4 present the mean and standard deviation for all observations (i.e., 1972 to 1990) of Burkina Faso and other SSA countries, respectively. Similarly, columns 2 and 5 show the statistics before the implementation of the VC program covering the years from 1972 to 1983. Conversely, columns 3 and 6 present the statistics after the VC program from 1984 to 1990. For demographic characteristics, Burkina Faso looks similar to other SSA countries, but they are quite different in economic characteristics. However, these differences are not a concern for the estimation method we use.

Outcome Variables We focus on both the short-term and long-term effects of vaccination. To measure the short- term outcome, we focus on both health and educational outcomes. We focus on two health outcomes– under-five child mortality rate and the prevalence of thinness among children aged 5-9 years (see Table 1). Under-five child mortality rates data comes from the World Bank's world development indicators. The prevalence of thinness (i.e., the proportion of extremely unhealthy) among children aged 5-9 years data comes from the World Health Organization (WHO) country nutrition profile. We also used two educational outcomes– primary school enrollment rate and primary school completion rate. We only focus on primary school out- comes because we lack data on secondary and above-secondary school outcomes. Educational outcome data comes from the World Bank's world development indicators.

Our first health indicator under-five child mortality rate provides an overall health status of the children. Children under five are more susceptible to disease and have a significantly higher mortality rate than other age groups. The under-five child mortality rate is measured by the percentage of total live births who die before reaching age five. Our second health outcome, the prevalence of thinness another indicator of the overall health status of children 5-9 years. Children are labeled as thin if their body mass index (BMI) is two standard deviations below the WHO-defined median BMI. Thus, the prevalence of thinness shows what percentage of all children 5-9 years are extremely thin. A high prevalence of thinness indicates that the children are severely unhealthy.

Our first educational outcome is primary school enrollment rate, which measures the percentage of children who are enrolled in school among the relevant age group. Children in Burkina Faso usually start their primary school at age 6 and complete it at age 12. Similarly, the primary school completion rate, our second educational outcome, measures the percentage of the relevant age group who completed primary school. If vaccination leads to better child health, we expect to see better educational outcomes.

We also explore the potential long-run effects of vaccination. We study labor market outcomes of the vaccinated children when they become adults (25-30 years). We look at two labor market outcomes– employment rate and employment in a formal sector. We use these two measures due to the lack of other more direct measures such as hours worked and earnings. The idea here is if measles vaccination leads to long-term improvement in human capital (i.e., health and educational outcomes) formation of the children, we should observe that vaccinated children are more likely to work and work in a formal sector. The employment rate is measured by the percentage of adults who are employed among all the adults born in a year. Similarly, employment in a formal sector is measured by the percentage of adults who are employed in the formal sector (i.e., professional jobs, services, and clerical work) among all the adults born in a year.

We construct the labor market outcomes from the Demographic and Health Survey (DHS) for Sub-Saharan African (SSA) countries. the Demographic and Health Survey (DHS) collects data on individuals' labor force participation decisions and occupations. We aggregate the individual-level data of employment and formal section employment by birth-year to construct our measures. Since DHS surveys are conducted in different years in our sample countries, we use a DHS survey round for each country between 2010 to 2015. For a country- DHS round, we observe birth-year and employment data for adults (15 years and above) in that country. Then, we find the employment rate by taking the ratio of the total number of employed individuals over the total number of individuals in a birth year.

3.2. Method

We want to estimate the causal effects of vaccination using the VC program as a natural experiment. The VC program was implemented in 1984 in Burkina Faso. We need a suitable method for estimating the counterfactuals– imputing the missing potential con- trol outcomes–to find the average treatment effects. Causal inference literature provides us three broad approaches– unconfoundedness, synthetic control, and model-based imputation (Athey et al. (2021)).

The unconfoundedness approach imputes missing potential control outcomes for treated units using observed control outcomes for control units with similar values for observed out- comes in previous periods (Rosenbaum and Rubin (1983); Imbens and Rubin (2015)). The synthetic control method imputes missing control outcomes for treated units using weighted average outcome for control units with the weights chosen so that the weighted lagged control outcomes match the lagged outcomes for the treated units (Abadie and Gardeazabal (2003); Abadie et al. (2015); Athey et al. (2021); Abadie et al. (2010)). Finally, the model-based imputation takes observations under the treatment condition as missing and uses model based estimation to impute counterfactuals of treated observations (Liu et al. (2021)).

Model-based imputation is more efficient and flexible than the other two approaches. It allows several alternative counterfactual estimation techniques such as fixed effects, iterative fixed effects and matrix completion. The matrix completion approach uses the observed elements of the matrix of control outcomes corresponding to untreated units to impute the missing elements of the control matrix (Athey et al. (2021)). The matrix completion ap- proach nests both unconfoundedness and synthetic control approaches and outperform those approaches.

We use the matrix completion approach in this study and apply the "counterfactual es- timators" proposed by (Liu et al. (2021))[4] The counterfactual estimators take observations under the treatment condition as missing and use observation under the control condition to build models and impute the counterfactuals of treated units based on the estimated models. Although the counterfactual estimators can deal with both balanced and unbalanced panel data, we describe the estimation framework using a balanced panel notation for notational convenience.

Let D_{it} be the treatment status, and $Y_{it}(1)$ and $Y_{it}(0)$ be the potential outcomes of unit i in period t when $D_{it} = 1$ and $D_{it} = 0$. Also, let X_{it} be a vector of exogenous covariates, U_{it} be unobserved attributes, and ϵ_{it} be the idiosyncratic error term. The class of outcome models for the untreated potential outcome can be written as follows:

$$Y_{it}(0) = f(X_{it}) + h(U_{it}) + \epsilon_{it} \tag{1}$$

where $f(.)$ and $h(.)$ are known parametric functions.

[4]Liu et al. (2021) provides both Stata and R packages to implement the estimation. The package is called Fixed Effects Counterfactual Estimators (Fect).

Let us define observations under the treatment condition as M and observations under the control condition as O, where M stands for missing and O stands for observed. The counterfactual estimators follow a four step procedure. First, fit a model of Y_{it} to obtain $\hat{f}$ and $\hat{h}$ using the subset of untreated observations. Second, predict the counterfactual outcomes $Y_{it}(0)$ for each treated observation using the $\hat{f}$ and $\hat{h}$, i.e., $\hat{Y_{it}}(0) = \hat{f}(X_{it}) + \hat{h}(U_{it})$ for all $(i,t) \in M$. Third, for each treated observation $(i,t) \in M$, estimate the treatment effects δ_{it} using $\hat{\delta}_{it} = Y_{it} - \hat{Y_{it}}(0)$. It is important to note that δ_{it} is not identified for each treated observations because of idiosyncratic errors. Finally, to find the average treatment effects, take average of $\hat{\delta_{it}}$,

$$A\hat{T}T = \frac{1}{|\mathbb{M}|} \sum_{(i,t)\in\mathbb{M}} \hat{\delta}_{it}$$

Similarly, the ATT at a time period s since the treatment started

$$A\hat{T}T_s = \frac{1}{|\mathbb{S}|} \sum_{(i,t)\in\mathbb{S}} \hat{\delta}_{it}$$

in which

$$\mathbb{S} = \{(i,t)|D_{i,t-s} = 0, D_{i,t-s+1} = D_{i,t-s+2} = ... = D_{i,t} = 1\}$$

To apply the general framework of counterfactual estimators into the matrix completion, we can express potential outcomes data matrix Y_{it} as the following equation:

$$Y_{it} = \delta_{it} D_{it} + L_{it} + x_{it}\beta + \eta_i + \gamma_t + \epsilon_{it} \tag{2}$$

where $Y_{it} \in (N \times T)$ matrix of untreated outcomes, $x_{it} \in (N \times T \times k)$ array of covariates, η_i represent the unit fixed-effects γ_t represent the time fixed-effects, and ϵ_{it} represent a $(N \times T)$ matrix of idiosyncratic errors. MC treats the treatment observations ($Y_{it}(1)$) as missing data and estimates the treated counterfactual by employing the information of the untreated observations. It uses the donor pool (i.e., other SSA countries) for model training and pre-treated data for model selection (i.e., model building and testing). Then, it uses the trained model to predict the counterfactual outcomes $\hat{Y}_{it}(0)$ for each observation under the treatment condition ($D_{it} = 1$) and obtains an estimate of the individual treatment effect. The method assumes that the ($N \times T$) matrix can be approximated by a lower rank matrix $L_{(N\times T)}$ (unobserved cofounders). The method estimate L by solving the minimization problem.

$$\hat{L} = \min_{L} \frac{1}{\mid \mathbb{A} \mid} \sum_{(i,t)\in\mathbb{A}} ((Y_{it} - L_{it})^2 + \lambda_L \|L\|) \tag{3}$$

where $\mathbb{A} = \{(i,t)|D_{it} = 0\}$ is the set of untreated observations and $\|L\|$ is the chosen matrix norm of L, and λ_L is a tuning parameter. λ_L controls the strength of the penalty term. Athey et al. (2021) proposed an iterative algorithm to estimate $\hat{L}$. MC tries to find a lower-rank representation of the matrix L to impute the missing data. Athey et al. (2021) suggests using nuclear norm to construct L, which is by putting regularization on the eigenvalues of the L matrix. One of the advantages of regularization is to prevent the overfitting of the model. The regularization term (λ_L) imposes a cost on the optimization function to make the optimal solution unique. The objective of the method is to construct L_{it} matrix such that the difference between Y_{it} and L_{it} is minimized and also put a penalty on the complexity of the L matrix. As L converges then $\hat{Y}_{it}(0) = \hat{L}^*_{it}$ and thus

$$\hat{\delta}_{it} = Y_{it}(1) - \hat{Y}_{it}(0) \tag{4}$$

where $\hat{\delta}_{it}$ is the average treatment of the treated. The estimate is the average difference between the observed outcome and its counterfactual estimate for the treated unit.

4. Results

4.1. Effect of Vaccination on Child Health

At first, we focus on how vaccination affects child health outcomes. We focus on two health outcomes– under-five child mortality rate and prevalence of thinness among 5-9 years. Figure 2 reports our main result for child mortality. The outcome variable here is the child mortality rate under five years in year t. The treatment variable is the exposure to the VC program. Figure 2 Panel-a plots the dynamic treatment effects of exposure to vaccination. It shows the average treatment effect on the treated (ATT), which is the treatment effect in Burkina Faso relative to counterfactual Burkina Faso. The first point to notice is that the ATTs before the treatments are close to zero, and post-treatment ATTs are negative. Thus, the vaccination has a negative effect on child mortality, and the effect becomes stronger over time. The treatment effect is statistically significant at a 10 percent significance level three years after the inception of the VC program. The relatively small reduction in under-five child mortality in the first few post-treatment

periods is most likely because some of the under-five children are already affected by measles and other vaccine-preventable diseases since the national vaccination rate was extremely low before the VC program. Moreover, vaccine eligibility starts at the age of nine months. At age five, those immunized children have also missed the positive health externality arising from the improved immune system generated by the vaccination. Studies suggest the improved immune system produced by the measles vaccination also protects children from other deadly diseases (Gadroen et al. (2018); Mina et al. (2019); Petrova et al. (2019)).

The VC program reduces the under-five child mortality rate by about 10 percent six years after the inception of the VC program. This rise in the VC program effect size comes from the positive externality of vaccinating current cohorts (who are already eligible for measles vaccine nine months to 6 years) and successfully vaccinating the newly vaccine-eligible chil- dren (who are less than nine months in 1984 or born after 1984) in coming years. Children who are vaccinated earlier in their childhood benefited more from the earlier improvement in immune system. Besides, the successive decline in the under-five child mortality rate also suggests that the effect of the vaccines on mortality persists several years after being immunized. This finding indicates that vaccination has a relatively long-term impact on children's morbidity and mortality. Koenig et al. (1990) also reach a similar conclusion.

We test the validity of the identifying assumptions (i.e., strict exogeneity and correct func- tional form) using a placebo test. The primary idea of the test is based on the "panel placebo test," which hides a few periods of observations right before the onset of the treatment for the treated units and use a model trained using the rest of the untreated observations to predict the untreated outcome of those holding out periods. If the identifying assumptions are valid, the average differences between the observed and predicted outcomes in those peri- ods should be close to zero. On the other hand, if these differences are significantly different from zero, the evidence will indicate that the identifying assumptions are not valid. In our case, we assume the treatment started three periods earlier than its actual onset in Burkina Faso and obtain the ATT estimates for those three periods using the usual counterfactual estimator.

In Figure 2 Panel (b), we see the confidence bounds for placebo ATTs are not statistically significant at a 10 percent significance level. The confidence bounds are set by the prespecified parameters or equivalence thresholds $\theta_1 = \theta_2 = 0.36\hat{\delta}_\epsilon$ following Hartman and Hidalgo (2018). Here, $\hat{\delta}_\epsilon$ is the standard deviation of the residualized untreated outcome. The null hypothesis based on the placebo $ATTs(ATT^p)$ is $ATT^p < -\theta_2$ or $ATT^p > \theta_1$. We show that fake ATT (i.e., ATT^p) falls within the equivalence range $[-\theta_2, \theta_1]$ with a probability of 0.517. Thus, we can not reject the null that the placebo ATTs are bigger than the true ATTs. The placebo test result suggests that our identifying assumptions hold.

Next, we present the pre-treatment fit between Burkina Faso and counterfactual Burkina Faso in Figure 2 Panel c. A common approach to test the pre-treatment fit is to jointly test a set of null hypotheses – that the average of the residuals in each pre-treatment period is zero, i.e., $ATT_s = 0$ for all pre-treatment period s– using a F-test. However, Liu et al. (2021) provides a better test called the "Equivalence Test" that is robust to the limitation of the F-test. The null of the equivalence test is $ATT_s < -\theta_2$ or $ATT_s > \theta_1$, $\forall_s \leq 0$. Here, s indicates the pre-treatment periods, and $[-\theta_2, \theta_1]$ is the equivalence range. The null hypothesis is rejected (i.e., equivalence holds) only when the tests for all pre-treatment periods generate significant results. In addition, they also calculate the minimum range, the smallest symmetric bound within which we can reject the null of inequivalence using the sample at hand. A rule of thumb is that the test is considered passed when the minimum range is within the equivalence range. In our case, the pre-treatment fit is great as the minimum range is within the equivalence range.

