

TRINITY COLLEGE DUBLIN

DOCTORAL THESIS

Essays in Development Economics

A THESIS SUBMITTED TO THE UNIVERSITY OF DUBLIN, TRINITY COLLEGE
IN APPLICATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

By

Hamad Mahar

Supervised by:

Andrea Guariso

2023

Declaration of Authorship

I, Hamad Mahar declare that this thesis titled, “Essays in Development Economics”, submitted to Trinity College Dublin for the degree of Doctor in Philosophy (Ph.D.), has not been submitted as an exercise for a degree at this or any other university. I confirm that I was the lead author for the co-authored chapter in the thesis. All research contained herein is entirely my and my co-authors’ work.

I agree to deposit this thesis in the University’s open access institutional repository or allow the library to do so on my behalf, subject to Irish Copyright Legislation and Trinity College Library conditions of use and acknowledgement. I consent to the examiner retaining a copy of the thesis beyond the examining period, should they so wish (EU GDPR May 2018).

Signed:

Hamad Mahar

Date:

30/03/2023

Summary

This thesis is a collection of three essays in Development Economics. In 2022, 685 million people globally lived in extreme poverty, the rate of decline in poverty is at a paltry rate of 2 percent per year (World bank, 2023). Many factors contribute to this situation such as global headwinds, ineffective national policies, uneven distribution of growth and restrictive social norms to name a few. This dissertation considers two facets that contribute to our understanding of poverty, social norms (their origins and policies to circumvent them) and the status of households in developing countries.

The first essay (Chapter 2), co-authored with Andrea Guariso, Marijke Verpooten and Elena Briones Alonso studies the relation between long-run disease burden and present-day witchcraft beliefs in sub-Saharan Africa (SSA). Scholars have distinguished several psychological and economic arguments for why a heavy disease burden may promote witchcraft beliefs, but there is little empirical evidence for such a relation. We focus on malaria, which is one of the major diseases in historical and contemporary SSA, and for which we can rely on a measure of ethnicity-level historical malaria mortality. Relating this measure to contemporary witchcraft beliefs across individuals and ethnic groups within 17 SSA countries, we find a statistically significant positive association that is robust to the addition of a large number of individual, regional and ethnicity-level control measures. This result, in combination with a substantial body of anthropological, psychological, economic, and evolutionary literature detailing underlying mechanisms, bolsters the idea that the disease environment played a role in explaining the emergence of witchcraft beliefs in SSA.

The second essay (Chapter 3), considers national policies to combat adverse social norms. This paper studies the impact of granting formal legal protection to children on their health by studying the impact of the Child Rights Act in Nigeria. Using a Difference in Differences model that is robust to the staggered adoption of this reform across states, I show that granting formal protection to children leads to a reduction in stunting and has limited positive effects on vaccinations. I provide suggestive evidence that the mechanism behind these results is a change in the demand of care by parents. These findings suggest that secular laws which grant protection improve outcomes for children in a society where harmful traditions persist.

The third essay (Chapter 4), studies the impact of changes in cassava prices on household food security. I find that an increase in the price of domestic and imported cassava is negatively associated with household food security measures and the effect varies depending on the wealth classification of a household, at baseline households which are classified as being wealthy are impacted by domestic and imported cassava prices more than poor and medium wealth households as measured by the Household Diversity Score (HDDS), while domestic and imported cassava prices impact the average (medium) wealthy households the most as measured by the share of food expenditure. These empirical results are consistent with the predictions of the theoretical models of Engel and Bennett's price increase impacts on households. Cassava producers and consumers see an increase in markers of household food insecurity associated with increases in the price of domestic and imported cassava, these findings support the idea of hungry farmers in developing countries.

The last section (Chapter 5) concludes and discusses the implications of this research.

Acknowledgements

Firstly, I wish to acknowledge my supervisor Professor Andrea Guariso for sticking with me through thick and thin and for accepting me as his first PhD student. His technical expertise guided me through a host of research issues but what stood out for me was his empathy. Without his empathy in relation to a plethora of difficulties that I faced during the program; I am convinced I would not have proceeded with the PhD program. His tireless work ethic and commitment continues to inspire me.

All my gratitude goes to my co-authors of my first chapter Dr Marijke Verpoorten and Dr Elena Briones Alonso who introduced me to the topic and accepted me as a co-author on this paper. I also express my appreciation to the editor of the Journal of Development Economics, Professor Nathan Nunn, and the anonymous referees for their constructive comments and suggestions.

I'd like to thank the Department of Economics at Trinity College Dublin for providing the funding I needed to partake in this Ph.D. A special thanks to the professors and my colleagues within the department who provided an open and friendly work environment. The weekly seminars and Ph.D working groups gave me an opportunity to receive constructive feedback and the ability to meet and engage with renowned academic scholars.

My gratitude is extended to my wife, Saba who provided vital support at the outset and continually motivated me throughout, without her encouragement this thesis would never have been completed. I also am extremely grateful to have become a father during my time as a PhD, my daughter Aiza's birth provided timely motivation for the reasons I undertook this journey.

I also want to thank my family, friends and colleagues who were ever-present to hear me rant about my research or academia in general. Finally, I acknowledge my mother (Rubina) and brother (Fawad), who always believed in me. My late father always warned me to not pursue a doctorate because he thought it took too long and yet here I am now. I think he would have been extremely proud to watch me reach this milestone.

Dedication

For my late father, Dr Sikandar Mahar

Contents

Chapter 1: General Introduction	15
1.1: Historical malaria burden and witchcraft beliefs in SSA	15
1.2: Child Rights, Traditions and Health Seeking behavior in Nigeria	16
1.3: Commodity by-product Prices and Intrahousehold labor allocation: Evidence from Nigerian farmers	18
 Chapter 2: Historical Malaria Burden and Present-day Witchcraft beliefs	21
2.1: Introduction	21
2.2 Background and Hypothesis	23
2.2.1: Witchcraft in Sub-Saharan Africa.....	23
2.2.2: Psychological mechanisms	25
2.2.3: Economic mechanisms	26
2.3 Data sources and description.....	28
2.3.1: Witchcraft beliefs	28
2.3.2: Long run disease burden.....	33
2.3.3: Historical malaria mortality and witchcraft beliefs	34
2.4 Estimation framework	36
2.4.1: Estimating equations	36
2.4.2: Calculating standard errors	40
2.5 Results	40
2.5.1: Alternative explanations.....	41
2.5.2: Contemporary individual characteristics	42
2.5.2.1: Variable classification	42
2.5.2.2: Results	43
2.5.3: Precolonial characteristics of the ethnic group	45
2.5.3.1: Variable classification	45

2.5.3.2: Results	46
2.5.4: European settlement and influence.....	46
2.5.4.1: Variable classification.....	46
2.5.4.2: Results	47
2.5.5: Slave trade and trust	47
2.5.5.1: Variable classification.....	47
2.5.5.2: Results	47
2.5.6: Ruggedness, Night Lights, Ethnolinguistic fractionalization and conflict	49
2.5.6.1: Variable classification.....	49
2.5.6.2: Results	49
2.6 Reverse causality	49
2.7 Robustness checks	50
2.8 Additional analysis	56
2.8.1: Heterogeneity by pre-colonial group characteristics	56
2.8.2: General trust.....	57
2.9 Conclusion.....	57
Appendix	59
Appendix 2A: Additional tables	62
Appendix 2B: Data sources and description.....	66
Appendix 2C: Additional details on data construction.....	71
Chapter 3: Child Rights, Traditions and Health Seeking behavior in Nigeria.....	72
3.1 Introduction	72
3.2 Background and Data	76
3.2.1: The introduction and enforcement of the Child Rights Act in Nigeria	76
3.2.2: Data, Sample and Measurements	79
3.3 Estimation framework	82
3.3.1: Differences in Differences	82

3.3.2: Triple Differences in Differences.....	83
3.3.3: Dynamic Differences in Differences	84
3.3.4: Cut off selection.....	85
3.4 The Main Results of the CRA's effect	86
3.4.1: Anthropometric estimates	88
3.4.2: Differences in Differences and Triple difference estimates	86
3.4.3: Dynamic Differences in difference estimates.....	92
3.4.4: Vaccination estimates.....	92
3.4.5: Differences in Differences and triple difference estimates	92
3.4.6: Dynamic Differences in difference estimates.....	95
3.4.7: Child Nutrition, Breastfeeding, Recent Illnesses and Pre-natal care	95
3.4.8: Child Nutrition estimates	95
3.4.9: Breastfeeding estimates	97
3.4.10: Episodes of recent illness	97
3.4.11: Prenatal care and Birthweight estimates	97
3.5 Robustness checks and threats to identification.....	99
3.5.1: Bootstrapped Standard errors	99
3.5.2: Weighted regressions [Probability and Analytical weights]	100
3.5.3: Mean reversion.....	102
3.5.4: Sun and Abraham estimates	103
3.5.5: Dropping one state at a time.....	103
3.5.6: Composition of treated and control states over time.....	103
3.5.7: Parallel trends	103
3.5.8: Exogeneity of Law.....	105
3.5.9: Concurrent policies.....	106
3.5.10: Goodman Bacon decomposition	106
3.5.11: Changes in demand vs changes in supply driving results	107
3.5.12: Multiple Hypothesis testing.....	107

3.6 Conclusion.....	108
Appendix	109
Clauses in the Child Rights Act.....	136
Nigeria National Immunization schedule.....	130
Chapter 4: Commodity prices and household food security	139
4.1 Introduction	139
4.2 Background and Data	142
4.2.1: Food and cassava production in Nigeria.....	142
4.2.2: Data	144
4.2.3: Household Survey Data	144
4.2.4: Price Data.....	146
4.3 Estimation Strategy	147
4.4 Results	149
4.4.1: Summary Statistics	149
4.4.2: Results	152
4.5 Robustness checks	155
4.6 Conclusion.....	158
Appendix	160
Chapter 5: General Conclusion	169
Bibliography	171

List of Figures

Chapter 2: Historical malaria burden and witchcraft beliefs in SSA

Figure 2.1: Share of respondents believing in witchcraft across SSA	29
Figure 2.2: Share of respondents believing in the evil eye across SSA	30
Figure 2.3: Historical malaria mortality and witchcraft beliefs across ethnic groups.....	35
Figure 2.4: Correlation between historical malaria mortality and witchcraft belief	36
Figure 2.5: Coefficient plot dropping one country at a time	55

Chapter 3: Child Rights, Traditions and Health Seeking behavior in Nigeria

Figure 3: States that passed the CRA and dates when it was passed	78
Figure 3.1: Fraction of children that received the first dose of each vaccine	124
Figure 3.2: Event study estimators	126
Figure 3.3: Composition and Evolution of treated states over time	130
Figure 3.4: Number of court cases and prison inmate population (prior-post)	131
Figure 3.5: Raw means of outcome variables as a function of age	132
Figure 3.6: Rambachan and Roth's breakdown value of parallel trends	132

Chapter 4: Commodity prices and Household food security

Figure 4.1: Cassava prices and survey windows	146
---	-----

List of Tables

Chapter 2: Historical malaria burden and witchcraft beliefs in SSA

Table 2: Summary statistics	31
Table 2.1: OLS estimates for malaria burden and witchcraft belief	41
Table 2.2: OLS estimates for malaria burden and witchcraft - additional individual controls	44
Table 2.3: OLS estimates for malaria burden and witchcraft - extended precolonial controls	48
Table 2.4: Logit estimates for malaria burden and witchcraft belief	51
Table 2.5: OLS estimates for malaria burden and other magical beliefs	52
Table 2.6: OLS estimates for malaria burden and witchcraft belief-heterogeneity	59
Table 2.7: OLS estimates for malaria burden and witchcraft belief-ethnicity level	60
Table 2.8: OLS estimates for malaria burden and general trust.....	61
Table 2.A1: Summary statistics (extended)	63
Table 2.A2: Belief in witchcraft & evil eye by country	64
Table 2.A3: Distribution of observations between PEW and Murdock ethnic groups	65

Chapter 3: Child Rights, Traditions and Health Seeking behavior in Nigeria

Table 3: Summary statistics at Child, Caretaker and Household level	80
Table 3.1: Effect of the CRA on Anthropometry	87
Table 3.2: Effect of the CRA on Anthropometry by Age Group	89
Table 3.3: Effect of the CRA on Anthropometry, Heterogeneity by Childs Gender	91
Table 3.4: Effect of the CRA on Vaccinations, full sample	93
Table 3.5: Effect of the CRA on Vaccinations, Heterogeneity by household wealth	95
Table 3.6: Effect of the CRA on Pre-natal care	98
Table 3.7: Effect of the CRA on Vaccinations and Anthropometry, Bootstrapped SE's ...	99
Table 3.8: Effect of the CRA on Anthropometry, Weighted regressions	101

Table 3.9: Effect of the CRA on Anthropometry, Mean reversion	102
Table 3.10: Effect of the CRA on Vaccinations and Anthropometry, Parallel trends	104
Table 3A.1: Effect of the CRA on Vaccinations, Bordering treated states	109
Table 3A.2: Effect of the CRA on Vaccinations, Southern states	110
Table 3A.3: Effect of the CRA on Nutrition	111
Table 3A.4: Effect of the CRA on Breastfeeding	112
Table 3A.5: Effect of the CRA on recent illnesses	113
Table 3A.6: Effect of the CRA on Vaccinations, Weighted regressions	114
Table 3A.7: Effect of the CRA on Vaccinations, Mean reversion	115
Table 3A.8: Bacon Decomposition: Anthropometry [Full sample]	116
Table 3A.9: Bacon Decomposition: Anthropometry [Bordering states]	117
Table 3A.10: Bacon Decomposition: Anthropometry [Southern states]	118
Table 3A.11: Effect of the CRA on Anthropometry- Sun and Abraham	119
Table 3A.12: Effect of the CRA on Height for Age- Dropping one state at a time	120
Table 3A.13: Can the CRA be predicted	121
Table 3A.14: Supply driven controls	122
Table 3A.15: Multiple Hypothesis testing using Romano-Wolf	123
Chapter 4: Commodity prices and household food security	
Table 4.1: Summary statistics at baseline	151
Table 4.2: Cassava prices and household food security	152
Table 4.3: Cassava prices and household food security, by wealth tercile	153
Table 4.4: Cassava prices and household food security, by producer/consumer status	154
Table 4.5: Cassava prices and household food security, Poisson and Fractional Probit ...	155
Table 4.6: Cassava prices and household food security, by HH diversification	156
Table 4.7: Cassava prices and household food security, HDDS 9	157
Table 4.8: Cassava prices and household food security, Inverse Probability Weights	158

Table 4A.1: Descriptives of attrition by wave	160
Table 4A.2: Linear model for attrition (pooled sample)	161
Table 4A.3: Linear model for attrition (by wave)	162
Table 4A.4: Producer/Consumer status vs Net buyer/seller status at baseline	163
Table 4A.5: Net Purchase quantity by wave for producers and consumers	163
Table 4A.6: Cassava prices and household food security, State level SE's	164
Table 4A.7: Cassava prices and household food security, by producer/consumer status..	165
Table 4A.8: Cassava prices and household food security, by producer/consumer status .	166

Chapter 1

General Introduction

This dissertation is a collection of three essays within Development Economics. Broadly it can be classified under two topics, the first being the origin of superstition and the role of policies to combat adverse social norms in developing countries and the second one on how rural farmers in developing countries are affected by changes in the prices of key dietary staples. All chapters have an empirical focus utilizing a wide variety of empirical approaches to answer the key research questions that the papers seek to investigate.

1.1: Historical malaria burden and witchcraft beliefs in SSA. *Joint with Andrea Guariso, Marijke Verpoorten and Elena Briones Alonso*

Witchcraft beliefs were thought to be a relic of the past, however recent work by Gershman (2022) has shown its prevalence at a global level in countries not normally associated with superstitious belief. Belief in witchcraft is not without consequence, it can have implications for groups which exhibit this belief in terms of their spending, the level of trust, their wellbeing and actions to deal with non-conforming members through accusations of witchcraft and pressure to redistribute surplus.

This chapter investigates the origin of such beliefs in Sub Saharan Africa by looking at the historical disease burden that ethnic groups in Africa were subject to due to Malaria. We focus on malaria which has been a major disease in historical and contemporary SSA due to the wide spread prevalence of the female *Anopheles* mosquito vector. To estimate the malaria-witchcraft relation, we combine survey data on self reported beliefs with ethnicity-level data on historical malaria mortality. The witchcraft data are taken from a survey conducted by the PEW Research Forum in 2008-2009 and record beliefs for 20,592 respondents across 17 countries in SSA. The historical malaria mortality measure is taken from Depetris- Chauvin and Weil (2016) and relies on estimates of the frequency of the sickle cell gene in a population, which results from the selective pressures exerted by malaria. These genetic data are used to calculate the historical probability of dying from malaria before reproductive age for a particular ethnic group. The general idea is that if a certain ethnic group was subject to an environment with a heavy malaria burden, they possess the sickle cell mutation which affords them some protection against malaria but also informs us about the severity of malaria that their ancestors were exposed to.

We find that a one standard deviation increase in historical malaria mortality is associated with an increase of individual level witchcraft beliefs by about 3 to 8 percentage points. This result is robust to the use of various estimation strategies and to the inclusion of individual, regional and ethnicity-level control variables. The positive disease-witchcraft correlation is consistent with direct psychological and economic mechanisms derived from different strands of literature. The psychological channels involve the idea that witchcraft beliefs meet a psychological need to find explanations or scapegoats for misfortune in the form of disease. The economic channels state that witchcraft beliefs strengthen resilience in the face of disease risk by instilling and enforcing strong norms of solidarity through social control and through simple mutual redistribution mechanisms via witchcraft accusations against well off members of society forcing them to share their surplus (Posner, 1980). We attempt to distill some empirical insights into the relevance of these mechanisms by conducting a comparative analysis of other types of magical beliefs, such as angels and spirits, and beliefs related to protection against misfortune. Our findings indicate that the disease-belief relation only arises for beliefs that relate to misfortune caused by human agency, namely witchcraft and the evil eye. We conclude that what matters is not the need to merely explain misfortune, but rather the need to obtain visible control over the (perceived) causes of misfortune or the need to mitigate its economic impact.

This paper considers a topic which is understudied in Development Economics by testing a hypothesis rooted in cultural evolutionary theory. To the best of our knowledge there is to date limited empirical evidence in support of such a relationship. The aim of this study is to contribute to filling this gap by quantitatively investigating the relation between long-run disease burden and contemporary witchcraft beliefs across countries and ethnic groups in SSA.

1.2: Child Rights, Traditions and Health Seeking behaviour in Nigeria

The prevalence of social norms in a society can lead to a general equilibrium which has negative effects on the weakest members in a society. This paper investigates if the tension between legal frameworks and social traditions can be overcome by policy makers in a society where (negative) social traditions are challenging to influence.

I investigate if the effect of granting formal legal protection to children improved investments in children by exploiting a natural experiment. In 2003, the central legislature in Nigeria, Abuja

legislated and passed an ambitious act known as the Child Rights Act (CRA). It regulated the behaviour of parents towards their children by guaranteeing protection for children against mistreatment and abuse in variety of different contexts such as providing adequate healthcare. Parents can be subjected to strict actions which can be limited to fines or can result in more extreme outcomes such as a prison sentence or some form of corporal punishment. Nigeria has one of the highest rates of negligence and violence towards children in sub-Saharan Africa, 6 out of 10 children in Nigeria experience some form of negligence or violence and Nigeria also has one of the highest rates of child labour in the world. Extreme manifestations of negligence and violence against children are the occurrence of Child Marriages, the practice of Female Genital Mutilation & accusations of Child Witches. I estimate the effect of the CRA on proxies for investments in children such as their anthropometry, their vaccination status and other measures of child care. I also consider second order effects on the health of the mother in terms of prenatal care, care for infectious disease in pregnancy and the birthweight of the child. To begin with I use a difference in differences approach that compares over time the children born in the states where the law changed to children born in the same state prior to the law change and children born in the states where the law did not change at all. To address concerns that the difference in differences estimates are not confounded by social, political or religious changes, I limit the comparison of children which were affected by the policy change to children born prior to the policy change in the same states. The advantage of this specification is that children born in these (southern) states are likely to experience the same socio-political forces. As an additional exercise, I consider only the bordering states to the northern control states as being the treated group, focusing on individuals living in bordering states and born a few years apart allows me to compare the behaviour of individuals living in a similar environment. Since the CRA regulates many different aspects of a parent's behaviour towards children, I examine its effect on different aspects of family welfare. First, I investigate the effect on the anthropometry of the child, my hypothesis being that children born under the protection of the CRA are taken better care of by their parents which should be reflected in their weight and height. Estimates from three rounds (2018, 2013 & 2008) of the Nigerian Demographic Health Survey (DHS) show that the children born under the new policy have a positive Z score gap of 0.25σ to 0.5σ (depending on the specification) for their height relative to their age. This positive score represents an improvement in the long-term wellbeing of children under 5. The reduction in stunting applies to all age groups under 5. I investigate the channels for this positive result by considering dimensions of care such as the duration of breastfeeding, how soon a child is put to the breast and dietary diversity of children and find no positive effect of the policy on

those dimensions. However, when looking at the effect of the policy on the birth weight of children, I find the CRA resulted in newborns with higher birth weights ranging from 0.11Kg to 0.18 Kg (depending on the specification), these effects are statistically significant. The main mechanism that I propose is the following. When the CRA came into effect, it created an environment whereby parents took better care of their existing children but also of expectant children by created disincentives against mistreating their children and thus risking fines and/or imprisonment. The effect of the CRA could be driven by the demand or supply of healthcare, I test whether the results are robust to inclusion of controls for the supply of health services such as the number of vaccination campaigns and distance to the nearest health facility. The results confirm this hypothesis as the findings are robust to the inclusion of supply driven controls. The core results are robust to the staggered rollout of the CRA and numerous other sensitivity tests.

The contribution this paper makes to the literature is to investigate the effects of secular laws on protecting children through effects on their health, the current literature is inconclusive about the effects of legal protection on children. It may be that granting legal protection to children may have unintended negative effects and backfire in an environment where the prevalent social norms are embedded and thus hard to influence. Basu (2018) and Acemoglu and Jackson (2017) demonstrate this result in a theoretical framework and Britto and Ulkuer (2012) and White (2002) demonstrate this finding empirically. Therefore, this paper contributes to the empirical literature on child protection in low-income settings with adverse social norms.

1.3: Commodity Prices and Household food security: Evidence from Nigeria

Africa is home to a third of the worlds undernourished population (Carvalho, 2021). 346 million people in Africa are severely food insecure (Boye at al, 2022), 50 million of which require emergency aid annually, Sub-Saharan Africa (SSA) receives the most food aid globally and 60% of the World Food Program's active programs are focused on Africa (Aboboa, 2021). Households in Developing Countries are subject to numerous risks which can adversely affect their welfare. The effect of food price changes on household food security hence remains an important topic of inquiry.

This paper investigates the relationship between price changes and household food security. The key questions it seeks to answer are (1) Do food price fluctuations lead to changes in household food security, (2) Does the impact of price changes vary by household characteristics such as the wealth level of a household or its status as a producer or consumer of the commodity.

To investigate these questions, I use a panel of households in Nigeria from 2010 to 2016 combined with historical price data. I focus on Domestic and International Cassava prices, Cassava is a dietary staple in Nigeria, 7 out of 10 Nigerians consume cassava at least once a day (Njoku and Muoneke, 2008). I use two measures of household food security: (1) The Household Diversity Score (HDDS) and (2) The food share of a household's expenditure on food. My primary estimation model is Ordinary Least Squares (OLS); however, I use alternative models such as the Poisson and a fractional probit. I find that an increase in the price of imported cassava is negatively associated with household food security measures and the effect varies depending on the wealth classification of a household, at baseline households which are classified as being wealthy are impacted by imported cassava prices more than poor and medium wealth households as measured by the Household Diversity Score (HDDS), while imported cassava prices impact the average (medium) wealthy households the most as measured by the share of food expenditure. These empirical results are consistent with the predictions of the theoretical models of Engel and Bennett's price increase impacts on households.

Both Producers and consumers see an increase in food insecurity due to an increase in the price of domestic and imported cassava, the effect is stronger for consumers but demonstrates an increase in food insecurity for cassava producing households providing evidence of food insecurity due to higher prices of domestic and imported cassava. The findings for household food security echo the findings on household food security as measured by the number of lean months (Bacon et al, 2017; Morris et al, 2013) and self-reported measures of annual food scarcity (Rogan & Reynolds, 2017). It is important to note that making causal claims in relation to price changes is difficult because unobservable factors may be correlated with both household food security and cassava prices, while I include various controls on observable factors, time varying unobservable factors such as global macroeconomic shocks, trade frictions and financial crisis may impact household's differently (Wooldridge, 2010). Therefore, the estimates in this paper should be seen as conditional correlations rather than causal estimates.

This study contributes to a few different strands of literature. First, it contributes to the growing literature of commodity price pass throughs to consumers and producers due to an increase in integration of global supply chains (Goldberg and Pavcnik, 2007). Importantly, as supply chains are not constrained by national boundaries, changes in global conditions can have important consequences at a local level. This study uses commodity by-product prices which is novel to the existing literature on commodity price pass through, the existing literature relies on the raw material prices as a source of exogenous variation. In situations where using the raw commodity price is unfeasible due to the perishable nature of the commodity, the use of by-product prices is an alternative way to capture changes in the price of import and export commodities conditional on its passthrough to households. Second, this study considers farmers which plant crops primarily for consumption as an important source of food intake and contributes to the debate around “hungry farmers” in developing countries (Bacon et al, 2014). Lastly, this study contributes to the effect of food price changes on Net food importers (See for example; Blom et al, 2021 and Kebede, 2020). Nigeria is a particularly suitable context for this study given its high levels of food insecurity and economic volatility due to its dependence on oil exports. The country continues to experience a turbulent exchange rate regime, high levels of conflict and political instability, low agricultural productivity, instability in food prices, and abrupt policy changes (Shittu et al., 2021).

Chapter 2: Historical Malaria Burden and Present-day Witchcraft beliefs

2.1 Introduction

Culturally embedded beliefs affect economic and institutional change and explain the persistence of different development paths (Alesina and Giuliano, 2015; Gorodnichenko and Roland, 2010; Mokyr, 2014). Gaining a proper understanding of how humans form their beliefs is therefore key to understanding economic development patterns and is “*fundamental to a new social science*” (North, 2008:1005).

Some belief systems have sparked extensive interest among economists, while others remain largely unexplored and poorly understood. For instance, a growing body of research has produced important insights into the economic origins and drivers of the world’s dominant religions (e.g. Iannaccone, 1998; Michalopoulos et al., 2012). In contrast, economic literature on the roots and dynamics of other globally prevalent belief systems, such as ancestral worship or witchcraft, is still in its infancy (see for e.g. Gershman, 2022).

We contribute to this line of research by studying the long-run drivers of present-day witchcraft beliefs in sub-Saharan Africa (SSA). ‘Witchcraft’ is used to denote a complex set of magical beliefs about the use of occult forces by humans¹ (Geschiere, 2011). These beliefs appear around the world, but remain especially powerful in SSA, where they are said to have a profound influence on economic life (e.g. D’Angelo, 2014; Leistner, 2014; Platteau, 2014). Although witchcraft beliefs and practices take a variety of forms across cultural groups, and their specifics depend on local contexts, there are cross-cultural similarities within and beyond SSA (Koning, 2013; Leistner, 2014). These similarities are the key factor motivating our analysis, as they suggest the existence of cross-cultural drivers of witchcraft beliefs.

The driver we focus on is historical disease burden. We investigate the hypothesis that the historical disease burden explains cross-cultural variation in the prevalence of witchcraft beliefs. This hypothesis is informed by work in various disciplines that has associated cultural differences and evolution with the disease environment (e.g. Fincher et al., 2008; Inglehart, 2016; McNeill, 1976; Thornhill et al., 2009; Webb, 2006). In particular, a heavy infectious disease burden has been empirically associated with collectivistic or embedded cultures (Fincher et al., 2008; Thornhill et al., 2009). The fact that witchcraft beliefs are associated with collectivistic cultures (Gershman 2022 & Platteau, 2014) already hints at a possible relation with the disease

¹ In this study witchcraft and evil eye denote beliefs which involve human agency causing misfortune. Any reference to witchcraft should be viewed as synonymous with the belief in the evil eye, following Gershman (2016, 2022).

environment. Several strands of research substantiate this link by identifying specific psychological and economic mechanisms through which a heavy disease burden can promote witchcraft beliefs (e.g. Keinan, 2002; Leistner, 2014; Miguel, 2005; Platteau, 2014).

However, to the best of our knowledge there is to date limited empirical evidence in support of such a relationship (see for example, Gershman 2022). The aim of this study is to contribute to filling this gap by quantitatively investigating the relation between long-run disease burden and contemporary witchcraft beliefs across countries and ethnic groups in SSA. We focus on the long-run burden of malaria, which is one of the major diseases in historical and contemporary SSA.

To estimate the malaria-witchcraft relation, we combine survey data on self-reported beliefs with ethnicity-level data on historical malaria mortality. The witchcraft and evil eye data are taken from a survey conducted by the PEW Research Forum in 2008-2009 and record beliefs for 20,592 respondents across 17 countries in SSA (Pew Research Centre, 2009). Overall, 53% of respondents report belief in witchcraft, with important cross-ethnic and cross-country variation. The historical malaria mortality measure is taken from Depetris-Chauvin and Weil (2016) and relies on estimates of the frequency of the sickle cell gene in a population, which results from the selective pressures exerted by malaria. These genetic data are used to calculate the historical probability of dying from malaria before reproductive age for a particular ethnic group.

We find that a one standard deviation increase in historical malaria mortality is associated with an increase of individual level witchcraft beliefs by about 3 to 8 percentage points. This result is robust to the use of various estimation strategies and to the inclusion of individual, regional and ethnicity-level control variables.

The control vectors serve to rule out alternative channels that may drive a positive relation between malaria burden and witchcraft beliefs. For instance, malaria had important effects on historical African settlement patterns (e.g. Webb, 2006) and colonizer settlement (Flückiger and Ludwig, 2017), which could affect witchcraft beliefs today through their impact on economic development. Yet, we cannot fully exclude the possibility that the location of ethnic groups, and thus our measure of historical malaria mortality, is associated with unobserved group-level characteristics that also affect witchcraft beliefs. Our finding should therefore not be interpreted as causal evidence, but as a robust conditional correlation.

The positive disease-witchcraft correlation is in any case consistent with direct psychological and economic mechanisms derived from different strands of literature. The psychological channels involve the idea that witchcraft beliefs meet a psychological need to find

explanations or scapegoats for misfortune in the form of disease. The economic channels state that witchcraft beliefs strengthen resilience in the face of disease risk by instilling and enforcing strong norms of solidarity through social control and through simple mutual redistribution mechanisms via witchcraft accusations against well off members of society forcing them to share their surplus (Posner, 1980). Experimental evidence from Hadnes and Schumacher (2012) confirm this finding, however Le Rossignol et al. (2021) find the opposite effect, that those who hold strong traditional beliefs tend to receive less pro-social behavior from others even when they themselves hold traditional beliefs.

We attempt to distill some empirical insights into the relevance of these mechanisms by conducting a comparative analysis of other types of magical beliefs, such as angels and spirits, and beliefs related to protection against misfortune. Our findings indicate that the disease-belief relation only arises for beliefs that relate to misfortune caused by human agency, namely witchcraft and the evil eye. We conclude that what matters is not the need to merely explain misfortune, but rather the need to obtain visible control over the (perceived) causes of misfortune or the need to mitigate its economic impact.

The next section (2.2) discusses witchcraft beliefs in SSA and how they may relate to the disease environment. Section 2.3 describes our key measures of witchcraft belief and historical malaria mortality. Section 2.4 presents the estimation framework and results, Section 2.5 addresses various alternative explanations for our baseline result, Section 2.6 discusses reverse causality, in Section 2.7 we present robustness checks, Section 2.8 presents additional analysis and Section 2.9 concludes.

2.2 Background and hypotheses

2.2.1 Witchcraft in SSA

Witchcraft is a notion riddled with definitional and conceptual controversy, as aptly described by Geschiere (2011: 233):

“Witchcraft’ (like ‘sorcery,’ ‘magic,’ ‘sorcellerie,’ etc.) is a precarious translation – especially because of the pejorative implications of this Western notion – of African terms that often have much broader implications and might therefore be better translated by a more neutral term like ‘occult force’ or even ‘special kind of energy.’ However, these Western terms have been so generally appropriated by the African public that it has become impossible to ignore or even avoid them.”

In this study we will use the term ‘witchcraft’ as an abstraction to indicate a complex series of beliefs regarding the use of occult powers by humans (for doing good or doing harm) (Gersham 2016; Leistner, 2014; Thornton, 2003).

Anthropologists have a long tradition of studying witchcraft, observing its omnipresence and importance in African societies as an integral part of religious, political, economic, and community life (e.g. Comaroff and Comaroff, 1999; Evans-Pritchard, 1937; Mbiti, 1990). The past decades have seen a renewed interest in the study of witchcraft, with various scholars noting that witchcraft beliefs remain as powerful as ever in African societies and may even be growing in importance (Geschiere, 1997; Kohnert, 2007; Koning, 2013; Leistner, 2014; Platteau, 2014). Cross-country surveys corroborate this observation, finding that about 53% of the surveyed population across various countries in SSA reports to believe in witchcraft or the evil eye (Gallup World Poll, 2009; Pew Research Centre, 2009). Belief in witchcraft is not limited to SSA, a new global dataset created by Gersham (2022) finds for 95 countries, 40% of individuals report belief in witchcraft which corresponds to close to billion followers globally.

Witchcraft is widely argued to have a profound influence on economic life in SSA through its effect on public and private decision-making (e.g. Comaroff and Comaroff, 1999; D’Angelo, 2014; Kohnert, 1996; Leistner, 2014; Platteau, 2014). Recent studies by Gersham (2023, 2020 and 2016) find that witchcraft beliefs affect trust and subjective well being negatively and are more prevalent in ethnic groups which had a high degree of exposure to the slave trade. LeMay-Boucher et al. (2013) show that households in Cotonou, Benin, spend a significant income share on protection against occult forces.