4.2. Effect of the Measles Vaccination on Prevalence of Thinness

Now, we turn to our second health outcome, the prevalence of thinness. The data on preva- lence of thinness is available from 1975, which gives us nine pre-treatment periods. Figure 3 Panel (a) plots the dynamic treatment effects of vaccination on the prevalence of thinness among children aged 5-9 years. The post-treatment ATTs are negative, which indicates that vaccines reduce the likelihood of being extremely thin. Six years after the inception of the VC program, it leads to about 23 percent lower prevalence of thinness among children aged 5-9 years. In other words, vaccination leads to significant improvement in health outcomes in Burkina Faso.Nandi et al. (2019) find a similar result for children 11-12 years in Vietnam.

In Figure 3 Panel (b), we show the placebo test result for the prevalence of thinness. We find the fake ATTs fall within the equivalence range with a probability of 0.456. Thus, we can not reject the null that the placebo ATTs are different than the true ATTs. Thus, our identifying assumption hold for this estimation. Panel (c) shows the equivalence test is passed as the minimum range is within the equivalence range. This result provides us evidence that the control and the treatment countries do not have any differential pre-trends.

4.3. Effect of Vaccination on Primary School Enrollment

In the previous section, we show that the vaccination leads to a better health and lower child mortality. The improved health outcome of the vaccinated children may also lead to better educational outcomes. In this section, we explore how vaccination affects children's educational outcomes. We focus on two educational outcomes– primary school enrollment and primary school completion.

Figure 4 Panel (a) shows the dynamic treatment effect of vaccination on children's primary school enrollment. The post-treatment ATTs are positive, which indicates the vaccination increases the likelihood of primary school enrollment. Six years after the inception of the VC program, there is a 4 percent rise in the primary school enrollment rate. Figure 4 Panel (b) shows that the placebo test is satisfied. We cannot reject the null that the placebo ATTs are different than the true ATTs. Figure 4 Panel (c) shows the equivalence test is passed as the minimum range is within the equivalence range. This result provides evidence that the control and the treatment countries do not have any differential pre-trends for primary school enrollment.

4.4. Effect of Vaccination on Primary School Completion Rate

We show the dynamic treatment effect of vaccination on children's primary school comple- tion rate in Figure 5 Panel (a). We see the vaccination increases the likelihood of primary school completion rate. Six years after the inception of the VC program, there is a 6 percent rise in the primary school completion rate. Figure 5 Panel (b) shows that the placebo test is satisfied. We cannot reject the null that the placebo ATTs are different from the true ATTs. Figure 5 Panel (c) shows the equivalence test is passed as the minimum range is within the equivalence range. This result suggests no differential trend in primary school completion rates in treatment and control countries.

4.5. Effect of Vaccination on Labor Market Outcomes

The positive health and educational outcomes we find are a relatively short-run benefits of vaccination. In this section, we focus on the relatively long-run outcomes of vaccination. We explore labor market outcomes of the vaccinated children when they become adults (25-30 years). We look at two labor market outcomes– employment rate and employment in a formal sector. The idea here is if measles vaccination leads to long-term improvement in human capital (i.e., health and educational outcomes) formation of the children, we should see the vaccinated children are more likely to work and gainfully work in a formal sector.

Figure 6 Panel (a) reports the dynamic treatment effect of vaccination on adults' employ- ment rate. The post-treatment ATTs are positive, which indicates the vaccination increases the likelihood of adult labor force participation. ATT at one year since the treatment started indicates the average rise in the employment rate for the children born in 1985. The result shows that the vaccinated children after six years of the inception of the VC program are about 10 percent more likely to work. Figure

6 Panel (b) shows that the placebo test is

satisfied, which indicates that we cannot reject the null that the placebo ATTs are different than the true ATTs. However, Figure 6 Panel (c) shows the equivalence test failed as the minimum range is outside the equivalence range. This equivalence result suggests that for some years, the pre-treatment fits are not good. This is not surprising because, unlike other outcome variables in our analysis, we are using sample data (i.e., DHS surveys) to generate aggregate (national) employment rates.

4.6. Effect of Vaccination on Formal Employment

Next, we present the dynamic treatment effect of vaccination on adults' formal sector employment rate in Panel (a) of Figure 7. The post-treatment ATTs are positive and increasing over time, which indicates the vaccination increases the likelihood of adults working in the formal sector. The result shows that the vaccinated children after six years of the inception of the VC program are about 4 percent more likely to work in the formal sector. Since formal sector workers earn on average more than informal sector workers, our result suggests that vaccinated children earn more when they enter the labor market. Atwood (2021) finds a similar result in the United States for measles vaccination. Figure 7 Panel (b) shows that the placebo test is satisfied, which indicates that we cannot reject the null that the placebo ATTs are different than the true ATTs. However, Figure 7 Panel (c) shows that the equiva- lence test failed as the minimum range is outside the equivalence range. This result suggests that for some years, the pre-treatment fits are not good.

5. Conclusion

Measles and other infectious diseases affect millions of people yearly, and Sub-Sahara African countries are no exception. Before 1984, the majority of children's death in

Burkina Faso was due to diseases that are preventable with vaccination. This is still true for many developing countries. Vaccines are the most effective but gravely under-utilized tool to prevent morbidity and mortality of children. Such under-investment and under-utilization of vaccines could be due in part to a misunderstanding of the overall impact of vaccines. This is not unsurprising given that there are only a few studies that empirically studies the impact of vaccines. To the best of our knowledge, there are only two studies that evaluate the impact of vaccination on human capital and labor market outcomes using national-level vaccination program.

In this study, we fill the gap in the literature by studying the effect of a national-level vaccination program on children's health and educational outcomes, and adulthood labor market outcomes. Besides, we utilize the VC program as a natural experiment to identify the causal effects. Our finding suggests that vaccination significantly increases human capi- tal for the treated cohorts. Vaccination significantly reduces child mortality, improves child health, and increases primary school enrollment and completion. In adulthood, vaccinated cohorts are more likely to be employed and gainfully employed in the formal sector.

The findings of this study have important policy implications that vaccination plays an im- portant role in enhancing the children's human capital. Developing countries with relatively lower human capital development can significantly improve their human capital through the vaccination program. Human capital development through vaccination can lead to the desired human capital to enhance economic growth.

CHAPTER II

THE EFFECT OF POLYGAMY ON FERTILITY: EVIDENCE FROM FIVE SUB-SAHARAN AFRICAN COUNTRIES

1. Introduction

Formally and legally speaking, marriage refers to the union of two people as partners in a personal relationship while polygamy is a marriage in which multiple women share a husband, or multiple men share a wife. Generally, there are three forms of polygamy, namely, polygyny[5], polyandry[6], and group marriage[7]. Fertility is on a decline across the globe due to different factors, but a change in social and economic conditions within a marriage and the type of marriage tend to have a huge impact on fertility. The effect of marriage on fertility and the impact of polygamy on fertility are the focus of this chapter.

Economists have tried to address the link between marriage and fertility; Becker (1981) tried to build a model that highlights the economic gain of marriage along with the cost of childbearing. Economic opportunity for women, family background, social status, and women's education are attributed to be the determining factors of marriage and fertility. The fertility rate can be viewed as a function of the fraction of reproductive married women; the intensity of marriage and the desire for offspring can be viewed as the main driver of fertility. The increase in the promotion of the use of birth controls, legalization of abortion, and low level of mortality have facilitated

[5] A man is married to more than a wife.
[6] A woman has more than one husband
[7] The combination of 1 and 2 above

the decline in fertility worldwide. Women's education was negatively associated with fertility (Requena and Salazar (2014); Hahn et al. (2018)). Educated women postpone having children, and the delay in maternity will lead to a drop in fertility.

The trend of decline in fertility around the world is yet to be felt across Sub-Saharan African countries, perhaps due to the practice of multiple wives by some men (polygamy). There is no consensus in the literature on whether polygamy increases fertility. A lot of work attributed the husband's limited resources, such as time devoted to each wife, as part of the reason why polygamous wives have lower fertility compared to monogamous wives (Lundberg and Pollak (1994); Muhsam (1956)). Some believe that women in polygamous unions compete for more children, thereby raising fertility Rossi (2019). The level of bride price has also been shown to affect fertility. Mbaye and Wagner (2017) suggested that lower bride price increases fertility pressure of polygamous wives. And Logue (1985) finds no difference in fertility between polygamous and monogamous families of Mormons in a Utah town.

Over the past five decades, advancements in the health care sector have changed the rate of birth and death across countries around the globe. A decrease in child mortality has increased parents' expectations of the child's survival rate. The significant change in the health care system coupled with technological advancement led to economic development worldwide. An increase in fertility is associated with a decrease in women's labor participation and vice versa; it is natural to assume mothers spend more time with their children and provide childcare, thus limiting their participation in the labor market. This especially happens in developing countries where access to childcare is not only expensive but unavailable. Child mortality has declined across the countries, and the prevalence of marital fertility control has been the ultimate concern in some developing world. In 1979, the Chinese government introduced a one-child policy for married couples, and other countries introduced family planning into their health care system. Several works have associated child mortality rate, and child sex, among others, as factors that depend on fertility. The link between the demand for children and human capital has also been studied Becker (1992)

Fertility is associated with the marriage market, while the marriage market is associated with income and, in turn, can predict the fertility of the women; if there is a decline in the income, people will marry later and have fewer children overall. Several factors can influence the marriage market; educated males and females tend to go to the same market and this raises their household income. In some developing countries, race and background play an essential role in the marriage market; for example, in India, women from a lower caste find it challenging to marry from an upper caste. Some tribes in Africa forbid marrying from a particular tribe. The number of available partners to men in society significantly affects the society's marriage pattern, economy, and culture.

Marriage pattern has contributed to underdevelopment in this region. Some men face high bride prices; as a result, this reduces the incentive for investment and channels resources into the marriage market.

Child mortality can affect a woman's fertility. High child mortality can raise women's fertility and a poor household in the region that fuels disease, inadequate health care, and inclement weather conditions will likely experience a high child mortality rate. Most African parents use children as old-age insurance. Thus, women in this type of household will raise their fertility. On the contrary, high child mortality can also discourage fertility. Women will be discouraged from childbearing, knowing that the child's chance of surviving is slim.

With bits of help coming from different organizations such as UNICEF, infant mortality rates have dwindled across the region due to the provision of immunization against childhood disease. As a result, life expectancy has increased dramatically.

The practice of polygamy can increase overall fertility. Polygamous women from poor households are likely to have no education, and they tend to marry early and are likely to have more children. While on the other hand, women from wealthy households tend to spend more years in school, start families late, and be exposed to family planning, overall, raising fewer children. Monogamous households could be able to invest in quality education for their children as well as increase their capital stock.

The polygamy practice is still widespread in sub-Saharan Africa despite countries on other continents taking a strong stand against it. Polygamy[8] has been spreading through the rural and urban cities in Sub-Saharan Africa.

Difference types of marriages are being practiced worldwide, especially in developing countries. While monogamy and polygamy are widely practiced in developing countries such as Africa, monogamy is the only common practice in most developed countries. Many studies have argued the fertility difference between monogamy and polygamy couples, and the relationship between polygamy and fertility is well documented. However, the direction of the causality is still debated. In this paper, we use data from five African countries to test the effect of polygamy on fertility.

We use census data from the IPUMS data set on women from five African countries to investigate the effect of polygamous unions on fertility. From the data set, most countries fail to report the ethnic groups, so the five countries are chosen based on the fact that they reported the ethnic group which we require to construct the instrumental variable that we need to account for the endogeneity of polygamy.

Going by the global fertility trend, this fertility rate has been falling over the years in the case of Senegal, from 7.22 in 1966 to 4.7 in 2017. Sierra Leone from 6.85 in 1966 to 4.36 in 2017, Zambia from 7.3 in 1966 to 4.72 in 2017. Libera from 6.55 in 1966 to 4.39 in 2017, and Uganda from 7.11 in 1966 to 5.10 in 2017.

[8] 4Polygamous is a practice involving polygamy. In this article, we will be using the two terms interchangeably

The high mortality rate of the mother has been identified as why men practice polygamy. But all the five countries under this study have witnessed a decline in child mortality rates over the last ten years, Senegal (31.8) with the least death per 1,000 and Sierra Leone (105.1) with the highest death per 1,000.

Our results rely on an instrumental variable approach to separate the effect of polygamy from confounding factors. Although each country faces different marriage markets, costs, traditions, and customary marriages, these factors are less likely to produce variation in the effect of fertility among women.

We use the ratio of females to males in each geographical location and ethnic group as an instrumental variable. The standard errors are clustered at both the geographical regions and ethnic groups.

Polygamy and fertility are positively correlated. Thus, examining the first stage, the instrumental variable appears to be a good instrument; it is connected with polygamy. We assume that there are no cross marriages between ethnic groups and also across geographical regions then use the assumption to construct the female to male ratio at the geographic level.

The impact of polygamy on fertility varied across the five nations under consideration. We also test the hypothesis that men take more wives due to the infertility of the first wife.

In Senegal results, the OLS result shows that there is a positive correlation between polygamy and fertility, women in a polygamous union on average have approximately 0.13 child more than women in a monogamous marriage, Sierra Leone and Liberia are not statistically significant. On the contrary, the OLS result of the remaining two countries shows that women in a polygamous union on average have fewer children than the women in a monogamous marriage, approximately -0.52 for Zambia, while Uganda's results is -0.00018, which is not economically significant. We consider two other specifications by controlling for religion and ethnicity. Our 2SLS estimate from Senegal and Liberia indicates that women's fertility in a polygamous union is not different from the fertility in monogamous marriage. The 2SLS results for Sierra Leone show on average, women in polygamy unions have lower fertility of about -0.0053 children; Uganda also shows a similar effect of about -0.008 fewer child. The result of

Zambia shows that women in polygamous unions, on average, have about two children more than women in a monogamous marriage.

We also compare the fertility of the first wife with women in a monogamous union. The result suggested no fertility difference between the first wife in a polygamous marriage and women in a monogamous marriage.

The paper attempts to contribute to the existing empirical studies on the effect of polygamy on fertility. Surprisingly, the study of fertility relative to ethnicity is scarce despite the spread and significance of ethnicity.

2. Brief description of the five countries under consideration

Senegal is in the coastal Westernmost part of Africa, with a total area of 196,190 km sq. Its population has grown from 3.79 million in the 1966 census to 15.85 million in 2018, with a rate of growth of about 2.8% in 2018. Islam is the religion of most of the population; in 2015, the male to female ratio was 94.67 males per 100 females of the total population. The legal system is based on French civil law, while three laws govern family relations. Christian, Islamic, and customary laws. It recognizes polygamous marriage; at the point of marriage, the groom must specify the option of monogamous, limited polygamous, or polygamous, which will allow him to acquire up to four wives. There is no concern concerning missing women, which can explain why Senegal is one of the African countries with a high rate of polygamy. Even for the youngest generations, 15 to 19 years old, polygamy rates are about 25%, suggesting that about one in four women first marries into a polygamous union.

Sierra Leone is in the Western coastal part of Africa. With a total area of 71,740 km sq. The country's population has grown from 2.55 million in 1966 to 7.65 million in 2018, with a rate of 2.1% in 2018. Most of the people in the country are Muslims, with about 77 percent of the population; in 2015, the male to female ratio was 99.33 males per 100 females. Three laws govern the country: general, customary, and Islamic law; it recognizes polygamous under customary law; under Islamic, a man is allowed to take up four wives, and many marriages are contracted under customary law. Sierra Leone's 2008 demographic and health survey shows that 37 percent of married women were in a polygamous marriage, and 29.7 percent of married girls aged 15 to 19 reported that their husband has more than one wife. Early marriage is prevalent among girls in Sierra Leone, about 25% of girls marry before age 15, and girls are forcefully taken out of school; this justifies very low literacy among women in Sierra Leone under this study. On average, Sierra Leone women would like to have five children.

Liberia, located in the coastal part of West Africa with a total area of 111,369 km sq., the country's population has grown from 1.27 million in 1966 to 4.82 million in 2018 at a rate of 2.5% 2018. Christianity covers 83 to 86 percent of the population. In 2015 male to female ratio was 100.68 males per 100 females of the total population. This ratio is much different from the remaining four countries under investigation. The country operates two types of marriage, statutory and customary; the latter allows men to have up to four wives. About one in every three married women aged 15 to 49 are in a polygamous marriage.

Uganda, located in the East-Central of Africa with a total area of 241,551 km sq., the country population has grown from 8.26 million in 1966 to 42.72 million in

2018 at a rate of 3.7% 2018. The country is tripartite in terms of religion: Islam, indigenous, and Christianity, which covers four out of five of the total population; in 2015, the male to female ratio was 96.54 males per 100 females. There are about four types of marriage that are permitted: Civil, Muslim, Hindu, and Customary marriage. Customary marriage is most widespread in the country and potentially polygamous.

Zambia, located in South-Central Africa, with a total area of 752,618 km sq., the country population has grown from 3.68 million in 1966 to 17.35 million in 2018 with a rate of 2.9% 2018. Christianity is the official religion, with about 85% of the population; in 2015, the male to female ratio was 97.94 males per 100 females. Under the marriage act, three types of marriage are allowed customary marriage, common law, and statutory marriages, the customary permits polygamous.

3. Literature Review

This chapter adds to the current literature by analyzing the effect of polygamy on fertility from a regional and ethnic point of view. The paper explores the links between polygamy and fertility in five Sub- Saharan African, three from the coastal area and the remaining two from the central part of Africa. The quest to understand the relationship between monogamy, polygamy, and fertility has generated a lot of work in the literature. There is no consensus on the effect of polygamy on fertility, Cahu et al. (2011) use a theoretical model to establish that polygamy increases the number of women in marriage. As a result increase fertility in aggregate, their result shows that monogamous relationship tends to have more children than women in polygamous relationship. This result is in line with the finding of Lundberg and Pollak (1994). Polygamist has fewer resources (e.g., time) to devote to each wife; by so doing, polygamy appears to reduce fertility within marriage. Garenne and Van de

Walle (1989) argue that the fertility of monogamous women tended to be higher than that of polygamous women. On the other hand, Pebley et al. (1988) suggested that increasing the exposure of women to marriage; polygamous may promote high fertility in the aggregate. Tertilt (2005) uses a theoretical model to establish that enforcing monogamy lowers fertility and shrinks the spousal age difference. In analyzing the effect of polygamous on fertility, Hayase and Liaw (1997) establish that education plays a prominent role, and they use multivariate analysis to show the effectiveness of education, using Ghana DHS data to establish that husband's education effect overwhelmed that of women's education. Women's education not only can also catalyze child health improvement but also delay childbearing; education improves individual health prevention and has helped to mitigate the fear of diseases that prompt families to desire more children Bauer et al. (2007). Ariho et al. (2018), delayed marriage among women and an increase in women's educational attainment contribute to the reduction of fertility among women in Uganda. Educated urban dwellers reduce fertility and delay marriage as well Keats (2018),. Ahn and Shariff (1992), suggested that there is a delay in the timing of the first birth for women below age 25 who live in an urban area and are educated beyond primary school; albeit the effect is much more robust in Togo than in Uganda. Early marriage can reduce women's social status and educational attainment; Skirbekk and Samir (2012) show a negative relation between median school leaving age and total fertility rate. Dierickx et al. (2019), focus on infertility of urban women in The Gambia, the paper finds that some infertility women in polygamous unions are in a precarious situation; the same can be said about other parts of Sub-Saharan Africa. Although the age at marriage and the wife's desire, the family's size can also directly affect fertility Bailey and Weller (1987). Most of the papers treated polygamy as an exogenous variable.

3.1. Men's motive for taking an additional wife

We highlight some of the men's motives for taking additional wives. Infertility is one of the common justifications for taking another wife. In some regions, polygamy marriage serves as a way of widowing or divorce to fulfill the obligation of remarriage not necessary for giving birth to children, especially if a woman already has desired children of her choice either from her late husband or her first marriage in case of divorce. The cultural reason is that in an ethnicity where men prioritize many children, society is likely to experience polygamy. Kollehlon (2003) shows that fertility differentials by ethnicity remain within a country, even after controlling for some socioeconomic and demographic variables. Some religions and cultures encourage both polygyny and high fertility. Zhang (2008), suggested that religious beliefs significantly positively affect fertility. Some men engage in polygamy because of economic gain, and men have more wives when women are more productive, which serves as cheap labor, Jacoby (1995). Women and children serve as cheap labor for the household that relies on a primitive farming method that necessitates much labor, Cudeville et al. (2017) find a positive impact of polygamy on female labor participation. Amone and Arao (2014), suggested that labor-intensive farming activities and low levels of education are behind the prevalence of polygamy among the Langi people of Northern Uganda. For sexual reasons, some men may want a variety of partners, Brown (1981). A high mortality rate in an ethnic group or region might propel the married men to take other wives since children mainly serve as insurance in old age. LeGrand and Barbieri (2002), study the effect of child survival on women's age and find that lower mortality levels are associated with later marriages and first births. Lack of cooperation and rivalry can lead polygamous households to be less efficient Barr et al. (2019). Rossi (2019) uses both the theoretical model and empirical test to show that children are a strategic complement. The paper demonstrated how women in a polygamous union rival over raising children. Using DHS data of Senegal, despite the rivalry between co-wives, women in a polygamous union have fewer children than women in a monogamous marriage. The preference for a male child can also lead to a man taking up another wife if the first wife cannot give birth to a male child.

The practice of levirate[9] and sororate[10], among others, is some of the excuses for practicing polygamy. There is a debate over the benefit of women in polygamous unions and how it affects the education of children in the household; Behaghel and Lambert (2017) observe that polygamous marriage adversely affects children's education. The practice of multiple wives by men in West Africa undoubtedly affects the population of this region, Cook (2007), claims that polygyny positively affects both women's fertility and population growth but also adversely affects the health and well-being of women and their children. Ahonsi (1991), suggested that West African countries will probably continue to experience high fertility for many decades. On this note, the region should advocate for the use of contraceptives. At the same time, others say that contraceptives play less role in fertility when compared with nuptiality and breastfeeding, Onuoha (1992). Cheng (2011), studied how mass media and social networks play a role in contraceptive knowledge on fertility; the paper concluded that contraceptive knowledge reduces fertility. The growth of a nation coupled with its size and development can also shape that nation's marriage market. Awad and Yussof (2017) use macroeconomic variables such as GDP, employment, infant mortality rate, and female education to show that these variables negatively impact the total fertility rate. Horowitz and Whittington (2001) show that the effect of fertility differs between small countries and Island, that the former is consistent with theories of economic growth while the latter is likely the result of a common effect. Women without a job tend to have ample time for domestic work and availability for their husbands when

[9] Type of marriage in which the man is obliged to marry his brother's widow to create both social and economic security for both the widow and the late husband's children if there any.

[10] Type of marriage in which a man marries his sister-wife the sister passes away or barren

needed. Kollehlon (1984), shows that the fertility of wage working women is slightly lower than that of nonwage working women. United Nations expert's report (United Nations Expect Group Meeting on Policy Responses to Low Fertility 2015) shows that job, finishing school, and having an independent household facilitate entry into adult roles associated with higher fertility. Job type can also affect marriage type, and two socio-occupation categories are more likely to practice polygamies, such as self-employing men employing payroll workers and small business owners, Antoine (2006). The high cost of marriage can also play a role in women's fertility in some parts of Africa, where men have to pay a high bride price. Mbaye and Wagner (2017) study rural Senegal and observed that higher bride price payment reduces the fertility pressure; women that received high bride price payment have fewer children. While Ntozi and Kabera (1988) suggested that the level of bride wealth is low for the people of Ankole, which allows the community to sustain high fertility. Lack of formal education for women can also result in women finding themselves in a polygamous marriage; for example, Senegal raked 73 out of 80 in terms of illiteracy Engelking (2008), but Fenske (2015) find no effect of modern education on polygamy; that is, the increase in education does not affect the prevalence of polygamy in Africa.

3.2. Data

We use data from census data collected from IPUMS, Sierra Leone with only one wave in 2004, Senegal, Uganda, and Liberia all have two waves, 1988 and 2002, 1991 and 2002, and 1974 and 2008, respectively, while Zambia has three waves 1990, 2000, and 2010.

The following percentage of women in our sample are married in polygamous union, 49.1% of women in Senegal, 30.8% in Sierra Leone, 18.8% in Uganda, 6.4% in Liberia, and 1.02% in Zambia.

Table 2 provides the descriptive statistic of the data, 49.1 percent of women from the Senegal data reported being in a polygamous union, of which 70.1 percent of these women live in the rural area. About 63 percent of the women under study are rural dwellers. About 78 percent of the women never completed primary school, 18.8 percent only completed primary education, 2.5 percent completed only secondary education, and less than 0.5 percent completed university. The primary occupation for women is in skilled agricultural and fishery, which is about 11.4 percent. Only one of the nine regions that are men bias, about 95.2 percent of the women are Muslim while 4.3 percent are Christian, and other and unknown accounted for the remaining 0.64 percent. The average age of women in the polygamous union (34.42 years) is higher than that of monogamous marriage (31.50 years).

About 30.8 percent of the women in Sierra Leone data are in a polygamous union, of which 79.2 percent of the women reside in the rural area. 68.82 percent of the total women live in a rural area, about 87.33 percent never completed primary education, 21.21 percent only completed primary education, and 0.61 percent of the women completed only secondary education. In comparison, only 0.35 percent completed university education. Skilled agricultural and fishery top the list of women occupations with about 29.1 percent, closely followed by elementary occupation, which is about 22 percent. Out of the fourteen regions, only three show male bias, about 81.1 percent of the women reported to be of Muslim faith, while Christian is approximately 17.95 percent. Similar to the Senegal average demographic age of married women, the average age of women in polygamous unions (33.49 years) is higher than that of women in monogamous marriages (30.48 years).

About 18.8 percent of the women in our Uganda data reported being in a polygamous union, of which the majority live in a rural area, roughly 92 percent. About 88.27 percent of the total women reside in the rural area, of which 64.92 percent never completed primary education, 31.76 percent completed only primary education, and about 2.93 percent completed only secondary education. In comparison, only 0.39 percent completed university education. One can infer from the data that married women, on average in Uganda, are much better educated, at least up to primary education, than married women in both Senegal and Sierra Leone. Skilled agricultural and fishery top the list of women occupations with about 45.06 percent, followed by service workers with only 4.16 percent of the population. Nine of the thirty-six regions are male bias; approximately 85.66 percent of the married women are in the Christian faith, while 12.1 percent are in the Muslim faith, no religion, and others accounted for the remaining 2.24 percent. The average age of women in polygamous unions (32.15 years) appears to be much older than that of women in monogamous marriages (29.53).

About 6.4 percent of married women in our sample in Liberia reported being in a polygamous union, of which 64.8 of these women live in rural areas. Close to 56.4 percent of the total married women reside in a rural area, about 75.84 percent of the women never completed primary school, and 16.2 percent completed only primary education. In comparison, about 7.11 percent completed only secondary education, and about 0.85 completed university. The data shows that married women in Liberia are better educated than their Senegal, Sierra Leone, and Uganda counterparts. The skilled agricultural and fishery top the list of women occupations with about 18.1 percent, closely followed by service worker occupation, which accounts for about 16.3 percent of the sample. Two out of five regions are male bias, about 84 percent of the married women are Christian, and about 14 percent are Muslim. The average age of women in a monogamous union (32.33 years) is higher than that of women in a polygamous marriage (31 years).

Zambia has a relatively low rate of women in polygamous unions, only about 1.02 percent of the married women in our sample reported to be in a polygamous marriage.

Approximately 35.19 percent of married women reside in rural areas. Married Zambia women are much more educated when compared to their counterparts in Senegal, Sierra Leone, Uganda, and Liberia.

More than half of the married women (50.55 percent) never completed primary school, and 40.94 percent completed only primary education. In comparison, 7.22 percent completed only secondary education, while almost 1 percent of the women completed university. Skilled agricultural and fishery top the list of women occupations with about 29.84 percent, followed by elementary occupation with only 4.27 percent.
Two of the eight regions are men bias, approximately 92.68 percent of the women are Christian. In contrast, only 0.47 percent are Muslim, and others and no religion accounted for the remaining 6.86 percent. The average age of women in monogamous unions (31.33 years) is higher than that of women in polygamous marriages (28.72 years).

3.3. Empirical Method

The study of polygamous fertility needs to put into consideration the local specification of gender. In some African countries, polygamous usually associated with Islam, although history does not support this proposition. The existence of unobserved variables makes the identification of causality more demanding.

We employed an instrumental variable technique to go around the endogeneity of polygamy. In a society that permits polygamy, if the female to male ratio increases, this will increase women's supply and reduce the competition among the men. Men could marry at a lower cost, and abler men will be able to marry more wives due to surplus. Thus, the ratio will directly affect the marriage market. An increase in this ratio can also reduce the demand for women in a monogamous society, limiting households. This type of society will encourage exogamy in most cases. We estimate the effect of polygamy on fertility using the sex ratio of men and women in the geographical region and ethnic group as an instrumental variable to account for the potential bias due to endogeneity. We assume that each woman married in her ethnic group and as well as her region. However, we believe that this assumption might not always be true, and this improbably seriously affects our results as well as our suggestions. As mentioned above, the direction of causation between polygamy and fertility behavior is a concern. One possibility is that polygamous affects fertility; women who are in polygamous unions compete with each other for the number of children Rossi (2019), suggesting this might eventually drive up their fertility Another possibility is that fertility affects polygamous unions; women with low fecundity might lead to an increase in polygamy in that region. In the region and ethnic groups with women bias, we expect more women in those regions to end up in a polygamous union Pollet and Nettle (2009), their result suggested that, among other things, polygynous marriages become more prevalent as the district sex ratio becomes more female-biased.