Gershman (2015) argues for evil eye beliefs as a culturally evolved mechanism for reducing conspicuous consumption and status signaling under conditions that incentivize destructive competition. The evil eye belief is the general idea that individuals can have a negative effect on other humans through envious glances at their property/status. In the PEW survey, the evil eye question is worded as “certain people can cast curses or spells that cause bad things to happen to someone.” due to the way the question is framed, there is nothing to distinguish it from how witchcraft is defined in the anthropological literature. Therefore, our measure of belief in witchcraft includes the evil eye as well, following Gershman (2016).

Given the continued vitality of witchcraft beliefs and their proposed effects on (economic) life, it becomes important to understand why these beliefs exist and persist. A small but growing body of work on witchcraft has aimed to shed light on this question by studying its historical and contemporary drivers (e.g. Comaroff and Comaroff, 1999; Geschiere, 1997;

2011; Koning, 2013; Nunn and Sanchez de la Sierra, 2017; Oster, 2004; Shaw, 1997; Thornton, 2003; van de Grijsparde et al., 2013).²

In this study we focus on the historical side, hypothesizing that groups exposed to a higher disease burden in the long run are more likely to hold witchcraft beliefs today. Our hypothesis is rooted in the general observation that various psychosocial behaviors among human populations are evolved mechanisms to protect against disease (Chiao and Blizinsky, 2010; Fincher et al., 2008; McNeill, 1976; Thornhill et al., 2009). For the specific case of witchcraft beliefs, several psychological and economic mechanisms can explain why they may have emerged and persisted in response to a heavy disease burden.

2.2.2 Psychological mechanisms

Anthropologists have long argued that witchcraft beliefs provide a framework for explaining misfortune – especially death and disease (Foster, 1976; Green, 1999; Liddell et al., 2005; Maslove et al., 2009).³ Foster (1976: 775) for instance categorizes most medical systems in SSA as mainly ‘personalistic’, where disease is explained as “*due to the active, purposeful intervention of an agent, who may be human (a witch or sorcerer), nonhuman (a ghost, an ancestor, an evil spirit), or supernatural (a deity or other very powerful being).*”

Psychological and evolutionary research has identified a cognitive underpinning for this anthropological observation. Humans have a strong psychological motivation to understand, predict, and control their environments, evidenced by the fact that undermining perceived control can have important negative effects on psychological and physical well-being (Case et al., 2004; Keinan, 2002). Evolved psychological predispositions of the human brain, such as the search for intentionality and human attributes, as well as easy recall of supernatural concepts, have resulted in a strong tendency to rely on supernatural human-like entities for explaining salient misfortune such as disease (Beck and Forstmeier, 2007; Boyer, 2003). ‘Witches’, as

² There is an important distinction between witchcraft beliefs and witch trials or killings. The latter have been studied by economists in various works, and can be seen as (extreme) outcomes of witch beliefs following particular shocks, such as extreme rainfall (Miguel, 2005; Oster, 2004). Hence, we expect their dynamics to be different: a rise in witch killings must not necessarily imply an increase or strengthening of witch beliefs, and the absence of witch trials or killings should not be interpreted as the absence or weakness of witch beliefs. As we are interested in long-run dynamics, it is more appropriate to study the underlying beliefs rather than shock-driven outcomes such as witch killings. In addition, even actual accusations of witchcraft generally do not produce such extreme outcomes as witch killings. Studying the latter would thus entail an inevitably narrow perspective on a much broader phenomenon.

³ Witchcraft tends to explain not the biological side of disease contraction (‘how did I become ill?’), but the ultimate reason for the occurrence or persistence of illness (‘why did I become ill/do I remain ill?’) (Liddell et al., 2005; O’Neill et al., 2015). In a Tanzanian case study, Muela et al. (1998) for instance describe how the community explains malaria infections by mosquito-transmitted parasites, but also believes that witches are able to make parasites invisible in the blood, so that the disease is not detected in a hospital, or to provoke the same symptoms as malaria during an attack to camouflage it and thereby gain more time to harm the victim.

human agents that possess supernatural powers, are especially compatible with these psychological predispositions.⁴

A closely related argument stems from scapegoat theory and posits that individuals and groups have a psychological tendency to assign unmerited blame for misfortune to others, either in a process of displaced anger and frustration or as a way of diverting attention from the true underlying cause of misfortune (Jensen, 2007). Studies of witch hunts in Europe often mention scapegoating as one of the explanations, and Oster (2004) relies on the scapegoat argument to explain a positive empirical relation between food shortages and the upsurge of witch trials in Medieval Europe. Leeson and Russ (2017) in contrast find that competition for religious market share in confessionally contested areas performs considerably better in predicting European witch hunts than temperature-induced food shortages.

2.2.3 Economic mechanisms

Next to meeting psychological needs, witchcraft beliefs may contribute to the survival of a community by strengthening the group's ability to deal with the negative economic effects of disease.

Witchcraft beliefs can serve as a way to instill and enforce strong in-group solidarity. Although stringent solidarity norms can be economically costly by limiting growth and dynamic efficiency, under conditions of high risk and income uncertainty they can promote the static efficiency and resilience of a community (Gorodnichenko and Roland, 2010; Platteau, 2014). Thus, in areas with high disease risk, more powerful witchcraft beliefs could have made communities better equipped to survive by boosting in-group solidarity. In his work on pre-industrial societies in West-Africa, Vansina, (2012: 318) aptly describes this mechanism:

“the ultimate effect of this set of [witchcraft] beliefs was to provide the very foundation of their celebrated solidarity within kingroups and/or local community groups, without which the existence of such groups could not have been sustained for very long. Indeed, both the fear of being accused and the need to stick together to guard against the attacks of witches created this solidarity and kept it alive. Consequently, belief in witchcraft actually undergirded the social basis of kinship and community.”

⁴ Leistner (2014:55-57) for instance writes: “In its broadest sense, witchcraft is an attempt to make sense of, and deal with, the afflictions of a world dominated by unpredictable occult forces, and to secure an agreeable personal and social life. ... People naturally want to understand the reasons for the hardships and disasters they have to suffer. ... where common-sense explanations fail, invisible forces are seen to be at work.”

This aspect of witchcraft beliefs is still relevant today. In particular, community members who violate sharing norms, thereby threatening the network of solidarity relations, face the risk of being accused of witchcraft (Geschiere, 1997; Platteau, 2014). The far-reaching strategies undertaken by those who want to escape solidarity obligations – wealth concealment at significant cost, religious conversion, or even migration (Platteau, 2014) – is testimony to the strength of solidarity norms and the fear of being accused of witchcraft. Platteau (2014) thus identifies witchcraft as an external enforcement strategy that complements the ever-imperfect internalization of solidarity norms and the associated values.

Yet, witchcraft beliefs may also contribute to the internalization process itself. Historians and anthropologists often emphasize the nature of witchcraft beliefs as an ethical discourse, where witches are associated with selfishness, greed, and individualism – as opposed to solidarity, other-regarding values, and collectivism (e.g. Geschiere, 1997; Leistner, 2014; Shaw, 1997; Thornton, 2003; Vansina, 2012).⁵ Indeed, a salient element of present-day witchcraft beliefs across cultures is the idea that witches use their occult powers to accumulate private wealth, and that they can only garner sufficient power by taking the life force of others through human sacrifice (Geschiere, 2013; Leistner, 2014; Stoop and Verpoorten, mimeo).

Empirical research offers indirect supportive evidence for this economic mechanism, finding that areas with a heavy infectious disease burden are more likely to be inhabited by collectivistic cultures (Fincher et al., 2008; Thornhill et al., 2009, Gresham 2021). One of the main explanations for this finding is that human evolution positively selected for strong in-group solidarity (or ‘parochial altruism’) in high disease environments, because it allows communities to better manage the negative effects of morbidity and mortality (Fincher et al., 2008; Henrich, 2004; Hruschka and Henrich, 2013). The widely replicated anthropological observation that witchcraft accusations are generally targeted to members of one’s intimate circle, such as neighbors and kin (e.g. Geschiere, 2013), fits well with a key role of in-group solidarity.

⁵ Thornton (2003:282) offers the following telling example: *“Merchants of any race or nationality were especially vulnerable to the charge of being witches because the necessarily individualistic behavior of merchants in the face of a folk ethic of sharing and community service could easily be seen as greed, the root of witchcraft.”* Another illustrative element of witchcraft discourse is the fact that witchcraft represents not simply a danger to individuals, but a fundamental threat to the survival of the community (Leistner, 2014).

2.3 Data sources and description

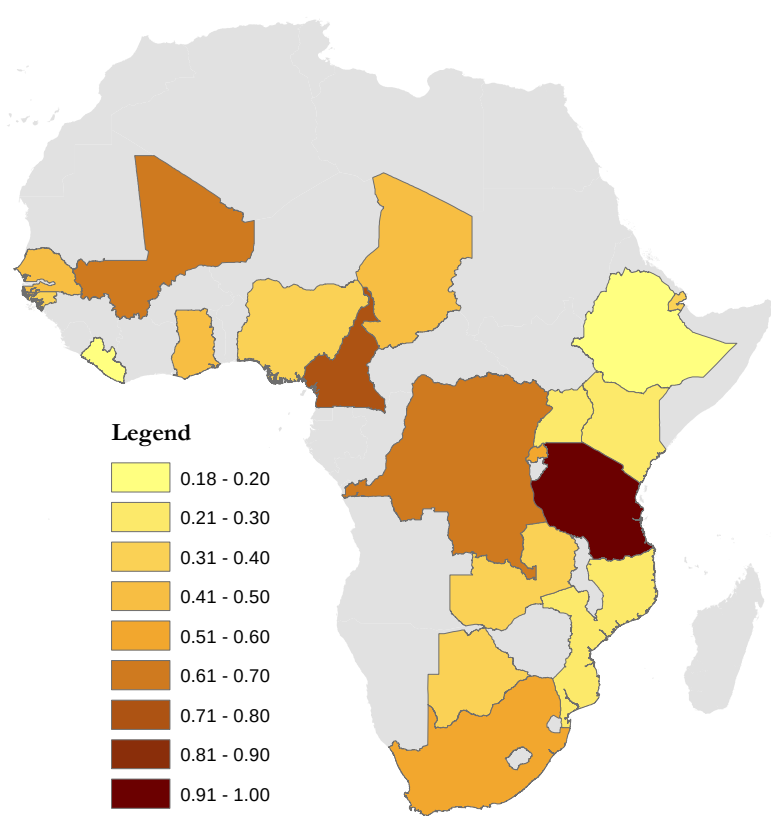
2.3.1 Witchcraft beliefs

We take our main data on witchcraft beliefs from surveys conducted by the PEW Research Forum between December 2008 and April 2009 among 25,091 respondents across 19 countries in SSA (Pew Research Centre, 2009). The surveys interviewed between 1,000 to 1,500 persons per country in nationwide samples and collected individual-level information on a wide range of cultural and religious beliefs and practices. Beliefs were recorded as *yes* or *no* answers to the question ‘*Which, if any, of the following do you believe in?*’ followed by various categories such as *witchcraft, the evil eye, evil spirits, heaven, hell, and angels*.

Witchcraft and the evil eye are similar beliefs in the sense that they both involve a human causing harm through occult forces. As such, one could argue that the evil eye belief is also compatible with the psychological and economic mechanisms outlined in the previous section. In the PEW survey, the question in relation to the evil eye asks whether a respondent believes in the “evil eye,” or that “certain people can cast curses or spells that cause bad things to happen to someone.” This makes the evil eye belief virtually in-distinguishable for the belief in witchcraft. Following the convention by Gersham (2016) we merge these questions to give a joint measure of belief in witchcraft and the evil eye.

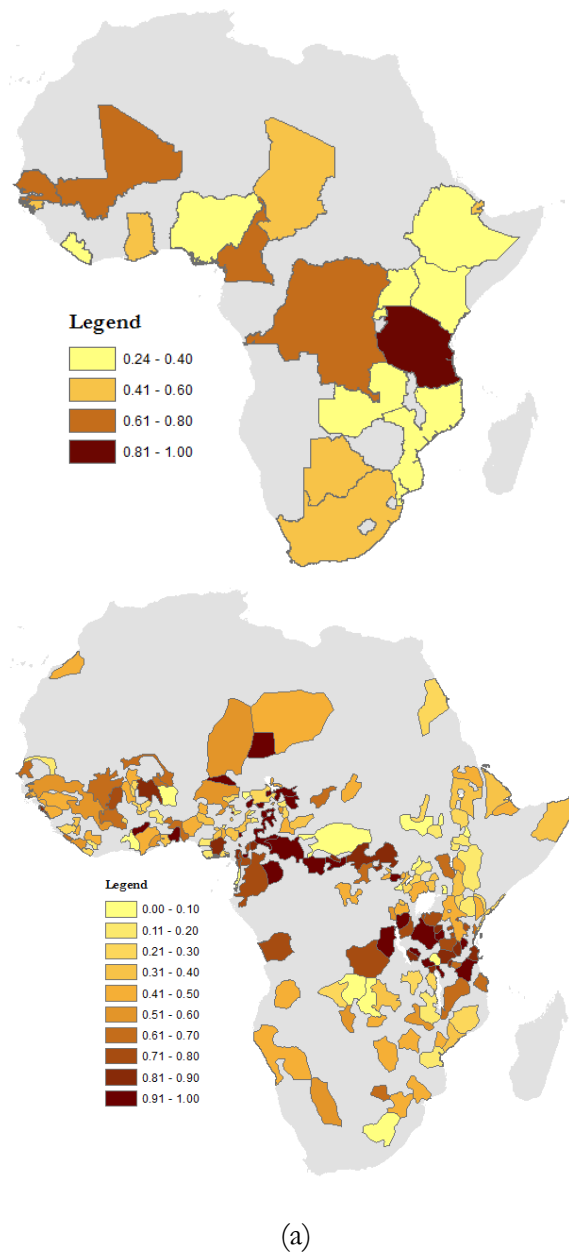
Figures 2.1 & 2.2 shows the share of respondents reporting to believe in witchcraft and the evil eye for each country in the PEW survey. There is considerable variation across countries, from 31 % in Ethiopia to 96 % in Tanzania. Overall, 53 % of our sample reports to believe in witchcraft or the evil eye.

Figure 2.1: Share of respondents reporting to believe in witchcraft across surveyed countries.



Note: This figure shows all countries included in the original PEW survey.

Figure 2.2: Share of respondents reporting to believe in the evil eye across surveyed countries (a) and ethnic groups (b).



Note: Panel (a) shows all countries included in the original PEW survey.

Table 2 compares selected socio-economic characteristics for individuals who report to believe in witchcraft and those who report not to. Believers in witchcraft are older, less

educated, worse off economically and more likely to be ethnoreligionist (following an ancestral, tribal, animistic, or other traditional African religion).⁶

Table 2: Descriptive statistics for selected individual characteristics in full sample, by self-reported belief in witchcraft & evil eye

Variable	Belief in witchcraft & evil eye		Difference	Full sample	N
	Yes	No			
Basic Individual Controls:					
Age	34.40	32.50	1.6***	33.40	20022
Female	0.53	0.53	0.01	0.54	20150
Extended Individual Controls:					
Rural residence	0.61	0.60	0.01	0.61	20150
Completed primary education or less	0.43	0.33	0.10***	0.39	19787
Completed secondary education (or part)	0.38	0.44	0.06***	0.41	19787
Post-secondary education	0.17	0.22	0.04***	0.19	19787
Christian religion	0.57	0.61	0.04***	0.59	20054
Muslim religion	0.37	0.37	0.01	0.37	20054
Traditional religion	0.03	0.02	0.03***	0.02	20054
Self-reported economic situation somewhat or very bad	0.43	0.50	0.06***	0.47	19990
Self-reported money shortages in past year	0.65	0.69	0.04***	0.67	19990
Economic development controls					
Absolute Latitude	9.18	9.66	-	9.40	20150
Mean Land Suitability	4.10	4.20	-	4.15	20096
Area of Ethnic Homeland on Murdock Map	57732	57807	-	57766	20150
Mean Altitude	0.37	0.40	-	0.39	20037
Access to River	0.71	0.72	-	0.72	20037
Distance from Murdock homeland to nearest point on the coast	477929	473206	-	475760	20150
Distance from Murdock homeland to nearest water body	137711	139710	-	138629	20150
Religion controls					

⁶ Among ethnoreligionists, 84 % reports to believe in witchcraft & the evil eye, but this group makes up only 1.6 % of the sample (compared to an estimated 9 % of the population according to the World Religion Database (2015)). As the PEW survey targeted Christians and Muslims, ethnoreligionists are presumably underrepresented.

Christian Missions per 1000 Sq km in Murdock homeland	0.01	0.01	-	0.01	20150
Climate controls					
Mean Annual Precipitation on ethnic homeland	7.48	6.40	-	7.14	20150
Mean annual temperature on ethnic homeland	4.62	4.33	-	4.48	20150
Mean SD of Annual Precipitation	0.03	0.03	-	0.03	20150
Mean SD of Annual temperature	0.05	0.06	-	0.06	20150
Mean SD in suitability of Agriculture for Murdock homeland	1.51	1.51	-	1.51	19951
Mean Daily Humidity	57.45	57.40	-	57.40	20037
Mean Daily Temperature	24.65	24.43	-	24.55	20037
Humidity*Temperature	1392	1381	-	1387	20037
TseTse suitability index	0.09	-0.03	-	0.04	20037
Precolonial settlement					
Settlement patterns of ethnicity from EA	5.70	5.40	-	5.60	19085
Precolonial centralization					
Political centralization of ethnicity from EA	0.59	0.57	-	0.58	18401
Population density					
Log of population density of ethnic homeland	2.30	2.43	-	2.35	16329
City in 1800	0.14	0.13	-	0.13	20033
Agro-pastoralism					
High dependence on Agriculture or Pastoralism	0.38	0.38	-	0.38	20037
European settlement controls					
Historic contact with European explorer	0.56	0.52	-	0.54	12739
Historic integration into Colonial Railway network	0.36	0.39	-	0.37	12739
Slave trade					
Slave exports from ethnic homeland	0.48	0.41	-	0.45	20001
Trust					
Self reported measure of trust in other people	0.58	0.71	-	0.64	19682
Self reported measure of trust in people from other religion	0.52	0.52	-	0.52	19002
Regional Controls					
Mean ruggedness	0.58	0.68	-	0.63	20150
Mean lights per capita	0.001	0.001	-	0.001	20150
Total ACLED events	1.23	1.83	-	1.51	20150
Ethnolinguistic Fractionalization Index	0.59	0.54	-	0.57	20150

Notes: The first two columns show the average for age and shares for dummy variables for each group. The third column shows the difference between the first two columns along with significance values for tests of differences in proportions or differences in means (for age). The fourth column shows the means and shares for the full sample *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

Using self-reported data raises the issue that people may not be willing to openly profess their belief in witchcraft, which could result in underestimations of true beliefs. Although the number of people refusing to answer is low for most countries (2%) (Table 2A.2 in Appendix 2A), respondents may give false negative answers for various reasons (e.g. Leistner, 2014). By analyzing beliefs within countries only, we account for sources of measurement error that

operate at the country level, such as colonial history and anti-witchcraft policies. This leaves us with sources of measurement error operating across ethnic groups within countries, such as the social acceptability of talking openly about witchcraft. To the extent that cross-ethnic measurement error is determined by (pre)colonial European influence, patterns of economic development, the embeddedness in traditional culture, the presence of conflict, the legacy of slavery or the influence of Islam and Christianity, our individual, regional and ethnicity-level control vectors will account for it. As for issues of different translations of witchcraft across ethnic groups, an average 60 % of interviews per sample country were conducted in the same language, and 45 % of interviews were conducted in European languages, whose translations for witchcraft have been widely adopted by the African public (Geschiere, 2011).

2.3.2 Long-run disease burden

As the proposed links between disease burden and witchcraft beliefs run through morbidity and mortality effects, our empirical exercise would ideally rely on a measure of disease-related long-run morbidity and mortality. Since such a comprehensive measure does not exist, we rely on a measure developed by Depetris-Chauvin and Weil (2016) that provides the closest approximation available: historical malaria mortality.

This measure infers the historical mortality burden of malaria from data on the prevalence of the sickle cell gene, which is the most important and widespread genetic polymorphism that protects against malaria infections in SSA (Carter and Mendis, 2002).⁷ The long-run selective pressures of malaria are therefore reflected in the prevalence of the sickle cell gene in a population.

To construct their measure, Depetris-Chauvin and Weil (2016) rely on a geo-database of sickle cell gene frequencies from Piel et al. (2010). These frequencies are calculated from blood sample surveys of populations that are representative of the indigenous population in a particular location. Combining the sickle cell gene data with a genetic transmission model, the authors derive the historical malaria mortality rate for over 800 ethnic groups across Africa. The resulting measure is interpreted as the estimated proportion of individuals that would have died

⁷ Receiving this gene from both parents causes sickle cell disease, which results in premature death in the absence of modern medical care. Receiving the gene from just one parent instead confers a significant level of protection against malaria (see Depetris-Chauvin and Weil (2016) for an extensive discussion). Although malaria mortality rates among adults are lowered through such protective genetic polymorphisms, as well as acquired functional immunity, morbidity and mortality can still have significant psychological and economic consequences. Mortality rates among young children and pregnant women are high; most adults experience some morbidity shocks with possibly severe complications; malaria infection increases vulnerability to a host of other diseases and health problems; and severe infections can leave survivors with permanent cognitive or physical disabilities (Carter and Mendis, 2002; Snow and Omumbo, 2006). These morbidity and mortality effects create several types of economic costs, including opportunity costs of lost labor and the costs of anticipatory coping strategies such as adjusted agricultural practices (Asenso-Okyere et al., 2011; Chima et al., 2003).

of malaria (through malaria itself or sickle cell disease) before reproductive age, conditional on not dying of something else. This proportion is on average 6 % for ethnic homelands in SSA, but shows high cross-ethnic variation from a low of 0 % to a high of 15 %.

Historical malaria mortality is a better approximation of the long-run malaria burden than contemporary malaria morbidity and mortality for several reasons. Most importantly, the contemporary malaria burden is strongly determined by recent socio-economic development (Asenso-Okyere et al., 2011; Gething et al., 2010; McCann, 2011) and may be influenced by changing climatic conditions since the mid-20th century (Alsan, 2015; Béguin et al., 2011). Such recent changes do not affect the historical malaria mortality measure.⁸

A disadvantage of the historical measure is that it may suffer from larger measurement error. Although Piel et al. (2010: 5) only consider indigenous populations, which they define as populations for which “*no information was available from the author to suspect that the population did not evolve locally in relation to the historical prevalence of malaria*”, it is possible that the location of indigenous populations in the sickle cell gene database does not match their historical location. However, such measurement error should mainly attenuate our results, and cause bias only if migration patterns are systematically related to witchcraft beliefs. We cannot fully exclude this possibility, but have not found any indications in the literature that this is the case.

2.3.3 Historical malaria mortality and witchcraft beliefs

The historical malaria mortality measure is calculated at the level of ethnic groups as defined in Murdock’s Tribal Map of Africa (Murdock, 1959), and thus proxies malaria mortality in precolonial times within the area defined as the historical ethnic homeland. We match the individual information from the PEW data to ethnicity-level malaria mortality by matching the PEW respondent’s self-reported ethnicity to the ethnic groups identified by Murdock (1959). The matching was based on ethnicity matches identified in previous empirical studies (Deconinck and Verpoorten, 2013; Gershman, 2016; Nunn and Wantchekon, 2011), and on ethnographic and linguistic sources (Olson, 1996; Simons and Fennig, 2016; Wimmer et al., 2009).

Since information on ethnicity is missing for Rwanda and South Africa in the original PEW data, these two countries are excluded from the analysis. Another 1,881 individual observations for other countries are excluded because of missing information on ethnicity. The

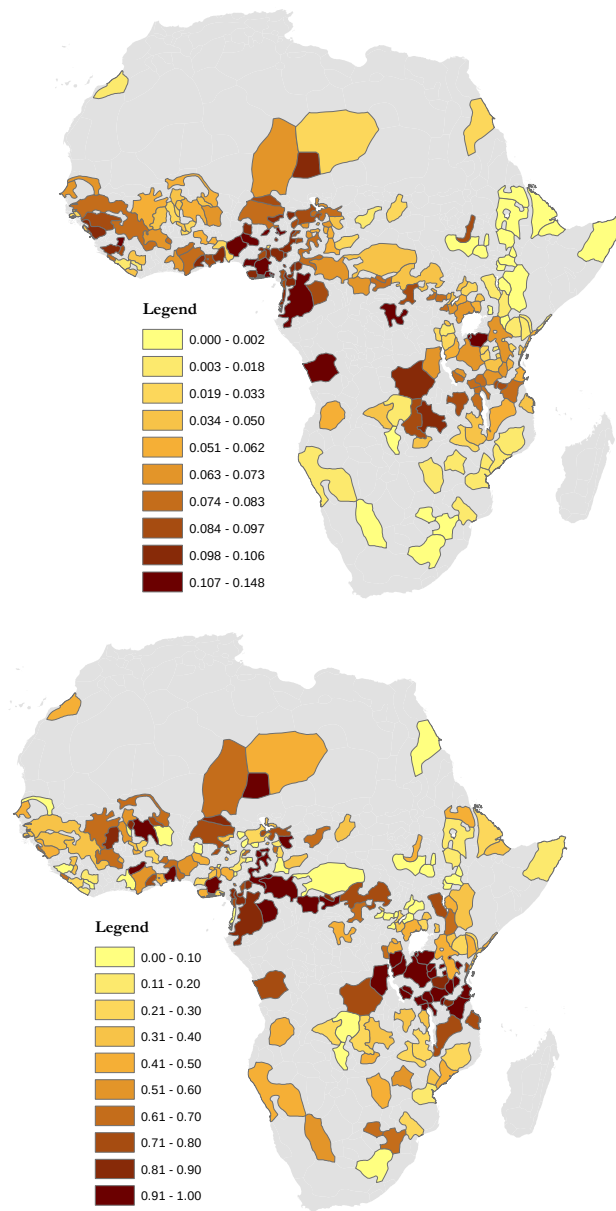
⁸ An alternative dataset offers indices of historical pathogen prevalence for several infectious diseases (Murray and Schaller, 2010), but these data are so far only available at the national level or at the level of pre-industrial societies in the Standard Cross-Cultural Sample. Combining these data with the PEW dataset would result in a sample of 17 to 28 units of observation – too few for a rigorous econometric analysis.

final sample counts 20,592 observations for 334 distinct Murdock groups across 17 countries (see Table 2A.2 for details).

This sample is then combined with the malaria mortality measure, with other datasets containing regional, ethnicity-level characteristics, and with geographical and climatic measures calculated in geo-processing software. Due to the limited availability of historical ethnographic data, the baseline regression sample includes 19,115 individual observations for 314 Murdock ethnic groups. Although coverage for certain ethnic groups is limited, this regression sample represents a significant part of the population across 17 countries in SSA.

Figure 2.3 presents historical malaria mortality across 334 ethnic homelands alongside the share of present-day witchcraft believers in each ethnic group. Both measures vary considerably across ethnic groups, and the spatial patterns suggest a correspondence between areas with high malaria mortality and areas with a high prevalence of witchcraft beliefs.

Figure 2.3: Historical malaria mortality and witchcraft beliefs across ethnic groups.



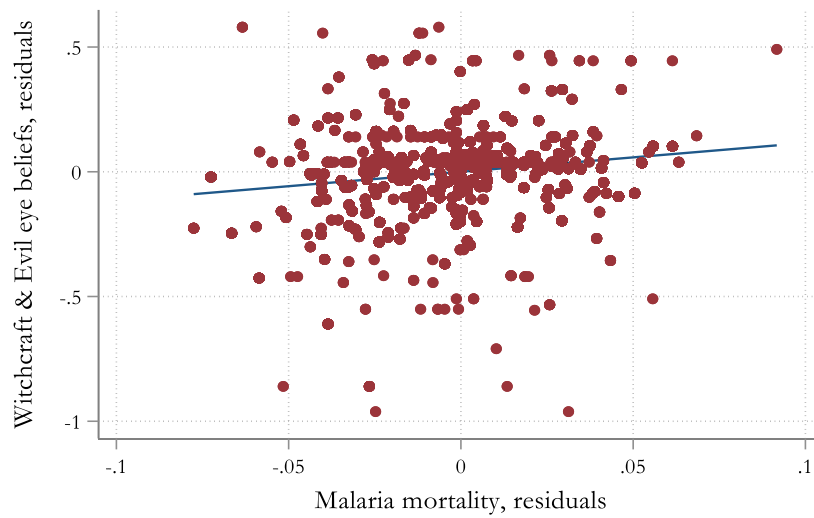
(a) Historical malaria mortality

(b) Witchcraft beliefs

Notes: The categories for historical malaria mortality correspond to 10 quantiles (rounded up to three decimals). Ethnicity-level witchcraft beliefs are measured as the share of respondents of that ethnicity reporting to believe in witchcraft.

This pattern is confirmed in Figure 2.4, which presents the (positive) correlation between historical malaria mortality and the prevalence of witchcraft and evil eye beliefs across ethnic groups, conditional on country dummies (0.22).

Figure 2.4: Correlation between historical malaria mortality and witchcraft & evil eye beliefs across ethnic groups.



Notes: The lines show fitted values for a linear regression of individual-level witchcraft & evil eye beliefs on historical malaria mortality. The vertical and horizontal axes show residuals from regressions of historical malaria mortality and individual-level witchcraft & evil eye beliefs conditional on country fixed effects. To ease visual interpretation, data points show the averages for historical malaria mortality and witchcraft & evil eye beliefs within equal-sized groups of observations (bins) based on the malaria mortality value

2.4 Estimation framework

We estimate the relation between historical malaria mortality and present-day witchcraft beliefs. The advantage of having individual-level data is that we can increase the precision of our estimates by controlling for a host of individual-level factors affecting witchcraft beliefs. In the robustness section to capture group effects, we change the unit of analysis to ethnic groups across countries because we are estimating a long-run relation that has likely evolved within cultural groups. Ethnic groups in SSA tend to be better approximations of cultural groups than political units and go further back in time. The reason for only presenting the ethnic-country

analysis in the robustness section is that the number of ethnic groups in our baseline regression sample is relatively small, and the number of individual observations available to calculate the share of witchcraft believers in an ethnic group can be small. Nevertheless, we show that our findings are similar when we use the ethnic group as the unit of analysis.

2.4.1 Estimating equations

To assess the effect of historical malaria mortality on the individual probability of believing in witchcraft, we estimate the following equation:

$$W_{i,e,c} = \beta M_{e,c} + B'X_{i,e,c} + \theta' C_{e,c} + \partial' D_{r,c} + \varphi_c + \varepsilon_{i,e,c} \quad (2.1)$$

where the subscript i refers to the individual, e refers to the ethnic group, and c refers to the country. The dependent variable W is a dummy variable taking value 1 if the respondent reports to believe in witchcraft or the evil eye, and 0 otherwise. The regressor of interest M is the standardized historical malaria mortality measure. The vectors X , C and D are sets of individual-level, ethnicity- and regional level control variables (in which continuous variables are standardized).⁹ φ refers to country fixed effects and ε is the heteroskedastic error term which is clustered at the Murdock cultural province level¹⁰.

To estimate the relation between historical malaria mortality and ethnicity-level prevalence of witchcraft & evil eye beliefs, we estimate the following specification:

$$W_{e,c} = \delta M_{e,c} + \Phi' C_{e,c} + \varphi_c + \epsilon_{e,c} \quad (2.2)$$

where the dependent variable W gives the share of respondents reporting to believe in witchcraft or the evil eye for ethnic group e in country c . The rest of the equation is analogous to equation (2.1), with the exception that the vector of individual-level controls is excluded.

In our main analysis we rely on OLS to estimate equation (2.1) with its binary dependent variable as a linear probability model. In the robustness section we show that our findings for equation (2.1) are robust to the use of a nonlinear logit model and estimating equation (2.2) with sample restrictions.

By including country dummies in the estimating equations, we only exploit within-country variation in witchcraft beliefs and historical malaria mortality. This approach allows us to account for a variety of potentially important country-level drivers of witchcraft beliefs today,

⁹ See Appendix 2B for a detailed description of all variables used in the analysis and their data sources.

¹⁰ Section 2.4.2 elaborates on our choice of clustering at the cultural province level

such as state-sponsored religion, national policies regarding witchcraft (e.g. anti-witchcraft laws), public health policies and investments, country-level economic development and inequality, and conflict history (e.g. Geschiere, 1997; Leistner, 2014). However, it also requires us to treat individuals of the same ethnic group but living in different countries as different units of observation. We argue that this approach in any case is conceptually more appropriate, as it accounts for the possibility that ethnic groups divided by national borders experienced a different history of (de)colonization, nation-state building, and national policies, and are therefore no longer culturally homogenous today.

In order to address within-country factors that may interfere with our hypothesized relation we include in our specification a number of plausibly exogenous individual-level, ethnicity-and regional level control variables in our baseline specifications.

The basic individual-level controls consist of age and gender. It is commonly assumed that younger generations are less likely to hold magical beliefs such as witchcraft, as these are eroded by ongoing processes of socio-economic modernization. As for gender, anthropological and ethnographic literature suggests that witchcraft beliefs can have particular gender dimensions (Ciekawy, 1999). The extended individual controls included are the level of education of the individual, type of residence (urban/rural), self-reported measures of economic situation, ethnic conflict, religion, crime and technical literacy¹¹

The list of ethnicity-level controls is more extensive. As economic development is associated with witchcraft beliefs and disease burden, we need to separate the effect of economic development patterns from the effect of historical malaria mortality. Since individual or ethnicity-level income may be endogenous to witchcraft beliefs, we control for deep correlates of long-run economic development: absolute latitude, suitability of land for agriculture, area, mean altitude, access to a river, distance from the coast, and distance from the nearest lake (Alsan, 2015; Gershman, 2016). The presence of water bodies and mean altitude also serve as proxies for accessibility or connectivity of the area, which is related to within-country differences in the impact of national institutions and policies (cf. Michalopoulos and Papaioannou, 2014).¹²

A number of anthropological studies have argued that the slave trade in SSA played an important role in shaping witchcraft beliefs and conversely, that witchcraft played an important part in the slave trade – for instance as a justification for selling slaves (e.g. Shaw, 1997;

¹¹ The full list of variables and their creation is described in the appendix 2A

¹² Michalopoulos and Papaioannou (2014) find specifically that the impact of national institutions decreases with distance to capital cities. As the PEW data do not include GPS coordinates or administrative units below regions, we cannot exploit variation in distance to the capital directly.