We start our estimation with an OLS regression model:

$$Fertility_i = \beta_0 + \beta_1 poly_i + \beta_2 X_i' + u_i \tag{5}$$

Fertility refers to the total number of children ever born by individual women i. poly is a dummy variable indicating that a woman i is in a polygamous union. Where X_{ire} is regional characteristics, sociodemographic characteristics such as the age of the wife and the age of the wife square are also included to capture the curvature of the fertility distribution and boost the predictive power of the specifications. We included education status as standard practice in the literature and controlled for occupation and the women's region, mortality of status of the mother, age of the eldest and younger child in the household, number of children in household, number of dead, number of surviving children, ethnicity and religion occupation, and geographical location, and u is the error term.

Simple correlations between polygamy and child ever born are likely to overstate the causal effect of the former on the latter. It seems reasonable to expect that regions with women bias will experience an increase in women in a polygamous union. Also, the region with women's bias may have some unspecified characteristics that are quite different from the region with men's bias; thus, these differences may be correlated with fertility. If the unobserved confounders, such as religious affliction, culture differences, etc., are positively correlated with polygamy and fertility, then OLS estimates will be biased upward. On the other hand, if those unobserved cofounders are negatively correlated with polygamy and fertility, the OLS estimates will be downward biased.

We address the problem of endogeneity by using an instrumental variable approach. We use the ratio of the female to male as an instrumental variable for polygamy and estimate the following two-stage equations.

$$Poly_{ire} = \alpha_0 + \alpha_1 A_{ire} + \alpha_2 X'_{ire} + \mu_{ire} \tag{6}$$

Poly is an indicator variable showing whether an individual woman i in a region r and from ethnic group e is in a polygamous union. Where X_{ire} is regional characteristics, sociodemographic characteristics as defined in equation 1. A_{ire} is the instrumental variable that measures the ratio of adult females to an adult male for an individual woman i in region r and ethnic group e, μ_{ire} is the regional and ethnicity error term. To construct A_{ire}, we assume that marriage occurs between men and women only if they are of the same region and ethnic group.

We constructed the ratio of female to male using both geographical region and ethnic group. Equation two above is the first stage, which estimates the effect of polygamy on fertility. The predicted polygamy from equation two, $\widehat{Poly_{ire}}$, is used in the second stage, equation three, to estimate the impact of polygamy on fertility.

$$Fertility_{ire} = \rho_0 + \rho_1 \widehat{Poly_{ire}} + \rho_2 X_i + \epsilon_i \tag{7}$$

Fertility represents the total number of children ever born by individual women i where X_i are the same as X in equation 1. We expect people of the same ethnic group to share the same marriage characteristics; thus, we include dummies for the ethnicity in some of the specifications as well as dummies for religion since this will undoubtedly influence marriage where Islam is predominant, poly is the estimate of the model (2) above, and ϵ is the error term. Standard errors clustered at both the geographical level and ethnicity.

The identification relies on the assumption that the ratio of female to male affects fertility only through its impact on polygamy that is $E(A_{ire}, \epsilon_i) = 0$ and also $E(A_{ire}, Poly_{ire}) \neq 0$ The instrumental variable correlated with polygamy, and this ratio does not directly affect the number of children ever born except through its influence on polygamy. If the female to male ratio increases, this does not necessarily mean that the number of children born will increase. An increase in the ratio will only affect the number of children if more women marry, obviously by marrying into a polygamous union. The ratio of female to male will, at least in part, will determine the incidence of polygamy; if the ratio is high, more adult women in the region will marry in a polygamous union.

4. Results

Table 3 presents the regression results of the total number of children ever born estimated with OLS for Senegal and Sierra Leone; table 4 shows results for Liberia and Zambia, while table 5 presents the result of both the OLS and first stage for Uganda. For most of the specifications, the explanatory variables have a significant impact on fertility, seen from the significant level of the t statistical values. The wife's education level is negatively associated with the number of children born. The wife's age and age of the wife squares are relevant for the estimation of polygamy on fertility; the wife's age and quantity of children follow the expected trend. As age increases, the numbers of children increase, but at a decreasing rate; thus, the negative age square captures this trend. The OLS results for Senegal show that polygamous union is positively associated with the total number of births. In Sierra Leone and Liberia, polygamy does not affect total childbirth. Zambia and Senegal's results are significant at 1 percent level for all specifications, while Uganda's result is 10 percent level. As discussed above, the result of the OLS does not consider the endogeneity issue of polygamy. We provide an estimate of two stages least square (2SLS) model for each country, which takes into account the issue of endogeneity. Tables part of table 5 and tables 6 and 7 provided the first stage for Uganda, Senegal and Sierra Leone, Liberia, and Zambia, respectively. As discussed earlier, most countries' regions are female-biased; the result from the first stage indicates that women in the regions with higher female bias are more likely to marry in a polygamous union than women in regions with men bias. It is interesting to note that the result of the first state for all the specification and across the five countries show a positive relationship between polygamy and the instrumental variable, an increase in the ratio of women to men increase the probability of women being in a polygamous union. The instrument explains polygamous very well, and the F statistics range from 44 to 367, which well over ten suggests that the instrument has good explanatory power. The first stage indicates that the female to male ratio plays a vital role in the region that witnessed a substantial number of polygamy unions. The ratio correlated with polygamy, so we expect a high ratio to lead to a high incidence of polygamy. Thus, the result indicates that we have a strong instrument. The result of the second stage are listed in tables 8, 9, and 10 for Senegal and Sierra Leone, Liberia and Uganda, and Zambia, respectively.

After considering the endogeneity issue, the sign of coefficients for the polygamous positive for Senegal result is no longer statistically significant. The result flipped the sign from positive for Sierra Leone statistically significant but not economically significant. For the case of Liberia, the result is not significant. Uganda's results remain negative. There is about 0.008 child less compared to women in monogamous unions. Similarly, the Zambia result also flips signs from negative to positive, and it shows that polygamous women have on average, about two children more than women in a monogamous marriage. Next, we compare the fertility of the first wife with a monogamous wife to see whether the infertility of the first wife can lead the husband to marry the additional one or more wives. If birth is delayed with the first wife, the husband's family might be inpatient with the wife and force the woman to face undue pressure, which might ultimately resolve to the husband taking the second wife. Also, if the first wife is sterile or sub-fecund, this can account for why polygamous women, on average, have fewer children than monogamous women. Garenne and Van de Walle (1989), suggested that polygamous marriage tends to have fewer children than monogamous marriage and that both the rank of the wife and the age of the husband have a significant effect on their fertility since we expect the husband to be old when taken the second or higher order wives. We present this result in table 11; the result no fertility differences between the first wife of the polygamous marriage and the monogamous union. These results support the finding of Bean and Mineau (1986) that the average level of fertility of all polygynous wives is lower than that of monogamous wives. Sup- pose more educated women happen to marry in a monogamous union. In that case, this might as well lower, on average, the number of children born in a monogamous marriage, and educated women are expected to have fewer co-wives if they are more productive Grossbard (1976).

5. Conclusion

This paper examines the effect of polygamy on fertility; in order to consider the endogeneity of polygamy in the fertility equation, we use an instrumental variable technique. The ratio of adult females to adult males is constructed and used as an instrument for polygamy. The result shows that the relationship between fertility and polygyny is not uniform across countries. In this paper, we find conflicting results; in the case of Sierra Leone and Uganda results, women in polygamy unions have lower fertility than women in a monogamous union. On the other hand, the Zambia result shows otherwise; women in a monogamous marriage have few children than women in a polygamous union. While, in Senegal and Liberia, results show no difference between women in polygyny unions and women in monogamous marriages. A complementary explanation for Sierra Leone and Uganda's results is that polygamists might have less time to devote to each wife and lowered the frequency of intercourse Anderton and Emigh (1989). The result is in line with Pebley et al. (1988), which suggested that individual women in monogamous marriages have more children than women in a polygamous marriage. Timæus and Reynar (1998) suggested an over-representation of childless in a polygamous union. Women might have a sharing formula of sleeping with their husbands, while on the other hand, the monogamous union will have all the time to herself. Type of marriage might also play a significant role in fertility; for example, the wedding where the groom has to pay a high bride price, one of the implications is that the husband is generally much older than their wife. An increase in the husband's age will reduce the man's fecundity, and most men in polygamous marriages take a second wife, probably not earlier than 30 years old. One might need additional information to justify the result in Zambia. External factors may determine the degree of both polygamous and fertility; for example, women with higher education might distaste for polygamy and, by so doing, are less likely to be in a polygamous union and reduce their desire for fertility. However, this might increase the husband's incentive to marry another wife. Suppose child mortality is disproportionate among women in the polygamous union. In that case, one will expect women in a polygamous marriage to have more children since children serve as insurance for old age. Rossi (2019) studied the co-wife rivalry on the number of children born and find women in polygamous unions compete and drive up their fertility. If this ideal of rivalry is well pronounced in Zambia; this can also explain why women in polygamy unions will have more children than women in a monogamous union. The different ethnic groups are more likely to face other marriage markets and economies. By so doing, different ethnic groups or regions will drive various reasons for the demand for children. The limitations of the data and the assumption made in constructing the instrumental variable can also affect the overall conclusion; the effect of age at first marriage, and the location of the husband relative to his wives, among others, can also influence the results. We do not also have access to the age of the husband, which can also play a central role here; the older the husband is, the less fertility the wives will be. Several studies related to marriage in Sub-Saharan Africa show that the westernization of marriage has not been fully adopted in the region. Although divorce is not that common compared to some western world in the U.S., divorce is rampant among married women in Senegal who follow the custom they remarry. It will be difficult to trace how often a woman has remarried and how long they stay before remarrying in case of divorce. Some authors have argued that the nuptiality change can negatively affect fertility. This argument can also shed more light on why polygamy women have fewer children

than monogamous women in Sierra Leone and Uganda. The paper's main objective is to investigate polygamy's effect on fertility in five Sub-Saharan African. If the region plans to reduce the population, it will not be able to apply marriage policy across the region uniquely.

CHAPTER III

ETHNICITY AND INEQUALITY IN LABOR PARTICIPATION IN AFRICA

1. Introduction

Political leaders can mobilize electoral support by trading or promising to trade benefits to voters in exchange for their votes. Implementing this strategy credibly requires that elected officials be able to identify their constituents. In some advanced democracies or geographical areas (e.g., blue and red states in the USA, rural and urban areas in Europe, etc.), education levels or professional occupations are often used by political parties to target better their constituents and their priorities[11] Kittilson and Tate (2005) Abman and Carney (2020) studied agricultural production and deforestation in Malawi. They observed the ethnic demography of the president's ethnic group received more subsidized fertilizer and less deforestation than the area predominantly occupied by other ethnic groups. Franck and Rainer (2012) find ethnic favoritism in primary education and infant mortality in their study that uses 18 African countries. Kramon and Posner (2016) find that the president's ethnicity increases the schooling acquisition, while Simson (2019) find the equitable distribution of public sector jobs along ethnicity in Kenya and Uganda. Li (2018) found that a coethnic president improves the likelihood of completing primary education in Kenya. Asatryan et al. (2021) found points toward increasing women's education for those of the same ethnicity as their national leader.

[11] minority (race, sexual orientation, etc) leaning more democratic in the US

Looking at the school construction in Benin, André et al. (2018) find that there is frequent school construction when the district is coethnic with the new education minister but not with the new president; others also found a similar result Kramon and Posner (2016), in Kenya. These results suggested that the minister in charge of a ministry can exact her their influence on where the school will be built and thereby is likely to fothereirr her ethnic group; eththeethnicc group of the president can even be penalized in such an area. Usually, a President consolidates his power by favoring other ethnic groups through political appointments of other ethnic group leaders, which indirectly will always support the President's ambition.

Kramon and Posner (2013) suggested that looking at a single distribution outcome might be deceptive in generalizing coethnic favoritism without considering other factors. Theisen et al. (2020) found that women from coethnic leaders benefit more in maternity health care services. Brockerhoff and Hewett (1998) also concluded that a region coethnic with its leader experiences lower child mortality compared to others. Most of the works look at public goods. This paper uses data from the Demographic and Health Survey (DHS) to study whether the president's ethnicity unfairly favors the youth's formal labor participation.

In most developing countries, jobs are very scarce, and most new graduates take up paid employment for their livelihood, not necessarily what they want to do or are trained to do. From one ethnicity to the other, individuals complain about a leader from one ethnic group marginalizing the other ethnic group in varying sectors of the economy. Some large ethnic groups have tried to dominate all the areas of the economy and have been involved in inciting violence that leads to ethnic cleansing.

In this paper, I investigate how political leaders in Sub-Saharan Africa use formal jobs to garner support and reward their constituents. In most of these countries, formal jobs are very scarce, and the public sector is usually the main supplier of these highly prized jobs. Specifically, I use nationally representative household surveys from 11 countries spanning 40 years to test whether sharing the same ethnicity with the president increases the probability of getting a formal job in the public sector. Using the microdata and publicly available data on political leaders, I construct a time-variant ethnic-level measure of formal labor participation and the president's ethnicity. I use the data to examine the effect of change in the president's ethnicity on employment and to estimate each country's average effect of ethnic favoritism.

My result shows heterogeneity across the countries which substantiated the prediction of the simple quo quid-pro-quo model. We estimated that the probability that youth in Malawi hails from the president's ethnicity increases by 4.8 percentage points getting into the formal labor market, while in Nigeria, there is a decrease of about 2.8 percentage points. Also, Zambia's result shows a 25 percent decrease in youth labor participation in formal employment for the president's ethnicity. These three countries had significant results at five percent and passed the placebo test there- Fore are forming the basis of the argument in this paper. The results of the remaining eight countries were not significant as some show a positive sign with the president's ethnicity while others show a negative sign.

Our results are consistent with the model prediction that some countries show favoritism. While some show no effect, some show that the president's ethnic group is adversely affected. Anecdotal evidence shows that some countries where the ethnic group of the president experienced a setback in the youth formal labor participation rate have already been over-represented in public office appointments.

Tribalism and ethnic favoritism are not only antithetical to the development of a nation, but they also lead to dwindling trust in the ability of a President to confidently rule the nation without ethnic bias. It is often assumed that a change in power will result in a difference in the allocation of public goods, but this may not exactly be the experience.

We estimated the effect of youth's formal labor participation in eleven countries while studying the effects of ethnicity favoritism in our sample. We provide an anecdote about Nigeria and why the result might likely hold. We use the cohorts to measure the ethnic level change in the formal labor sector, and the DHS provides information about the labor sector for everyone in our sample. We created the formal labor if an individual reported working in the following job description: managerial, professional, technical, and clerical, which take values one and zero otherwise. The idea behind the use of the age group 20 and 30 years old comes from the fact that we know most individuals in this age group would have finished their college degrees, an,d most probably, they will actively be engaged in the labor market. We linked everyone with their ethnicity and determined whether the individual belongs to the ethnicity of their leader.

We do not expect a homogeneous outcome; the President's policies can be diverged, including but not limited to public infrastructure projects or transfer of payment. While the motive from one leader to the other might also differs, as reflected in Kenya, Burgess et al. (2015) show there is favoritism in road construction in Kenya.

2. The Model

To establish if the ethnicity of a President affects positively or adversely in the allocation of public goods I proposed a simple model in a democratic state where political leaders sort for votes by making promises on public goods. The model prediction is ambiguous; the coethnic of the president can be favored, penalized, or have equal opportunitynity as the other ethnic groups. The model is a reciprocal where the citizen votes hoping to get a benefit. Assume in a democratic system; the president would like to implement a policy for the ethnic group politically to garner political support. Voting in most of Sub-Saharan Africa is influenced by ethnicity; take the case of Nigeria, there is a famous slogan ('Na we we') literary translated as "he/she is our own." Also, Elischer (2008) established that ethnicity voting in Kenya, people vote along the ethnicity line. In the state of political victory in which "winner- takes-all," but due to institutional constraint, at least the minimal allotment has to go to the losing side. The model captures several outcomes, the ethnic group that voted for the president can experience an increase in their allocation, decrease or stay the same depending on the outcome of the presidential election. Let $\mathcal{N}$ represent the total number of the citizen in the economy, for simplicity's sake, assume $\mathcal{N}$ is partitioned into two ethnic groups, (i.e the president ethnic group and the rest of the ethnic group taken together). Assume that citizen i belong to one of $\{N_1, N_2\}$ of the two ethnic groups. [12] Ethnic N_1 comprises a fraction α of the total population $\mathcal{N}$. assume there are two-period say $t \in \{1, 2\}$. at each period t, one of the $\{N_1, N_2\}$ produces a president, without loss of generality, we assume that the president comes from an ethnic group N_1. The president decides on poll tax τ to provide the citizen with amenities and employment. Assume the country operating a two-party system. The president makes the promise of an equal share of formal employment.

Let $\epsilon^P_{vt}(\epsilon^O_{vt})$ represent an equal proportion of formal employment president(other) ethnic groups. The president promised equal employment if both the ethnic groups vote for him and punish either ethnic group that fails to vote for him if he eventually wins and rewards the other ethnic group that voted for him. Let λ be the size of punishment and the size of the reward, for simplicity's sake, we assume that λ is equal for the two ethnic groups. Before the election, the president announces the policy vector $P_t = \{\tau_t, \epsilon^P_{vt}, \epsilon^O_{vt}\}$. The payoff matrix can be represented in figure 10

[12] Each ethnic group have some inscriptive characteristics that are identifiable and cannot be easily changed such as the skin color or language

Assuming the president only needs the majority vote to win an election. Let $\rho_1(\rho_2)$ be the fraction of president(others) ethnic groups that support the president for the second bid, the president wins' reelection iff: $(2\rho_1 - 1)N^P + (2\rho_2 - 1)N^O > 0$ There are three possibilities for the incumbent to retain his seat

1. if both $\rho_1, \rho_2 > \frac{1}{2}$ (won in both ethnic groups)

2. if $\rho_1 < \frac{1}{2}$ and $\rho_2 \gg \frac{1}{2}$ (lost in his ethnic group and won in other ethnic groups)

3. if $\rho_1 \gg \frac{1}{2}$ and $\rho_2 < \frac{1}{2}$ (won in his ethnic group and lost in other ethnic groups)

If both $\rho_1, \rho_2 < \frac{1}{2}$, the president lost and the policy is not implemented ie. $P_t = (0, 0, 0)$. Any of the 1 to 3, the president gets elected and the policy $P_t = \{\tau_t, \epsilon^P_{zt}, \epsilon^O_{vt}\}$ get implemented. Thus the payoff of the president ethnic group depends on the other ethnic group's decision. Normalize the total employment available at time t.

Suppose that each group know ϵ^i_{vt} then we have two cases;

1. Case 1

   If $\epsilon^i_{vt} < \frac{1}{2}$, then either ethnic i did not vote for the president party and the president was reelected or lost the election. Thus the ethnic group will be discriminated against in job allocation. Hence voting for the president party is strictly dominated by not voting for the president part.

2. Case 2

   If $\epsilon^i_{vt} > \frac{1}{2}$ethnic i voted for the president party while the other ethnic group fails to vote for the president party and the president party wins, again voting for the president party is strictly dominates by not voting for the president party.

Consider case that each ethnic group do not know ϵ^i_{vt} , then we have two cases; (Peru strategies and mixed strategies).

Pure Strategies.

Using the backward induction, the president ethnic group anticipates that the other ethnic group will vote for the president party and they will also vote for the president party. They will both enjoy the proportionate employment ϵ_{vt}^{P} and ϵ_{vt}^{O}.

Assume that neither ethnic group knows the ϵ_{vt}^{i}. Assume that each ethnic group observe $E_{vt}^{i} = \epsilon_{vt}^{i} + \mu_i$ where μ_i is the noise term and is distributed uniformly on $[-\xi, \xi]$ and $\xi \in (0, 1)$. Assume that ϵ_{vt}^{i} is uniformly distributed in the interval $[-\psi, \psi]$ where $\psi \gg 1 + \xi$. Also, assume that $(\epsilon_{vt}^{P}, \epsilon_{vt}^{O}, \mu_P, \mu_O)$. are independently distributed.

If the ethnic group of the president wants to vote for the president party, he will think that the other ethnic group signal is higher than his own with the probability of $\frac{1}{2}$ and lower than his own with the probability of $\frac{1}{2}$, thus, using the fact the both ϵ_{vt}^{P}, ϵ_{vt}^{O} are uniformly distributed, we have that

$$Pr(E_{vt}^{O} < E_{vt}^{P} | E_{vt}^{P}) = Pr(E_{vt}^{O} > E_{vt}^{P} | E_{vt}^{P}) = \frac{1}{2} \tag{8}$$

Next, we want to show symmetric Bayesian Nash equilibria

let u_i be monotone strategy with $\bar{E}_i$, ethnic i vote for the president ethnic group if and only if signal exceeds $\bar{E}_i$. Thus

$$u_i(E_{vt}^{i}) = \begin{cases} \text{support the president party} & \text{if} \quad E_{vt}^{i} \geq \bar{E}_i \\ \text{oppose the president party} & \text{if} \quad E_{vt}^{i} < \bar{E}_i \end{cases} \tag{9}$$

For any symmetric Bayesian Nash equilibrium in $\hat{u}$ is monotone strategies must have a cutoff value $\bar{E}_i$ such that

$$\hat{u}_i(E_{vt}^{i}) = \begin{cases} \text{support the president party} & \text{if} \quad E_{vt}^{i} \geq \bar{E} \\ \text{oppose the president party} & \text{if} \quad E_{vt}^{i} < \bar{E} \end{cases} \tag{10}$$

2.1. Lemma 1

Consider $E^i_{vt} \geq \bar{E}$, by the monotone strategies, the ethnic group i will vote for the president party and yielding a payoff of

$$E^i_{vt} - Pr\hat{u}_j(E_j) = \text{Not voting for president party}|E_{i_{vt}} = E_{i_{vt}} - Pr(E^j_{vt} < \bar{E}|E^i_{vt})$$

Similarly, consider the case when $E^i_{vt} < \bar{E}$, again by the monotone strategies, the ethnic group i does not vote for the president party, yielding a payoff of

$$E^i_{vt} - Pr(E^j_{vt} < \bar{E}|E^i_{vt})$$

iff

$$E^i_{vt} < Pr(E^j_{vt} < \bar{E}|E^i_{vt})$$

Hence

$$\bar{E} = Pr(E^j_{vt} < \bar{E}|\bar{E}) \tag{11}$$

Thus by continuity, we have $E^i_{vt} = \bar{E}$

2.2. Proposition 1

There exist a unique symmetric Bayesian Nash equilibrium in monotone strategies

$$\hat{u}_i(E^i_{vt}) = \begin{cases} \text{support the president party} & \text{if} \quad E^i_{vt} \geq \frac{1}{2} \\ \text{oppose the president party} & \text{if} \quad E^i_{vt} < \frac{1}{2} \end{cases} \tag{12}$$

By Lemma 1, we have that

$$\bar{E} = Pr(E^j_{vt} < \bar{E}|\bar{E})$$

Also, by equation (9), we have that

$$Pr(E^j_{vt}) < \bar{E}|\bar{E} = \frac{1}{2}$$

Hence

$$\bar{E} = Pr(E^j_{vt} < \bar{E}|\bar{E}) = \frac{1}{2}$$

2.3. Hybrid Democracy

The row and column (oppose, oppose) can correspond to the idea of dictatorship. Since both, the ethnic group did not vote for the president. The president ethnic group receive payoff of $\epsilon^P_{vt} - \lambda$, while the other ethnic group receive payoff of $\epsilon^O_{vt} - \lambda$

Let E be the total formal employment.

$$\epsilon^P_{vt} + \epsilon^O_{vt} - 2\lambda < E \tag{13}$$

from (14), there is a positive surplus $E - \epsilon^P_{vt} - \epsilon^O_{vt} + 2\lambda$

let α, β be the fraction of the surplus that goes to president ethnic group and other ethnic group, respectively, i.e $\alpha + \beta = 1$ let the $E^P_{vt}(E^O_{vt})$ be the final allocation that goes to the president(Other) ethnic groups.

$$E^P_{vt} = \epsilon^P_{vt} - \lambda + \alpha(E - \epsilon^P_{vt} - \epsilon^O_{vt} + 2\lambda)$$

Simplify, we have

$$E^P_{vt} - (1 - \alpha)\epsilon^P_{vt} = \alpha(E - \epsilon^O_{vt} + 2\lambda) - \lambda \tag{14}$$

similarly,

$$E^O_{vt} - (1 - \beta)\epsilon^O_{vt} = \beta(E - \epsilon^P_{vt} + 2\lambda) - \lambda \tag{15}$$

Thus, the surplus divided among the two ethnic group in the ratio of

$$\frac{E^P_{vt} - (1-\alpha)\epsilon^P_{vt}}{E^O_{vt} - (1-\beta)\epsilon^O_{vt}} = \frac{\alpha(E - \epsilon^O_{vt} + 2\lambda) - \lambda}{\beta(E - \epsilon^P_{vt} + 2\lambda) - \lambda}$$

We can write in the slope intercept form

$$E^P_{vt} = \gamma E^O_{vt} - \gamma\beta'\epsilon^O_{vt} + \alpha'\epsilon^P_{vt} \tag{16}$$

Where $\gamma = \frac{(k-\epsilon^P_{vt})\alpha-\lambda}{(k-\epsilon^P_{vt})\beta-\lambda}$, $k = E + 2\lambda$, $\alpha' = 1-\alpha$, and $\beta' = 1-\beta$

Note $E^P_{vt} + E^O_{vt} = E$

Final allocation to the president ethnic group:

$$E^{P*}_{vt} = \frac{\gamma}{1+\gamma}[E - \beta'\epsilon^O_{vt}] + \frac{\alpha'}{1+\gamma}\epsilon^P_{vt}$$

In figure 8, point e represents the initial allocation of the formal employment, points that divide the employment in the proportion α and β lie along the straight line that passes through point e and interest line $E^P_{vt} + E^O_{vt} = E$ at NE (Nash equilibrium). Allocation to the left of NE tilts the employment towards the president ethnic group while allocation to the right of NE tilts the employment towards the other ethnic group.

3. Youth Employment

The impact of ethnic diversity on formal labor participation in Sub-Saharan Africa is yet to be empirically investigated, especially in youth employment. Apart from youth unemployment, underemployment is another thing to be worried about in Sub-Saharan Africa. The high rate of youth unemployment remains a concern across Africa; the COVID- 19 pandemic coupled with the rise in population across the region have also compounded the unemployment issue. According to International Labor

Organization (ILO), unemployment in Sub-Saharan Africa remains low, but most youths are employed in the informal economy. A large proportion of youth entering the labor market every year, coupled with the weak structural transformation of African economies, have diverted a lot of youth towards the informal job. In the formal sector, jobs remain elusive for the youth, and a reasonable number of youths who graduate from college will have to go for vocational training to survive. The difficulty of youth securing a job in the formal sector motivated the study of the allocation of youth employment in the formal sector based on their ethnicity visa-vise the leader's ethnicity. Parents using their connections to secure their children's jobs have also been studied, Magruder (2010) observed that in South Africa, father use their network to help ensure their son's employment but not their daughters. Across the region, youth unemployment is estimated at 38 percent (ILO), and getting a job for the youth, especially in the formal sector, is becoming more difficult as years go by. About 10 to 12 million youth join the labor market each year, but only 3.1 million formal jobs are provided by the countries (The Africa Development bank report) In most African countries, the formal sector is not growing at the pace to absorb its educated population. Thus, many youths are confined to the informal sector. The continent cannot absorb all its skilled workers, which propels the brain drain from the region. Some factors can be attributed to growing youth unemployment in Africa; for example, it has been estimated that Africa is the fasted growing continent in terms of population, and Nigeria has been estimated to be the third-largest country by the year 2050 with about 2.55 percent per annual population growth rate. The educational sector fails to provide the students with the adequate skill requirements for a modern-day job. The rural area of the region also suffers more than the urban area; the disparity between the urban and rural schools' infrastructure might well account for the high unemployment rate in rural areas. Addressing youth unemployment would improve the overall national economy.

4. Sample Selection and Data

The paper wants to know whether or not the ethnic groups that share the president's ethnicity unduly benefited from formal labor employment. The paper used the cross-sectional data of eleven Sub-Saharan African countries from Demographic and Health Surveys (DHS). The survey ranges from 1992 to 2019; data from more than twenty-five countries were initially collected, which contains all the ethnic groups of the respondents; since we are interested in the change of ethnic group of the president, we dropped the countries that do not meet this requirement (countries that are governed by one ethnic group throughout the survey and countries that have only one or two rounds of the survey were dropped as well).