Thornton, 2003).¹³ We capture exogenous variation in slave trade intensity through distance to the coast, which Nunn and Wantchekon (2011) show to be a good predictor of slave exports and also directly control for the intensity of slave trade.

Witchcraft is related to religion in several ways. For instance, religion can be seen as protective against witchcraft, and Catholic churches often take vocal stances against the existence of witchcraft (Geschiere, 2013; Kohnert, 1996; Leeson and Russ, 2017; Leistner, 2014). As individual religious affiliation is most likely endogenous to witchcraft beliefs, we include measures of the historical influence of the two dominant religions in SSA: Christianity and Islam. For Christianity, this measure is the historical presence of Christian missions in the ethnic homeland (Nunn, 2010; Nunn and Wantchekon, 2011). The number of missions may be associated with the local malaria burden, although a priori the direction of the effect is unclear: a high malaria burden could both increase (e.g. higher need for missionary health care) or decrease (e.g. obstacle to settlement) the presence of missions. For Islam, we rely on the finding of Michalopoulos et al. (2012) that inequality in land endowments, measured by variability in land suitability for agriculture, was a major driver of the spread of early Islam. Variability in land suitability for agriculture has also been identified as a deep driver of ethnolinguistic diversity (Michalopoulos, 2012). Since historical malaria mortality has been linked to the diversity and strength of ethnic identities (Chiovelli et al., 2015), variability in land suitability also serves to absorb any impact of ethnolinguistic diversity¹⁴.

Finally, climate is an important determinant of the malaria burden and may affect witchcraft beliefs indirectly through economic development or directly as another source of misfortune (e.g. in the form of extreme rainfall). Broad climate zones are captured by absolute latitude, which is already included. We control for recent climatic conditions through the mean and standard deviation of annual rainfall and temperature during the growing season for the period 1957-2002 (Guariso and Rogall, 2016). Historical climate is proxied by mean daily humidity and temperature in 1871 (Alsan, 2015). To control for another important source of misfortune that may be correlated with the malaria burden, we include a measure developed by Alsan (2015) that captures climatic suitability for the Tse Tse fly, which is the disease vector for trypanosomiasis.¹⁵

¹³ The link between malaria mortality and slave trade is less clear. There may have been less demand for slaves from areas with a high infectious disease burden, but the data indicate that slave trade intensity is positively correlated with disease burden. If areas with a high malaria mortality were less economically or politically developed, one would also expect less slave trade (Nunn, 2008). A further possible link could stem from the positive correlation between disease burden and geographic factors that facilitated the slave trade, such as closeness of water bodies.

¹⁴ We also explicitly control for Ethnolinguistic fractionalization in all specifications

¹⁵ Aside from malaria, the second infectious disease presumed to have affected political, economic, and cultural development in SSA in major ways is trypanosomiasis (Akyeampong, 2006; Webb, 2006). We do not consider the

The inclusion of regional level controls is to account for confounding variables which were not accounted for in the individual or ethnicity level controls. Nunn and Puga (2012) have shown that land ruggedness is correlated with African development and slave trade. To account for regional differences in land ruggedness which may have impacted historical malaria mortality, we include mean land ruggedness as a control. We have controlled for the economic situation of an individual on the basis of self-reported economic shortages or their experience of shortages of money, these might be overreported in the survey. Therefore, we include nighttime lights per capita at the regional level as a proxy for economic development. Disease burden strengthened kinship in small groups but perhaps may have led to a weaker connection with other members of society (to reduce the risk of catching communicable diseases), to control for this we include a measure of ethnolinguistic polarization labelled the ethnolinguistic index which was created by Gersham (2016) and finally we include a measure of conflict at the regional level (which is different from the self-reported perceived causes of conflict) since conflict has been associated with witchcraft (Nunn and Sanchez de la Sierra, 2017; Włodarczyk, 2009), and may be associated with the frequency of disease epidemics.

2.4.2 Calculating standard errors

Error terms will likely be correlated between individuals of the same ethnic group because of a common cultural heritage. However, Murdock ethnic groups are not necessarily culturally independent units; many groups are likely to be culturally related because they share a common ancestry or history. Such cultural relatedness is more likely for ethnic groups that are genealogically related or geographically close. Alsan (2015) addresses this by allowing error terms to be correlated within cultural provinces, which are larger groupings devised by Murdock that should be culturally independent from each other. Hence, we allow for standard errors to be clustered at the level of these cultural provinces.

Once all baseline control variables are included, our regression sample counts 37 cultural provinces with unbalanced cluster sizes. Since this data structure increases the risk of incorrect statistical inference (inflated p-values) for cluster-robust standard errors, we check whether our

long-run burden of trypanosomiasis in this study for two reasons. First, we do not have a comparable measure of long-run mortality related to trypanosomiasis. Second, an analysis of the trypanosomiasis burden would be complicated by its important effects on several precolonial political and economic characteristics (Alsan, 2015), which interacted in dynamic ways with witchcraft beliefs (Koning, 2013). Depetris-Chauvin and Weil (2016) in contrast find that historical malaria mortality is only strongly correlated with population density in precolonial SSA (Depetris-Chauvin and Weil, 2016).

results hold when cluster-robust standard errors are calculated using pair-wise bootstrapping with asymptotic refinement.^{16 17}

2.5 Results

Table 2.1 presents estimation results for equation (2.1). In columns (1) - (7) we include a progressively richer set of control variables. The final column (8) shows results when bootstrapped cluster-robust standard errors are used. In all columns, historical malaria mortality is positively and statistically significantly correlated with the individual probability of believing in witchcraft or the evil eye. All else equal, a one standard deviation increase in historical malaria mortality is associated with an approximately 3 percentage point higher probability of believing in witchcraft on average.

Table 2.1: OLS estimates for relation between malaria and individual belief

Dependent variable	Individual probability of believing in witchcraft or the evil eye							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Historical malaria mortality	0.082*** (0.022)	0.044*** (0.012)	0.045*** (0.012)	0.042*** (0.013)	0.041*** (0.012)	0.035*** (0.012)	0.034*** (0.012)	0.034***
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Economic development controls	No	No	No	Yes	Yes	Yes	Yes	Yes
Religion controls	No	No	No	No	Yes	Yes	Yes	Yes
Climate controls	No	No	No	No	No	Yes	Yes	Yes
Regional Controls	No	No	No	No	No	No	Yes	Yes
Observations	19,557	19,557	19,557	19,557	19,557	19,557	19,557	19,557
R-squared	0.027	0.147	0.148	0.151	0.151	0.154	0.155	
Number of clusters	38	38	38	38	38	38	38	38

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Individual belief is a binary variable which is 1 if an individual reports belief in witchcraft or the evil eye. Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (7). Column (8) shows significance levels for cluster-robust standard errors calculated using pairs-bootstrapping with

¹⁶ We rely on the program `clustse` which bootstraps the pivotal t-statistic by sampling observations (independent and dependent variables together) with replacement by cluster groups, and uses the distribution of the t-statistic over the bootstrap samples for statistical inference. The program code was developed by Andrew Menger in 2015 and provided by the Boston College Department of Economics in its series Statistical Software Components with number S457989. As this program does not provide estimates of standard errors, all tables only show significance values for the coefficient estimates when bootstrapped cluster-robust standard errors are used. The R-squared is not reported for these estimates as post-estimation procedures cannot be run on this model.

¹⁷ We also conducted two-way clustering for the full individual specification at the province-regional and province-ethnicity level using the command by Cameron et al (2011) [`psacalc`] and find our results are robust to this type of clustering. The results are not shown but are available upon request.

2.5.1 Alternative explanations

A number of alternative explanations for the positive malaria-witchcraft relation remain. We account for them by enriching our specification with a large number of additional variables that are organized into contemporary individual factors, precolonial ethnicity-level characteristics, measures of European settlement/influence and regional characteristics, we recognize that these variables could be potentially endogenous. Finally, we discuss to what extent our finding can be explained by reverse causality.

2.5.2 Contemporary individual characteristics

2.5.2.1 Variable classification

Classic modernization theory assumes that processes of modernization such as income growth, urbanization, the spread of education, and technological advancement erode religion, superstition, and magical beliefs (e.g. Iannaccone, 1998). If this is true for SSA, the positive malaria-witchcraft relation could arise when areas with a high malaria burden were the last to ‘modernize’, e.g. because these areas attracted less foreign investments (Sachs and Malaney, 2002).

To capture the possible influence of education and urbanization, we include dummies for secondary education, tertiary education, urban residence, and semi-urban residence. As the PEW data do not include measures of income that are comparable across countries, we proxy income with a dummy variable indicating self-reported money shortages in the past year and a categorical variable indicating whether the respondent rates his economic situation as (somewhat or very) bad (plus its squared term). Technology use is captured by dummies indicating use of the internet, email, or a pc, which may also partly capture income.

If classic modernization theory is incorrect, it is still possible that areas with a higher malaria burden were the places where traditional African culture and worldviews persisted for a longer time, for instance because Europeans were less likely to settle there. To address this possibility, we include an index for personal engagement in practices that are associated with traditional life and culture, and a dummy for reliance on a traditional healer in case of illness.

We further control directly for the influence of religion by including two dummies for Christian religion and ethnoreligion and an index of religiosity.¹⁸ We also include a Herfindahl index for Christian denominations (at the regional level) to account for the possibility that different denominations compete for religious market share by offering protection against witchcraft (Leeson and Russ, 2017).

Conflict has been associated with witchcraft (Nunn and Sanchez de la Sierra, 2017; Włodarczyk, 2009), and may be associated with the frequency of disease epidemics. We therefore control for perceived severity of crime, religious conflict, and ethnic conflict.

Finally, van de Grijsparde et al. (2013) find that in eastern Sierra Leone witchcraft manifestations are higher in communities that experience the competing pull of traditional and market-based institutions and norms. Potential non-linear effects of this sort may already be captured by semi-urban residence and by the quadratic function of personal economic situation. We further include a dummy variable indicating whether the respondent believes that Western popular culture has hurt morality in the country, which may capture a perceived conflict between different cultures or value systems.

2.5.2.2 Results

Table 2.2 presents OLS estimation results for the extended individual-level specification. Columns (2)-(5) report estimation results when we include a progressively richer set of additional controls. The coefficient estimate for historical malaria mortality remains statistically significant at the 5% level in all columns and its magnitude is virtually unchanged.

Table 2.2 also shows estimation results for the control variables, as these offer some noteworthy insights into the contemporary correlates of witchcraft beliefs. We highlight the main findings.

Most results for measures of modernization are inconsistent with the standard predictions of modernization theory, and support anthropological observations on the ‘modernity’ of witchcraft (Geschiere, 1997). In particular, age and education do not matter once we control for embeddedness in traditional culture and religiosity, and urban residents are more likely to hold witchcraft beliefs – suggesting that these beliefs are not a relic of rural village life.

As for income, money shortages and assessing one’s personal economic situation as bad is insignificantly correlated with witchcraft beliefs.

¹⁸ We obtain similar results when we include a more refined measure of religious affiliation that distinguishes between different branches of Christianity (Protestantism, Anglicanism, African independent churches, and the Ethiopian Orthodox Church; results not reported, but available on request).

Finally, the results point to an important role of traditional culture and religion in witchcraft beliefs (i.e: the positive and statistically significant correlation between traditional practices and the use of a traditional healer and belief in witchcraft, and give some support to the hypothesis that perceived tension between different value systems matters.

Table 2.2: OLS estimates for relation between malaria and individual beliefs - additional individual controls

Dependent variable	Individual probability of believing in witchcraft or the evil eye					
	(1)	(2)	(3)	(4)	(5)	(6)
Historical malaria mortality	0.034*** (0.012)	0.026* (0.013)	0.025** (0.012)	0.025** (0.012)	0.026** (0.012)	0.026**
Secondary education		-0.033** (0.014)	-0.022* (0.013)	-0.015 (0.013)	-0.015 (0.013)	-0.015
Tertiary education		-0.050** (0.021)	-0.032 (0.019)	-0.023 (0.019)	-0.025 (0.019)	-0.025
Urban residence		0.021 (0.016)	0.037** (0.016)	0.041** (0.018)	0.041** (0.017)	0.041**
Semi-urban residence		-0.018 (0.051)	-0.008 (0.051)	-0.006 (0.053)	-0.007 (0.054)	-0.007
Bad economic situation		0.010 (0.027)	0.029 (0.025)	0.023 (0.026)	0.021 (0.026)	0.021
(square) Bad economic situation		0.001 (0.006)	-0.002 (0.005)	-0.002 (0.005)	-0.002 (0.005)	-0.002
Shortage of money in past year		0.019 (0.015)	0.007 (0.015)	0.009 (0.015)	0.006 (0.015)	0.006
Use of internet		0.023 (0.027)	-0.001 (0.023)	-0.006 (0.024)	-0.009 (0.025)	-0.009
Use of a pc		-0.043**	-0.029	-0.027	-0.027	-0.027

	(0.018)	(0.019)	(0.018)	(0.018)		
Use of email	-0.010	0.002	0.008	0.010	0.010	
	(0.027)	(0.025)	(0.027)	(0.028)		
Western popular culture hurts morality	0.034***	0.033***	0.038***	0.039***	0.039***	
	(0.011)	(0.010)	(0.010)	(0.010)		
Traditional practices		0.079***	0.074***	0.074***	0.074***	
		(0.008)	(0.007)	(0.007)		
Reliance on traditional healer		0.101***	0.099***	0.100***	0.100***	
		(0.012)	(0.012)	(0.012)		
Christian religion			0.017	0.019	0.019	
			(0.016)	(0.016)		
Ethnoreligion			0.147***	0.149***	0.149***	
			(0.048)	(0.053)		
Religiosity			-0.049***	-0.048***	-0.048***	
			(0.007)	(0.008)		
Competition among Christian denominations			-0.005	-0.003	-0.003	
			(0.016)	(0.015)		
Perceived crime				-0.009	-0.009	
				(0.009)		
Perceived religious conflict				-0.005	-0.005	
				(0.008)		
Perceived ethnic conflict				0.008	0.008	
				(0.007)		
All Table 2.1 Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,855	15,855	15,855	15,855	15,855	15,855
R-squared	0.163	0.171	0.213	0.220	0.221	
Number of clusters	38	38	38	38	38	38

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Individual belief is a binary variable which is 1 if an individual reports belief in witchcraft or the evil eye. Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (5). Column (6) shows significance levels for cluster-robust standard errors calculated using pairs-bootstrapping with asymptotic refinement (standard errors are not reported by the command, the p-value>t is 0.02). Appendix 2B provides details on control variables. *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

2.5.3 Precolonial characteristics of the ethnic group

2.5.3.1 Variable classification

Historical malaria mortality could have been affected by two important group-level adaptive strategies: (semi-)nomadic settlement patterns that allowed groups to avoid high transmission

periods through seasonal migration, and low population densities that limited the risk of contagion and spread of a disease. In addition, societies with more complex institutions or centralized power may have been better able to control infectious diseases (e.g. through faster quarantine or evacuation in case of epidemics). As these three features of group organization and settlement could also be related to witchcraft beliefs and their evolution (Geschiere, 1997; Koning, 2013), they may interfere with our hypothesized relation.

To address this issue, we extend the list of controls in equation (2.1) to the complexity of precolonial settlement patterns (Murdock 1967), precolonial institutional centralization (Murdock 1967), and two alternative estimates for precolonial population density: colonial population density (Murdock 1967) and the presence of cities with over 20,000 inhabitants in 1800 (Chandler, 1987). Precolonial centralization of institutions also allows us to better control for within-country variation in contemporary economic development (Michalopoulos and Papaioannou, 2013) and (post-)colonial governance quality (Gennaioli and Rainer, 2005; 2007).

Finally, witchcraft beliefs have been linked to wealth inequality and social stratification, which are historically associated with pastoralism and agriculture (Gershman, 2015; Koning, 2013). As the historical malaria burden is also related to agricultural development (Carter and Mendis, 2002), we include a dummy for strong dependence of precolonial production on agriculture or husbandry.

2.5.3.2 Results

Table 2.3 presents OLS estimation results for equation (2.1). In columns (2)-(4) we show that our result is robust to the gradual inclusion of the precolonial control variables discussed above. The positive coefficient estimate for historical malaria mortality remains statistically significant at the 1 % level and there is minor variation in the point estimate.

2.5.4 European settlement and influence

2.5.4.1 Variable classification

Disease burden affects not only the indigenous population, but also (and often more so) immigrant populations. As such, a heavy historical malaria burden could have discouraged European settlement during the colonial era. European settlement patterns in turn are found to predict contemporary patterns of urbanization and economic development within countries (Flückiger and Ludwig, 2017; Jedwab et al., 2017). Hence, it is possible that areas with a heavier historical malaria burden have less witchcraft beliefs today because they continue to be less urbanized and economically developed. These regional effects may not be fully captured by the

controls outlined above. Alternatively, a higher presence of European settlers, who brought with them different cultural beliefs, values, and norms, in low malaria areas could have initiated processes of cultural change (Nunn, 2012) that eroded witchcraft beliefs in those areas.

To check whether our finding is driven by these alternative channels, we need to control for within-country variation in European settlement patterns.

Given that regional centers established by Europeans often persisted into urban centers today (Flückiger and Ludwig, 2017; Jedwab et al., 2017), the already included measures of colonial population density and the presence of a city in 1800 should capture part of the effect of spatial patterns in European settlement.

In addition, Jedwab et al. (2017) show that in Kenya the location of colonial railways determined the location of European settlers, Asian traders, and main cities at independence. In a similar vein, Nunn and Wantchekon (2011) measure exposure to European influence in the colonial era across SSA by the pass-through of colonial railways and European explorer routes in the ethnic homeland. We add both measures as additional controls to our regression specification.

2.5.4.2 Results

Column (5) in Table 2.3 presents OLS estimates when we add the railway and explorer route variables to the list of precolonial controls. Since these measures are unavailable for several countries in our dataset, we lose about a third of the regression sample shown in Table 2.1, but can still rely on over 7,000 individual observations. Our positive coefficient estimate for historical malaria mortality remains statistically significant at the 1% level and the point estimate remains largely unchanged.

2.5.5 Slave trade and Trust

2.5.5.1 Variable classification

The slave trade has been shown to effect economic development in SSA which could have affected settlement patterns and thus belief in witchcraft (Nunn 2017), therefore we control for slave trade using a measure of slave exports developed by (Nunn, 2007). Gresham (2017) has shown that witchcraft beliefs negatively affect trust which has been shown to effect economic development, hence we include measures of general trust and trust in people of different religions.

2.5.5.2 Results

Columns (6) and (7) in Table 2.3 show the inclusion of these controls. The effect of malaria burden on present day witchcraft belief remains statistically significant at the 1% level and the point estimate remains largely unchanged with its inclusion.

Table 2.3: OLS estimates for relation between malaria and individual witchcraft belief - Extended precolonial controls

Dependent variable	Individual probability of believing in witchcraft or the evil eye								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Historical malaria mortality	0.026** (0.012)	0.066*** (0.017)	0.071*** (0.012)	0.071*** (0.012)	0.065*** (0.014)	0.076*** (0.013)	0.073*** (0.013)	0.064*** (0.011)	0.064*** (0.011)
All Table 2.1 and Table 2.2 Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Precolonial Settlement & Centralization	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population density & City in 1800	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Agro-pastoralism	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
European settlement	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Slave trade	No	No	No	No	No	Yes	Yes	Yes	Yes
Trust	No	No	No	No	No	No	No	Yes	Yes
Regional controls	No	No	No	No	No	No	No	Yes	Yes
Observations	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387	7,387
R-squared	0.234	0.235	0.237	0.237	0.238	0.239	0.241	0.242	0.242
Number of clusters	23	23	23	23	23	23	23	23	23

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Individual belief is a binary variable which is 1 if an individual reports belief in witchcraft or the evil eye. Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (8). Column (9) shows significance levels for cluster-robust standard errors calculated using pairs-bootstrapping with asymptotic refinement (standard errors are not reported by the command, the p-value>t is 0.00). Appendix 2B provides further details on control variables. Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

2.5.6 Ruggedness, Nightlights, Ethnolinguistic fractionalization and Conflict

2.5.6.1 Variable classification

The inclusion of regional level controls is to account for confounding variables which were not accounted for in the individual or ethnicity level controls. Nunn and Puga (2012) have shown that land ruggedness is correlated with African development and slave trade. To account for regional differences in land ruggedness which may have impacted historical malaria mortality, we include land ruggedness. We have controlled for the economic situation of an individual on the basis of self-reported economic shortages or their experience of shortages of money, these might be misreported in the survey. Therefore, we include nighttime lights per capita at the regional level as a proxy for economic development. Disease burden strengthened kinship in small groups but perhaps may have led to a weaker connection with other members of society (to reduce the risk of catching communicable diseases), to control for this we include a measure of ethnolinguistic polarization labelled the ethnolinguistic index which was created by Gersham (2016) and finally we include a measure of conflict (which is different from the self-reported perceived causes of conflict) at the regional level since conflict has been associated with witchcraft (Nunn and Sanchez de la Sierra, 2017; Włodarczyk, 2009), and thus may be associated with the frequency of disease epidemics.

2.5.6.2 Results

Table 2.1 (column 7) and Table 2.3 (column 8) show the inclusion of these regional level variables. In each model, the inclusion of these controls does not reduce the statistical significance of historical malaria burden on belief which remains statistically significant at the 1% level and causes minor fluctuations in the point estimate.

2.6 Reverse causality

Qualitative and quantitative work has argued that magical beliefs can negatively affect preventive and treatment behavior (Briones Alonso, 2015; Stoop et al., 2017). For instance, patients may not seek biomedical treatment because they see it as unable to deal with illness caused by occult forces. The question then arises whether historically the strength of witchcraft beliefs could have affected malaria mortality.¹ We argue that this scenario is unlikely. Highly

¹ Historical malaria mortality is also correlated with contemporary disease burden (Depetris-Chauvin and Weil, 2016), which raises the question whether historical malaria mortality might capture a positive effect of strong witchcraft beliefs on contemporary malaria burden. Our results do not change when we control for contemporary intensity of malaria transmission (Kiszewski et al., 2004) (results not reported, but available on request).

effective prevention strategies such as insecticides and bed nets were unavailable in precolonial SSA, and treatment methods sufficiently effective so as to change selective pressures were presumably not available either.²

A more indirect channel of reverse causality would entail historical witchcraft beliefs affecting exposure to malaria by influencing settlement location.³ As we cannot fully exclude this possibility, we emphasize that our finding remains correlational.⁴

2.7 Robustness checks

We check the robustness of our main finding to a number of alternative estimation strategies.

Since the dependent variable in equation (2.1) is a binary variable we had shown estimations using OLS for ease of interpretation, we verify whether our results hold under a logit model. Table 2.4 presents estimated marginal effects for various specifications of equation (2.1), and confirms the main results obtained using OLS estimation.

² The biomedical sciences did not uncover the cause and transmission of malaria until the 19th century. This in itself does not imply the absence of knowledge on malaria prevention and treatment among precolonial societies in SSA, as many human populations independently developed biomedically consistent knowledge of and treatment for infectious diseases (Briones Alonso, 2015). However, we have found no research suggesting the existence of effective prevention or treatment (rather than symptom alleviation) for malaria, or accurate knowledge on its transmission mechanism, among precolonial societies in SSA. In addition, any such treatment or prevention method would need a high degree of effectiveness to significantly change selective pressures at the population level.

³ An important determinant of settlement location is success in inter-group conflict. Yet, if conflict explains settlement location, we should find a negative malaria-witchcraft relation. Nunn and Sanchez de la Sierra (2017) argue that witchcraft beliefs help communities in DR Congo to win violent conflict today. In historical terms, a growing body of evolutionary literature argues that in-group solidarity or parochial altruism, which is said to be promoted by witchcraft beliefs, evolved among humans precisely because it increased the odds of surviving inter-group conflict (Bowles, 2009). Hence, one would expect stronger witchcraft beliefs to be associated with success in conflict and thus with settlement on desirable land with a lower disease burden (conditional on agricultural suitability).

⁴ Following Depetris-Chauvin and Weil (2016), we attempted to instrument historical malaria burden with a temperature-dependent index reflecting the climatic suitability of an area to the malaria vector and parasite. This instrument, however, does not fully solve the issue at hand, as unobserved characteristics of human populations (such as historical witchcraft beliefs or military success) can determine where populations ultimately settle, and thus the suitability of their homeland to malaria.

Table 2.4: Logit estimates of marginal effects for relation between malaria and individual belief

Dependent variable	Individual probability of believing in witchcraft or the evil eye								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Historical malaria mortality	0.04* ** (0.02 2)	0.05* ** (0.01 6)	0.08* ** (0.02 0)	0.06* ** (0.02 0)	0.07* ** (0.01 3)	0.06* ** (0.01 3)	0.06* ** (0.01 3)	0.08* ** (0.01 4)	0.07* ** (0.01 3)
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Baseline controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Extended individual controls	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Precolonial controls	No	No	No	No	Yes	Yes	Yes	Yes	Yes
European settlement controls	No	No	No	No	No	Yes	Yes	Yes	Yes
Population Density	No	No	No	No	No	No	Yes	Yes	Yes
Slave trade and trust	No	No	No	No	No	No	No	Yes	Yes
Regional controls	No	No	No	No	No	No	No	No	Yes
Observations	7,421	7,421	7,421	7,421	7,421	7,421	7,421	7,421	7,421
Number of clusters	38	38	38	38	36	23	23	23	23

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Individual belief is a binary variable which is 1 if an individual reports belief in witchcraft or the evil eye. Standardized continuous regressors. Marginal effects reported at means. Cluster-robust standard errors at the level of cultural provinces in parentheses. Sections 4 and 5 provide details on control variables. *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

To verify whether the observed positive correlation is particular to Witchcraft & Evil eye beliefs, we explore the relation between historical malaria mortality and other magical beliefs. If our hypothesis is correct, we should find a statistically insignificant relationship between historical malaria mortality and other magical beliefs which do not involve belief in human agency and adverse events.

Table 2.5 presents OLS estimation results for equation (2.1), the PEW survey documents other beliefs associated with traditional African worldviews: belief in evil spirits, and the belief that you can protect yourself from ‘bad things happening’ through sacrifices to spirits or ancestors, through certain spiritual people, or through juju, shrines, or other sacred objects. Another set of magical beliefs documented in the PEW survey are more strongly associated with Islam or Christianity: belief in heaven, hell, angels, and miracles. If the relation between witchcraft and historical malaria mortality is explained solely by the fact that it allows one to explain and protect against misfortune, we might expect a similar positive relation between historical malaria mortality and these other magical beliefs.

Table 2.5: OLS estimates for the relation between malaria and other magical beliefs, at the individual level

Dependent variable	Protection against misfortune	Evil spirits	Abrahamic beliefs
	(1)	(2)	(3)
Historical malaria mortality	0.041 (0.028)	0.019 (0.017)	-0.010 (0.030)
All controls in Tables 2.1, 2.2 & 2.3	Yes	Yes	Yes
Observations	8,970	9,234	9,101
R-squared	0.405	0.226	0.118
Number of clusters	26	26	26

Notes: Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses. Column (1) shows results for an index that only captures beliefs related to protection against misfortune. Column (2) show results for belief in evil spirits and Column (3) for Abrahamic beliefs using an index of beliefs typically related to Christianity and Islam (heaven, hell, angels, and miracles). *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

None of the individual beliefs or belief indices are statistically significantly related to historical malaria mortality.

These findings give us two important pieces of information that may shed light on the underlying mechanisms, even though they do not allow us to unequivocally exclude one or the other. First, the fact that we find no relation with beliefs related to protection against harm suggest that any psychological mechanism centers around the clear identification of the cause of misfortune, rather than a general need to feel protected against misfortune. Second, the two beliefs that show the strongest relation with disease burden, witchcraft and the evil eye, have in common that they involve a human agent of misfortune. As non-human agents such as evil spirits are often invoked to explain disease (e.g. Foster, 1976; Liddell et al., 2005) these results suggest that the underlying mechanism involves something more than a mere identification of the cause of misfortune, and that human agency plays a key role in it.

We see two possible reasons for the importance of human agency. First, the identification of a human cause of misfortune may facilitate scapegoating or give a greater sense of control over misfortune, by allowing a clear removal of the threat (a human can be visibly removed from the community). Second, spirits do not take active part in the social (kinship) relations and concurrent sharing norms of the living members of a community. In other words, one cannot enforce material solidarity from non-human agents.

Yet, in theory these mechanisms are compatible with other types of beliefs, including belief in non-human supernatural entities. For instance, it is possible to have spiritual leaders consult the ancestors as to which person has angered them and brought disease upon the community, or to enforce solidarity norms by instilling fear of punishment by the gods if the norms are violated. Why would witchcraft in particular have emerged and persisted?

The answer may lie in the decentralized nature of these beliefs. In principle, anyone can accuse another of witchcraft (or the evil eye); the process does not require higher-level institutions or persons of authority, even though spiritual or political leaders may be involved to arbitrate and resolve accusations. This decentralized, community-driven characteristic could have generated two important types of advantages. The first is lower transaction costs and informational advantages, for instance in identifying breaches of solidarity norms within kinship networks. The second is greater flexibility and adaptability. Systems embedded in higher-level institutions or particular power structures may be more rigid and less capable of surviving major societal transformations, such as the erosion of traditional power structures by colonial

governments²³. Anthropological work has indeed emphasized the dynamic nature of witchcraft and its ability to adapt to new political and economic environments (Comaroff and Comaroff, 1999; D'Angelo, 2014; Geschiere, 1997; 1998). These two types of advantages may explain why witchcraft and the evil eye outcompeted alternative systems and retained so much of its power until today.

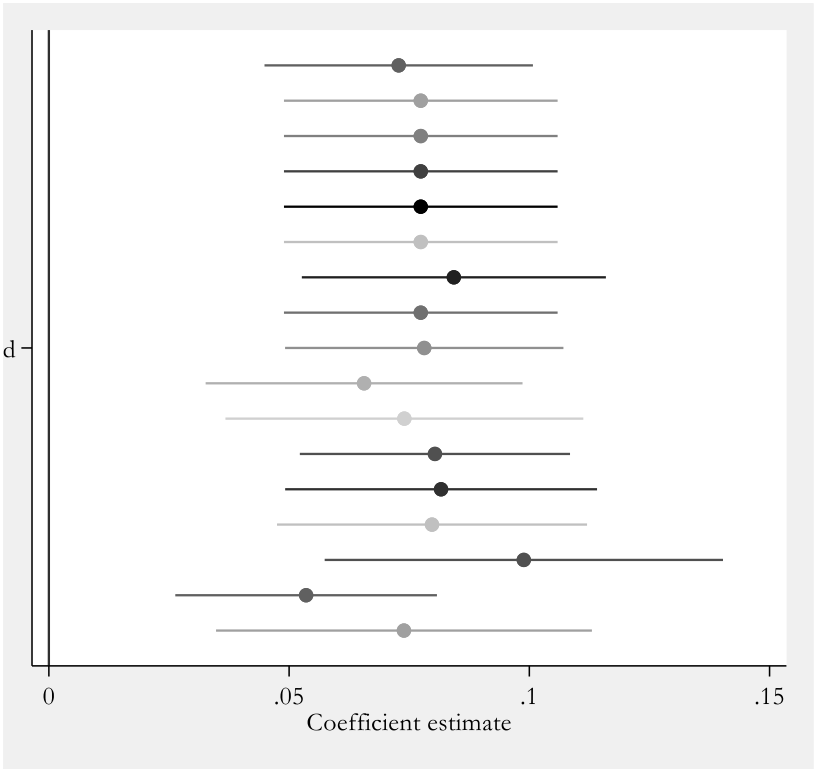
We also present the results of equation (2.2) in Table 2.7 in the appendix as a further robustness check by collapsing individual level observations at the ethnicity-country level and restricting the results to ethnicities which have at least 10 observations across countries. The sample size is restricted to permit comparison across different specifications and reassuringly our main estimates hold and remain statistically significant at the 5% level with minor fluctuations in the point estimate.

Finally, for equation (2.1) we check whether our main finding is driven by any particular country. We re-estimate the richest specifications (i.e. including all individual, regional and ethnicity-level control variables) for an adjusted sample that excludes one country, and repeat this exercise for all countries.

Figure 2.5 presents the coefficient estimates and confidence intervals for historical malaria mortality. The estimates generally remain within the same range, and the confidence intervals are above zero in all cases which suggests that the results are not driven by the inclusion of certain countries.

²³ This flexibility of witchcraft beliefs is well illustrated by the fact that it can be seen as a desirable quality of leaders, enabling them to protect the community against attacks, or as a dangerous power that corrupts leaders into greed and selfishness. As such, witchcraft can serve both to support existing power structures, or to justify community-driven uprisings against and removal of unwanted leaders (Thornton, 2003).

Figure 2.5: Estimated relation between historical malaria mortality and witchcraft/evil eye beliefs, for adjusted samples excluding one country at a time from individual level regressions.



Equation (1)

Notes: The dots indicate the magnitude of the coefficient estimate and the horizontal lines represent the corresponding 95 % confidence interval for each of the 17 adjusted samples

2.8 Additional Analysis

2.8.1 Heterogeneity by pre-colonial group characteristics

So far, we have investigated in detail the effect of a historical disease burden and its effect on belief in witchcraft today across various ethnic groups distributed across various countries in SSA. In order to distil our analysis further, we now investigate the heterogeneity in witchcraft belief across different ethnic groups in SSA. For this purpose, we use the information provided in the Murdock Atlas on various characteristics of ethnic groups such as the level of jurisdictional hierarchy in the ethnic group, the settlement pattern of the ethnic group, the reliance of the ethnic group on hunting, fishing, animal husbandry and agriculture. We focus on these characteristics based on our reading of the anthropological literature on the evolution and development of witchcraft beliefs in pre-colonial SSA (Mesaki, 1995; Swantz, 1990; Latham, 1972; Nadel, 1935). In our regression specification in equation (2.1), we include an interaction term which captures the effect of historical malaria burden on witchcraft belief through the identification of a particular characteristic of the ethnic group in question. The results are shown in Table 2.6 (in the appendix), in summary, we do not find any evidence of heterogeneity along these dimensions with the exception of the degree of agropastoralism of the ethnic group. For individuals that belonged to an ethnic group with a higher than median reliance on animal husbandry were 3.4% less likely to believe in witchcraft compared to those individuals which had a lower than median reliance on animal husbandry the result being statistically significant at the 10% level. Carrillo et al (2022) show that the nature of how production is organized and the mobility of agropastoral groups makes accusations of witchcraft against members complicated and causes a high degree of disturbance within the local environment hence their lower prevalence among ethnic groups that have a high reliance of agropastoralism.