United Nations defines youth in the age range as 15 to 24; based on the delay in schooling, we restrict our sample to accommodate only youth who are likely to have finished their college education and are likely to be active in the labor market and also restrict those that are likely to have gotten jobs before the leader from their ethnic group ascend to power.

We focus on men whose ages were between twenty and thirty at the time of each survey. These men are expected to be more active in the labor market. Summary statistics for the eleven countries are presented in Table1. There are 62353 individuals in the sample, and the average formal employment in countries ranges from 9.67 percent to 20.1 percent. The number of waves ranges from three to nine waves, and the number of Presidents in each country ranges from two to four for all the rounds. Table 12 also shows the number of ethnic groups that produce a president for the periods, ranging from two to four ethnic groups. We are using the information on the ethnic group of the individual and the age group between twenty and thirty years to construct both the treatment group and the control groups. The treatment group is the age group twenty to thirty who share the president ethnic group at the time of the survey, while the control group is the same age group that is not from the ethnic group of the president. Table 13 shows the mean and standard deviation of the formal employment for both the treated and control groups. Formal labor participation is defined as those engaged in the following economic activities, i.e., managerial, professional, technical, and clerical.

5. Identification and Empirical Strategy

The individual's birth year, ethnicity, and the president's ethnicity jointly determine the treatment. We consider an individual who is between the age of 20 and 30 who are already in the labor market (for example, if the survey was done in 2000, we consider all the individuals who were born between 1971 and 1980, we exclude individuals who are still in school or not working.) The treatment group is individuals in the age group mentioned above who hail from the president's ethnicity. We assume that individuals above thirty are likely to have gained employment irrespective of ethnicity. Thus, we believe that they are less likely to benefit from the president from their ethnic group. Although, we know that the delay in finishing school could lead to few of these individuals above thirty years old benefit from having the president from their ethnicity. The cohort 20 and 30 years old are assigned as a treated cohort if an individual is a member of this cohort when the president of the country is from his ethnic group, which takes the value of one and zero otherwise. We employed the DID_L proposed by De Chaisemartin and D'Haultfoeuille (2022a); the method is robust to heterogeneous and dynamic treatment effects.

$$Y_{iet} = \alpha + \tau P_{et} + \beta_e + \epsilon_{iet} \tag{17}$$

Where i refer to an individual in a cohort age 20 to 30 years old, Y_{iet} is the share of formal youth employment of the ethnicity e in time t, and P_{et} is a dummy variate that takes the value one if an individual i share the same ethnicity with the president at time t and zero otherwise. Each ethnicity is treated at a different time, depending on the time that the president assumed and left office. So, the treatment is considered to expire when the president leaves power. In addition, we include ethnicity fixed effect β. We clustered the standard errors at the treatment level (Ethnicity). The method estimates the average effects of having changed the treatment in l time ago; in this case, the method estimates the average treatment of the first-time switcher. It compares the first-time switcher in the panel with the group that is yet to switch in the same panel. The dynamic effect relies on generalizing the standard parallel trends' assumption. Thus, the method relies on two parallel trend assumptions de Chaisemartin and D'Haultfoeuille (2022b) Each assumption for both switchers in and switchers out. We use the Stata command proposed by de Chaisemartin and D'Haultfoeuille (2022b) ($did-multiplegt$) to estimate the effect of youth formal labor participation. We provide the placebo estimators and reflect the dynamic effects estimators.

6. Results

We employed DID_L to estimate the effects of leader ethnicity on youth formal labor participation in eleven Sub-Saharan African countries. Since all the countries did not survey in the same year, we ran the estimation separately for each country. We then average across the eleven countries. Also, from the variance, since the estimators are independent because they use data from different countries, thus we can use the fact that

$$\text{variance(average)} = (averageofthevariance)/11.$$

We also ran the placebo test, which is robust to heterogeneous and dynamic treatment effects for each country. The null hypothesis of the placebo test state that the estimators are all zero; that is, the pre-treatment trend is the same. The placebo test is satisfied in three countries, Mali, Nigeria, and Zambia. Figure 1 shows the result for Mali; the placebo test result is not statistically significant (that is, to the left of t=0). Similar result is obtained for Nigeria and Zambia in figure 2 and in figure3, respectively. For Senegal and the other seven countries, we reject the null hypothesis for the placebo test for the eight countries, Figure 4 below shows Senegal's result for this case.

Despite the law engagement of youth in the labor market in Sub-Saharan Africa, it is worth exploring whether there is a disparity between the ethnicity of the president in the youth labor participation or not. The table shows that most of the country shows that there are significant differences between the control and treatment ethnicity in youth labor participation column 5 shows the difference in the t-test of difference between treatment and control groups.

Table 15 shows the result of the full sample; the full sample is the labor participation of everyone in the sample irrespective of age. We can use the two method, the DID Imputation method developed by Borusyak et al. (2021) (did-imputation) and the method proposed by De Chaisemartin and D'Haultfoeuille (2022a)(did-multiplegt). Since the treatment is staggard adoption, we can employ the two approaches. Most of the result follows the same pattern and are significant. Ghana's result shows that the president ethnic group is disadvantaged in formal labor participation. The Guinea result shows a similar pattern, but only the imputation method is statistically significant. A similar effect is found in Malawi, Nigeria, and Zambia. While Kenya's result shows ethnicity favoritism in the whole sample, the imputation method result shows a significant impact. Benin and Senegal results have the same pattern where the multiplegt shoe=ws positive sign but not statistically significant, but the imputation shows a disadvantage for the president's ethnicity.

The Mali dynamic effect to the right of t=0 is positive and significant after the first treatment. Nigeria and Zambia result, the dynamic effect to the right of t=0 is negative and statistically significant after the first treatment.

Our estimate with DID_L can be interpreted as the average total effect of change of the leader as described by de Chaisemartin and D'Haultfoeuille (2022b) Table 14 shows the result of each country; the table also shows the instantaneous effect of the change of the leader.

7. Conclusion

Our study exploits a change in the president's ethnicity across eleven countries. We demonstrated that ethnicity alliance relative to the youth formal labor participation does not produce a uniform outcome in the eleven countries studied. In Kenya, youth aligned with the president's ethnic group is about 3.9 percentage points more likely to have access to formal employment than youth from another ethnic group, while in Nigeria and Zambia, the result contradicts the ethnic favoritism literature prediction that politicians will favor their ethnic group, we have the opposite effect; Nigeria, youth aligned with the president ethnic group, is about 4.8 percentage point less likely to have access to formal employment same result with Zambia about 25 percentage point less likely to have access to formal employment. The remaining eight countries show no differences between the youth aligned with the president and youth aligned with other ethnic groups.

Discrimination takes a different form in African society; in this paper, we study discrimination's effect on formal youth labor participation. Caution should be exerted interpreting the result of these findings, so the ethnic group may have been well placed in the labor market before they had the opportunity to present a president, and this ethnic group might well be interested in other amenities such as road or health infrastructures which will take the attention of this group, there could be diverse of interest-based of economic standing. Or the ethnic group might be well-positioned in the public sector or naturally positioned where they control the nation's food basket. (Regional farming)

We estimated the effect of the president's ethnicity on youth formal labor participation in Sub-Saharan African countries. Taking the nations, we find no significant difference between being from the ethnic group of the president or not. Still, when we do our analysis on the bases of each country, we only observe ethnic favoritism in the youth's formal labor participation in Mali, and the result is statistically significant. There is a decrease in the youth labor participation in the president's ethnicity in Nigeria and Zambia results. The remaining eight countries show no significant differences between youth formal labor participation of the president's ethnicity and others. The individual country outcome substantiates the model prediction. For the Nigeria case, the outcome is very predictable. The Northern part of the country has been in power for a very long time (Fulani), and they have flooded the government parastatals while only a few are in the private sectors. The northern part of the country dominated the Nigerian National Petroleum Corporation (NNPC) workforce. A similar trend can be seen in the NNPC subsidiaries and other government agencies. This other region has been pushed to battle for employment in most private sectors.

Our result substantiated the model outcomes that the effect of leaders on youth formal labor participation in Sub-Saharan Africa has a heterogeneous impact across the countries.

The structure of the labor force in each country matters a lot, and leaders have diverse agenda across the countries. Avenues for future research, having public data on government establishments will allow answering the question of whether favoritism of the employment is in the government firms.

The government of each country needs to make a concerted effort to embark on policies that will support youth employment, such as fostering innovation, restructuring the educational system to incorporate skills required for the modern-day technology, improving the infrastructure across the region, promoting the exchange of knowledge across the region, and encourage local production and less depend on importation from the oversea.

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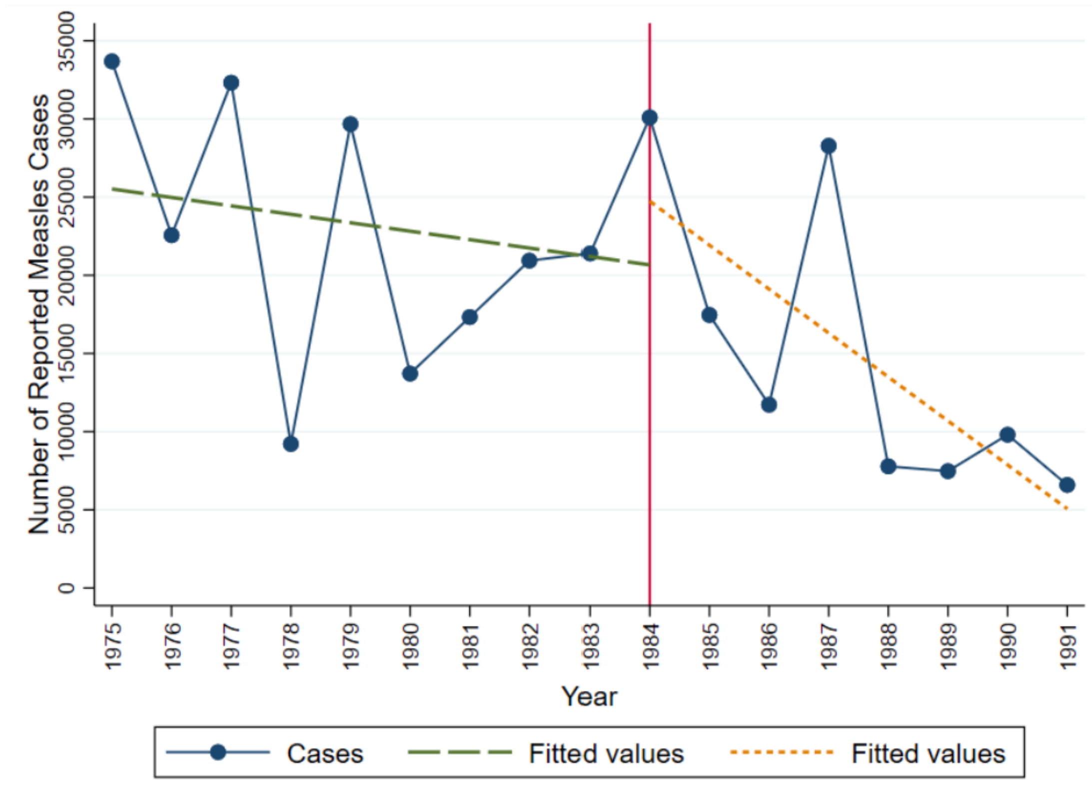
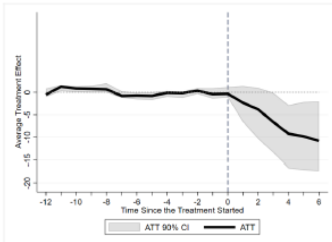


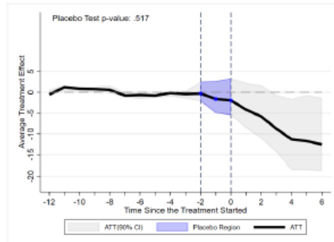
(a) Number of Measles Cases

Figure 1: Trends in Number of Reported Measles Cases in Burkina Faso

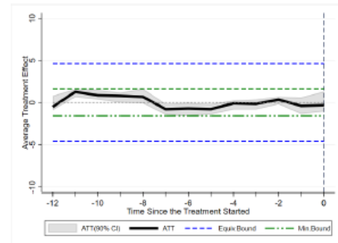
Figure 1: Trends in Number of Reported Measles.



(a) Mortality rate under five



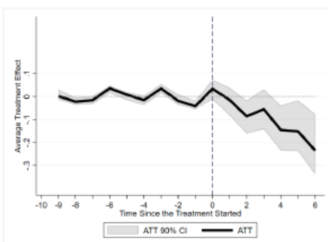
(b) Mortality rate placebo test



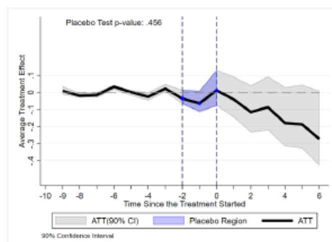
(c) Mortality rate equivalence test.

Figure 2: (a) shows the result of mortality rate under five, (b) shows the result for placebo test (c) shows the result of an equivalent test for the mortality rate under five

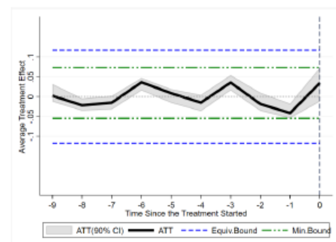
Figure 2: Effect of Vaccination on Mortality rate under five.



(a) BMI



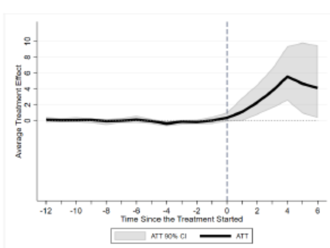
(b) Placebo test for BMI



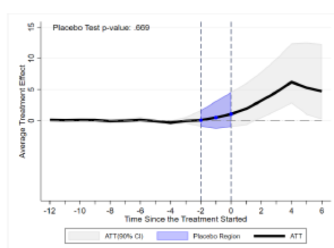
(c) Equivalence test for BMI

Figure 3: (a) shows the result of BMI less than two s.d, (b) shows the placebo test for BMI less than two s.d (c) shows the equivalent test for BMI less than two s.d

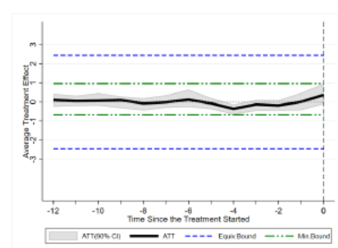
Figure 3: Effect of the Measles Vaccination on Prevalence of Thinness



(a) Primary school enrollment net overall



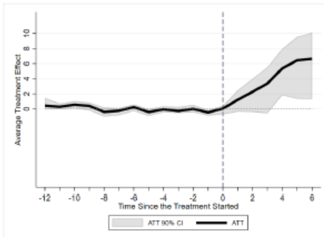
(b) Placebo test for primary school enrollment



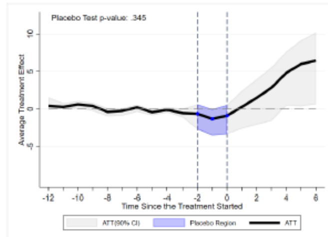
(c) Equivalence test for primary school enrollment.