2.8.2 General trust

We have argued that the effect of a heavy disease burden is to promote a society which is inward looking to combat the adverse effects of a heavy disease burden. Work by Gershman (2016) has demonstrated that belief in witchcraft reduces societal trust in SSA. In the individual specifications we controlled for trust, however in Table 2.8 (in the appendix), we investigate if a heavy disease burden leads to a reduction in general trust (in other people). We use equation

2.1 and change the outcome to a binary variable of trust in other people. We find that a one s.d increase in malaria burden leads to a reduction in trust in other people by 5.4%²⁴

2.9 Conclusion

We set out to study the link between long-run disease burden and witchcraft beliefs in SSA. Based on various psychological and economic mechanisms proposed in different strands of literature, we hypothesize that long-run exposure to a heavy disease burden promoted witchcraft beliefs. These underlying mechanisms, if accurate, could still be actively stimulating witchcraft beliefs in contemporary African societies, but not necessarily. It is possible that witchcraft beliefs and practices find their origins in these mechanisms, but became institutionalized into a self-sustaining and self-perpetuating belief system.

Our empirical findings are consistent with our hypothesis: historical malaria mortality is significantly and positively associated with contemporary witchcraft beliefs. This result applies to a sample of at least 7,000 individuals belonging to more than 200 ethnic groups for 17 countries in SSA. Although coverage is limited for some ethnic groups and regions in the sample countries, the dataset nevertheless spans a significant geographic area and share of the population in SSA.

We rule out a number of alternative explanations for our finding by including a battery of relevant individual, regional and ethnicity-level controls. Yet, as we cannot fully exclude the possibility that historical witchcraft beliefs affect settlement location, or that both witchcraft beliefs and malaria burden are determined by unobserved group characteristics, we emphasize that our finding should be interpreted as correlational rather than causal evidence.

Our study also captures just one aspect (mortality) of one infectious disease (malaria). As SSA suffers from the highest infectious disease burden of all continents, both historically and today, our empirical finding may underestimate the true witchcraft-disease relation. If comparable measures of the historical burden of other diseases become available, a broader replication exercise of our analysis would be useful.

Since we are not able to identify any particular mechanism's as the main driver of our finding, further research in this area is also needed. Survey data on collectivistic and individualistic values and behaviors, in particular in-group solidarity or parochial values, and psychological characteristics related to perceived control and scapegoating could be useful for identifying the underlying mechanisms.

²⁴ We also investigated if a heavy malaria burden led a reduction in trust of individuals which belong to other religions but found no statistically significant effects here (the results are not shown but available upon request)

Gaining a better understanding of how beliefs are formed and how they change is, as noted by North (2008: 1005), “*fundamental to a new social science*”. Given the omnipresence and profound influence of witchcraft in present-day SSA, a deeper understanding of its origins and evolution could shed light on contemporary issues and dynamics. The witchcraft-disease relation in particular can provide historical context for recent upsurges of superstitious belief discourse following the AIDS and Ebola epidemics (BBC, 2014; IFRC, 2014; Kalichman and Simbayi, 2004; Thomas, 2007).

A proper understanding of major culture traits can also improve policy effectiveness. Some examples of possible benefits are greater cultural compatibility or a better assessment of the broader impact and implications of policies. Studying contemporary dynamics alongside historical, long-run processes may thus prove to be a fruitful research agenda for understanding how and why witchcraft beliefs affect African societies today

Appendix:

Table 2.6: OLS estimates for relation between malaria and individual belief - Heterogeneity

Dependent variable	Individual probability of believing in witchcraft or the evil eye					
	(1)	(2)	(3)	(4)	(5)	(6)
Hunting*Malaria Burden	0.035 (0.027)					
Hunting reliance	0.033 (0.023)					
Fishing*Malaria Burden		-0.007 (0.015)				
Fishing reliance		-0.050 (0.034)				
Pastoralism*Malaria Burden			0.010 (0.029)			
Agropastoralism			-0.034* (0.020)			
Agriculture*Malaria Burden				0.017 (0.021)		
Agriculture reliance				0.005 (0.023)		
Nomadic*Malaria Burden					0.047 (0.284)	
Nomadic Settlement					0.043 (0.282)	
Hierarchy*Malaria Burden						0.027 (0.023)
Hierarchy (some)						-0.014 (0.017)
All Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,839	8,839	8,839	8,839	8,831	8,838
R-squared	0.242	0.242	0.242	0.242	0.242	0.242
Number of clusters	26	26	26	26	26	26

Notes: Standardized continuous regressors. Individual belief is a binary variable which is 1 if an individual reports belief in witchcraft or the evil eye. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (6). *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

Table 2.7: OLS estimates for relation between malaria and ethnicity-country level belief

Dependent variable	Share of individuals believing in witchcraft or the evil eye				
	(1)	(2)	(3)	(4)	(5)
Historical malaria mortality	0.064** (0.028)	0.068** (0.026)	0.085** (0.036)	0.090** (0.035)	0.082** (0.039)
All Table 2.1 and Table 2.2 Controls	Yes	Yes	Yes	Yes	Yes
Precolonial Settlement & Centralization	No	Yes	Yes	Yes	Yes
Population density & City in 1800	No	No	Yes	Yes	Yes
Agro-pastoralism	No	No	No	Yes	Yes
European settlement controls	No	No	No	No	Yes
Observations	99	99	99	99	99
R-squared	0.852	0.852	0.867	0.873	0.886
Number of clusters	19	19	19	19	19

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Share of individuals is calculated as the proportion of people for a Murdock group in a country which report belief in witchcraft or the evil eye. Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (5). *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent level.

Table 2.8: OLS estimates for relation between malaria and individual trust

Dependent variable	Trust in other people					
	(1)	(2)	(3)	(4)	(5)	(6)
Historical malaria mortality	0.005 (0.014)	-0.048*** (0.011)	-0.050*** (0.012)	-0.057*** (0.011)	-0.055*** (0.010)	-0.055*** (0.010)
Country fixed effects	No	Yes	Yes	Yes	Yes	Yes
Baseline controls	No	Yes	Yes	Yes	Yes	Yes
Extended individual controls	No	Yes	Yes	Yes	Yes	Yes
Precolonial settlement	No	No	Yes	Yes	Yes	Yes
Precolonial centralization	No	No	No	Yes	Yes	Yes
Population density	No	No	No	No	Yes	Yes
Agro-pastoralism	No	No	No	No	No	Yes

European settlement controls	No	No	No	No	No	N
Regional Controls	No	No	No	No	No	N
Slave trade	No	No	No	No	No	N
Observations	8,617	8,617	8,617	8,617	8,617	8,6
R-squared	0.000	0.047	0.048	0.049	0.049	0.0
Number of clusters	26	26	26	26	26	26

Notes: Historical malaria mortality is the historical probability of dying from malaria before reproductive age for a particular ethnic group, this is standardized. Trust in other people is a binary variable which is 1 if an individual reports that “generally people can be trusted”. Standardized continuous regressors. Cluster-robust standard errors at the level of cultural provinces are shown in parentheses for columns (1) - (9). *** Significant at the 1 percent level, ** significant at the 5 percent level, * significant at the 10 percent

Appendix 2A. Additional tables

Table 2A.1 gives summary statistics for the full list of individual controls used in the empirical analysis, for the full sample.

Table 2A.2 shows the distribution of answers given to the survey question about belief in witchcraft & the evil eye across countries.

Table 2A.3 presents the distribution of individual observations across countries for the original PEW dataset and our baseline regression sample, as well as the number of Murdock ethnic groups per country in the baseline regression sample.

Table 2A.1: Summary statistics for individual characteristics in the full sample

Variable	Mean/Share	St. dev.	N
Belief in witchcraft	0.44	0.50	19,540
Belief in witchcraft or the evil eye	0.54	0.50	20,150
Age	33.44	12.88	20,463
Male	0.54	0.50	20,592
Rural residence	0.60	0.49	20,592
Completed primary education or less	0.39	0.49	20,186
Completed secondary education (or part)	0.41	0.49	20,186
Post-secondary education	0.20	0.40	20,186
Reports own economic situation as bad	0.47	0.50	20,415
Reports money shortages in past year	0.68	0.47	20,238
Use of internet (at least occasionally)	0.20	0.40	20,341
Use of computer (at least occasionally)	0.22	0.41	20,334
Use of e-mail (at least occasionally)	0.19	0.40	20,310
Reports crime as big problem	0.89	0.32	20,452
Reports religious conflict as big problem	0.57	0.50	20,168
Reports ethnic conflict as big problem	0.59	0.49	20,160
Thinks Western culture is hurting morality	0.73	0.45	19,441
Christian religion	0.59	0.49	20,490
Ethnoreligion	0.02	0.13	20,490
Index value for traditional practices (0 to 3)	0.70	1.00	19,703
Uses traditional religious healer when sick	0.43	0.50	19,678
Index value of religiosity (7 (lowest) to 1 (highest))	2.05	0.85	20,573
Belief in evil eye	0.45	0.50	19,544
Belief in evil spirits	0.49	0.50	19,616
Belief in protective power of sacrifices to ancestors	0.32	0.47	19,566
Belief in protective power of sacred objects	0.29	0.45	19,304
Belief in protective power of spiritual people	0.41	0.49	19,582
Belief in heaven	0.95	0.22	20,114
Belief in hell	0.84	0.36	19,966
Belief in angels	0.82	0.39	19,719
Belief in miracles	0.76	0.43	19,697

Notes: The first column shows the mean for continuous and index variables, and shows the share of observations for which the variable takes value 1 for dummy variables.

Table 2A.2: Responses to the survey question regarding witchcraft & evil eye beliefs, by country

Country	Yes (%)	No (%)	Don't know (%)	Refused (%)	N
Botswana	47	49	3.5	0.2	980
Cameroon	86	14	0.07	0.0	1,410
Chad	56	44	0.8	0.0	1,181
DR Congo	69	26	4.5	0.8	806
Djibouti	43	49	7	1.2	1,339
Ethiopia	31	68	0.7	0.0	1,465
Ghana	54	44	2.1	0.0	1,490
Guinea-Bissau	50	44	5.7	0.2	893
Kenya	35	64	0.5	0.0	1,481
Liberia	35	64	0.61	0.0	1,486
Mali	27	67	5.5	0.2	937
Mozambique	43	56	0.6	0.0	1,136
Nigeria	44	55	0.8	0.0	1,493
Senegal	63	31	5.4	0.0	990
Tanzania	96	4	0.3	0.0	1,482
Uganda	41	58	0.8	0.1	1,040
Zambia	42	58	0.4	0.1	983
Total	53	45	2.0	0.2	20,592

Notes: Data are shown for the full sample.

Table 2A.3: Distribution of individual observations and Murdock ethnic groups across countries in the original PEW dataset and the baseline regression sample.

Country	PEW dataset		Regression sample		Share of PEW observations in regression sample	Murdock ethnic groups (regression sample)
	Obs.	%	Obs.	%	%	Number
Botswana	1,002	4.0	817	4.5	82	21
Cameroon	1,503	6.0	1,395	6.8	93	55
Chad	1,503	6.0	1,040	4.5	69	17
DR Congo	1,519	6.1	722	2.9	48	16
Djibouti	1,500	6.0	1,081	5.9	72	2
Ethiopia	1,500	6.0	1,441	7.9	96	13
Ghana	1,500	6.0	1,429	7.8	95	25
Guinea Bissau	1,000	4.0	767	4.2	77	12
Kenya	1,500	6.0	1,433	7.7	96	25
Liberia	1,500	6.0	1,403	7.7	94	20
Mali	1,000	4.0	820	4.5	82	17
Mozambique	1,500	6.0	1,080	4.9	72	15
Nigeria	1,516	6.0	1,429	7.8	94	32
Rwanda	1,000	4.0	NA	NA	NA	NA
Senegal	1,000	4.0	880	4.8	97	17
South Africa	1,504	6.0	NA	NA	NA	NA
Tanzania	1,504	6.0	1,386	7.5	92	65
Uganda	1,040	4.1	1,022	5.6	98	16
Zambia	1,000	4.0	970	5.3	97	27
Total	25,091		19,115			

Notes: The first four columns show the number of individual observations per country and their share in the total dataset, for the original PEW dataset and for our baseline regression sample. The third column shows the share of individual observations from the original PEW dataset that was retained in our baseline regression sample. The final column shows the number of Murdock ethnic groups per country in our baseline regression sample after we have matched the individual PEW observations to ethnic groups identified by Murdock (1967).

Appendix 2B. Data sources and description

B.1. PEW survey data

Raw data and documentation for the PEW survey “Tolerance and Tension: Islam and Christianity in Sub-Saharan Africa” are available at <http://www.pewforum.org/datasets>.

Individual belief in witchcraft & Evil eye. Dummy variable equal to 1 if the respondent reports to believe in witchcraft or evil eye, and 0 otherwise.

Ethnicity-level prevalence of witchcraft beliefs. Proportion of people from Murdock group y in country x reporting to believe in witchcraft. Calculated based on matching of self-reported ethnicity in the PEW data to ethnic groups devised by (Murdock, 1967).

Age. Self-reported age.

Female. Dummy variable equal to 1 if the respondent is female, and 0 otherwise.

Secondary education. Dummy variable equal to 1 if the respondent reports to have attained some secondary education or completed secondary education, and 0 otherwise.

Tertiary education. Dummy variable equal to 1 if the respondent reports to have attained postsecondary education or higher, and 0 otherwise.

Urban residence. Dummy variable equal to 1 if respondent lives in an urban area, and 0 otherwise.

Semi-urban residence. Dummy variable equal to 1 if respondent lives in a semi-urban area, and 0 otherwise.

Personal economic situation. Categorical variable indicating how the respondent assesses his personal economic situation. On the ordinal scale: very good, somewhat good, somewhat bad, very bad.

Shortage of money in past year. Dummy variable equal to 1 if respondent reports that there have been times during the last year when he/she did not have enough money to buy food that the family needed, to pay for medical and health care that the family needed, or to buy clothing that the family needed. Equals zero when the respondent answers ‘no’ to all three questions.

Use of internet. Dummy variable equal to 1 if the respondent reports to “use the internet, at least occasionally”, and 0 otherwise.

Use of a pc. Dummy variable equal to 1 if the respondent reports to use a computer at the workplace, at school, at home, or anywhere else on at least an occasional basis, and 0 otherwise.

Use of email. Dummy variable equal to 1 if the respondent reports to send or receive e-mail, at least occasionally, and 0 otherwise.

Perception of crime as a problem. Categorical variable indicating to what extent the respondent thinks that crime is a problem in the country. On the ordinal scale: not a problem at all, small problem, moderately big problem, very big problem.

Perception of religious conflict as a problem. Categorical variable indicating to what extent the respondent thinks that conflict between religious groups is a problem in the country. On the ordinal scale: not a problem at all, small problem, moderately big problem, very big problem.

Perception of ethnic conflict as a problem. Categorical variable indicating to what extent the respondent thinks that conflict between ethnic groups is a problem in the country. On the ordinal scale: not a problem at all, small problem, moderately big problem, very big problem.

View on Western popular culture. Dummy variable equal to 1 if the respondent thinks that Western music, movies and television have hurt morality in the country.

Christian religion. Dummy variable equal to 1 if the respondent reports to be a Christian, and 0 otherwise.

Ethnoreligion. Dummy variable equal to 1 if the respondent reports to have an ancestral, tribal, animist, or other traditional religion, and 0 otherwise.

Traditional practices. Index variable capturing the respondent's engagement in practices associated with traditional religion or culture. Equals the number of questions to which the respondent answers yes, for the following questions: (i) do you have traditional African sacred objects in your home, such as shrines to ancestors, feathers, skins, skulls, skeletons, powder, carved figures or branches, spears, cutlasses or animal horns? (ii) do you ever participate in traditional African ceremonies or perform special acts to honor or celebrate your ancestors? And (iii) do you ever participate in traditional African puberty rituals or manhood/womanhood initiation rituals for friends, relatives or neighbors in your area, such as endurance or challenge tests, or initiation to a traditional dance?

Use of traditional healer. Dummy variable equal to 1 if the respondent says that he/she or their family ever use traditional religious healers when someone is sick, and 0 otherwise.

Religiosity. Index variable indicating the frequency with which the respondent engages in religious activities and the importance of religion in his/her life. The index is based on the following categorical variables with ordinal scales: Frequency of attending religious services (never, seldom, a few times a year, once or twice a month, once a week, more than once a week); frequency of praying (never, seldom, a few times a month, once a week, a few times a week, once a day, several times a day); frequency of reading religious scripture (never, seldom, several times a year, once or twice a month, at least once a week); frequency of sharing religious views (never, seldom, several times a year, once or twice a month, at least once a week); importance of religion in one's life (not at all important, not too important, somewhat important, very important).

B.2. Regional controls

Competition among Christian denominations. Herfindahl index capturing the religious market share of the different Christian denominations in a region. Religious market share is calculated as the share of Christian respondents in a region reporting to follow denomination d .

Nighttime lights per capita. Data on luminosity come from the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS) that reports stable images of Earth at night captured between 20:00 and 21:30. The measure ranges from 0 to 63 and is available for cells at 30 arc-second resolution, see Henderson et al. (2012) for technical details. We aggregate luminosity data for 2008 and 2009 at the regional level and then take their average. The latter is then divided by the region's population size to obtain the final measure of lights per capita. Source: <http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html>.

ACLED events. Geographical coordinates for all fighting events during 1997–2009 are taken from the Armed Conflict Location and Event Database (ACLED, version 3). We calculate the total number of events for each region. Source: <http://www.acleddata.com/data/>.

Ethnolinguistic fractionalization. Standard ELF index based on regionally representative household surveys (DHS and MICS), and the original Pew Forum survey. Created by Gersham (2016)

Ruggedness index. Index of terrain ruggedness as constructed by Nunn and Puga (2012) for cells at 30 arc-second resolution. The variable used in the analysis is the average value of the index across cells in each region. Source: <http://diegopuga.org/data/rugged/#grid>.

B.3. Ethnicity-level controls

For all own calculations, the geo-processing software ArcMap 10.4 was used to spatially match geographical information to ethnic homelands on the Murdock (1959a) Tribal Map of Africa and to perform the necessary analyses.

Geographic controls

Absolute latitude. Absolute latitude of the centroid of the Murdock ethnic homeland. Source: (Alsan, 2015), (Depetris-Chauvin and Weil, 2016), and Murdock (1959a).

Mean land suitability. Based on the index of suitability of land for rain-fed agriculture (maximizing technology mix) provided by the FAO GAEZ dataset (plate 46). Coded on a scale from 1 (very high suitability) to 8 (not suitable) for cells at 5 arc-minute resolution. The variable used in the analysis is the average value of the suitability index across cells in each Murdock ethnic homeland. Source: FAO GAEZ dataset (plate 46) downloaded at <http://webarchive.iiasa.ac.at/Research/LUC/GAEZ/index.htm>, and own calculations.

Variation in land suitability. Based on the same data as mean land suitability. Calculated as the standard deviation of index values across cells in each Murdock ethnic homeland.

Area. Area of the Murdock ethnic homeland measured in 1000 sq. km. Source: own calculations based on the sinusoidal projection for Africa and Murdock (1959a).

Mean altitude. Average elevation in km. Source: (Alsan, 2015).

Access to river. Dummy variable taking value 1 if the historical ethnic homeland has access to a river, and 0 otherwise. Source: (Alsan, 2015).

Distance to coast. Geodesic distance from the centroid of the Murdock ethnic homeland to the nearest point on the coast in meters. Source: own calculations using the coastline shapefile downloaded at <http://www.naturalearthdata.com>.

Distance to lake. Geodesic distance from the centroid of the Murdock ethnic homeland to the nearest water body in meters. Source: own calculations using the shapefile for water bodies in Africa downloaded at <http://geoportal.rcmrd.org>.

Slave exports. Natural logarithm of one plus the number of exported slaves of a given ethnicity normalized by the area of land historically inhabited by the respective ethnic group. Source: Nunn and Wantchekon (2011), dataset available at <http://scholar.harvard.edu/nunn/pages/data-0>.

Climate data

Mean annual rainfall (1957-2002). Weighted average of mean annual rainfall (m) during the growing season for the period 1957-2002 across cells for the Murdock ethnic homeland. Weights based on relative area of the cell compared to total area of the Murdock ethnic homeland. Source: own calculations based on data obtained from (Guariso and Rogall, 2016). See Guariso and Rogall (2016) for more information on the underlying data (ERA-40).

Mean annual temperature (1957-2002). Weighted average of mean annual temperature (C°) during the growing season for the period 1957-2002 across cells for the Murdock ethnic homeland. Weights based on relative area of the cell compared to total area of the Murdock ethnic homeland. Based on the same data as mean annual rainfall for this period.

Mean daily humidity (1871). Relative humidity (%) in the earliest year of available data (20th Century Reanalysis version 2.0). Source: (Alsan, 2015).

Mean daily temperature (1871). Temperature (C°) in the earliest year of available data (20th Century Reanalysis version 2.0). Source: (Alsan, 2015).

Tse Tse Suitability. Tse Tse suitability index capturing the normalized steady state population of the Tse Tse fly for the Murdock ethnic homeland depending on historical temperature and humidity. Source: (Alsan, 2015).

Precolonial political and economic outcomes

Complexity of settlement pattern. A measure of the complexity of the precolonial settlement

pattern of the ethnic group constructed by (Murdock, 1967), on the ordinal scale: nomadic or fully migratory; semi-nomadic; semi-sedentary; compact but impermanent settlements; neighborhoods of dispersed family homesteads; separated hamlets, forming a single community; compact and relatively permanent settlements; complex settlements. Source: (Nunn and Wantchekon, 2011) and (Gershman, 2016).

Centralization of institutions. Dummy variable equal to 1 if the precolonial jurisdictional hierarchy (constructed by (Murdock, 1967)) is at least 2 levels above the local authority, and 0 otherwise. Source: (Alsan, 2015).

Historical population density. Proxied by population data estimated by (Murdock, 1959b) for African ethnic groups for approximately the 20th century. Population density is defined as the logarithm of inhabitants per square kilometer. Source: (Nunn and Wantchekon, 2011) and (Alsan, 2015).

Presence of city in 1800. Dummy variable equal to 1 if a city with over 20,000 inhabitants was located on the Murdock ethnic homeland in 1800, and 0 otherwise. Source: (Alsan, 2015), based on (Chandler, 1987).

High dependence on agro-pastoralism. A dummy variable equal to 1 if the ethnic group depended on agriculture or husbandry for at least 66 % of subsistence production, and 0 otherwise. Source: (Alsan, 2015) and (Gershman, 2016).

Other ethnicity-level controls

Christian missions by area. Number of Christian mission stations on the Murdock ethnic homeland per 1000 sq. km. Source: own calculations using data from (Nunn, 2010), provided in shapefile available at <https://scholar.harvard.edu/nunn/pages/data-0>.

Connection to railway network. Dummy variable equal to 1 if any part of the railway network was built on land historically inhabited by the ethnic group. Source: (Nunn and Wantchekon, 2011).

European explorer route. Dummy variable equal to 1 if a European explorer traveled through land historically occupied by the ethnic group. Source: (Nunn and Wantchekon, 2011).

Historical malaria mortality

Historical malaria mortality. Estimated proportion of children in the Murdock ethnic group that would have died of malaria (through malaria itself or sickle cell disease) before reproductive age, conditional on not dying of something else. Source: (Depetris-Chauvin and Weil, 2016).

Appendix 2C. Additional details on data construction.

In the original PEW dataset, ethnicities are not recorded for Rwanda and South Africa. Hence, these two countries were dropped. The resulting sample included 17 countries, 22,587 individuals, and 697 self-reported ethnicity categories – of which a large number are synonyms, languages, or particular clans within an ethnic group.

For 370 individual observations (or 13 self-reported ethnicities) matching was not possible because the PEW ethnicity is reported as nationality or religion. The large majority of these cases (345) is due to respondents from Mozambique describing their ethnicity as Portuguese, which does not figure in the Murdock list of ethnic groups. An additional 268 respondents refused to answer or said not to know. For 1,243 individual observations, corresponding to 91 self-reported ethnicity categories, we could not find any information that allowed a match with a Murdock group. The 593 remaining self-reported ethnicities were then matched to 334 Murdock groups, resulting in a sample of 20,592 observations.

For 10 countries this final sample includes over 90 % of the observations from the original PEW dataset, and for 6 others we keep (roughly) between 70 % and 90 %. For the Democratic Republic of the Congo, the self-reported PEW ethnicity Bantu/other could not be matched to any Murdock group, resulting in the loss of 52 % of the original observations. Table 2A.3 in Appendix A shows the correspondence between the original PEW dataset and our baseline regression sample in terms of individual observations, and lists the number of Murdock ethnic groups for each country in the baseline regression sample. The same Murdock group may appear in several countries due to overlaps with national borders

Chapter 3: Child Rights, Traditions and Health Seeking behaviour in Nigeria

3.1 Introduction

One billion children suffer some form of violence each year and nearly 3 out of 4 suffer from negligence or abuse at the hands of caregivers and parents. In Sub Saharan Africa, rates of Child Neglect and Abuse are the highest in the world (UNICEF, 2020). While child negligence and abuse can be of different forms that which is rooted in social traditions can be exceptionally harmful such as the practice of Female Genital Mutilation, Child Marriages and accusations against children of Witchcraft (Camilotti, 2016).

There have been a wide array of policies designed to curb such practices from micro interventions such as cash transfers to families (Saha et al, 2018) to macro interventions such as the outright banning of social practices which harm children (Camilotti, 2016). The evidence on the efficacy of macro policies working is mixed ranging from finding no effect to short to medium run positive effects (Camilotti, 2016; Alfano, 2020).

Part of the reason why macro policies may not work is that they are applied in settings where local customs are embedded and hard to change (Fouka, 2020). 170 countries in the world have signed up to some form of child protection orders, however there is no clear consensus in the literature if these policies have improved the lives of children. In fact, it may be that granting legal protection to children may have unintended negative effects and backfire in an environment where the prevalent social norms are embedded and thus hard to influence. Basu (2018) and Acemoglu and Jackson (2017) demonstrate this result in a theoretical framework and Britto and Ulkuer (2012) and White (2002) demonstrate this finding empirically.

This study estimates the effect of granting formal legal protection to children on investments in children by exploiting a natural experiment. In 2003, the central legislature in Nigeria, Abuja legislated and passed an ambitious act known as the Child Rights Act (CRA). The CRA was described as a “milestone “and a “very ambitious legislation” (Philip and Ajanwachuku, 2018), it regulated the behaviour of parents towards their children by guaranteeing protection for children against mistreatment and abuse in variety of different contexts such as providing adequate healthcare. Parents can be subjected to strict actions which can be limited to fines or can result in more extreme outcomes such as a prison sentence or some form of corporal punishment. Over a period of 12 years, 26 states passed the legislation with differential timing due to differences in state machinery and debates around the passing of the law, the 11 northern states have yet to pass the legislation²⁵. The Nigerian setting has various unique features, which help to

²⁵ As of 2023, more states in Nigeria have made a commitment to enact the CRA. However, in practice this is an ongoing internal process for many of the Northern states which have yet to fully implement the CRA’s framework.

identify the causal effect of child protection laws. The staggered introduction of the act provides unique temporal and geographic variation in laws that in many other settings stay in place for a long time.

Why would we expect the CRA to impact children directly? From a theoretical perspective, work by Becker (1991) has found that families which are characterized by altruism achieve pareto optimal outcomes through within family bargaining, therefore child neglect can be viewed as an exception to this form of altruism. Child abuse and neglect are closer to theoretical models of crime rather than models of altruism (Doyle and Aizer, 2018). There are two possible mechanisms through which the CRA could impact children, the first emanates from the perceived threat of punishment due to non-compliance with the CRA. Studies on policy in North America regarding the legality of abortion have linked it to lower maltreatment of children (Gruber et al, 1999 and Bitler & Zavodny, 2002) and work by Alfano (2020) in Sub-Saharan Africa has found positive effects of non-secular (Sharia) law protection on the duration of breastfeeding and a reduction in child mortality. The second mechanism emanates from a change in the information scenario prevalent in Nigeria, the CRA can be viewed as changing the available information regarding mis-treatment of children. Stegmann & Bravo (2020) investigate the effect of (mis)information on preventive healthcare (vaccinations) in Pakistan and find negative effects on vaccination uptake. The focus of this paper is to investigate the effect of the CRA on two broad aspects of child welfare, their general well-being and preventative healthcare. To capture general equilibrium effects on child welfare, I investigate the effect on the anthropometry of the child, my hypothesis being that children born under the protection of the CRA are taken better care of by their parents which should be reflected in their weight and height. To investigate if the CRA improved the uptake of preventive healthcare, I focus on the uptake of vaccines (the first and subsequent doses) after controlling for supply side factors. Since the CRA regulated a wide array of actions towards children focusing on these outcomes will reflect general investments in children by their caretakers. This study considers the general effectiveness of Child Rights by investigating quantitatively and at scale the causal effects of their implementation and therefore contributes to the limited empirical work on the topic which has thus far focused on cross country correlations (Britto & Ulker, 2012) or considered small scale settings (White, 2002).

To begin with I use a difference in differences approach that compares over time children born in the states where the law changed to children born in the same state prior to the law change and children born in the states where the law did not change at all²⁶. To address concerns that the difference in differences estimates are not confounded by social, political or religious changes, I limit the comparison of children which were affected by the policy change to children born prior to the policy change in the

²⁶ In the literature, this model is also known as the two-way fixed effects difference in differences model for repeated cross sections. For a detailed discussion see Cunningham (2021)

same states²⁷. The advantage of this specification is that children born in these (southern) states are likely to experience the same socio-political forces. That being said, when the sample is the entire country the parallel trend assumption is satisfied before the CRA was enacted²⁸

As an additional exercise, I consider only the bordering states to the northern control states as being the treated group, focusing on individuals living in bordering states and born a few years apart allows me to compare the behaviour of individuals living in a similar environment²⁹. These comparisons show effects in line with the estimates for all of Nigeria.

Since the CRA regulates many different aspects of a parent's behaviour towards children, I examine its effect on different aspects of family welfare. First, I investigate the effect on the anthropometry of the child, my hypothesis being that children born under the protection of the CRA are taken better care of by their parents which should be reflected in their weight and height. Estimates from three rounds (2018, 2013 & 2008) of the Nigerian Demographic Health Survey (DHS) show that the children born under the new policy have a positive Z score gap of 0.25 σ to 0.5 σ (depending on the specification) for their height relative to their age³⁰. This positive score represents an improvement in the long-term wellbeing of children under 5.

In terms of other interventions and contextualising the magnitude of these findings, there are a vast number of studies conducted on the effect of nutrition on height for age Z scores. It is important to note that Height for Age (HForA) is a reflection of a variety of factors which includes genetics, disease, nutrition and environmental influences (Perkins et al, 2016). Out of these factors, the external factor which most affects linear growth is nutrition specifically protein as a single nutrient followed by minerals and Vitamins (Silventoinen, 2003). The nutritional interventions in the RCT literature are based on supplementation of vitamin A, iron, zinc, or multiple micronutrients. Broadly, there are split into interventions targeting children under 5 years of age (when of majority of stunting occurs) and children greater than 5 years of age. In interventions for children under 5 years of age, studies on Vitamin A supplementation found mixed results on HForA ranging from an increase of 0.75 σ (Nepal; West, 1997) 0.2 σ (Peru; Alcaro, 2004) , 0.25 σ (China; Lie, 1993) to minimal or no effects (Fahmida, 2007, Villamora, 2002 & Rahman, 2002), when looking at Iron supplementation the effects ranged from increases of 0.2 σ (Indonesia; Fahmida, 2002), 0.3 σ (Thailand ;Wasantwisut ,2006) to minimal or no effects (Berger, 2006, Smuts, 2010), Zinc supplementation improved HForA in children by 0.5 σ (Thailand ;Wasantwisut ,2006) 1 σ (China; Yang 2002) or had limited to no effects (Ecuador; Wueheler, 2008 and Peru; Brown,

²⁷ In effect, this sub sample limits the study sample to states which changed their policy thus removing states which never experienced the policy

²⁸ Outcomes change only after the introduction of the law for states which implemented the law, while states where the law was not introduced there is no change in the behaviour of parent's conditional on controls.

²⁹ The bordering states have greater commonalities in religion, ethnicity and culture

³⁰ Stunting is the best measure of the cumulative effects of chronic nutritional deprivation, reflecting the inability to reach linear skeletal growth potential and is therefore a key indicator of long-term well-being

2007). Lastly, Multiple Micronutrition interventions were found to have positive effects on HForA by 0.4σ (Guatemala; Begin, 2008) 0.4σ (Cambodia; Giovanni, 2006) and 0.3σ (Vietnam; Hop Le, 2005) or had limited to no effects (Olney, 2006 and Faber, 2005). Outside of individual supplementation, RCT's which provided broader information on infant and young feeding combined with nutritional supplementation found a positive Z score gap in HforA of $+0.16\sigma$ in Zimbabwe (Smith et al ,2019), $+0.39\sigma$ in Peru (Penny et al, 2005), $+0.50\sigma$ in Zambia (Fink et al, 2017). My HforA estimates from my main specifications (TWFE) and the Sun and Abraham (2021) estimator are broadly in line with the effects found in the literature from nutritional and combined nutrition and information interventions.

When segregating children by their age, the reduction in stunting applies for all age groups under 5. I find these positive effects on children's anthropometry are larger for smaller ethnic groups (Ekoi, Ibibio, Igala and Tiv). I investigate the channels for this positive result by considering dimensions of care such as the duration of breastfeeding, how soon a child is put to the breast and dietary diversity of children and find no positive effect of the policy on those dimensions. However, when looking at the effect of the policy on the birth weight of children, I find the policy resulted in new-borns with higher birth weights ranging from 0.11Kg to 0.18Kg (depending on the specification), these effects being statistically significant. Low birth weight has been shown to be a dominant predictor of stunting (Achadi et al, 2017). Therefore, the reduction in stunting is possibly caused by higher birthweights.

Second, I consider the effect on preventive healthcare of the CRA such as the uptake of the first dose and subsequent doses of essential vaccinations. I find no effect on the 1st doses of essential vaccines of children. However, this results masks heterogeneity in relation to wealth of a household, the effect of the policy on richer households is positive and statistically significant for the 1st doses of essential vaccines such as Polio, BCG & Hepatitis B. For the full doses of essential vaccines, I find a negative effect on receiving the full measles vaccine, however this result is for a selected subsample of states and years and not the full study sample but may be evidence of a backlash against the CRA.

The effect of the CRA could be driven by the demand or supply of healthcare, I test whether the results are robust to inclusion of controls for the supply of health services such as the number of vaccination campaigns and distance to the nearest health facility. The results confirm this hypothesis as the findings are robust to the inclusion of supply driven controls. The core results are also robust to the staggered rollout³¹ of the CRA and numerous other sensitivity tests³².

³¹ I use the estimator by Sun and Abraham (2021) to overcome problems with the traditional TWFE estimator, the discussion in relation to those results is elaborated upon later in this paper

³² These include calculation standard errors with bootstrapping, formal tests of pre-period parallel trends, using weighted regressions, checks for mean reversion, graphing the evolution of treated and controls groups, estimating the analysis by dropping one state at a time, presenting a variety of event study estimators, multiple hypothesis testing, the exogeneity of the law and a formal test of the breakdown value of the pre-trends for the results to hold

These results contribute to our understanding of how changes in laws can affect parental decisions in the context of Social Norms which may be adverse. Research indicates that social norms can be harmful (Camilotti, 2016 and Heise et al, 2018) are interrelated with health outcomes for children (Britto and Ulkuer, 2012 and White, 2002) and laws which are designed to combat this may end up backfiring (Basu, 2018 and Acemoglu and Jackson, 2017, Fouka, 2020). Lastly, the effect of legislation specifically protecting children is connected to the growing knowledge base on the protection of children (Aizer et al, 2018). By linking laws to child outcomes, this analysis also relates to studies which investigate social (La Ferrara et al. 2012; Bassi et al. 2014, Rasul et al 2020) and historical (Dell, 2010) influences on parental behaviour and children's outcomes.

The next section (3.1) outlines the introduction of the Child Rights Act in Nigeria and presents the data. Section 3.2 lays out the empirical strategy; the results are presented in section 3.3. Section 3.4 discusses robustness & identification issues and Section 3.5 concludes.

3.2 Background & Data

3.2.1 The introduction and enforcement of the Child Rights Act in Nigeria

In 1999, Nigeria established its fourth republic, which granted considerable autonomy to each of its 37 states. Laws that protected children in Nigeria prior to the CRA fall broadly into two categories, secular and non-secular protection. Secular laws that existed prior to 2003 were part of the wider protection afforded to children under laws put in place by the British colonialists which eventually graduated to the 1979 acceptance of the declaration of children rights, under these older secular laws there was limited protection for children due to the lack of clarity on violations and enforcement. These secular laws governed the entire country until the implementation of Sharia (non-secular) laws in the northern part of Nigeria in 2000. Sharia law has both detailed laws and procedures to protect children and studies find them as being effective in improving child related outcomes (see for example Alfano, 2020).

Nigeria has a rich cultural heritage with many positive traits; however, the existence of harmful traditions is also prevalent in Nigeria. Traditional birth practices are still widely used by untrained birth attendants and traditional healers and new born babies are subject to practices such as bathing in boiling water leading to skin burns and trauma, female genital mutilation is conducted on girl babies as young as 7 days old usually by untrained healers who report severe bleeding after circumcision, sometimes so severe that it leads to death (Alabi, 1990)³³.

The CRA's focus can be broadly classified as improving the health of children, the banning of exploitative practices against children such as Child Labour and Child Marriage with the imposition of

³³ This is a subsection of adverse traditions in Nigeria, there also exists food taboos during pregnancy and for feeding under 2-years-olds specific types of foods which lead to malnutrition in children (Ekowchi et al, 2016)

strong penalties if the act is violated and in certain cases, the right to revoke the guardianship of the child if deemed necessary by the relevant authorities. The CRA's enforcement entailed setting up special family courts at the local and district level and aid from local law enforcement with specialised units dedicated to ensure the CRA was enforced³⁴ There is extensive anecdotal evidence based on coverage in Nigerian English news reports and public prints including those reported by NGOs of both an awareness of the law and its enforcement³⁵.

Analysis of the enforcement of the CRA within Nigeria had been conducted by Oko & Eno (2012) who investigated its implementation by Civil Servants and found 70% of the CRA has been implemented as intended. Smaller scale studies on the knowledge of the CRA in different settings such as Imo state (Ikeh, 2023), Oyo state (Onwuka, 2018) and Enugu state (Okoye, 2014) find wide spread knowledge of the CRA however find mixed results in its adherence by parents driven primarily by challenges in effective implementation due to state capacity constraints.

Evidence based on the number of cases of Child Abuse, Defilement and Abandonment and the prison inmate population shown in Figures 3.4A & Figure 3.4B demonstrate for those states that implemented the CRA, a twofold increase in the Child cases reported and a 21% increase in the general inmate population³⁶. Since not all cases would lead to incarceration and a case being filed, the real number of cases is likely higher. The National Humans Rights commission in Nigeria has received 212,480 complaints of child rights abuses in 2020 which increased to 367,440 in 2021³⁷ (ICIR, 2022). Furthermore, the Nigerian Ministry of Women Affairs has established Family courts in 16 of the implementing CRA states to improve capacity to deal with complaints regarding the CRA (Voice of Nigeria, 2022) and there has been a push at state level to increase knowledge of the CRA in conjunction with local NGO's (Kogi state) or local universities (Anambra state) (Kogi Reports, 2023 and Nigerian Sun, 2023).

Beginning in September, 2003 Abuja become the first state to pass the Child Rights Act (CRA) (Parliamentary proceedings Nigeria, 2003). The CRA was applicable to all children and their caretakers in the state without exception, the passing of the legislation was a top down process which began in the

³⁴ The specific clauses protecting children and some publicly known cases are detailed in the appendix

³⁵ A simple search on Google News for the keywords "Child Rights Act Nigeria" returns 190,000 hits, including "Prosecution or enforcement" returns 39,100 hits. Since not all cases pertaining to the CRA were reported by news outlets or NGOs, the real number of cases is likely to be higher.

³⁶ The number of child cases and inmate population is obtained from the data provided by the Nigerian police force in the Annual statistical abstract of Nigeria for a limited period of years (2002, 2004, 2005, 2006, 2006, 2009 and 2010) and for certain states this information is not present. The aggregate value of cases heard is low and likely reflects underreporting, however these numbers provide evidence of increased child cases being heard in courts post the CRA in the states that implemented it.

³⁷ The states with the most complaints were Kaduna (38,456), Delta (35,309), Imo (29,421), Niger (23,680), Lagos (19,176), Abia (11,481), and Kwara (11,386), all of which have passed the CRA.

To pass the Child Rights Act, the 26 Southern states all debated the merits of the act before implementing the law, this resulted in variation in the timing of when the law was passed ranging from its first passing in September, 2003 to its most recent passing on August, 2016. As a result of this policy, children's rights in Southern states were protected by secular law. The remaining northern states which were governed by Sharia law already contained child protection clauses experienced no change (Alfano, 2020), see Figure 3.

A detailed map of Nigeria showing its 36 states and the Federal Capital Territory (FCT). Each state is labeled with its name and the year it was created (e.g., T:2016 for Niger, T:2006 for Oyo). The map includes major cities, the Niger River, Lake Chad, and the Gulf of Guinea. A compass rose is in the top left, and a scale bar is at the bottom left. A legend in the bottom right identifies symbols for national and state capitals, international boundaries, and state boundaries. An inset map shows Nigeria's location in Africa.

Legend:

- National capital (star in a circle)
- State capital (dot in a circle)
- International boundary (dashed line)
- State boundary (solid line)

States and Years of Creation:

- Abia: T:01
- Adamawa: T:2001
- Act: T:01
- Ag: T:01
- Anambra: T:01
- Ani: T:01
- Ar: T:01
- Asaba: T:01
- Awka: T:01
- Benue: T:2009
- Bauchi: T:2016
- Bayelsa: T:16
- Benue: T:2009
- Borno: T:2016
- Calabar: T:08
- Cross Rivers: T:09
- Delta: T:09
- Enugu: T:16
- Ekiti: T:06
- Imo: T:04
- Kaduna: T:2016
- Kano: T:2016
- Katsina: T:2016
- Kebbi: T:2016
- Kogi: T:07
- Kwara: T:2007
- Lagos: T:04
- Niger: T:2016
- Nigeria: T:2016
- Northern: T:2016
- Ogun: T:04
- Ondo: T:07
- Oyo: T:2006
- Plateau: T:2005
- Rivers: T:10
- Sokoto: T:2016
- Taraba: T:2005
- Yobe: T:2016
- Zamfara: T:2016

³⁸ The States which adopted the CRA are Anambra, Imo, Ogun, Nasarawa, Taraba, Ekiti, Kwara, Delta, Kogi, Ebonyi, Abuja, Plateau, Abia, Oyo, Ondo, Lagos, Edo, Osun, Akwa Ibom, Cross River, Benue, Rivers, Niger, Kaduna, Bayelsa, Enugu

3.2.2 Data, Sample and Measurements

My main data source is the Demographic and Health Survey (DHS) a nationally representative survey of Nigerian households. These data contain individual-level data on each child living in the household, and household and caretaker level data. Interviews in the DHS are conducted in English, Hausa, Igbo and Yoruba³⁹

I rely on data from four waves of the DHS (2003, 2008, 2013 & 2018). The pooled sample yields on 94,053 children which are less than 5 years old which were born between July, 2003 and December, 2018. Out of the 37 states, I exclude 10 states where the exact date of the policy is unclear⁴⁰. Therefore, the final sample of states is 16 Southern Treated States & 11 Northern Control states which yields 27 state clusters in total with unbalanced cluster sizes⁴¹. It is important to note the 16 Southern Treated States also serve as control states prior to the passing of the CRA, while the 11 Northern Control states always serve as the control states⁴².

Detailed summary statistics are presented in Table 3.

³⁹ Publicly available at <https://dhsprogram.com/>

⁴⁰ In these cases, there is no record of parliamentary proceedings on when the CRA was passed and information from news coverage reports is either conflicting or unclear, therefore in order to minimize error of incorrectly attributing a specific date to a state for the policy, I choose to exclude them until better information becomes available regarding the specific date of enactment. The states excluded are Anambra, Imo, Ogun, Nasarawa, Taraba, Ekiti, Kwara, Delta, Kogi & Ebonyi

⁴¹ The treated states are Abuja, Plateau, Abia, Oyo, Ondo, Lagos, Edo, Osun, Akwa Ibom, Cross River, Benue, Rivers, Niger, Kaduna, Bayelsa, Enugu. The control states are Kano, Sokoto, Zamfara, Katsina, Yobe, Borno, Adamawa, Gombe, Bauchi, Kebbi & Jigawa

⁴² In order to ensure the comparison of treated and control states is valid, results from the Bacon decomposition are discussed in the robustness section and presented in the appendix

Table 3: Summary Statistics (Pre-Period)

Child Characteristics

Variable	Full Sample			Treated States			Control States		
	Mean/Share	St. dev.	N	Mean/Share	St. dev.	N	Mean/Share	St. dev.	N
Child's age in months	26.80	17.34	4981	27.10	17.10	2769	26.65	17.17	2212
Ever had any vaccination	0.69	0.46	4222	0.77	0.42	2147	0.60	0.48	2075
Childs Gender_Male	0.49	0.49	6029	0.48	0.49	3281	0.49	0.50	2748
DPT0	0.41	0.49	5117	0.56	0.49	2853	0.21	0.40	2264
DPT1	0.32	0.46	5102	0.47	0.49	2838	0.14	0.35	2264
DPT2	0.22	0.42	5102	0.33	0.47	2838	0.09	0.28	2264
Polio0	0.24	0.42	5169	0.34	0.47	2875	0.11	0.32	2294
Polio1	0.65	0.47	5160	0.74	0.43	2866	0.55	0.49	2294
Polio2	0.54	0.49	5121	0.65	0.47	2845	0.42	0.49	2276
BCG	0.49	0.49	5136	0.66	0.47	2859	0.28	0.45	2277
Measles	0.35	0.47	5102	0.45	0.49	2835	0.21	0.40	2267
Weight for Height_WHO	-0.27	1.46	4406	-0.21	1.40	2537	-0.34	1.55	1869
Height for Age_WHO	-1.62	1.92	4406	-1.23	1.80	2537	-2.14	1.95	1869
Weight for Age_WHO	-1.13	1.36	4406	-0.87	1.28	2537	-1.49	1.39	1869
Body Mass Index_WHO	-0.11	1.50	4406	-0.10	1.44	2537	-0.14	1.58	1869

Caretaker Characteristics

Respondents current age	28.90	6.90	4406	29.50	6.80	2537	28.20	6.94	1869
Catholic	0.11	0.32	4401	0.19	0.39	2537	0.01	0.08	1864
Muslim	0.15	0.35	4401	0.23	0.42	2537	0.91	0.15	1864
Tradionalist	0.58	0.49	4401	0.33	0.47	2537	0.01	0.08	1864
Other Christian	0.15	0.35	4401	0.22	0.41	2537	0.05	0.15	1864
Age at First Birth	18.69	3.94	6029	19.60	4.11	2537	17.40	3.29	1869
No Education	0.47	0.49	4406	0.30	0.46	2537	0.71	0.45	1869
Primary Education	0.24	0.43	4406	0.31	0.46	2537	0.15	0.36	1869
Secondary Education	0.23	0.42	4406	0.33	0.47	2537	0.11	0.32	1869
Higher Education	0.04	0.19	4406	0.05	0.22	2537	0.02	0.15	1869

Household Characteristics

Polygamous House (Y/N)	0.33	0.47	4179	0.28	0.44	2373	0.40	0.49	1806
Rural Residence	0.62	0.48	4406	0.59	0.49	2537	0.66	0.47	1869
Electricity	0.49	0.49	4337	0.53	0.49	2487	0.44	0.49	1850
Radio	0.77	0.42	4346	0.82	0.38	2492	0.69	0.46	1850
TV	0.31	0.46	4336	0.38	0.48	2488	0.23	0.42	1848
Family Size	2.27	1.21	4406	2.14	1.16	2537	2.45	1.25	1869

Notes: Table 3 reports summary statistics by location of residence; all figures are drawn from the 2003 round of the Nigerian DHS; columns 1-3 refer to the whole of Nigeria, columns 4-6 refer to states that introduced the CRA, and columns 7 to 9 refer to states that did not introduce the CRA, numbers are based on children born between April 1998 and Jul 2003 (i.e. the pre period).

The average age of children in the sample is 27 months, the gender of children is approximately the same in the treated and control states and the number of children reporting receiving some vaccination is higher in the treated states. Children in the treated states have a higher proportion of children which report receiving the first and subsequent doses of essential vaccines and better anthropometry compared to the control states.

For caretakers, the majority of caretakers are the biological mothers of the child (not shown), there is a higher proportion of mothers who follow Islam in the northern control states, report a lower level of education, a higher degree of polygamy, a lower age of first birth and slightly larger family sizes compared to the treated southern states.

Since the CRA regulates different aspects of child welfare, I examine its effect on two important aspects of family welfare, the anthropometry of the child and their vaccination status. The choice of these variables is driven by what they represent, investments in preventive healthcare (vaccinations) and investments in general child wellbeing (anthropometry). The general equilibrium effects of the CRA on the wellbeing of children are well captured by these dependant variables. Therefore, the main dependant variables are the anthropometry of the child and their vaccination status.

Anthropometric measurements allow comparisons to population norms, the obtained measurements are compared to standardized percentiles. This methodology allows for boys and girls aged 0 to 60 months percentile and z-score curves for length/height-for-age, weight-for-age and BMI-for-age in relation to a reference guideline. Each Z-score expresses the anthropometric values of a child as a number of standard deviations below or above a reference mean/median⁴³.

For the vaccination status of the child, in the majority of specifications I only code yes responses to vaccinations if it was verified by the enumerator using the vaccination card, 0 otherwise thus confirming the vaccination status of the child for the first doses of DPT, Polio and Measles and BCG and all subsequent doses of the vaccines⁴⁴. Despite potential measurement error and problems based with recall, as an additional check I discuss results with recall also coded as 1, 0 otherwise. The results are robust to this change.

I also employ alternative dependant variables from the DHS which measure care towards children which are already born and those in utero. For Children that are already born when the interview occurs, I consider the birthweight of the child, duration of breastfeeding, how soon the child is put to the breast, variety in the nutrition they receive within the last 24 hours and episodes of recent illness such as diarrhoea or a cough within the last 2 weeks. For Children that are still in utero, I consider care during

⁴³ The anthropometric measures are calculated using the guidelines issued by the WHO.

⁴⁴ Enumerators for the DHS surveys can choose among the following options in order to record a child's vaccination status: 1) yes (vaccination date marked on the vaccination card); 2) yes (based on mother's recall); 3) yes (vaccination marked on the vaccination card but with no date); 4) no (no card seen) 5) no (card seen) 6) Don't know.

pregnancy for the mother such as infectious disease control for intestinal parasites, iron supplementation and visits for regular check-ups during pregnancy.

3.3 Estimation framework

This paper establishes a causal effect of the child rights act on two main dependent variables i) the Anthropometry of a child for and ii) if a child received the first and subsequent doses of essential vaccines. I start by estimating various differences in differences estimates, which compare outcomes over time and across states.

3.3.1 Difference in Differences

The first model is a Differences in Differences specification which compares the children born in the states where the CRA was implemented compared to children living in non-CRA states⁴⁵.

$$Y_{i,j,t} = \alpha + \delta_{DD} \left(\sum_{j=Ogun}^{Sokoto} State_j * \sum_{t=2003}^{2018} Born After_t \right) + \sum_{j=Ogun}^{Sokoto} \beta_s State_j + \sum_{t=2003}^{2018} \beta_k year_t + \sum_{j=Ogun}^{Sokoto} \omega_l (State_j * t) + \lambda'(C_i) + \varepsilon_j \quad (3.1)$$

where $Y_{i,j,t}$ denotes outcome y for child i , in state j , at year t , state=1 if the child resides in the state where the CRA was enacted, born after=1 if the child is born in a year-month after the policy was enacted (depending on the outcome, but this is normally after 2003). The specification includes State Fixed effects to control for the time-invariant characteristics of states that affect child investment decisions, Year of birth Fixed effects which control for the trend and seasonality in vaccination and anthropometry common to all states and a term which captures Linear State year trends following the example of Angrist & Pischke (2014). Furthermore, I include controls at the child, caretaker and household level⁴⁶. Standard errors are clustered at the state level of which there are 27 clusters, since this is slightly below the threshold of 30 clusters recommended for clustering (Angrist & Pischke, 2014), I re estimate the results with bootstrapping within Cluster with 1000 Repetitions⁴⁷.

By comparing individuals living in two different areas of the country over time, the specification in equation 3.1 differences out time-invariant differences between children in CRA states and children in non CRA states. However, if there are any time-varying differences between children in CRA and non-CRA states, the coefficient would attribute this to the introduction of the CRA. To address this possibility, I control for the different Linear State year trends and also re-estimate equation 3.1 by using

⁴⁵ The first difference is outcomes between the CRA and non-CRA states and the second difference in outcomes is between the CRA states to the counterfactual post policy

⁴⁶ Age at first birth, Education level, Number of vaccinations in a Childs life, Child Gender, Rural Household, Family Size, Religion, Polygamous Household, Wealth Index and Distance to nearest Health Facility. The selection of these controls is through consulting the literature, for example Age at First Birth is known to be a predictor of vaccination status (Bravo & Stegmann, 2019). Furthermore, the results are robust to the inclusion/exclusion of these controls.

⁴⁷ The results are shown and discussed in the robustness section

a control group comprised of only children born in the southern states (thereafter referred to as southern states).

As an additional check, I re-estimate equation 3.1 but limit the treated states to only those bordering the northern treated states (thereafter referred to as bordering treated states), focusing on individuals living in bordering states and born just a few years apart allows me to compare the behaviour of individuals living in a similar environment. In this specification there are 4 states that border the Northern Control states⁴⁸. While greatly reducing the sample size at my disposal in this specification, I have 14 state clusters but the advantage of only comparing states where there is a greater similarity in ethnicity & customs.

I augment equation 3.1 by allowing for heterogeneity in the impact of the policy on the basis of the wealth index of the household to assess if richer households with better access to media are more aware and therefore more compliant with the new policy, the gender of the child to capture if the policy benefitted a specific gender's welfare more and the ethnicity of the household on the basis of the language spoken to ascertain if minority ethnicities benefitted from the CRA.

3.3.2 Triple Difference in Differences

To investigate the heterogeneity on various dimensions such as gender or wealth, I expand Equation 3.1 by including a triple interaction term, in the estimation below I use the gender of the child⁴⁹ to investigate if the CRA inadvertently widened gender differences in the household, I formally estimate the specification below for girl children where $Gender_i$ is equal to 1 if the child is a girl.

$$\begin{aligned}
 Y_{i,j,t} = & \alpha + \delta_{DDD} \left(\sum_{j=Ogun}^{Sokoto} State_j * \sum_{t=2003}^{2018} Born After_t * Gender_i \right) + \beta_1 \sum_{j=Ogun}^{Sokoto} State_j * \\
 & \sum_{t=2003}^{2018} Born After_t + \beta_2 \sum_{t=2003}^{2018} Born After_t * Gender_i + \beta_3 \sum_{j=Ogun}^{Sokoto} State_j * \\
 & Gender_i + \sum_{j=Ogun}^{Sokoto} \beta_4 State_j + \sum_{t=2003}^{2018} \beta_5 year_t + \sum_{j=Ogun}^{Sokoto} \omega_l (State_j * t) + \lambda'(C_i) + \varepsilon_j
 \end{aligned}
 \tag{3.2}$$

⁴⁸ Taraba, Plateau, Niger & Kaduna

⁴⁹ When investigating the heterogeneity by wealth of the household, I replace the gender term with the wealth index of the household. The same logic applies when replacing gender with the ethnicity of the household.

3.3.3 Dynamic Difference in Difference framework

A concern in my setting is the possibility that the effect of guaranteeing child protection varies over states or over time. This could occur, for example, if there is a lag between the enactment of the law and its implementation, or if the impact of the reform on vaccinations and anthropometry takes some time to materialize. Since there is no reason why the impact of guaranteeing child protection on vaccinations and anthropometry should remain constant over time, I estimate a number of Dynamic Difference in Differences estimates⁵⁰. The primary model I use is the one developed by Sun and Abraham (2021) which assesses the dynamic effects of the policy and the plausibility of the parallel trends assumption. The parameters of this model are as follows: Always treated states are omitted, leads and lags are binned at distant relative periods, and the reference periods are $t=-1$ and $t=+6$ are omitted following Sun & Abraham's (2021) advice to avoid multicollinearity. The choice of Sun & Abraham's (2021) model is due to the advantage it has of overcoming heterogeneity bias and weighing problems.

These estimates should demonstrate when the policy change influences behaviour and provide evidence supporting the parallel trend assumption by estimating a version of the baseline specification that allows the effect to vary over time, I present the estimates in a graph that plots leads and lags of the effect of the policy. I plot leads and lags of 5 years which is the time frame employed in similar studies when considering short to medium run effects (Mastrorocco & Ornaghi, 2020 and Alfano, 2020)⁵¹

For this exercise, I exploit the exact timing of the CRA and estimate whether changes in the anthropometry of children and their vaccinations occurred the same time as the policy change or was there a lag in the effect of the policy. I group children into 1-year cohorts⁵² and estimate the following equation, using the broadest comparison group at my disposal (27 states). More formally I estimate:

$$Y_{i,j,t} = \alpha + \delta_1 \left(\sum_{j=Ogun}^{Sokoto} State_j * \sum_{y=1}^{t \min} Born \ prior_{t-y} \right) + \beta_1 \left(\sum_{j=Ogun}^{Sokoto} State_j * \sum_{y=0}^{t \max} Born \ post_{t+y} \right) + \sum_{j=Ogun}^{Sokoto} \beta_2 State_j + \sum_{t=2003}^{2018} \beta_3 year_t + \sum_{j=Ogun}^{Sokoto} \omega_l (State_j * t) + \lambda'(C_i) + \varepsilon_j \quad (3.3)$$

If the CRA indeed affected investments in children, one would expect parents in CRA states to change their behaviour (relative to parents in non-CRA states) only after the CRA has been introduced. Before

⁵⁰ In the literature, this framework is also labelled as an event study

⁵¹ To assess the long run, I plot a longer time horizon of 10 year leads and lags which still fluctuate around zero in the pre-period, the results are not shown but are available upon request

⁵² I also group cohorts into 6-month intervals which does not change the trends shown here, the results are not shown but are available upon request

the CRA, by contrast, the time trends of both groups should be parallel (i.e: the beta coefficients to vary around 0 and be statistically insignificant) which is the case for equation 3.3⁵³

3.3.4 Cut off selection

My identifying assumption is the state of residence and date of birth of the child jointly determine a child's exposure to the shock induced by the change in the law. However, for the vaccination status of children in the CRA states it is theoretically possible children can always get vaccinated at older age; therefore, the non-exposed groups are not a pure control group. There exist three possibilities, children which were born after the CRA (fully exposed cohorts), children born *much earlier* which were not exposed to the shock as they were already older by the time the law changed (the non-exposed cohorts)⁵⁴ and children born *shortly before* the law change (the partially exposed) for who part of their childhood occurred under the new conditions after the law had changed.

I empirically identify the exact age a child receives vaccinations by plotting the percentage of children that receive a vaccination as a function of their age for the first & subsequent doses of DPT, BCG, Polio and measles using the pre-period survey (DHS 2003) shown in Figure 3.1.

These graphs show the likelihood of receiving the first dose of Polio, DPT and BCG. The likelihood of receiving a vaccination grows rapidly for the first 4 months of the infant's life, while there are subsequent increases the rate of increase is fastest in the 4 months of life. While for the Measles vaccine the likelihood of receiving the vaccination grows for the first 12 months of the infant's life and then reaches a plateau⁵⁵. Therefore, when considering the immunization status of DPT, Polio and BCG, I consider the children born 4 months prior to the change in the CRA as being partially treated and for the Measles vaccine, children born 12 months prior to the change in the CRA as being partially treated.

For simplicity in comparing results, I exclude all children born 1 year prior to the CRA for the first & subsequent doses of DPT, BCG, Polio and measles. The results are robust to the exclusion and inclusion of the partially treated groups⁵⁶.

For the WHO anthropometric measures, the arguments outlined above apply and the results presented exclude all children born 1 year prior to the CRA, similar to vaccinations the results are robust to selecting different cut offs.

⁵³ Figure 3.2 and Table 3A.11 show the event study estimators using Sun and Abraham (2021)

⁵⁴ Theoretically, older children can always get vaccinated. However, empirically investigating the age profiles demonstrates that there is a plateau in receiving the vaccinations which partially alleviates this concern

⁵⁵ When children actually receive the vaccine is different from what the national immunization schedule stipulates, to illustrate, BCG is meant to be given at birth but children continue to receive it till they are 10 months old. The official schedule is shown in the appendix

⁵⁶ These results are not shown but are available upon request

3.4 The Main Results of the CRA's effect

3.4.1 Anthropometric estimates

The dependent variable is the anthropometric score of the child, measured in standard deviations using the standards provided by the World Health Organization in 2006⁵⁷. The anthropometry for children born in the 5 years prior to the interview is calculated⁵⁸.

The estimates shown in Table 3.1 are estimated using equation 3.1 and include the full set of covariates and fixed effects. The results in Table 3.1 are re-estimated using only children under 2 years of age as the sample group, as this is the period where the majority of stunting occurs in children (IARC, 2015), the effects are all statistically significant as for the full and limited sample⁵⁹

⁵⁷ Available at https://www.who.int/childgrowth/software/who_anthro_pc.pdf

⁵⁸ Using the command ZSCORE06 in STATA

⁵⁹ The results are not shown but available upon request

Table 3.1: Effect of the CRA on Anthropometry

	Dependant Variables			
	(1) (HforA)	(2) (WforA)	(3) (WforH)	(4) (BMI)
Panel A: Full Sample-27 States				
Born After* State Policy Change	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Mean Dep Var (Control)	-1.45	-1.11	-0.38	-0.25
Observations	40,245	40,284	40,329	40,295
R-squared	0.163	0.067	0.154	0.073
Number of clusters	27	27	27	27
Panel B: Bordering Treated States- 14 States				
Born After* State Policy Change	0.502** (0.147)	0.226 (0.134)	-0.124 (0.145)	-0.141 (0.150)
Observations	25,993	26,065	26,028	26,038
R-squared	0.109	0.083	0.059	0.069
Number of clusters	14	14	14	14
Panel C: Southern States- 16 States				
Born After* State Policy Change	0.246* (0.122)	0.166 (0.107)	-0.002 (0.082)	0.009 (0.082)
Observations	18,874	18,889	18,879	18,882
R-squared	0.155	0.104	0.072	0.087
Number of clusters	16	16	16	16

Notes: Table 3.1 reports estimates for the effect of the CRA on various anthropometric measures using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states.; all parameters are estimates based on the pooled sample of DHS; standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels. Sample consists of children between July, 2003 and December, 2018 who are under 5 years of age at the time of the interview.

3.4.2 Differences in differences and triple difference estimates

In Table 3.1, Panel A compares children born in the CRA states to children born in the non-CRA states prior to the law and children born after the policy between the CRA and non-CRA states. In Panel A, the sample is for the entire country, the positive result for Height for Age (HforA) can be interpreted as the average treatment effect of the policy which suggests that children born under the protection of the CRA had a Height for Age (HFA) z-score gap of $+0.35\sigma$. In Panel B, I limit the treated states to only the bordering states to the northern control states and find a stronger effect on the z-score gap of $+0.50\sigma$ and in Panel C, I exclude the states that never changed the policy and compare only children in the southern states⁶⁰ and find a smaller effect of $+0.25\sigma$ of the CRA but a statistically significant impact nonetheless. In Table 3.2, I compare children by their age at the time of interview to dis-entangle the group which is driving the improvement in anthropometry, In Panel A which compares all of Nigeria the effect is driven by all age groups, and this effect is similar in Panel B, in Panel C the effect is limited to 4 and 5 year-olds.

⁶⁰ This is also to deal with the clustering of the control and treated states in the north and south of the country, this estimation uses only the southern states which serve as both the control and treatment groups, prior and post policy

Table 3.2: Effect of the CRA on Anthropometry by Age Group

Dependant Variable	(1 year)	(2 year)	(3 year) (HforA)	(4 year)	(5 year)
Panel A: Full Sample-27 States					
Born After* State Policy Change	0.411** (0.180)	0.355* (0.187)	0.419*** (0.159)	0.400*** (0.170)	0.317*** (0.103)
Mean Dep Var(Control)	-0.61	-1.60	-1.85	-1.71	-1.66
Observations	9,614	8,055	7,509	8,038	7,029
R-squared	0.087	0.141	0.173	0.170	0.202
Number of clusters	27	27	27	27	27
Panel B: Bordering Treated States- 14 States					
Born After* State Policy Change	0.572* (0.303)	0.639* (0.306)	0.411** (0.172)	0.610*** (0.208)	0.509*** (0.110)
Observations	6,254	5,115	4,731	5,423	4,650
R-squared	0.074	0.062	0.059	0.069	0.083
Number of clusters	14	14	14	14	14
Panel C: Southern States- 16 States					
Born After* State Policy Change	0.195 (0.122)	0.194 (0.250)	0.321 (0.229)	0.402*** (0.128)	0.263*** (0.111)
Observations	4,388	3,823	3,680	3,731	3,249
R-squared	0.103	0.14	0.163	0.162	0.214
Number of clusters	16	16	16	16	16

Notes: Table 3.2 reports estimates for the effect of the CRA on Height for Age using the estimation shown in Equation 3.1 by comparing specific age groups; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

In Table 3.3, the results from equation 3.2 using the gender of the child are shown where each column represents a different measure of the child's anthropometry. The first row shows the baseline estimates from Table 3.1. In the 2nd row of Panel A, I don't see a differential outcome by gender for the effect of the policy on Height for Age. However, I do find a negative and statistically significant gap for the z-score on girl children for Weight for Height and their Body mass index suggesting a trade-off of resources in the household. In Panel B & Panel C, the effect dissipates. I also conduct a heterogeneity analysis by the ethnicity of the caretaker (mother)⁶¹, I find these positive effects on children's anthropometry are larger for smaller ethnic groups (Ekoi, Ibibio, Igala and Tiv). This is perhaps due to the nature of the CRA which guarded the rights of children and hence had a larger positive effect on children belonging to minority ethnicities. I also conducted a heterogeneity analysis on the basis of belief in witchcraft of the ethnic group⁶² that the child belonged to. I replace the gender term in equation 3.2 with a dummy if the child belonged to an ethnic group with higher than median belief in witchcraft or not⁶³, the point estimate of the effect of the CRA on the anthropometry (Height for Age) of the child is higher for children that belong to an ethnic group which has a higher than median belief in witchcraft compared to those groups that do not⁶⁴. Belief in witchcraft can be seen as a proxy for belief in superstition, given the accusations against Children in Nigeria of being "Child Witches" (Snow and College, 2017), this positive effect on children belonging to ethnic groups with higher than median belief in witchcraft can be viewed as suggestive evidence of the CRA combatting adverse social norms.

⁶¹ The results are not shown but are available upon request

⁶² This data was taken from the PEW survey in 2008/2009 in SSA on Religious life

⁶³ The ethnic groups with higher than median belief in witchcraft were Hausa, Ibibio, Igala, Tiv Yoruba. The ethnic groups with lower than median belief in witchcraft were Ijaw and Kanuri. Not all ethnic groups in the DHS were able to be matched with the PEW survey.