Figure 4: (a) shows the result of primary school enrollment net overall, (b) shows the placebo test for primary school enrollment, (c) shows the equivalent test for primary school enrollment.

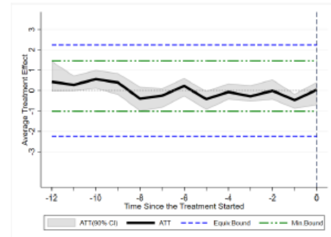
Figure 4: Effect of the Vaccination on Primary School Enrollment



(a) Primary school completion rate



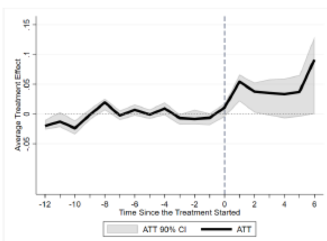
(b) Placebo test for primary school completion rate



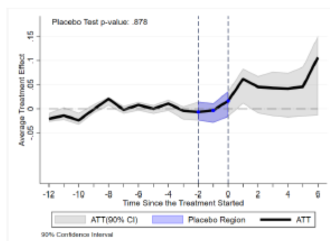
(c) Equivalence test for primary school completion rate.

Figure 5: (a) shows the result of primary school completion rate, (b) shows the placebo test for primary school completion rate, (c) shows the equivalent test for primary school completion rate.

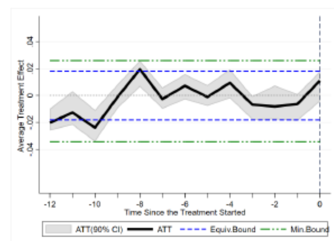
Figure 5: Effect of the Vaccination on Primary School Completion Rate



(a) Employment rate



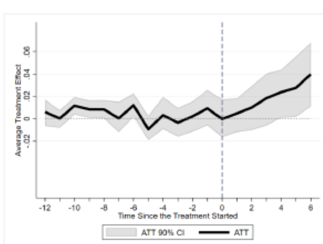
(b) Placebo test for employment rate



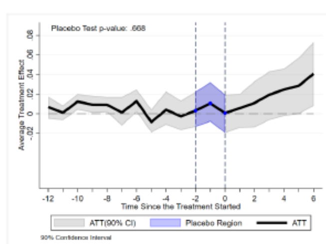
(c) Equivalence test for employment rate.

Figure 6: (a) shows the result of employment rate, (b) shows the placebo test for employment rate, (c) shows the equivalent test for employment rate.

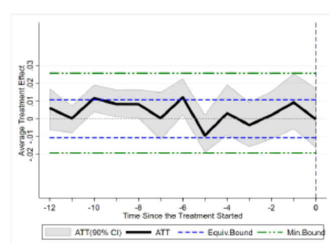
Figure 6: Effect of Vaccination on Employment Rate.



(a) Formal employment.



(b) Placebo test for formal employment.



(c) Equivalence test for formal employment.

Figure 7: (a) shows the result of formal employment rate, (b) shows the placebo test for formal employment rate, (c) shows the equivalent test for formal employment rate.

Figure 7: Effect of Vaccination on Formal Employment.

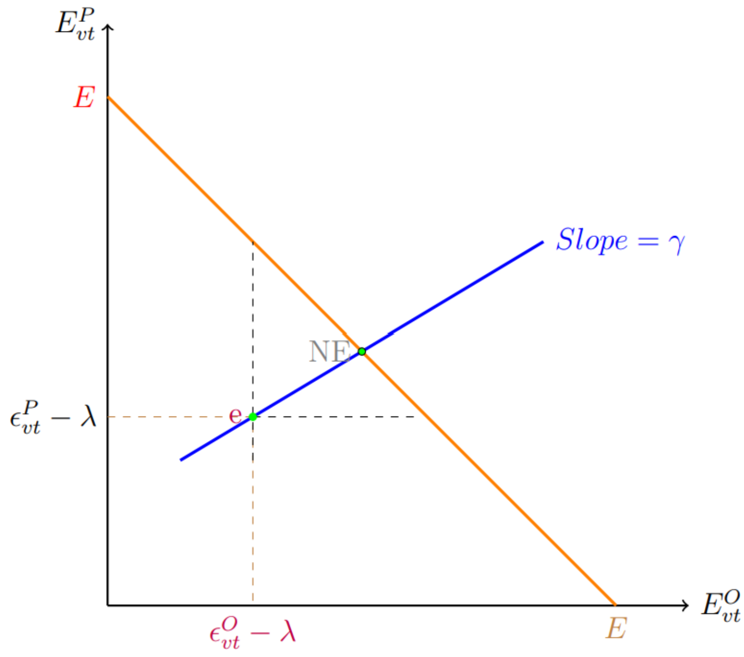
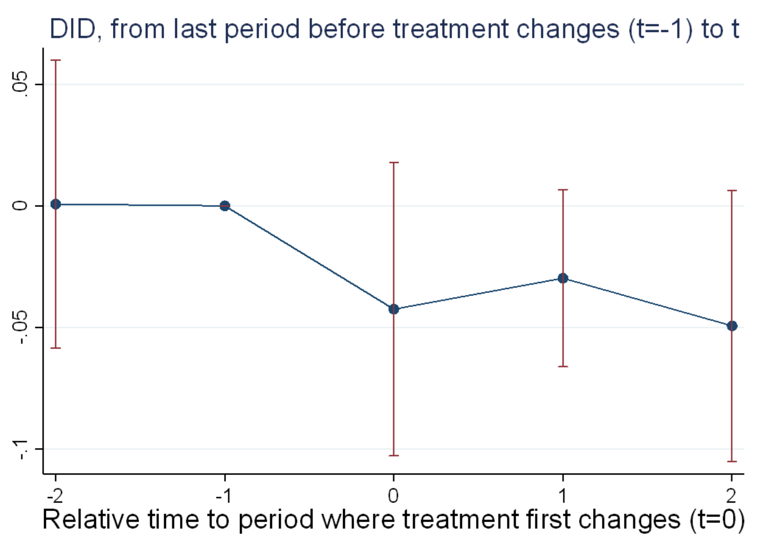


Figure 8: Formal Employment Allocation.



Note: The above figure is the result of the DID L using the dynamic option for Nigerian youth. The vertical axis displaces the of president's ethnicity on the youth labor participation.

Figure 9: The Result of Dynamic Effect (Nigeria).

President- Others	support	oppose
support	$\epsilon_{vt}^P, \epsilon_{vt}^O$	$\epsilon_{vt}^P + \lambda, \epsilon_{vt}^O - \lambda$
oppose	$\epsilon_{vt}^P - \lambda, \epsilon_{vt}^O + \lambda$	$\epsilon_{vt}^P - \lambda, \epsilon_{vt}^O - \lambda$

Figure 10: Payoff matrice

Table 1: Descriptive Statistics

	Burkina Faso			Other SSA Countries		
	All	Before	After	All	Before	After
	(1)	(2)	(3)	(4)	(5)	(6)
Population, female (%)	50.92	50.79	51.15	50.47	50.47	50.46
	(0.26)	(0.24)	(0.01)	(1.22)	(1.26)	(1.14)
Population, male (%)	49.08	49.22	48.86	49.54	49.53	49.54
	(0.26)	(0.24)	(0.01)	(1.22)	(1.26)	(1.14)
Population growth (%)	45.75	45.03	46.98	45.48	45.25	45.87
	(1.20)	(0.89)	(0.29)	(2.32)	(2.43)	(2.04)
Population ages 0-14 (%)	2.27	2.07	2.61	2.91	2.85	3.02
	(0.34)	(0.26)	(0.04)	(0.76)	(0.62)	(0.95)
Life expectancy at birth	45.95	43.93	49.41	50.13	48.96	52.14
	(3.56)	(2.94)	(0.20)	(5.72)	(5.45)	(5.61)
Mortality rate, adult female (per 1,000)	323.86	343.27	290.578	320.50	330.31	303.49
	(39.90)	(38.51)	(3.21)	(53.20)	(49.92)	(54.54)
Mortality rate, adult male (per 1,000)	387.60	410.75	347.919	383.88	391.28	371.05
	(46.48)	(44.06)	(3.71)	(55.057)	(50.37)	(60.38)
Agricultural land (%)	32.46	31.60	33.93	45.44	44.82	46.51
	(1.42)	(0.74)	(1.03)	(17.76)	(17.40)	(18.37)
Crop production index	28.94	24.35	36.79	47.26	44.69	51.71
	(7.25)	(2.87)	(5.34)	(25.68)	(24.93)	(26.42)
Food production index	28.88	24.07	37.12	43.21	40.84	47.32
	(7.28)	(2.53)	(4.70)	(19.59)	(19.13)	(19.75)
Livestock production index	28.89	23.69	37.81	42.20	39.37	47.11
	(8.58)	(2.97)	(7.58)	(17.22)	(16.54)	(17.31)
Rural population (%)	359.19	343.60	385.905	1682.3	1719.6	1617.6
	(29.42)	(24.11)	(14.61)	(2533.2)	(2661.6)	(2299.4)
GDP per capita (constant 2010 US$)	90.32	92.21	87.08	73.87	75.97	70.24
	(2.90)	(1.67)	(0.78)	(13.43)	(12.29)	(14.52)
Mortality rate, under-5 (per 1,000 live births)	241.56	261.70	207.029	182.06	193.74	161.81
	(35.82)	(29.44)	(7.57)	(59.16)	(58.28)	(55.22)
Prevalence of thinness aged 5-9 years (%)	14.23	14.80	13.49	12.62	13.13	11.97
	(0.79)	(0.47)	(0.35)	(3.08)	(2.93)	(3.14)
Primary school enrollment rate (%)	17.25	13.35	23.95	56.57	54.63	59.93
	(5.78)	(2.38)	(2.63)	(29.08)	(31.58)	(23.85)
Primary school completion rate (%)	11.27	8.68	15.70	49.05	47.41	51.91
	(3.92)	(1.55)	(2.31)	(22.81)	(23.20)	(21.90)
Employed (= if Yes)	0.89	0.92	0.84	0.83	0.87	0.76
	(0.05)	(0.02)	(0.04)	(0.13)	(0.10)	(0.16)
Formal employment (=1 if yes)	0.04	0.06	0.02	0.16	0.18	0.13
	(0.02)	(0.01)	(0.01)	(0.11)	(0.11)	(0.10)
Observations	19	12	7	492	312	180

Note: In this table, we present the mean and standard deviation of the variables. The standard deviations are in parentheses.

Table 2: Description of the sample, and percentage distribution

	Senegal	Sierra Leone	Liberia	Zambia	Uganda
Children ever born (mean)	2.87	3.74	3.58	3.68	4.3
s.d	(3.05)	(3.10)	(2.87)	(3.02)	(3.30)
Education Att.					
No education	78.22	81.05	75.84	50.88	69
Primary	18.83	17.99	16.2	40.94	28.83
Secondry	2.52	0.83	7.11	7.22	1.89
University	0.43	0.14	0.85	0.95	0.28
Residence					
Urban	43.79	31.08	43.47	35.19	11.45
Rural	56.21	68.92	56.53	64.81	88.54
Religious Affliation					
Muslim	95.16	81.05	13.77	0.46	11.22
Christianity	4.3	17.99	84.05	92.68	6.17
Others	0.37	0.83	0.77	4.65	2.27
Unknown	0.17	0.14	1.4	2.19	0.33
Marital status					
Monogamy	33.77	69.16	93.63	98.98	81.23
Polygamy	32.59	30.4	6.37	1.02	18.54
Unknown	33.63				
Number of region	9	14	5	8	37
number of ethnic grp.	65	20	20	67	106
Observation	238,875	91,408	48,273	464,168	616,007

Table 3: OLS for Senegal (i to iii) and Sierra Leone (iv to vi)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Polygamy	0.122***	0.119***	0.126***	1.03e-04	1.03e-04	1.06e-04
	(0.0106)	(0.0106)	(0.0106)	(1.18e-04)	(1.18e-04)	(1.18e-04)
Age of Wife	0.217***	0.217***	0.217***	-1.9e-05	-1.9e-05	-1.89e-05
	(0.00312)	(0.00312)	(0.00312)	(3.32e-05)	(3.32e-05)	(3.32e-05)
Age of Wife Sq.	-0.0016***	-0.0016***	-0.0016***	5.09e-06	5.09e-06	5.14e-06
	(4.37e-05)	(4.37e-05)	(4.37e-05)	(4.72e-07)	(4.72e-07)	(4.72e-07)
Primary	-0.487***	-0.484***	-0.487***	2.34e-05	2.26e-05	3.21e-06
	(0.0164)	(0.0164)	(0.0165)	(1.76e-04)	(1.77e-04)	(1.78e-04)
Secondary	-1.036***	-1.027***	-0.992***	-1.81e-04	-1.82e-04	-2.22e-04
	(0.0410)	(0.0411)	(0.0415)	(7.12e-04)	(7.14e-04)	(7.15e-04)
University	-1.071***	-1.063***	-0.992***	-2.03e-04	-2.03e-04	-1.75e-04
	(0.0799)	(0.0799)	(0.0812)	(8.94e-04)	(8.96e-04)	(9.05e-04)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
Observation	158532	158532	158532	91408	91408	91408

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1% (i) to (iii) are Senegal while (iv) to (vi) is Sierra Leone.

Table 4: OLS for Liberia (i to iii) and Zambia(iv to vi

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Polygamy	-0.0008	-0.0009	-0.0008	-0.499***	-0.517***	-0.518***
	(0.0012)	(0.0012)	(0.0012)	(0.034)	(0.0323)	(0.0323)
Age of Wife	-0.0012***	-0.0011***	-0.0011***	0.520***	0.501***	0.501***
	(2.1e-04)	(2.1e-04)	(2.1e-04)	(0.0022)	(0.0024)	(0.0024)
Age of Wife Sq.	1.8e-05***	1.8e-05***	1.8e-05***	-0.0049***	-0.0047***	-0.0047***
	(3.1e-06)	(3.1e-06)	(3.1e-06)	(3.1e-05)	(3.5e-05)	(3.e-05)
Primary	0.00041	0.00042	0.0004	0.142***	0.0533***	0.0578***
	(0.0008)	(0.0008)	(0.0008)	(0.0075)	(0.0084)	(0.0085)
Secondry	0.0013	0.0014	0.0014	-1.011***	-1.047***	-1.020***
	(1.2e-03)	(1.2e-03)	(1.2e-03)	(0.016)	(0.017)	(0.017)
University	-0.0013	-0.0012	-0.0012	-0.975***	-1.017***	-0.957***
	(0.0032)	(0.0032)	(0.0033)	(0.0355)	(0.0426)	(0.0427)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
Observation	48,273	48,273	48,273	338,526	338,526	338,526

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1% (i) to (iii) are Liberia while (iv) to (vi) is Zambia.