⁶⁴ The point estimate for height for age is 0.533*** for the full sample. The results are not shown but are available upon request

Table 3.3: Effect of the CRA on Anthropometry, Heterogeneity by Childs Gender

	Dependant Variables			
	(1) (HforA)	(2) (WforA)	(3) (WforH)	(4) (BMI)
Panel A: Full Sample-27 States				
Born After* State Policy Change	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Born After* Policy Change*Female	-0.009 (0.037)	-0.051 (0.032)	-0.131*** (0.036)	-0.085** (0.036)
Mean Dep Var (Control)	-1.45	-1.11	-0.38	-0.25
Mean Dep Var for Males (Control)	-1.54	-1.17	-0.41	-0.24
Mean Dep Var for Females (Control)	-1.34	-1.07	-0.37	-0.27
Observations	40,245	40,284	40,284	40,295
R-squared	0.163	0.067	0.068	0.073
Number of clusters	27	27	27	27
Panel B: Bordering Treated States- 14 States				
Born After* Policy Change*Female	0.015 (0.027)	-0.076 (0.099)	-0.172 (0.124)	-0.143 (0.136)
Observations	25,993	26,065	26,028	26,038
R-squared	0.109	0.083	0.06	0.069
Number of clusters	14	14	14	14
Panel C: Southern States- 16 States				
Born After* Policy Change*Female	-0.025 (0.046)	-0.015 (0.028)	-0.03 (0.039)	0.007 (0.040)
Observations	18,874	18,889	18,879	18,882
R-squared	0.155	0.104	0.072	0.087
Number of clusters	16	16	16	16

Notes: Table 3.3 reports estimates for the effect of the CRA on Height for Age using the estimation shown in Equation 3.2 by comparing outcomes for girls versus boys; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child and gender takes the value 1 if the child is a girl, 0 if a boy. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

3.4.3 Dynamic Differences in differences estimates

To investigate the exact timing of behavioural changes and to support the parallel trend assumption, I group children into 1 year birth cohorts and reformulate equation 3.2 by substituting pre and post with dummies for each of the cohorts as shown in equation 3.3 using the estimator developed by Sun and Abraham (2021). Figure 3.2 in the appendix shows a parallel time trend for children in CRA and non-CRA states prior to the passing of the CRA with coefficients that are fluctuate around zero for vaccinations and anthropometry.

3.4.4 Vaccination estimates

The dependent variable takes the value 1 if a child received the first dose of the vaccine verified by their vaccination card and 0 otherwise. Vaccination rates based on recall have been shown to be subject to a large extent of measurement error, mainly due to over-reporting of vaccination status (Research and Development Solutions (2012); Sheikh et al (2011). Table 3.4 presents the results with successful vaccinations only if the enumerator was able to verify the information on children's vaccination card, children which are born 1 year prior to CRA are excluded here⁶⁵. The results are stable to including vaccinations based on recall.

3.4.5 Differences and differences and triple difference estimates

In Table 3.4, Panel A, the sample is for the entire country and estimates the effect of the CRA on the first doses of essential vaccinations, I find no statistically significant effect of the CRA on the uptake on the first doses of vaccinations. In Panel B, I investigate the effect of the CRA on receiving the full doses of all essential vaccines, there are negative and statistically significant effects of receiving any full doses of 7.9% (Column 6), receiving all full doses 14.1% (Column 7) driven primarily by the measles vaccine of 4.2%⁶⁶. This is limited evidence of the CRA causing a backlash against the uptake of preventive healthcare, similar effects are found in the literature (see for example Bravo & Stegmann, 2019).

⁶⁵ The partially exposed groups are not included in these estimations, the results are stable to their inclusion. The results are not shown but are available upon request.

⁶⁶ It should however be noted these negative results are limited to children born between 2015 and 2018.

Table 3.4: Effect of the CRA on receiving

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DPT	Polio	BCG	Hepatitis B	Measles	Any First Dose	All First Doses
Panel A: 1st Dose of each vaccine							
Born After* State Policy Change	-0.009 (0.023)	0.007 (0.025)	0.011 (0.027)	-0.01 (0.025)	-0.028 (0.023)	0.001 (0.035)	-0.016 (0.028)
Mean Dep Var (Control)	0.33	0.29	0.35	0.36	0.18	0.44	0.27
Observations	39478	43,232	43,232	26,364	40,423	22,882	17,919
R-squared	0.402	0.342	0.344	0.379	0.276	0.433	0.492
Number of clusters	27	27	27	27	27	27	27
Panel B: All doses of each vaccine							
Born After* State Policy Change	-0.009 (0.020)	-0.005 (0.026)	0.011 (0.027)	-0.009 (0.025)	-0.042*** (0.007)	-0.079*** (0.012)	-0.141*** (0.032)
Mean Dep Var (Control)	0.25	0.29	0.35	0.27	0.04	0.61	0.1
Observations	39,223	27,361	39,308	26,210	10,464	8,056	3,804
R-squared	0.365	0.333	0.455	0.348	0.080	0.314	0.340
Number of clusters	27	27	27	27	27	27	27

Notes: Table 3.4 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples in both panels are for the whole of Nigeria. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

In Tables 3A.1 and 3A.2 (in the appendix), I re-estimate equation 3.1 but change the definition of the treated states to those bordering the northern states (Table 3A.1) and to only children born in the southern states (Table 3A.2) similar to the exercise for anthropometry. In Table 3A.1, the Panel A & B there no statistically significant effects of the CRA on the uptake of the first doses of vaccination. In Table 3A.2, Panel A I find a negative statistically significant impact on the uptake of Hepatitis A of 5.6% and a reduction in the likelihood of receiving all first doses of vaccines of 6.6%⁶⁷. In Table 3A.2, Panel B I find a negative statistically significant impact on the uptake of Hepatitis A (6.4%), Measles (3.5%), receiving any full dose (8.2%) and all first doses (6.1%).

I re-estimate the specification for receiving the first and subsequent doses of vaccines limiting the sample to under 2-year-olds, as the vaccine schedule stipulates (even with imperfect compliance) that children should receive the full doses by 2 years⁶⁸. Compared to Table 3.4, the results remain unchanged in Panel A when limiting the sample, for Panel B the point estimates are identical for Measles and receiving the first dose of any vaccine or receiving the full first doses of vaccines, however the magnitude of the coefficients is larger, of receiving any full doses is lower by 13.5%, receiving all full doses 23.8% and for receiving the measles vaccine of 9.3%.

To further investigate these negative results for vaccinations, I expand the specification by including a triple interaction term for the wealth index of the household that the child belongs to investigate if the CRA had a differential effect conditional on the wealth of the household, it is clear that higher income household have a higher likelihood of vaccinating their children but the intention to include them in interaction is to decipher if the CRA had a positive effect on richer households.

I formally estimate Equation 3.2 but replace the child gender indicator with an indicator for the wealth index of the household which varies between 5 (richest) to 1(poorest). In Table 3.5 the results of the estimation are shown, row 1 has the baseline estimates. In Panel A, the results are different compared to the previous estimations and show a positive and statistically significant effect of the CRA on receiving the first dose of Polio (+1.6%), BCG (+1.5%) Hepatitis B (+2.7%), receiving any first dose (+2.1%) and receiving all first doses (+3.7%). For the full doses of each vaccine the results are similar for BCG (+1.5%) & Hepatitis B (+2.5%). These results demonstrate that compared to poorer households, the CRA had limited positive effects on the vaccinations of children⁶⁹

⁶⁷ It should however be noted these negative results are limited to children born between 2015 and 2018.

⁶⁸ These results are not shown but available upon request

⁶⁹ I repeat this exercise by religion of the caretaker but find no significant effects

Table 3.5: Effect of the CRA on receiving, heterogeneity by wealth of the household

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DPT	Polio	BCG	Hepatitis B	Measles	Any First Dose	All First Dose
Panel A: 1st Dose of each vaccine							
Born After* State Policy Change	-0.009 (0.023)	0.007 (0.025)	0.011 (0.027)	-0.01 (0.025)	-0.028 (0.023)	0.001 (0.035)	-0.016 (0.028)
Born After* Policy Change*Wealth Index	0.008 (0.008)	0.016** (0.007)	0.015* (0.008)	0.027** (0.012)	-0.007 (0.008)	0.021* (0.012)	0.037*** (0.015)
Mean Dep Var (Control)	0.33	0.29	0.35	0.36	0.18	0.44	0.27
Observations	17,193	18,027	17,114	10,841	18,028	9,565	6,958
R-squared	0.415	0.375	0.469	0.391	0.25	0.457	0.521
Number of clusters	27	27	27	27	27	27	27
Panel B: All doses of each vaccine							
Born After* State Policy Change	-0.009 (0.020)	-0.005 (0.026)	0.011 (0.027)	-0.009 (0.025)	-0.042*** (0.007)	-0.079*** (0.012)	-0.141*** (0.032)
Born After* Policy Change*Wealth Index	0.009 (0.008)	0.012 (0.009)	0.015* (0.008)	0.025** (0.011)	-0.019 (0.012)	0.019 (0.022)	0.026 (0.028)
Mean Dep Var (Control)	0.25	0.29	0.35	0.27	0.04	0.61	0.1
Observations	17,042	12,359	17,114	10,749	3,113	2,448	982
R-squared	0.366	0.339	0.469	0.35	0.104	0.317	0.438
Number of clusters	27	27	27	27	27	27	27

Notes: Table 3.5 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.2 for the entire country of Nigeria; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The joint indicator is interacted with the wealth index of the household that the child belongs to. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

3.4.6 Dynamic Differences in differences estimates

Similar to the motivation for anthropometry, to support the parallel trend assumption, I group children into 1 year birth cohorts and reformulate equation 3.1 by substituting pre and post with dummies for each of the cohorts as shown in equation 3.3. Figure 3.2 (in the appendix) shows a parallel time trend for children in CRA and non-CRA states prior to the passing of the CRA with coefficients that are fluctuate around zero for the first doses of Polio, BCG, Measles and DPT. As the results showed in Table 3.4, Panel A show there is no statistically significant effect of the CRA the graphs in Figure 3.2 reflect this lack of behavioural change post the CRA.

3.4.7 Child Nutrition, Breastfeeding, Recent Illnesses and Pre-Natal care

The nature of the CRA was such that it regulated a large number of actions towards children both who were born and un-born⁷⁰. In this section, I estimate the effect of the CRA on measures of Child Nutrition, Recent Illnesses and Pre-Natal care.

3.4.8 Child Nutrition estimates

I first turn my attention to channels related to nutrition and diet, my motivation to undertake this exercise is to understand the channel by which children improve their anthropometry. In particular I use the module on food consumption in the last 24-hour module which captures the dietary diversity of foods given to children. Given the lengthy list of potential foods which can be given to children, I follow conventional practice in the literature and group individual foods into 6 food groups, these food groups are: (i) grains, roots and tubers; (ii) legumes and nuts; (iii) dairy products; (iv) flesh foods & eggs; (v) vitamin-A rich fruits and vegetables; (vi) other fruits and vegetables (Rasul et al, 2020). I also construct a measure of dietary diversity which sums the number of food groups the child has received from the 6 foods groups. The result is shown in Table 3A.3 (in the appendix). In Panel A, which compares the entire country there is a negative statistically significant effect of the CRA on the consumption of flesh foods & eggs, vitamin-A rich fruits and vegetables and the dietary diversity index⁷¹. In Panel B, which limits the treated states to bordering states, the magnitude of the coefficients is larger but similar in terms of effects on food group consumption. In Panel C, the effect is negative and statistically significant with a lower magnitude for flesh foods & eggs, grains, roots and tubers and the dietary diversity index.

⁷⁰ Section 17 of the CRA specifically guards the rights of the unborn child

⁷¹ The Individual food groups driving this is a reduction in the consumption of Potato's, Cassavas, Grains, Meat, Green Leaves & Fish, these results not shown but are available upon request

While these results show a negative effect of the CRA as measured by 24-hour recall, they do not reflect more sustained dietary changes over the course of the year for which one would need a measure of 30-day dietary patterns or a measure of food security which unfortunately are not currently available in the DHS.

3.4.9 Breastfeeding estimates

In this sub-section, I investigate the effect of the CRA on 3 measures of breastfeeding. (i) How soon a child is put on the breast, 1 if immediately and 0 if later; (ii) the duration of breastfeeding in months; (iii) if a child is given anything other than breastmilk. In Table 3A.4 (in the appendix) the results are shown, there is no statistically significant effect of the policy on these various measures of breastfeeding.

3.4.10 Episodes of recent illness

Considering an alternative measure of care, I evaluate the effect of the CRA on recent episodes of illnesses such as a cough or diarrhoea in the last 2 weeks where the dependant variables take the following values; Cough takes value 1 if child had a cough in the last two weeks and 0 otherwise. Diarrhoea takes value 1 if child had diarrhoea in the last two weeks and 0 otherwise. In Table 3A.5 (in the appendix), the results are shown. My prior would be the coefficients to be negative in magnitude, I find for the point estimates of episodes of diarrhoea in the last 2 weeks for panel B (column 2) and panel C (column 2) this is indeed the case but neither effect is statistically significant.

3.4.11 Prenatal care and Birthweight estimates

Finally, I investigate the effect of the CRA on measures of care for children while their mothers are pregnant and upon delivery, Table 3.6 presents the results. I find a positive and statistically significant effect of the CRA on increasing the birth weights of new born babies by 0.11 Kg to 0.18 Kg (Panel A & Panel C; Column 1), the birthweight is captured from the birthweight on the card provided at birth and not from recall of the mother. I also find negative effects on taking medication for intestinal parasites during birth, a reduction of 6.5% (Panel A, column 5), 10.4% (Panel B, Column 5) and 3.8% (Panel C, Column 5). Outside of these significant results, the CRA had no effect on general care during pregnancy such as getting regular check-ups for blood, urine & getting blood pressure taken or on the uptake of iron supplementation or malaria tablets.

Table 3.6: Effect of the CRA on Pre Natal-Care
Dependant Variables

	(1)	(2)	(3)	(4)	(5)
	(Birth Weight)	(Pre-care)	(Iron-S)	Infectious Disease Control (Malaria)	(Parasites)
Panel A: Full Sample-26 States					
Born After* State Policy Change	0.111** (0.049)	0.028 (0.049)	0.001 (0.038)	-0.066 (0.041)	-0.065** (0.018)
Mean Dep Var (Control)	3.31	0.75	0.63	0.35	0.14
Observations	4,052	27,966	43,901	19,705	43,155
R-squared	0.088	0.157	0.296	0.437	0.068
Number of clusters	27	27	27	27	27
Panel B: Bordering Treated States- 14 States					
Born After* State Policy Change	-0.094 (0.136)	0.031 (0.124)	0.023 (0.065)	-0.112 (0.086)	-0.104*** (0.023)
Observations	1,376	15,931	29,990	19,705	29,384
R-squared	0.136	0.155	0.3	0.437	0.078
Number of clusters	14	14	14	14	14
Panel C: Southern States- 16 States					
Born After* State Policy Change	0.179*** (0.038)	0.034 (0.042)	0.041 (0.037)	-0.007 (0.048)	-0.038** (0.036)
Observations	3,110	15,723	19,338	12,872	19,023
R-squared	0.073	0.138	0.18	0.5	0.048
Number of clusters	16	16	16	16	16

Notes: Table 3.6 reports estimates for the effect of the CRA on prenatal care using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. Birthweight is measured in kilograms which is a continuous variable and taken from the birthweight card of the child. Pre care takes value 1 if the mother while pregnant had some form of care such as getting regular check-ups for her blood, urine etc and 0 otherwise. Iron s refers to iron supplementation during pregnancy, Malaria refers to taking malaria medication and parasites refers to intestinal parasite medication during pregnancy. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

3.5 Robustness checks and threats to identification

3.5.1 Bootstrapped Standard Errors

So far, I have shown results with clustered standard errors at the state level and one of the concerns for the estimates is the small number of cluster sizes, this small cluster size may lead incorrect inference therefore I re-estimate the baseline models shown and bootstrap within cluster with 1000 repetitions. The results are shown in Table 3.7. The magnitude of the estimates and statistical significance for vaccinations and anthropometry are similar to the clustered estimates shown previously in the paper with smaller values for the standard errors.

Table 3.7: Effect of the CRA on Vaccinations & Anthropometry, Standard Errors bootstrapped

	(1) DPT	(2) Polio	(3) BCG	(4) Hepatitis B	(5) Measles	(6) Any First Dose	(7) All First Doses
Panel A: 1st Dose of each vaccine							
Born After* Policy Change	-0.009 (0.0018)	0.007 (0.022)	0.011 (0.021)	-0.01 (0.018)	-0.028 (0.014)	0.001 (0.018)	-0.016 (0.017)
Observations	39,478	43,232	43,232	26,364	40,423	22,882	17,919
R-squared	0.323	0.288	0.376	0.297	0.221	0.350	0.394
Number of clusters	27	27	27	27	27	27	27
Panel B: Anthropometry							
	(1) (HforA)	(2) (WforA)	(3) (WforH)	(4) (BMI)			
Born After* Policy Change	0.352*** (0.086)	-0.102 (0.068)	0.146 (0.057)	-0.111 (0.055)			
Observations	40,245	40,284	40,329	40,295			
R-squared	0.132	0.124	0.069	0.078			
Number of clusters	27	27	27	27			

Notes: Table 3.7 reports estimates for the effect of the CRA on vaccinations and anthropometry using the estimation shown in Equation 3.1, standard errors are estimated with bootstrapping within cluster using 1000 repetitions; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The sample is for the whole of Nigeria. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

3.5.2 Weighted regressions using probability & analytical weights

In Table 3.8, I account for error in sampling and differences in state sizes by weighting observations by state. For equation 3.1, I re-estimate the results shown for anthropometry and vaccinations using

probability & analytical weights⁷² which are calculated using the sample weight provided in the children's recode DHS dataset, Table 3.8 reports the estimates for anthropometry. In Panel A Row 1, the unweighted estimates are shown, in Row 2 the estimates with probability weighting show a larger magnitude of the coefficient for Height for Age, of the coefficient for Weight for Age the sign changes and becomes statistically significant. In Panel B, the magnitude of coefficients for Height for Age is larger than Panel A with identical levels of statistical significance. In Panel C, magnitude of coefficient for Height for Age is closer to the unweighted regressions in Panel A, row 1 and are still statistically significant albeit at a lower level.

Table 3.8: Effect of the CRA on Anthropometry, Weighted Regressions

Dependant Variables				
(1)	(2)	(3)	(4)	
(HforA)	(WforA)	(WforH)	(BMI)	
Panel A: Full Sample-27 States				

⁷² The results are identical therefore only the probability weighted results are shown

Born After* Policy Change	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Born After* Policy Change [W=P]	0.456*** (0.104)	0.246** (0.111)	0.043 (0.118)	-0.052 (0.123)
Mean Dep Var (Control)	-1.45	-1.11	-0.38	-0.25
Observations	40,245	40,329	40,284	40,295
R-squared	0.163	0.154	0.068	0.076
Number of clusters	27	27	27	27
Panel B: Bordering Treated States- 14 States				
Born After* Policy Change [W=P]	0.629*** (0.146)	0.335** (0.136)	-0.070 (0.132)	-0.082 (0.145)
Observations	25,993	26,065	26,028	26,038
R-squared	0.109	0.083	0.06	0.069
Number of clusters	14	14	14	14
Panel C: Southern States- 16 States				
Born After* Policy Change [W=P]	0.383** (0.153)	0.271* (0.147)	0.040 (0.103)	0.043 (0.108)
Observations	18,874	18,889	18,879	18,882
R-squared	0.155	0.104	0.072	0.087
Number of clusters	16	16	16	16

Notes: Table 3.8 reports estimates for the effect of the CRA on anthropometry using the estimation shown in Equation 3.1 using probability weights which are calculated using the sample weight provided in the children recode DHS dataset and weighting observations by state; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.6 (in the appendix) reports the estimates for vaccinations. In Panel A Row 1, the un-weighted estimates are shown, in Row 2 the estimates with probability weighting show larger magnitudes but identical levels of statistical significance compared to the un-weighted estimates. The same description is true for Panel B. In Panel C, the estimates for the first doses of Hepatitis. Measles and receiving any first dose of these vaccines demonstrate a statistically significant effect.

3.5.3 Mean reversion

Next, I investigate the robustness of my estimates controlling for pre- treatment levels and changes in the dependent variable, (i.e: the possibility of mean reversion in my estimates). The results are presented in Table 3.9 for Anthropometry and Table 3A.7 (in the appendix) for vaccinations.

Table 3.9: Effect of the CRA on Anthropometry with Mean Reversion

	Dependant Variables			
	(1)	(2)	(3)	(4)
	(HforA)	(WforA)	(WforH)	(BMI)
Panel A: Full Sample-27 States				
Born After* State Policy Change	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Born After* State Policy Change [MR]	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Mean Dep Var (Control)	-1.45	-1.11	-0.38	-0.26
Observations	40,245	40,284	40,329	40,295
R-squared	0.163	0.067	0.154	0.073
Number of clusters	27	27	27	27

Notes: Table 3.9 reports estimates for the effect of the CRA on anthropometry using the estimation shown in Equation 3.1 while controlling for mean reversion; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Row 1 presents the baseline estimates for comparison. In row 2, I control for the mean of the dependent variable in pre-treatment period (i.e: for non-exposed cohorts) interacted with a full set of cohort fixed effects. These controls address the possibility that mean reversion may affect my estimates, since states with different levels of vaccination & anthropometry of children at the beginning of the sample are allowed to have a differential trend in the evolution of vaccination & anthropometry rates. The results are robust to these controls. These checks mitigate the concern that the results are driven by differential rates across states that have a continuous decline or increase in vaccination & anthropometry rates.

3.5.4 Sun and Abraham estimates

In Table 3A.11, I show the estimates using the Sun and Abraham (2021) estimator for Anthropometry and find that compared to the original estimates, the point estimates are larger and possess the same degree of statistical significance. Broadly, these results confirm that my main findings are not driven by the biases present in TWFE models, nor are they driven by the choice of the traditional or augmented dynamic differences in differences model as opposed to other models that account for the biases in TWFE models.

3.5.5 Dropping one state at a time

In Table 3A.12, I show the estimates of the effect of the CRA on Height for Age by dropping one of the treated states, the coefficient remains stable and statistically significant at the 1% level.

3.5.6 Composition of treated and control states over time

I also check the composition of the treated states and the stage of adoption to determine if there were any particularly large or small states which were early or late adopters. In Figure 3.3 in the appendix, I plot the share of treated population and the number of treated states and find that they evolve uniformly over time.

3.5.7 Parallel trends

In the TWFE DiD design, identification depends upon the existence of parallel trends between the treated and un-treated groups. To begin with I show a comparison of the raw data trends during the pre-period in anthropometry and vaccination between children in the CRA and non-CRA states in Figures 3.5, based on these descriptive graphs for anthropometry & vaccinations show similar trends for children as a function of their age in months.

I next formally test for pre-trends in the pre-period to provide evidence of this assumption holding in my framework, I formally test for parallel trends by estimating an intention to treat framework, where I interact states which would implement the CRA in the future with a time trend variable which is a continuous variable for the child's month of birth in the period prior to the policy being implemented⁷³. In Table 3.10 the results are shown, throughout all the estimates are very small in size and only statistically significant for the first dose of Measles & Polio.

⁷³ The pre-period is data drawn from 2003 DHS

Table 3.10: Effect of the CRA on Vaccinations & Anthropometry, Parallel Trends

	(1)	(2)	(3)	(4)	(5)	(6)
	DPT	Polio	BCG	Measles	Any First Dose	All First Doses
Panel A: 1st Dose of each vaccine						
State Policy Change*Time Trend	0.00001 (0.00001)	-0.00002** (0.00001)	0.00001 (0.00001)	0.000006*** (0.00001)	0.00001 (0.00001)	0.00003** (0.00001)
Mean Dep Var	0.19	0.15	0.27	0.12	0.28	0.11
All controls in Eq 3.1	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,463	2,463	2,463	2,463	2,463	2,463
R-squared	0.39	0.25	0.47	0.25	0.49	0.47
Panel B: Anthropometry						
	(1) (HforA)	(2) (WforA)	(3) (WforH)	(4) (BMI)		
State Policy Change*Time Trend	0.00001 (0.0005)	0.00004 (0.0003)	0.00004 (0.0004)	0.00001 (0.0004)		
Mean Dep Var	-1.62	-1.13	-0.27	-0.12		
All controls in Eq 3.1	Yes	Yes	Yes	Yes		
Observations	3,364	3,364	3,364	3,364		
R-squared	0.07	0.18	0.23	0.08		

Notes: Table 3.10 conducts a formal test of parallel trends in the pre-period for vaccinations and anthropometry using data only from DHS 2003; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The sample is for the whole of Nigeria. Standard errors are reported in parentheses and are clustered at the state level. each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Next, I present a number of event studies using the Dynamic differences in differences estimator in TWFE, the Sun and Abraham (2021) estimator and Gardner's (2021) two-stage estimator, Borusyaks et al (2022) robust and efficient estimator and Clément & D'Haultfoeuille (2021) TWFE's estimator with heterogeneity in Figures 3.2A to 3.2H. The premise of presenting these event studies for the entire study sample is to provide additional evidence of the existence of parallel trends in the pre-period. In the pre-

period coefficients are statistically indistinguishable from zero. In the post period the coefficients become statistically significant after T3 for the main results of height for age.

Lastly, I employ Rambachan and Roth's (2022) "honest" differences-in-differences approach which uses the estimator developed by Callaway and Sant Anna (2021) to relax the parallel trends assumption and provides a method to conduct sensitivity analysis on what the allowable deviations are from parallel trends in the pre-period. In essence, the honest DiD approach is estimating the amount of non-linearity permissible while still rejecting the null hypothesis, the breakdown value or M as it is referred to. In simple terms when $M=0$ only linear violations from parallel trends are allowed, while increasing the value of M permits greater deviations from linearity. In Figure 3.6, I show the results of the honest DiD analysis. It demonstrates that imposing linear parallel trends yields an estimate for my main anthropometric result regarding height for age which is positive and statistically significant (i.e: when $M=0$), and this is the case when increasing non-linear violations up till $M=0.20$. In effect, this means that the treatment effect of the CRA on children's anthropometry (height for age) is robust to non-linearity of differential trends equal to $M=0.20$ for the full sample of 27 states which is equal to approximately 84% of the average change in slope in the pre-period. Broadly similar patterns are observed when I run the sensitivity analysis on the bordering treated states and the southern treated states sub-samples, the breakdown value remains at $M=0.20$.⁷⁴

In summary, I have demonstrated that the assumption of parallel trends in my setting is plausible on the basis of the formal test of parallel trends, the various event study estimators and using Rambachan and Roth's (2022) "honest" differences-in-differences approach and do not present a sizeable threat to causal interpretation of the anthropometric and vaccination outcomes. Furthermore, the honest DiD approach stipulates my results for HforA are robust to a degree of non-linear deviations of trends between the treated and un-treated groups.

3.5.8 Exogeneity of Law

The likelihood that a certain state should pass the CRA could potentially be endogenous to state level characteristics which would influence its timing. Factors that could plausibly cause states to adopt the CRA could be due poor anthropometry, low vaccination rates or a high proportion of children under 5 residing in the state. In Table 3A.13 in the appendix, I consider if poor anthropometry, vaccination rates or a high proportion of children under 5 during the year of policy enactment, in the year prior or the trend of these variables over time prior to enactment increased the likelihood of a state passing the CRA and find these variables do not predict state policy changes suggesting there was no anticipation of the

⁷⁴ I do not show the results for the remaining anthropometric measures or vaccine outcomes but these are available upon request

policy being passed or that the policy being enacted at state level was endogenous to various outcomes for that state.

3.5.9 Concurrent policies

It could also be possible that other policies could be causing the positive results I observe for anthropometry, in relation to policies/interventions in support of child development there were some nationwide policies prior to the policy change notably the Baby Friendly Hospital Initiative in 1992, the National Breastfeeding Policy in 1998, the National Policy on Food and Nutrition in 2001 and one during the same time as the CRA notably the National Policy on Infant and Young Child Feeding in 2005. The National Policy on Infant and Young Child Feeding in 2005 was nationwide therefore should affect both the treated and control states in my setting. Research into the efficacy of the National Policy on Infant and Young Child Feeding in 2005 by Page et al (2016) find that this policy had limited effects on breastfeeding and complementary feeding practices primarily due to lack of engagement with community and health care professionals. While I cannot fully rule out differential policy adoption of these policies in certain states, I have not found any suggestions in the literature that this was the case.

3.5.10 Goodman bacon decomposition

This paper has so far utilized a range of variations within the traditional two-way fixed effects differences in differences design augmented by a host of robustness checks and different control group selections to determine the effect of the CRA on children within Nigeria. With the recent growth in the differences in differences literature raising concerns regarding the causal interpretation of differences in differences design due to weighting problems and heterogeneity bias in static and non-static models, I discuss and apply the Goodman Bacon decomposition.

Weighting problems have been identified by Goodman Bacon (2022) which decompose traditional did models based on 2x2 pairwise weights, the problem with this is that different weights applied may not satisfy the no-sign flip property (i.e: the did estimator may have a different sign to the one calculated) due to bias in the estimates and due to incorrect comparisons (for example an early treated group serving as a control for a later treated group). The Bacon decomposition requires a strongly balanced dataset and panel data. In this paper, the data is a repeated cross section with unbalanced clusters, therefore in order to run the decomposition I collapse the data at the state-year level, the resulting dataset is 772 state-year observations and drop 23% of the sample to ensure the data is strongly balanced, the criteria for dropping these observations was purely mechanical and not based on any priors. The final dataset is 592 state-year observations which are strongly balanced. I present results of the Bacon decomposition for Anthropometry in Table 3.A8 to Table 3.A10 (in the appendix) for all anthropometric measures, when considering Height for Age these results demonstrate that for the full sample of 27 states around 63% of the unadjusted difference-in-differences estimate is composed of valid comparisons between treated and untreated units, for the bordering sample of 14 states 89% of the unadjusted difference-in-

differences estimate is composed of valid comparisons between treated and untreated units and when only using Southern states 47% of the unadjusted difference-in-differences estimate is composed of valid comparisons between later treated to earlier control states lending further credence to the empirical strategy and estimation results.

3.5.11 Changes in demand versus changes in supply driving results

The improvement in Anthropometry due to the CRA could be driven by demand or supply side factors. In this subsection I present additional disaggregated analysis to substantiate the hypothesis that the changes in Anthropometry are due to changes in demand of healthcare by parents. To begin with I present results in the appendix in Table 3A.14 which shows the estimates without the inclusion of the two supply driven controls namely distance to the nearest health facility and if there was a vaccination campaign in the last two years in which the child was vaccinated. The point estimates fluctuate minimally with the inclusion of these controls. A more nuanced measure of capturing supply driven effects could be to look at the intensity/frequency of vaccinations campaigns that took place during the period of study such data unfortunately is not publicly available and thus a limitation on this study. It is pertinent to mention that Nigeria has 14% of the global population of zero-dose children (i.e: those which have never been vaccinated), in 2017 Nigeria declared routine immunization a public health emergency (Sodha et al, 2018) and re-ignited efforts to improve the supply of vaccines. In this study, the last cohorts born are in 2018 which is after the national push to improve vaccinations. This itself does not rule out supply side effects but with the empirical analysis provided which includes different supply driven controls, it partially alleviates this concern. In terms of looking at the demand of healthcare by parents, I estimate the empirical specification in equation 3.1 with the outcome now a health seeking measure by parents (i.e: if they travelled to a health facility in the last 12 months). I find a positive correlation of 6.4% for this behaviour by parents of children born under the protection of the CRA compared to those that were not⁷⁵. Naturally, it is possible that consulting a traditional practitioner was involved when the child became unwell but unfortunately, this data unfortunately is not available within the DHS survey to formally test this hypothesis.

3.5.12 Multiple hypothesis testing

This paper has considered a number of outcomes of the CRA's effect. Adding additional hypothesis from a computational perspective is virtually costless but using the same data to examine multiple hypothesis increases the probability of falsely rejecting a true null hypothesis as suggested first by Bonferroni (1935). I address this problem of using multiple hypothesis tests by implementing a stepdown procedure that controls for the family-wise error rate (FWER) or the probability of falsely rejecting at least one true null hypothesis in the family of hypothesis which are tested (Romano and Wolf, 2005).

⁷⁵ This result is not shown but available upon request

The Romano Wolf procedure allows for dependence among p-values by bootstrap resampling and permits cases where subset pivotality does not hold⁷⁶. In Table 3A.15 the results are shown after controlling for the family-wise error with 1000 repetitions. All hypothesis that are presented in this paper are jointly tested, however only a sub-set of them are shown in table 3A.15. In summary, the adjusted p-values using this test discovers identical levels of significance for each of the hypothesis which was individually tested earlier demonstrating that no true hypothesis was incorrectly rejected.

3.6 Conclusion

The evidence presented in this paper suggests that the introduction of formal protection to Children in Nigeria led to a reduction in stunting. The results also suggest that the Child Rights Act increased the uptake of preventive healthcare conditional on the wealth of the household and improved outcomes for children in utero. These findings may be of interest to policy makers in as far as they shed further light on how parents in low-income countries make decisions regarding their children in environments characterized by adverse social traditions. The results regarding stunting, in particular, illustrate how changes in the environment can influence parental behaviour. The size of the Child Rights effect on child welfare illustrates the importance of cultural and secular factors in determining how parents treat their children. This insight is important for anyone interested in designing policies aimed at improving child welfare. The results presented in this paper may also serve as an indication of the importance of child protection in low-income settings.

Finally, although these findings pertain to one particular case study, there are reasons to believe that the results may also be relevant to other contexts. The Child Rights Laws introduced in Nigeria are based on the Convention of Child Rights, Child Rights in a variety of developing country settings are based on the same convention and thus likely to have common aspects (Britto and Ulker, 2012).

In any case, this paper has argued that the granting children formal protection reduces stunting and improves infant outcomes generally by specifying precisely how children should be protected and which punishments can be expected in case of neglect or abandonment. This importance of child welfare is a central feature of many societies around the world irrespective of their history or geographical location.

⁷⁶ There are alternative estimators to correct for multiple hypothesis such as controlling for the False Discovery Rate (FDR). However, these techniques are less conservative than controlling for the FWER and apply in cases where a huge amount of null hypothesis are considered (Romano and Wolf, 2015). Hence, the choice of this estimator is on the basis of its efficiency and generalizability.

Chapter 3 Appendix

Tables

Table 3A.1: Effect of the CRA on receiving, bordering treated states

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DPT	Polio	BCG	Hepatitis B	Measles	Any First Dose	All First Doses
Panel A: 1st Dose of each vaccine							
Born After* State Policy Change	-0.037 (0.039)	0.008 (0.048)	0.002 (0.049)	-0.032 (0.030)	-0.024 (0.027)	-0.022 (0.030)	-0.016 (0.028)
Mean Dep Var (Control)	0.33	0.29	0.35	0.36	0.18	0.44	0.27
Observations	29,767	31,904	29,801	19,730	29,875	16,883	14,070
R-squared	0.27	0.243	0.317	0.261	0.178	0.319	0.303
Number of clusters	14	14	14	14	14	14	14
Panel B: All doses of each vaccine							
Born After* State Policy Change	-0.009 (0.034)	-0.007 (0.032)	0.002 (0.049)	-0.015 (0.027)	0.404 (0.249)	0.025 (0.576)	0.911 (0.525)
Mean Dep Var (Control)	0.25	0.29	0.35	0.27	0.04	0.61	0.1
Observations	29,646	19,009	29,801	19,666	7,629	5,618	3,146
R-squared	0.227	0.219	0.317	0.221	0.063	0.268	0.236
Number of clusters	14	14	14	14	14	14	14

Notes: Table 3A.1 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.1 defining only the bordering states to the control states as being treated; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A & Panel B is for 14 states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.2: Effect of the CRA on receiving, Southern States

	(1) DPT	(2) Polio	(3) BCG	(4) Hepatitis B	(5) Measles	(6) Any First Dose	(7) All First Doses
Panel A: 1st Dose of each vaccine							
Born After* State Policy Change	-0.021 (0.030)	-0.026 (0.032)	0.004 (0.029)	-0.056*** (0.023)	-0.038 (0.023)	-0.036 (0.024)	-0.066** (0.028)
Mean Dep Var (Control)	0.33	0.29	0.35	0.36	0.18	0.44	0.27
Observations	13,950	16,158	13,741	9,493	15,022	8,455	5,654
R-squared	0.325	0.296	0.381	0.316	0.277	0.363	0.503
Number of clusters	16	16	16	16	16	16	16
Panel B: All doses of each vaccine							
Born After* State Policy Change	-0.027 (0.028)	-0.033 (0.032)	0.004 (0.029)	-0.064** (0.029)	-0.035*** (0.008)	-0.082*** (0.012)	-0.061* (0.035)
Mean Dep Var (Control)	0.25	0.29	0.35	0.27	0.04	0.61	0.1
Observations	13,765	11,464	13,740	9,381	4,269	3,558	1,139
R-squared	0.325	0.333	0.381	0.329	0.098	0.247	0.438
Number of clusters	16	16	16	16	16	16	16

Notes: Table 3A.2 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.1 comparing only children born in the southern (CRA) states before and after the policy change; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples in panel A & Panel B is the Southern CRA states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.3: Effect of the CRA on Nutrition

	Dependant Variables						
	(1) (GTR)	(2) (LN)	(3) (Dairy)	(4) (FFE)	(5) (VAFV)	(6) (CL)	(7) (DDI)
Panel A: Full Sample-27 States							
Born After* State Policy Change	0.029 (0.028)	-0.092 (0.063)	-0.032 (0.055)	-0.135*** (0.055)	-0.088** (0.041)	-0.010 (0.013)	-0.388** (0.194)
Mean Dep Var (Control)	0.65	0.24	0.24	0.34	0.23	0.91	2.61
Observations	49,310	49,117	49,207	49,207	49,200	49,309	49,319
R-squared	0.177	0.08	0.081	0.081	0.09	0.066	0.204
Number of clusters	27	27	27	27	27	27	27
Panel B: Bordering Treated States- 14 States							
Born After* State Policy Change	-0.076 (0.057)	-0.218* (0.109)	-0.098 (0.107)	-0.196** (0.071)	-0.166* (0.077)	-0.013 (0.026)	-0.759* (0.387)
Observations	34,456	34,317	34,379	34,354	34,377	34,452	34,462
R-squared	0.177	0.082	0.072	0.138	0.071	0.059	0.178
Number of clusters	14	14	14	14	14	14	14
Panel C: Southern States- 16 States							
Born After* State Policy Change	0.044* (0.022)	0.058 (0.036)	-0.004 (0.041)	-0.077** (0.033)	-0.002 (0.026)	-0.008 (0.011)	-0.198* (0.112)
Observations	20,558	20,485	20,525	20,512	20,515	20,561	20,561
R-squared	0.175	0.096	0.095	0.226	0.134	0.095	0.237
Number of clusters	16	16	16	16	16	16	16

Notes: Table 3A.3 reports estimates for the effect of the CRA on Nutrition using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. GTR is abbreviated for Greens, Tubers and Roots, LG is Legumes & Nuts, Dairy is Dairy products, FFE is Flesh Foods and Eggs, VAFV is Vitamin A Rich Fruits and Vegetables, CL is Child Liquids and DDI is the Dietary Diversity Index. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.4: Effect of the CRA on Breast Feeding
Dependant Variables

	(1) (CB)	(2) (DB)	(3) (EBM)
Panel A: Full Sample-27 States			
Born After* State Policy Change	-0.015 (0.040)	-0.299 (0.349)	0.049 (0.035)
Mean Dep Var(Control)	0.77	12.44	0.18
Observations	68,082	34,742	20,275
R-squared	0.13	0.663	0.484
Number of clusters	27	27	27
Panel B: Bordering Treated States- 14 States			
Born After* State Policy Change	-0.012 (0.062)	-0.533 (0.344)	-0.003 (0.039)
Observations	47,288	24,581	13,646
R-squared	0.131	0.686	0.579
Number of clusters	14	14	14
Panel C: Southern States- 16 States			
Born After* State Policy Change	0.024 (0.050)	-0.244 (0.325)	0.055 (0.033)
Observations	28,923	14,302	8,911
R-squared	0.062	0.632	0.429
Number of clusters	16	16	16

Notes: Table 3A.4 reports estimates for the effect of the CRA on Breastfeeding using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. CB is abbreviated for Child Breast, where the variable takes value 1 if immediately and 0 otherwise. DB is duration of breasting feeding and is measured as a continuous variable in months, EBM is Else Breast Milk, which takes value 1 is child is given anything other than breast milk and 0 otherwise. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.5: Effect of the CRA on Recent Illnesses

	Dependant Variables	
	(1) (Cough)	(2) (Diarrhoea)
Panel A: Full Sample-27 States		
Born After* State Policy Change	0.030 (0.034)	0.012 (0.026)
Mean Dep Var (Control)	0.25	0.23
Observations	62,613	62,711
R-squared	0.051	0.074
Number of clusters	27	27
Panel B: Bordering Treated States- 14 States		
Born After* State Policy Change	0.014 (0.035)	-0.043 (0.048)
Observations	42,674	42,722
R-squared	0.051	0.066
Number of clusters	14	14
Panel C: Southern States- 16 States		
Born After* State Policy Change	0.009 (0.029)	-0.014 (0.015)
Observations	27,469	27,484
R-squared	0.052	0.041
Number of clusters	16	16

Notes: Table 3A.5 reports estimates for the effect of the CRA on recent episodes of illnesses in the last two weeks using the estimation shown in Equation 3.1; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. Cough takes value 1 if child had a cough in the last two weeks and 0 otherwise. Diarrhoea takes value 1 if child had diarrhoea in the last two weeks and 0 otherwise. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.6: Effect of the CRA on Vaccinations, Weighted Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	DPT	Polio	BCG	Hepatitis B	Measles	Any First Dose	All First Doses
Panel A: 1st Dose of each vaccine							
Born After* Policy Change	-0.009 (0.023)	0.007 (0.025)	0.011 (0.027)	-0.01 (0.025)	-0.028 (0.023)	0.001 (0.035)	-0.016 (0.028)
Born After* Policy Change [W=P]	0.025 (0.023)	-0.002 (0.022)	0.001 (0.023)	-0.030 (0.024)	-0.056* (0.029)	-0.018 (0.029)	-0.056* (0.029)
Mean Dep Var(Control)	0.33	0.29	0.35	0.36	0.18	0.44	0.27
Observations	39,478	43,232	43,232	26,364	40,423	22,882	17,919
R-squared	0.402	0.342	0.344	0.379	0.276	0.433	0.492
Number of clusters	27	27	27	27	27	27	27
Panel B: Bordering Treated States- 14 States							
Born After* Policy Change [W=P]	-0.064 (0.041)	-0.010 (0.040)	-0.033 (0.043)	-0.067 (0.039)	-0.045 (0.028)	-0.066 (0.039)	-0.059 (0.036)
Observations	29,767	31,904	29,801	19,730	29,875	16,883	14,070
R-squared	0.27	0.243	0.317	0.261	0.178	0.319	0.303
Number of clusters	14	14	14	14	14	14	14
Panel C: Southern States- 16 States							
Born After* Policy Change [W=P]	0.034 (0.031)	-0.037 (0.027)	-0.009 (0.027)	-0.081** (0.034)	-0.063* (0.032)	-0.069** (0.028)	-0.083 (0.038)
Observations	13,950	16,158	13,741	9,493	15,022	8,455	5,654
R-squared	0.325	0.296	0.381	0.316	0.277	0.363	0.503
Number of clusters	16	16	16	16	16	16	16

Notes: Table 3A.6 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.1 using probability weights which are calculated using the sample weight provided in the children recode DHS dataset and weighting observations by state; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria, Panel B limits the treated states to only those states that border the northern states and Panel C only compares outcomes for the Southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.7: Effect of the CRA on Vaccination with Mean Reversion

	(1)	(2)	(3)	(4)	(5)	(6)
	DPT	Polio	BCG	Measles	Any First Dose	All First Doses
1st Dose of each vaccine						
Born After* State Policy Change	-0.009 (0.023)	0.007 (0.025)	0.011 (0.027)	-0.028 (0.023)	0.001 (0.035)	-0.016 (0.028)
Born After* State Policy Change [MR]	-0.001 (0.022)	0.012 (0.023)	0.013 (0.024)	-0.015 (0.024)	-0.004 (0.028)	-0.025 (0.022)
Mean Dep Var (Control)	0.33	0.29	0.35	0.18	0.18	0.44
Observations	39,478	43,232	43,232	40,423	40,423	22,882
R-squared	0.402	0.342	0.344	0.276	0.276	0.433
Number of clusters	27	27	27	27	27	27

Notes: Table 3A.7 reports estimates for the effect of the CRA on vaccinations using the estimation shown in Equation 3.1 while controlling for mean reversion; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3.A8:

Table 3.A8: Full sample (27 states)		
Dep var: Height for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.138	0.224
Later treated vs earlier control	0.171	-0.066
Treated vs Never treated	0.633	0.02
Treated vs already treated	0.058	-0.035
Dep var: Weight for height		
	Weight	Average DiD estimate
Earlier treated vs later control	0.138	0.012
Later treated vs earlier control	0.171	0.054
Treated vs Never treated	0.633	-0.177
Treated vs already treated	0.058	0.082
Dep var: Weight for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.138	0.161
Later treated vs earlier control	0.171	0.021
Treated vs Never treated	0.633	-0.105
Treated vs already treated	0.058	0.034
Dep var: Body Mass Index		
	Weight	Average DiD estimate
Earlier treated vs later control	0.138	0.026
Later treated vs earlier control	0.171	0.098
Treated vs Never treated	0.633	-0.163
Treated vs already treated	0.058	0.067

Notes: Table 3A.8 reports estimates for the effect of the CRA on anthropometry using the Bacon Decomposition. The estimates are for all of Nigeria.

Table 3.A9:

Table 3.A9: Bordering treated states (14 states)		
Dep var: Height for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.046	0.731
Later treated vs earlier control	0.06	0.041
Treated vs Never treated	0.894	0.395
Treated vs already treated	-	-
Dep var: Weight for height		
	Weight	Average DiD estimate
Earlier treated vs later control	0.046	0.056
Later treated vs earlier control	0.06	0.276
Treated vs Never treated	0.894	-0.083
Treated vs already treated	-	-
Dep var: Weight for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.046	0.521
Later treated vs earlier control	0.06	0.249
Treated vs Never treated	0.894	0.207
Treated vs already treated	-	-
Dep var: Body Mass Index		
	Weight	Average DiD estimate
Earlier treated vs later control	0.046	0.089
Later treated vs earlier control	0.06	0.347
Treated vs Never treated	0.894	-0.073
Treated vs already treated	-	-

Notes: Table 3A.9 reports estimates for the effect of the CRA on anthropometry using the Bacon Decomposition. The estimates are for the bordering treated states.

Table 3.A10:

Table 3.A10: Southern treated states (16 states)		
Dep var: Height for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.376	0.224
Later treated vs earlier control	0.467	-0.066
Treated vs Never treated	-	-
Treated vs already treated	0.157	-0.035
Dep var: Weight for height		
	Weight	Average DiD estimate
Earlier treated vs later control	0.376	0.012
Later treated vs earlier control	0.467	0.054
Treated vs Never treated	-	-
Treated vs already treated	0.157	0.082
Dep var: Weight for Age		
	Weight	Average DiD estimate
Earlier treated vs later control	0.376	0.161
Later treated vs earlier control	0.467	0.021
Treated vs Never treated	-	-
Treated vs already treated	0.157	0.034
Dep var: Body Mass Index		
	Weight	Average DiD estimate
Earlier treated vs later control	0.376	0.026
Later treated vs earlier control	0.467	0.098
Treated vs Never treated	-	-
Treated vs already treated	0.157	0.067

Notes: Table 3A.10 reports estimates for the effect of the CRA on anthropometry using the Bacon Decomposition. The estimates are for the southern treated states.

Table 3A.11: Effect of the CRA on Anthropometry using Sun and Abraham (2021)

	Dependant Variables			
	(1) (HforA)	(2) (WforA)	(3) (WforH)	(4) (BMI)
Panel A: Full Sample-26 States				
Sun and Abraham (2021)	0.385*** (0.085)	0.117 (0.095)	-0.19 (0.113)	-0.19 (0.116)
Born After* State Policy Change- TWFE	0.352*** (0.102)	-0.102 (0.099)	0.146 (0.092)	-0.111 (0.102)
Observations	40,245	40,284	40,329	40,295
R-squared	0.163	0.067	0.154	0.073
Number of clusters	27	27	27	27
Panel B: Bordering Treated States- 14 States				
Sun and Abraham (2021)	0.579*** (0.159)	0.197 (0.170)	-0.259 (0.191)	-0.286 (0.193)
Born After* State Policy Change-TWFE	0.502** (0.147)	0.226 (0.134)	-0.124 (0.145)	-0.141 (0.150)
Observations	25,993	26,065	26,028	26,038
R-squared	0.109	0.083	0.059	0.069
Number of clusters	14	14	14	14
Panel C: Southern States- 16 States				
Sun and Abraham (2021)	0.313*** (0.122)	0.150 (0.111)	-0.094 (0.088)	-0.085 (0.086)
Born After* State Policy Change- TWFE	0.246* (0.122)	0.166 (0.107)	-0.002 (0.082)	0.009 (0.082)
Observations	18,874	18,889	18,879	18,882
R-squared	0.155	0.104	0.072	0.087
Number of clusters	16	16	16	16

Notes: Table 3A.11 reports estimates for the effect of the CRA on anthropometry using the Sun and Abraham (2021) estimator shown in equation 3.3; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. The samples are panel A is for the whole of Nigeria. Panel B is restricted to the Northern bordering states and Panel C is only for the southern states. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.12: Effect of the CRA on Height for Age dropping one state at a time

	State being dropped				
	(Kaduna)	(Lagos)	(Abuja)	(Plateau)	(Benue)
Born After* State Policy Change	0.322*** (0.111)	0.367** (0.109)	0.353*** (0.106)	0.366*** (0.111)	0.308*** (0.107)
Observations	38,439	38,510	38,992	38,902	38,705
R-squared	0.166	0.166	0.162	0.164	0.163
Number of clusters	26	26	26	26	26
	(Oyo)	(Osun)	(Ondo)	(Edo)	(Enugu)
Born After* State Policy Change	0.347*** (0.109)	0.359*** (0.107)	0.402*** (0.092)	0.365*** (0.107)	0.352*** (0.106)
Observations	38,786	39,019	39,044	39,317	39,225
R-squared	0.166	0.163	0.166	0.160	0.164
Number of clusters	26	26	26	26	26
	(Cross River)	(Akwa Ibom)	(Abia)	(Rivers)	(Bayelsa)
Born After* State Policy Change	0.358*** (0.104)	0.351*** (0.108)	0.331*** (0.106)	0.380*** (0.103)	0.367*** (0.109)
Observations	39,187	39,205	39,140	38,939	38,510
R-squared	0.163	0.162	0.162	0.165	0.157
Number of clusters	26	26	26	26	26

Notes: Table 3A.12 reports estimates for the effect of the CRA on anthropometry dropping one state at a time using the estimation shown in equation 3.1; State Policy Change is a dummy taking value 1 if Child *i* resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.13: Can the CRA be predicted

	Policy Change in State (1/0)
HforA	0.806 (0.826)
HforA (t-1)	0.559 (0.681)
HforA (State time trend)	-0.003 (0.004)
WforA	0.631 (0.465)
WforA (t-1)	-0.693 (1.121)
WforA (State time trend)	-0.001 (0.003)
WforH	-1.291 (1.372)
WforH (t-1)	0.559 (0.681)
WforH (State time trend)	0.006 (0.008)
BMI	0.059 (0.609)
BMI (t-1)	0.791 (0.615)
BMI (State time trend)	-0.265 (0.519)
Proportion of Children under 5	0.102 (0.211)
Proportion of Children under 5 (t-1)	0.242 (0.110)

Proportion of Children under 5 (State time trend)	0.001 (0.003)
---	------------------

Notes: Table 3A.13 reports estimates if certain state level characteristics such as anthropometry, vaccination rates and the proportion of children under 5 on the likelihood that a state passed the CRA. All specification's include state and year fixed effects. Standard errors are reported in parentheses and are clustered at the state level; each state year contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.14: Supply driven controls

	Dependant Variable		
	(1)	(2) (HforA)	(3)
Panel A: Full Sample-26 States			
Born After* State Policy Change	0.346*** (0.102)	0.351*** (0.103)	0.352*** (0.102)
Distance to nearest health facility	N	Y	Y
Number of vaccination campaigns	N	N	Y
All other controls in Table 3.1	Y	Y	Y
Observations	40,242	40,118	40,245
R-squared	0.164	0.164	0.163
Number of clusters	27	27	27

Notes: Table 3A.14 reports estimates for the effect of the CRA on anthropometry after including supply driven controls; State Policy Change is a dummy taking value 1 if Child i resides in state that introduced the CRA; Born After takes the value 1 if the child is born after the policy changed using the month & year of birth of the child. Standard errors are reported in parentheses and are clustered at the state level; each child contributes 1 observation; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3A.15: Multiple Hypothesis testing using Romano & Wolf

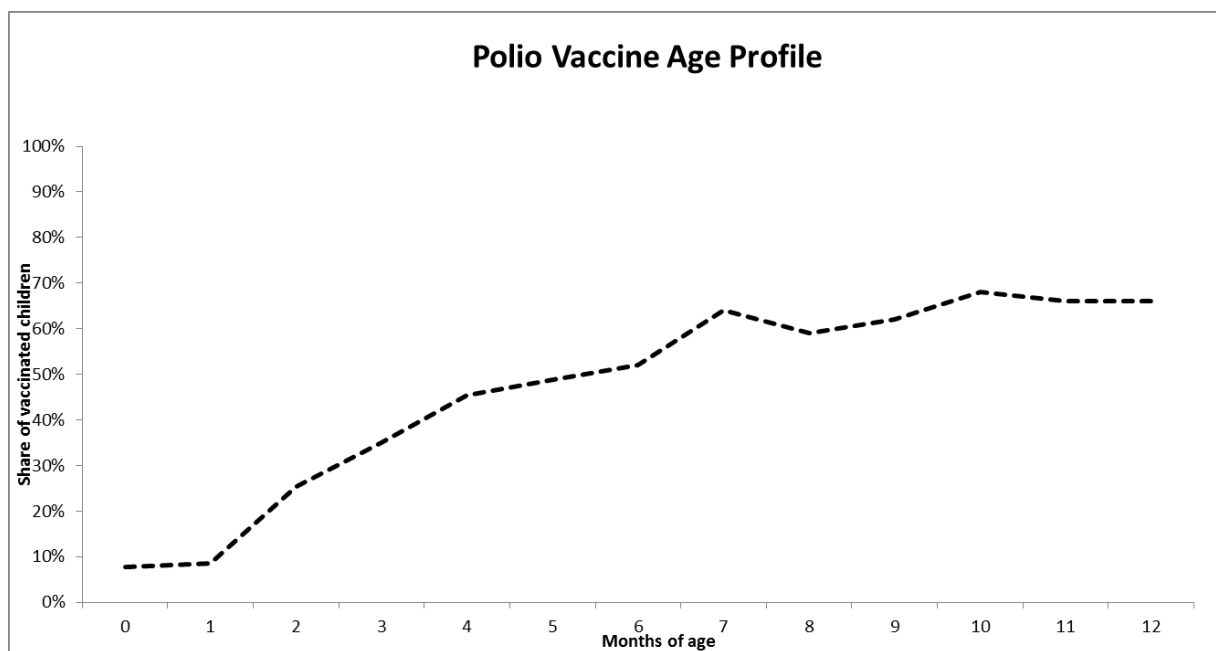
	(1)	(2)	(3)	(4)	(5)	(6)
	DPT	Polio	BCG	Measles	Any First Dose	All First Doses
Model p-value	0.97	0.753	0.64	0.61	0.55	0.58
Resampled p-value	0.95	0.54	0.34	0.23	0.44	0.51
Romano-Wolf p-value	0.97	0.97	0.94	0.92	0.51	0.57
All controls in Eq 3.1	Yes	Yes	Yes	Yes	Yes	Yes
	(7)	(8)	(9)	(10)	(11)	(12)
	(HforA)	(WforA)	(WforH)	(BMI)	(BW_Kg)	(Intestinal Para)
Model p-value	0.002	0.12	0.34	0.31	0.16	0.001
Resampled p-value	0.001	0.001	0.006	0.004	0.06	0.001
Romano-Wolf P value	0.003	0.17	0.51	0.45	0.23	0.001
All controls in Eq 3.1	Yes	Yes	Yes	Yes	Yes	Yes

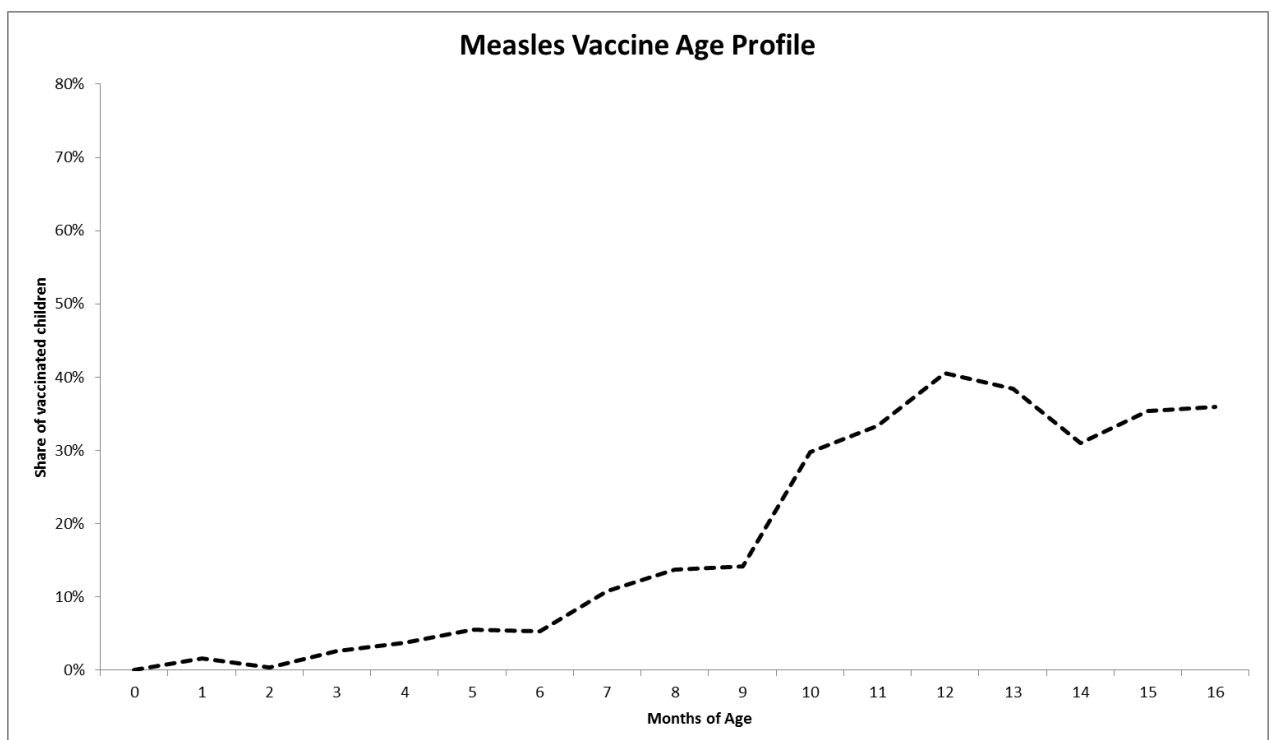
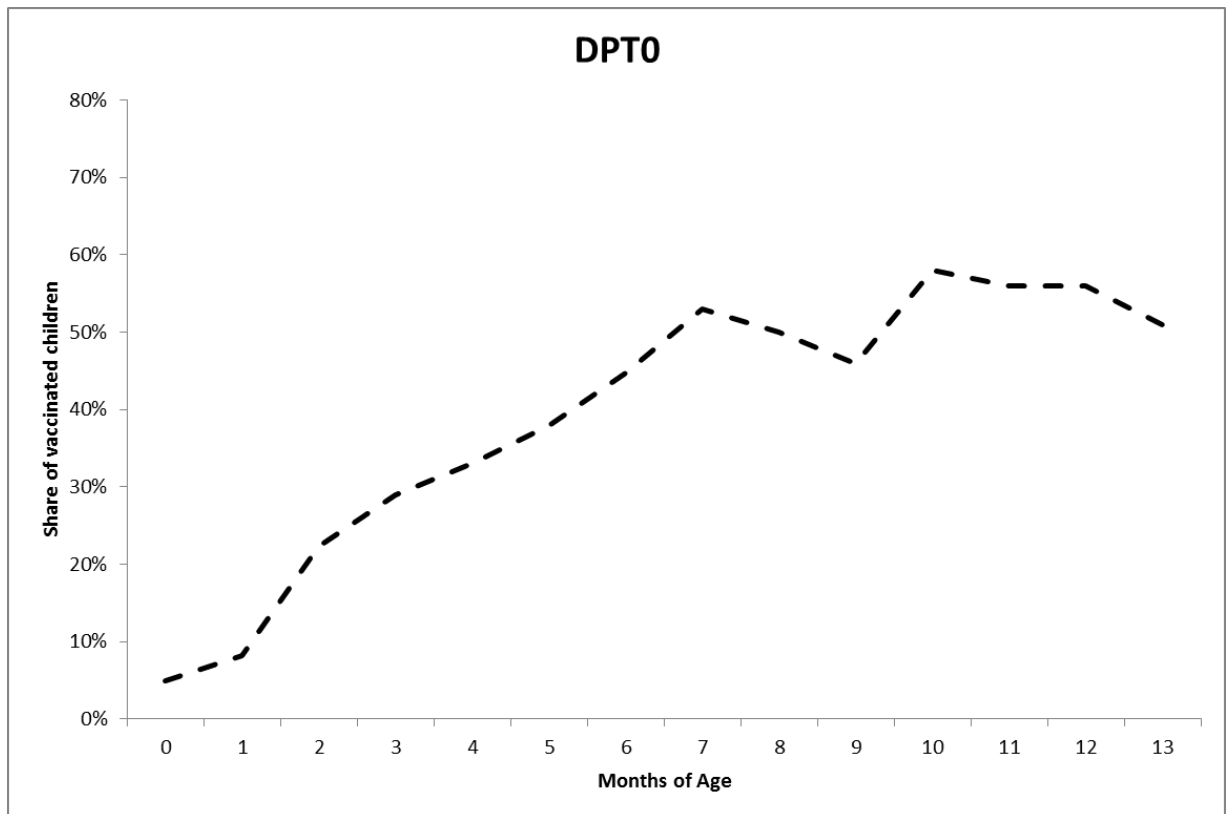
Notes: Table 3A.15 shows the estimates from the Romano wolf estimation procedure for multiple hypothesis testing. The sample is for the whole of Nigeria.

Figures

Figure 3.1:

Notes: These figures show the fraction of children that received the first dose of each vaccine by their age at the time of the interview, only the pre-period wave of DHS 2003 is shown below.





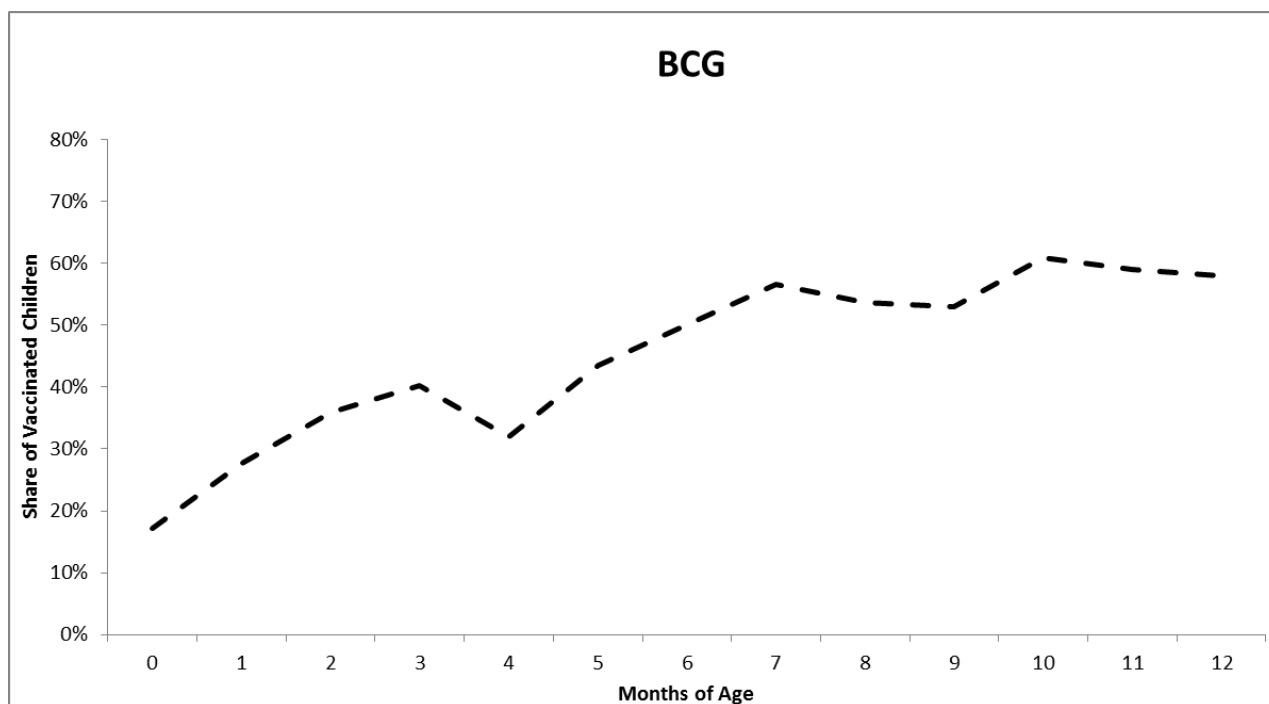
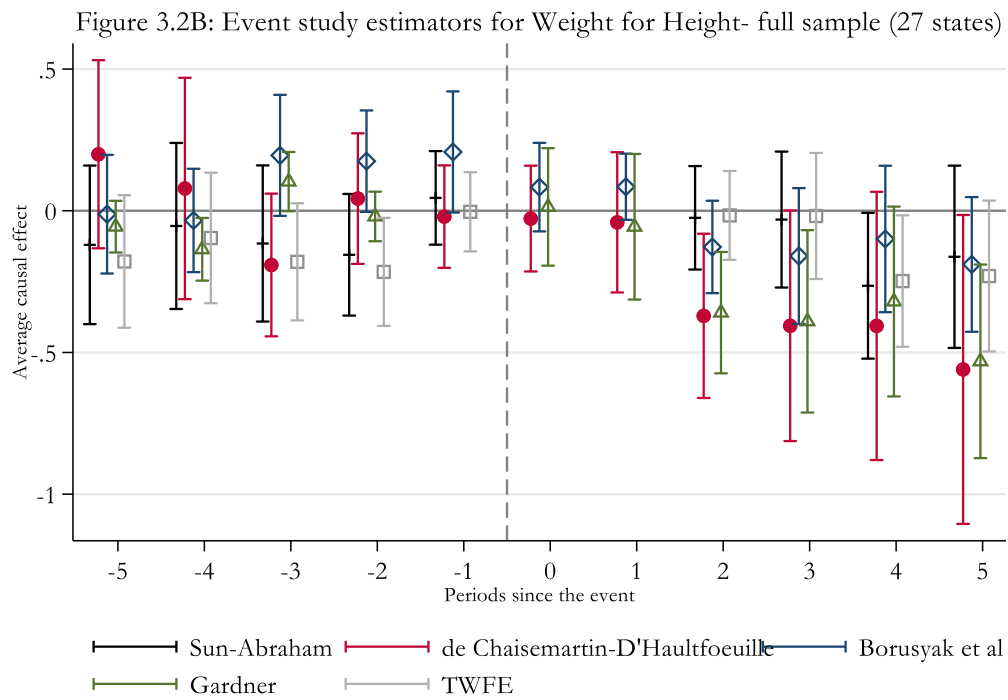
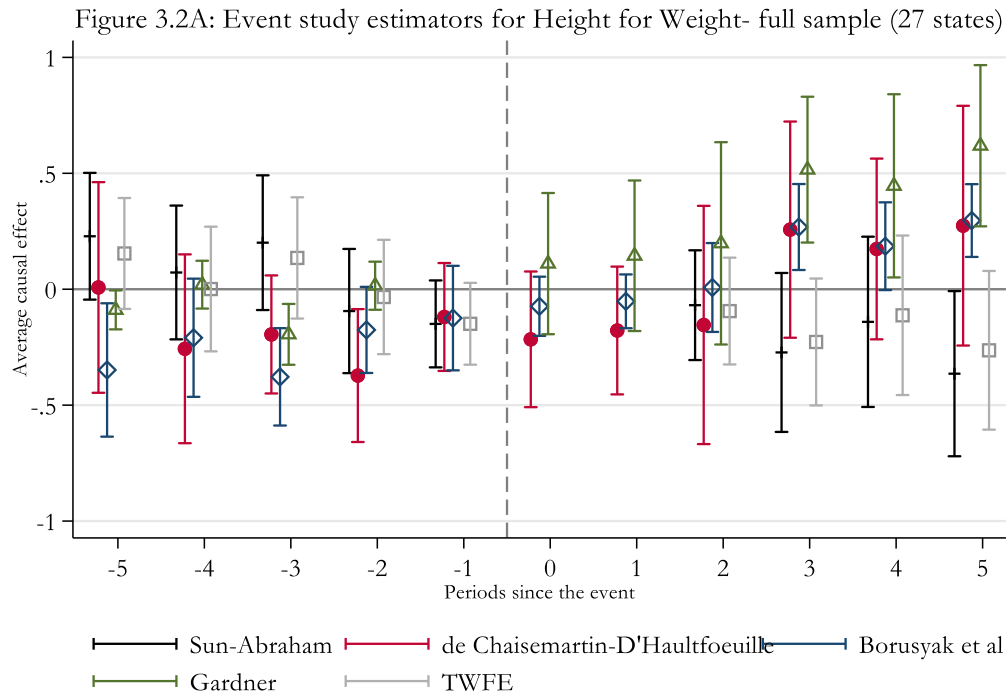
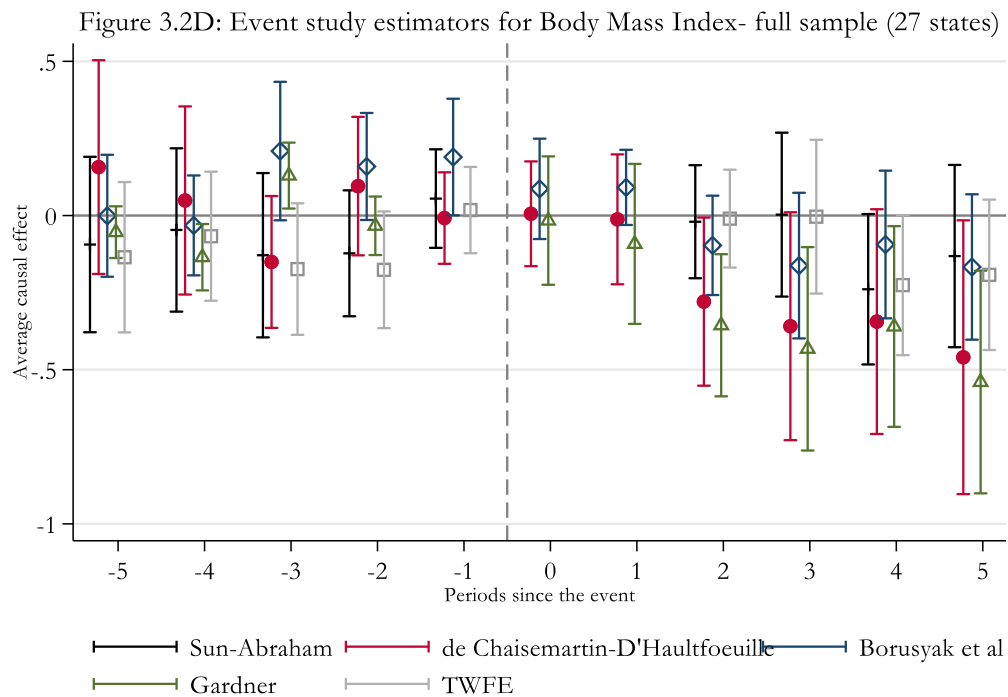
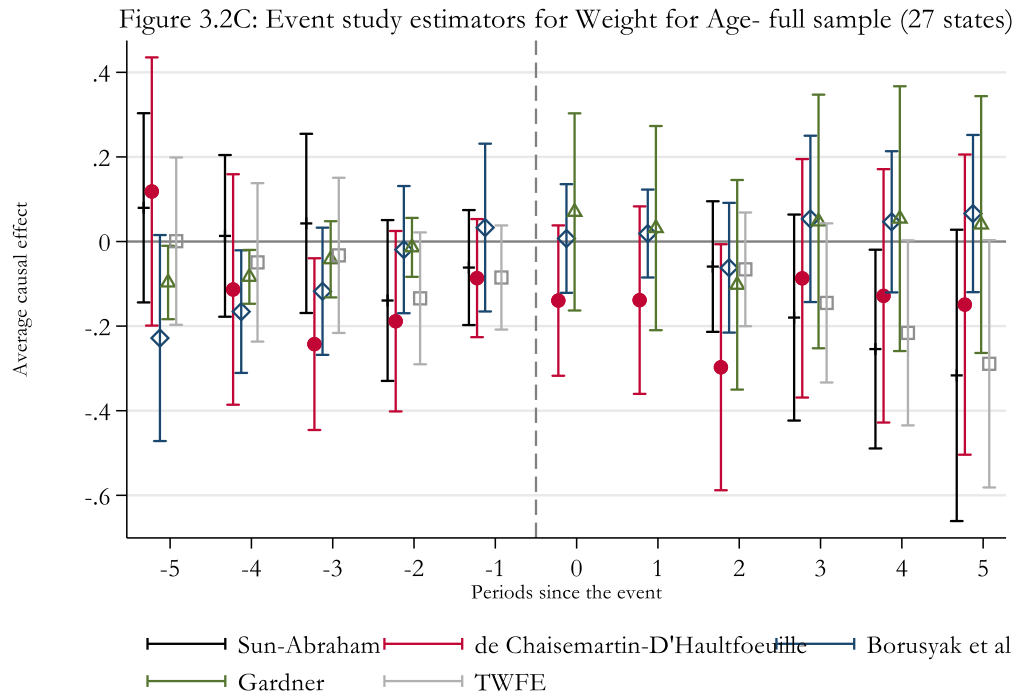