Table 5: OLS (i to iii)and first stage(iv to vi) for Uganda

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Polygamy	-1.82e-04*	-1.81e-04*	-1.8e-04*			
	(9.9e-05)	(9.9e-05)	(9.9e-05)			
Age of Wife	-1.02e-04***	-1.02e-04***	-1.02e-04***	0.0191***	0.0194***	0.0194***
	(3e-05)	(3e-05)	(3e-05)	(0..0005)	(0.0005)	(0..0005)
Age of Wife Sq.	1.03e-06*	1.02e-06*	1.02e-06*	-2.2e-04***	-2.2e-04***	-2.2e-04***
	(4.4e-07)	(4.4e-07)	(4.4e-07)	(7.e-07)	(7.52e-06)	(7.2e-07)
Primary	7.5e-04**	7.5e-04**	7.4e-04**	-0.0114***	-0.0126***	-0.0111***
	(2.7e-04)	(2.7e-04)	(2.7e-04)	(0.0015)	(0.0015)	(0.0015)
Secondry	0.00112	0.00110	0.00116	-0.0582***	-0.0548***	-0.0525***
	(7.8e-04)	(7.8e-04)	(8.1e-04)	(0.0045)	(0.0045)	(0.0045)
University	0.00171	0.00173	0.00169	-0.0879***	-0.87***	-0.0756***
	(0.00145)	(0.00145)	(0.00146)	(0.0131)	(0.013)	(0.0133)
Female\Male				.0172***	0.0111**	.0191***
				(0.0045)	(.0045)	(0.005)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
F Test				227	295	147
Observation	366242	366242	366242	366,110	366,110	366,110

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1% (i) to (iii) are OLS for Uganda while (iv) to (vi) are the first stage for Uganda

Table 6: first stage for Senegal (i to iii) and Sierra Leone(iv to vi)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Age of Wife	0.028***	0.028***	0.028***	0..0194***	0..0195***	0..0195***
	(7e-04)	(7e-04)	(7e-04)	(9.3e-04)	(9.3e-04)	(9.3e-04)
Age of Wife Sq.	-0.0003***	-0.0003***	-0.0003***	-0.00021***	-0.00021***	-0.00021***
	(1.04e-05)	(1.03e-04)	(0.000103)	(1.33e-05)	(1.3e-05)	(1.32e-05)
Primary	-0.105***	-0.0994***	-0.0972***	-0.0913***	-0.0795***	-0.076***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.0051)
Secondary	-0.164***	-0148***	-0.146***	-0.17***	-0.1446***	-0.139***
	(0.0097)	(0.0097)	(0.0098)	(0.020)	(0.020)	(0.020)
University	-185***	-0.167***	-0.162***	-0.18***	-0.146***	-0.130***
	(0.019)	(0.0189)	(0.019)	(0.025)	(0.025)	(0.026)
Female\Male	.143***	.197***	.0.107***	.0696***	0.0913**	.137***
	(0.0119)	(0.012)	(0.0168)	(0.0108)	(.0108)	(0.0145)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
F Test		365	134	284	272	190
Observation	158,508	158,508	158,508	91,395	91,395	91,395

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significan level are * 10%, ** 5%, and *** 1% (i) to (iii) are first stage for Senegal while (iv) to (vi) are the first stage for Sierra leone

Table 7: first stage for Zambia (i to iii) and Liberia(iv to vi)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Age of Wife	0.00115***	0.00114***	0.0012***	-0.0024***	-0.0023***	-0.00215***
	(2.8e-04)	(2.8e-04)	(2.8e-04)	(8.1e-04)	(8.1e-04)	(8.1e-04)
Age of Wife Sq.	-2e-05***	-2e-05***	-2e-05***	-3e-05***	-3e-05***	-3e-05***
	(3.91e-06)	(3.91e-06)	(3.91e-06)	1.18e-05)	1.17e-05)	1.17e-05)
Primary	-0.0075***	-0.0074***	-0.0080***	-0.0248***	-0.0210***	-0.0215***
	(0.0008)	(0.0008)	(0.0008)	(0.0031)	(0.0031)	(0.0031)
Secondry	-0165***	-0165***	-0.0171***	-0.0314***	-0.0258***	-0.0275***
	(0.0015)	(0.0014)	(0.0015)	(0.0046)	(0.0046)	(0.0046)
University	-0.026***	-0.027***	-0.03***	-0.040***	-0.0331***	-0.036***
	(0.0058)	(0.0058)	(0.0059)	(0.0124)	(0.0124)	(0.0124)
Female\Male	.00649	.0069	.0.024***	.0071	.0419***	.106***
	(0.0048)	(0.0048)	(0.0064)	(0.00845)	(0.0087)	(0.013)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
F Test	295	258	102	62	65	44
Observation	187,708	187,708	187,708	48,273	48,273	48,273

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significan level are * 10%, ** 5%, and *** 1% (i) to (iii) are first stage for Liberia while (iv) to (vi) are the first stage for Zambia

Table 8: Two stage least square for Senegal(i to iii) and Sierra Leone(iv to vi)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Polygamy	-0.250	-0.0194	1.275	-0.0107	-0.00825*	-0.00525**
	(0.846)	(0.609)	(1.250)	(5.9e-03)	(0.004)	(1.9e-03)
Age of Wife	0.228***	0.221***	0.185***	1.9e-40	1.4e-04	8.5e-05
	(0.0256)	(0.0203)	(0.0355)	(1.3e-04)	(9.1e-05)	(6e-05)
Age of Wife Sq.	-0.00172***	-0.00165***	-0.00128***	-1.8e-06	-1.2e-06	-6.2e-07
	(2.9e-04)	(2.3e-04)	(3.7e-04)	(1.5e-06)	(1.1e-06)	(7.9e-07)
Primary	-0.525***	-0.497***	-0.373**	-1e-03	-6.5e-04*	-4.2e-04*
	(0.0944)	(0.0695)	(0.127)	(5.3e-04)	(3.2e-04)	(2.1e-04)
Secondry	-1.096***	-1.047***	-0.822***	-0.00204*	-0.00141*	-9.9e-04**
	(0.139)	(0.0970)	(0.188)	(0.00103)	(6e-04)	(3.1e-04)
University	-1.137***	-1.083***	-0.805***	-0.00212*	-0.00145*	-9.1e-04**
	(0.175)	(0.124)	(0.213)	(0.00105)	(6e-04)	(3.5e-04)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
Observation	158508	158508	158508	91395	91395	91395

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significan level are * 10%, ** 5%, and *** 1% (i) to (iii) are 2SLS for Senegal while (iv) to (vi) are for Sierra Leone

Table 9: Two stage least square for Liberia(i to iii) and Uganda(iv to vi)

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Polygamy	0.390	0.0822	0.0428	8.9e-04	2.2e-03	-7.e-03*
	(1.722)	(0.0632)	(0.0248)	(0.00445)	(7.1e-03)	(0.00393)
Age of Wife	-2e-04	-9.5e-04**	-0.00104**	-1.2e-04	-1.5e-04	4.5e-05
	(0.0042)	(3.5e-04)	(3.8e-04)	(8.6e-05)	(1.4e-04)	(8e-05)
Age of Wife Sq.	6.3e-06	1.6e-05**	1.7e-05**	1.3e-06	1.6e-06	-6.7e-07
	(5.3e-05)	(5.3e-06)	(5.8e-06)	(1e-06)	1.6e-06	(9.6e-07)
Primary	0.0101	0.00222	0.00139	1,5e-04	1.7e-04	3.3e-053
	(0.0426)	(0.00161)	(9.1e-04)	(9.6e-05)	(1.2e-04)	(8.7e-05)
Secondry	0.0137	0.00361	2.3e-03	8.2e-4	8.8e-04	3.4e-04
	(0.0542)	(0.00200)	(1.2e-03)	(5e-04)	(6e-04)	(4.5e-04)
University	0.0145	0.00182	5.3e-04	01.2e-03	0.00131	5.8e-04
	(0.0704)	(0.00273)	(1.4e-03)	(8.e-04)	(1e-04)	(8.5e-04)
Occupation	Yes	Yes	Yes	Yes	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes
Ethnicity	No	No	Yes	No	No	Yes
Observation	48273	48273	48273	366110	366110	366110

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1% (i) to (iii) are 2SLS for Liberia while (iv) to (vi) are for Uganda

Table 10: Two stage least square for Zambia

	(i)	(ii)	(iii)
Polygamy	1.901	1.693	1.908*
	(2.935)	(2.518)	(0.930)
Age of Wife	0.0398***	0.0400***	0.0397***
	(0.00376)	(0.00330)	(0.00218)
Age of Wife Sq.	-0.000467***	-0.000471***	-0.000466***
	(5.9e-05)	(5.1e-05)	(3e-05)
Primary	0.00148	0.000126	0.00299
	(0.0222)	(0.0189)	(0.00816)
Secondry	-0.0529	-0.0558	-0.0501**
	(0.0483)	(0.0415)	(0.0176)
University	-0.0674	-0.0666	-0.0553
	(0.0767)	(0.0685)	(0.0284)
Occupation	Yes	Yes	Yes
Religion	No	Yes	Yes
Ethnicity	No	No	Yes
Observation	187708	187708	187708

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1%

Table 11: Two stage least square for polygamous first wife and monogamous

	(i)	(ii)	(iii)
Polygamy	1.436	0.0650	-0.00821
	(1.213)	(0.0394)	(0.00431)
Age of Wife	0.193***	-9.52e-04*	5.29e-05
	(0.0295)	(3.94e-04)	(8.66e-05)
Age of Wife Sq.	-0.00138***	1.57e-05*	-7.43e-07
	(3e-04)	(6e-06)	(1.02e-06)
Primary	-0.421***	0.00133	6.2e-05
	(0.0925)	(9.46e-04)	(8.3e-05)
Secondry	-0.894***	0.00267*	3.7e-04
	(0.140)	(0.00122)	(4.6e-04)
University	-0.882***	7.1e-04	6.1e-04
	(0.158)	(0.00163)	(8.6e-04)
Occupation	Yes	Yes	Yes
Religion	Yes	Yes	Yes
Ethnicity	Yes	Yes	Yes
Observation	138700	47387	357497

The dependent variable is the number of children ever born, the standard error are cluster at both the geographical region and ethnic group Significant level are * 10%, ** 5%, and *** 1% (i) to (iii) are 2SLS for Senegal,, Liberia, and Uganda, respectively.

Table 12: Descriptive Statistics

Country	No. of waves	No. of Pres.	No. Et. Pres.	No.of Obs.
Benin	5	4	3	5116
Ghana	5	3	3	4094
Guinea	4	2	2	2481
Kenya	5	3	2	7077
Malawi	4	3	2	6120
Mali	5	4	3	3739
Niger	3	3	3	1995
Nigeria	4	4	3	12157
Senegal	9	3	3	9703
Sierra Leone	3	2	2	3758
Zambia	4	4	4	6113
All countries	51	35	30	62353

Table 13: Means, Standard Deviations, And Test of of treatment and Control

Country	All	Control	Treatment	Difference
Benin	0.165	0.136	0.292	-0.156
	(0.0051)	(0.00532)	(0.0147)	(0.0131)
Ghana	0.188	0.173	0.231	-0.0581
	(0.0061)	(0.00688)	(0.0129)	(0.0139)
Guinea	0.151	0.153	0.144	0.009
	(0.007)	(0.0084)	(0.0138)	(0.0164)
Kenya	0.201	0.2	0.206	-0.0059
	(0.0048)	(0.0052)	(0.0115)	(0.0125)
Malawi	0.106	0.103	0.122	-0.191
	(0.0039)	(0.0042)	(0.0104)	(0.0107)
Mali	0.136	0.133	0.151	-0.018
	(0.0056)	(0.0062)	(0013)	(0.0139)
Niger	0.131	0.153	0.084	0.068
	(0.0076)	(0.0097)	(0.0112)	(0.0162)
Nigeria	0.193	0.197	0.127	0.0697
	(0.0036)	(0.0037)	(0.0121)	(0.0147)
Senegal	0.0967	0.104	0.079	0.024
	(0.003)	(0.0037)	(0.0051)	(0.0066)
Sierra Leone	0.126	0.131	0.11	0.0217
	(0.0054)	(0.006)	(0.011)	(0.0128)
Zambia	0.128	0.125	0.175	-0.05
	(0.0043)	(0.0043)	(0.0233)	(0.0209)

The standard error are in parentheses

Table 14: The Result of Youth Sample Age 20 to 30 Using the Multiplegt Method

Youth Sample Country	Mutiplegt Method
Benin	0.0194
	(0.0368)
Ghana	-0.0225
	(0.0406)
Guinea	-0.0564
	(0.0596)
Kenya	-0.0237
	(0.0237)
Malawi	-0.0298
	(0.00871)
Mali	0.0413
	(0.00982)
Niger	0.0187
	(0.150)
Nigeria	-0.039
	(0.0118)
Senegal	0.0245
	(0.0378)
Sierra Leone	-0.116
	(0.0263)
Zambia	-0.257
	(0.0705)

The standard error are in parentheses

Table 15: Result of Full Sample using the Two Methods

Full Sample	Method	
Country	Multiplegt	Imputation
Benin	0.0074	-0.073
	(0.018)	(0.0074)
Ghana	-0.0192	-0.0195
	(0.006)	(0.00541)
Guinea	-0.017	-0.0547
	(0.0254)	(0.0147)
Kenya	0.0175	0.0206
	(0.0200)	(0.01)
Malawi	-0.0187	-0.0152
	(0.0623)	(0.00622)
Mali	0.0217	0.0105
	(0.00847)	(0.0124)
Niger	0.0189	
	(0.0587)	
Nigeria	-0.0286	-0.0286
	(0.0116)	(0.0168)
Senegal	0.0065	-0.0282
	(0.0162)	(0.00651)
Sierra Leone	-0.049	
	(0.0067)	
Zambia	-0.0168	-0.0107
	(0.0224)	(0.00265)

The standard error are in parentheses

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