Figure 3.2:

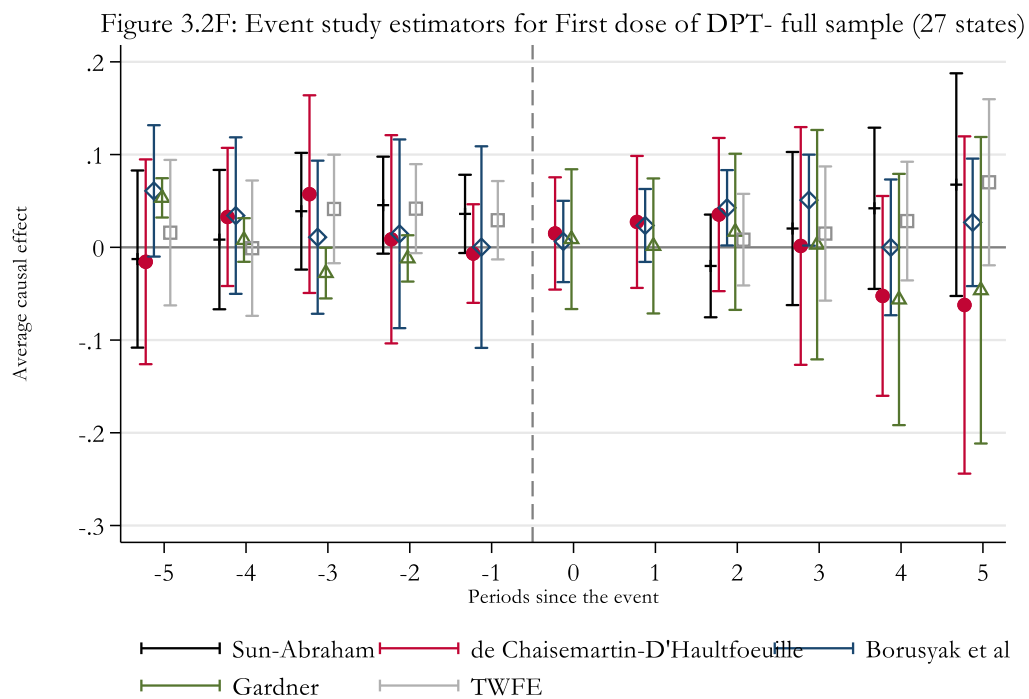
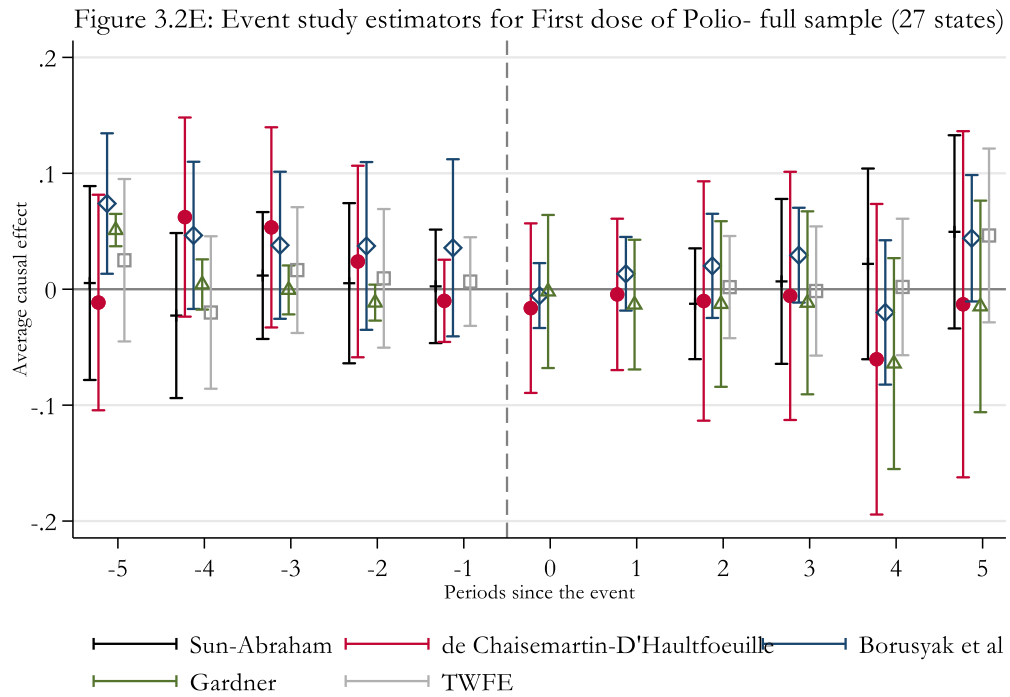
Notes: Figure 3.2 shows event study graphs for the effect of the CRA on anthropometry using Sun and Abraham (2021); standard errors are clustered at the state level; each child contributes 1 observation; the dependent variable for the anthropometric measures for Height for Age, Weight for Height, Body Mass Index and Weight for Age are expressed in standard deviations. For vaccination status, the dependant variable is equal to 1 if vaccination is marked on card and 0 otherwise. Sample consists of children between July, 2003 and December, 2018 who are under 5 years of age at the time of the interview.

Anthropometric measures:





Vaccination Status:



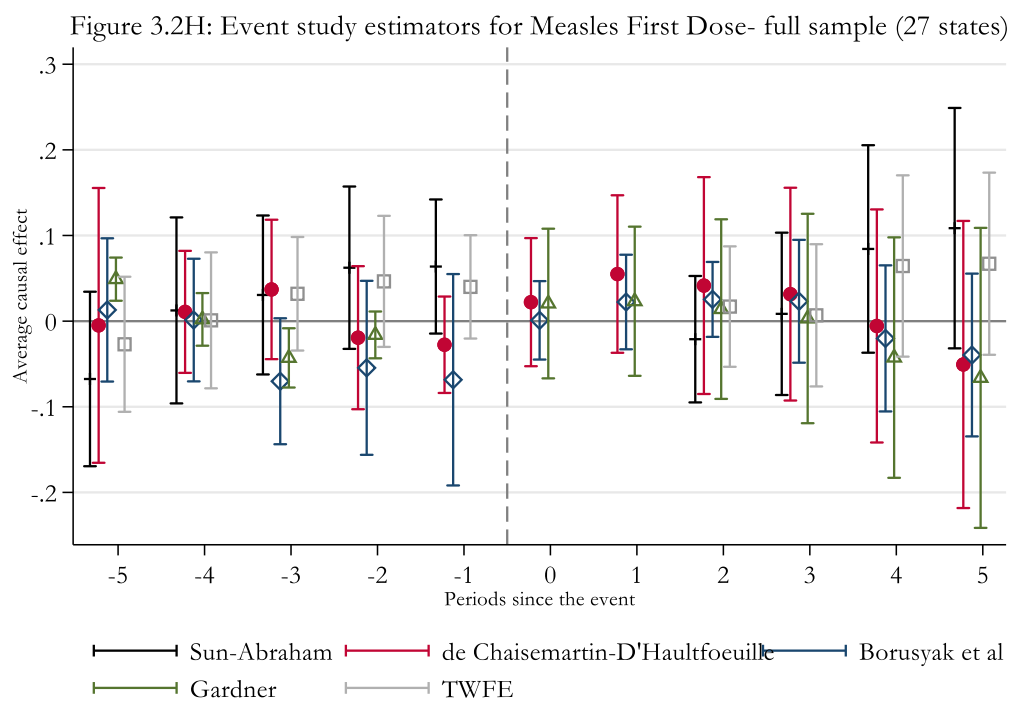
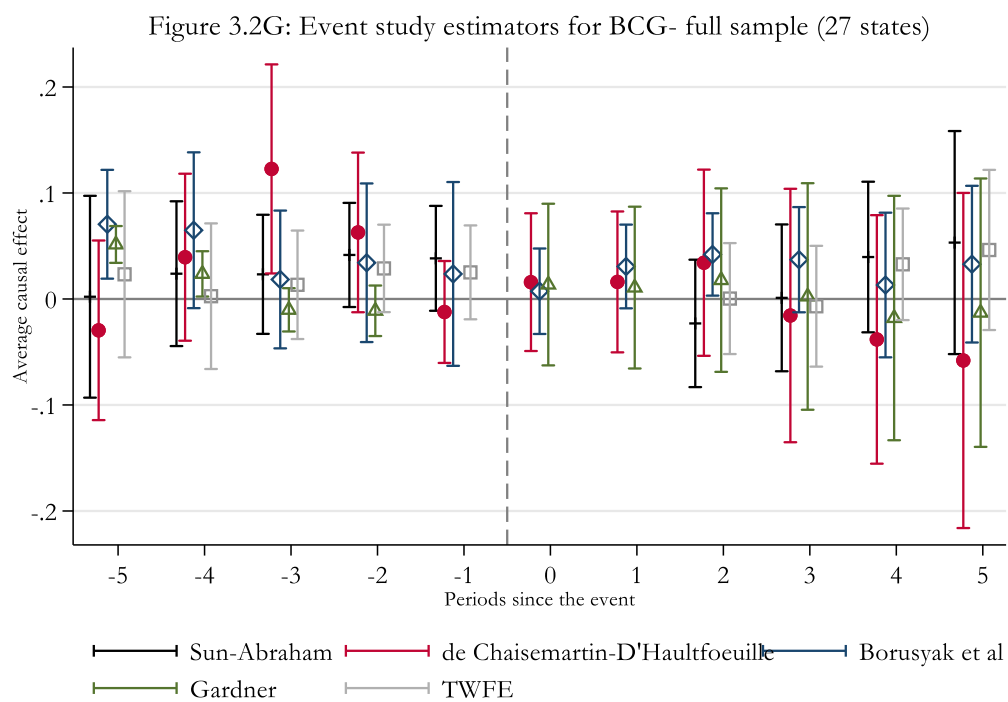
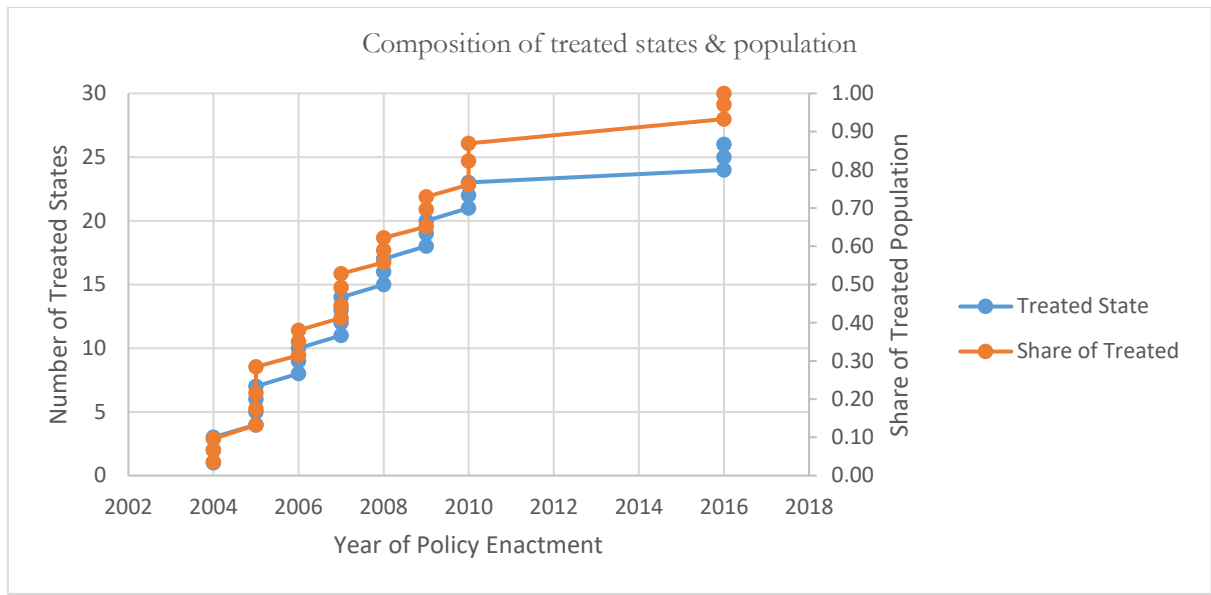


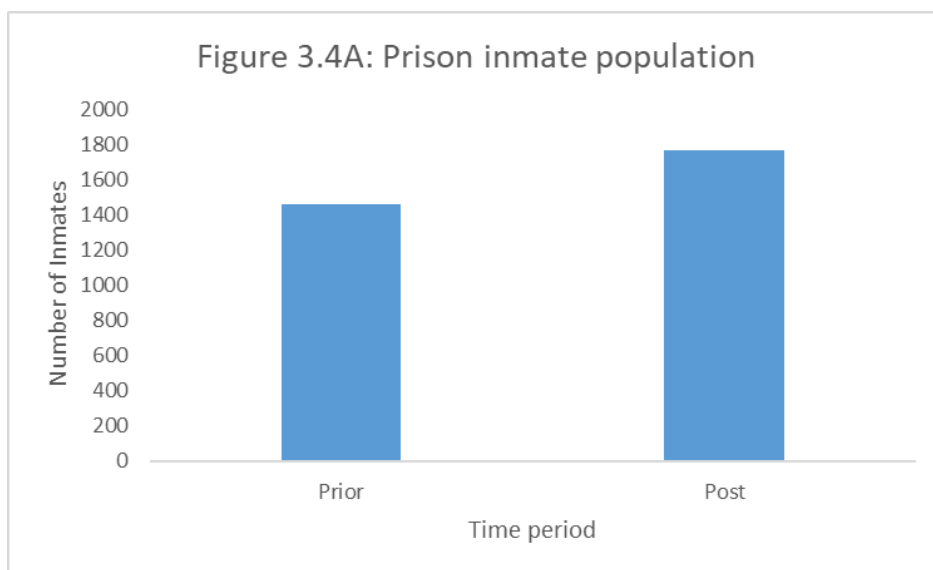
Figure 3.3:



Notes: Figure 3.3 shows the composition of the treated states and share of treated individuals over time.

Figure 3.4:

Notes: Figures 3.4A & B show the number of inmates and number of cases (by type) in Nigeria in the period prior to the policy and in the period post the policy in the states where the CRA was implemented and where it was not (this is aggregated). The number of child cases and inmate population is obtained from the data provided by the Nigerian police force in the Annual statistical abstract of Nigeria for a limited period of years (2002, 2004, 2005, 2006, 2006, 2009 and 2010) and for certain states this information is not present.



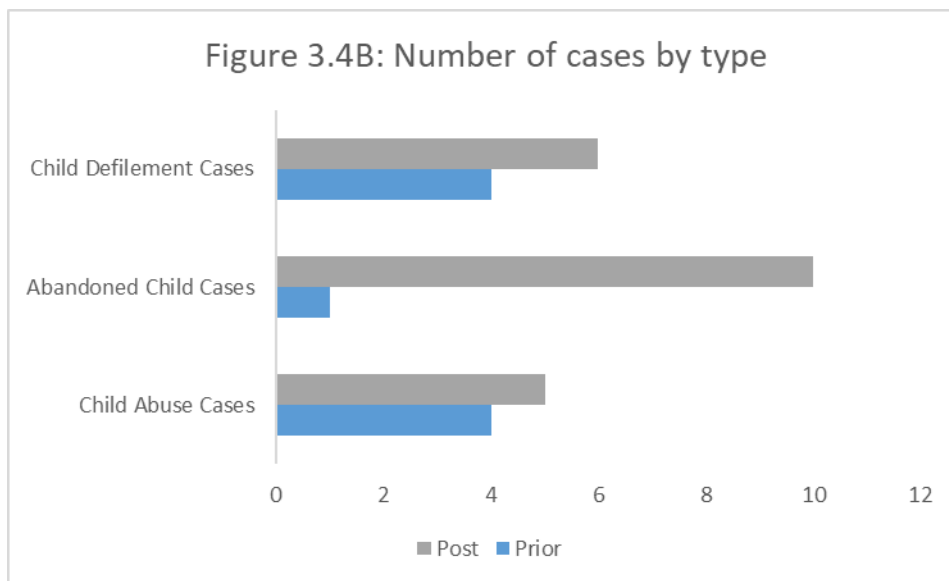
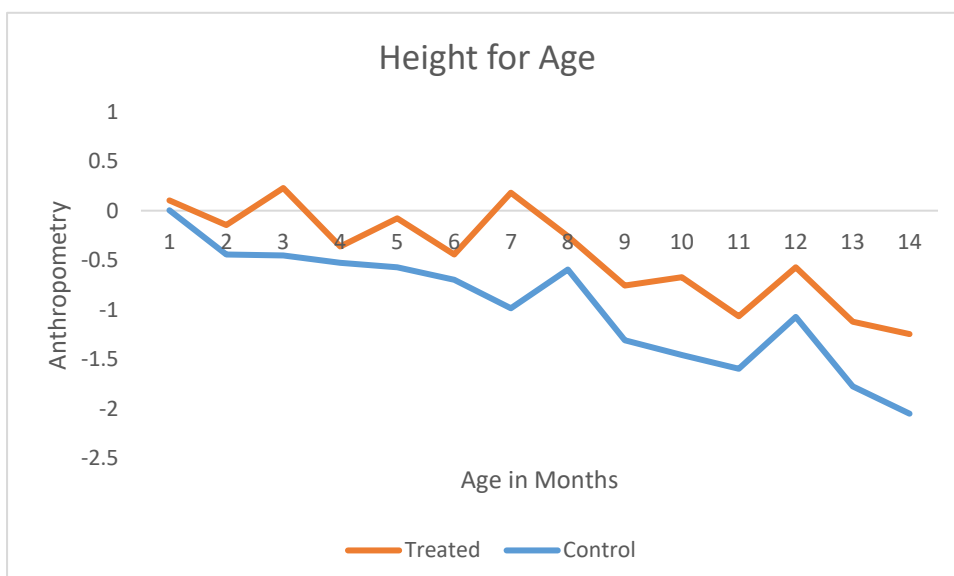
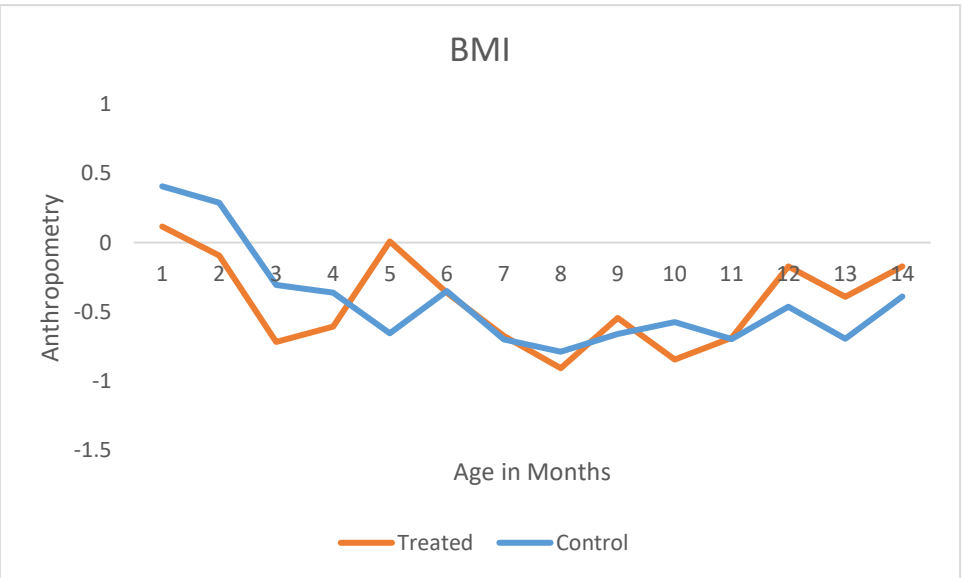
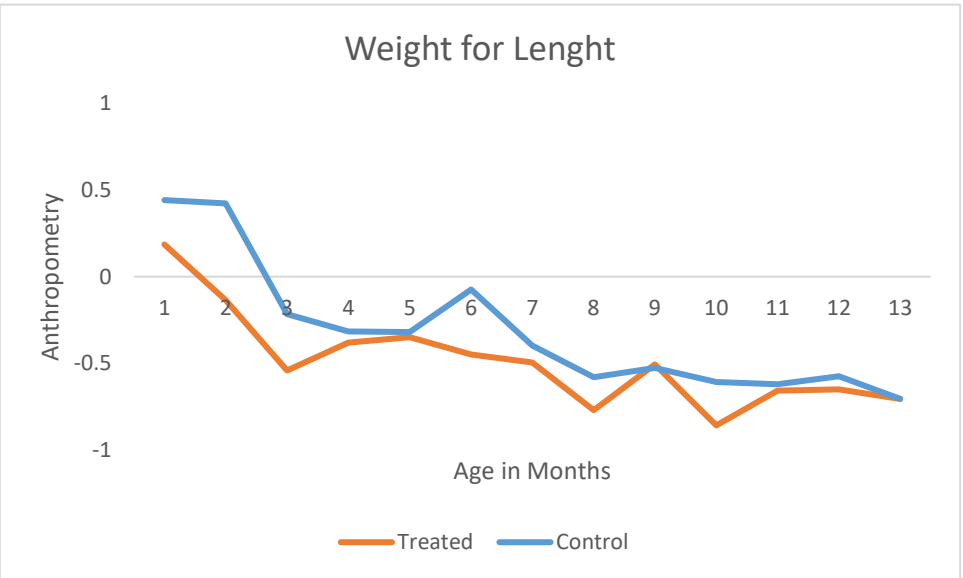
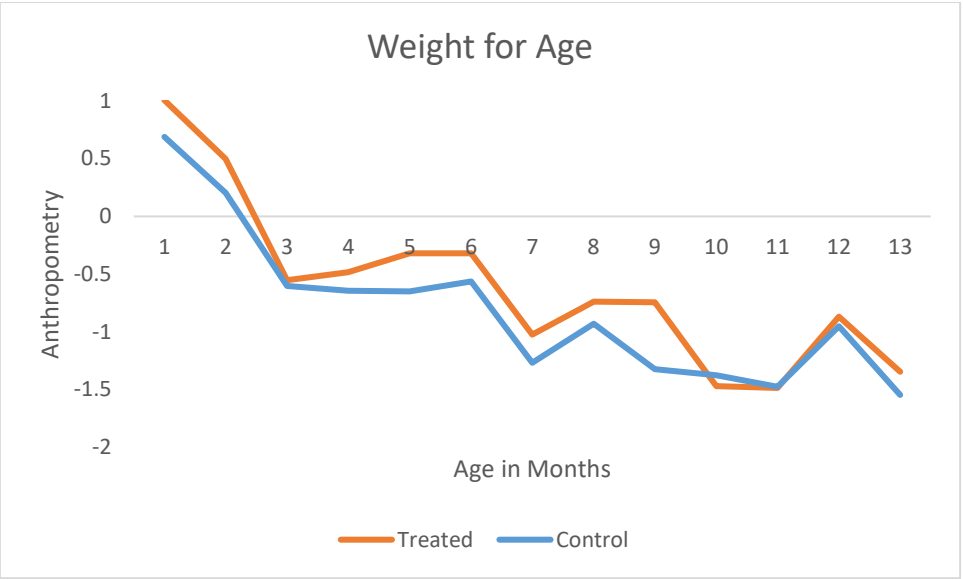


Figure 3.5:

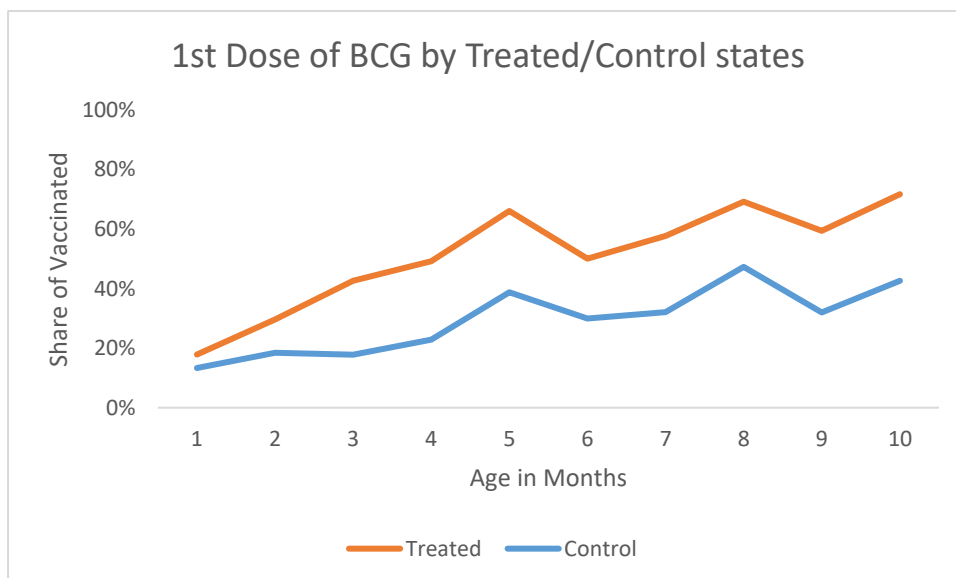
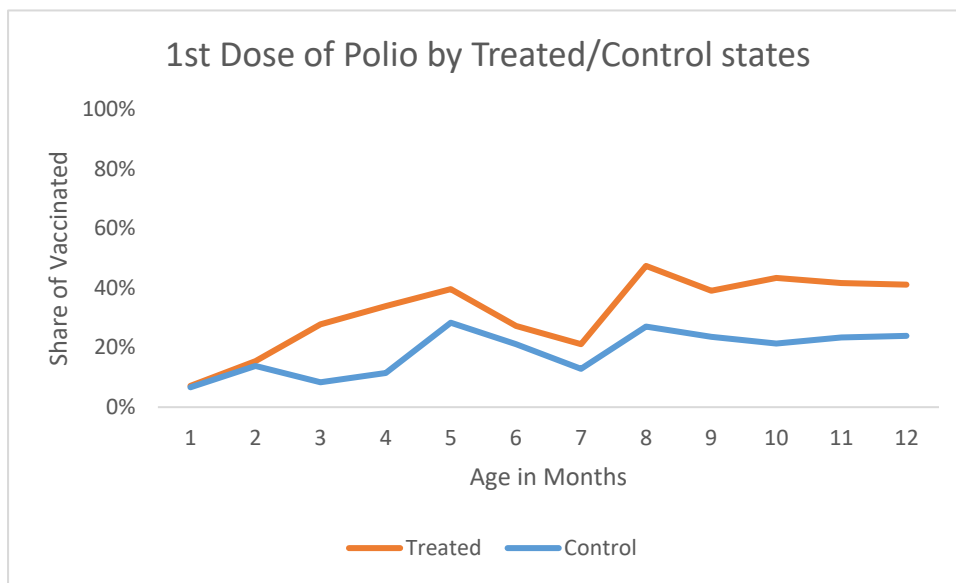
Notes: Figure 3.5 show a comparison of the raw data trend (means) during the pre-period in anthropometry and vaccination between children in the CRA and non-CRA states for children as a function of their age in months.

Anthropometry:





Vaccination rates:



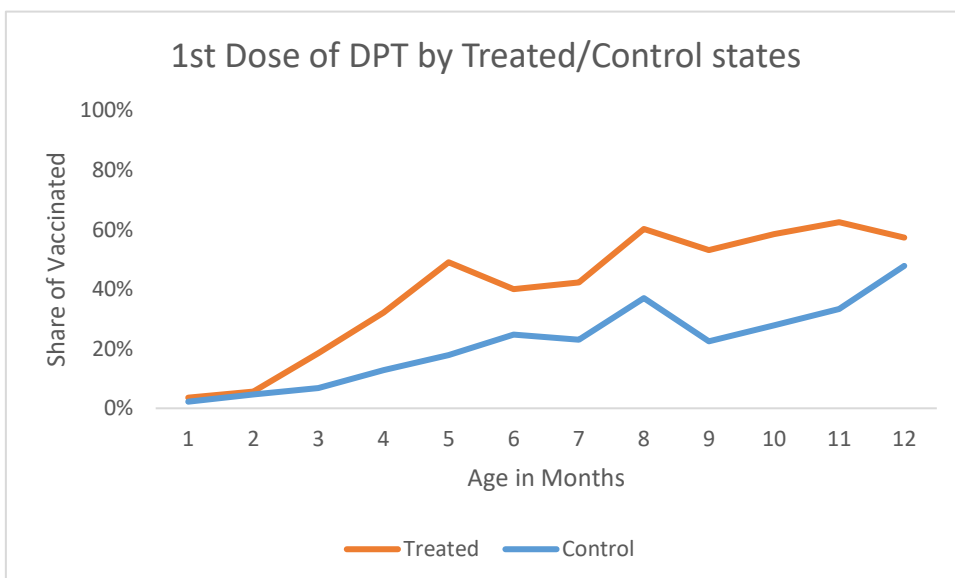
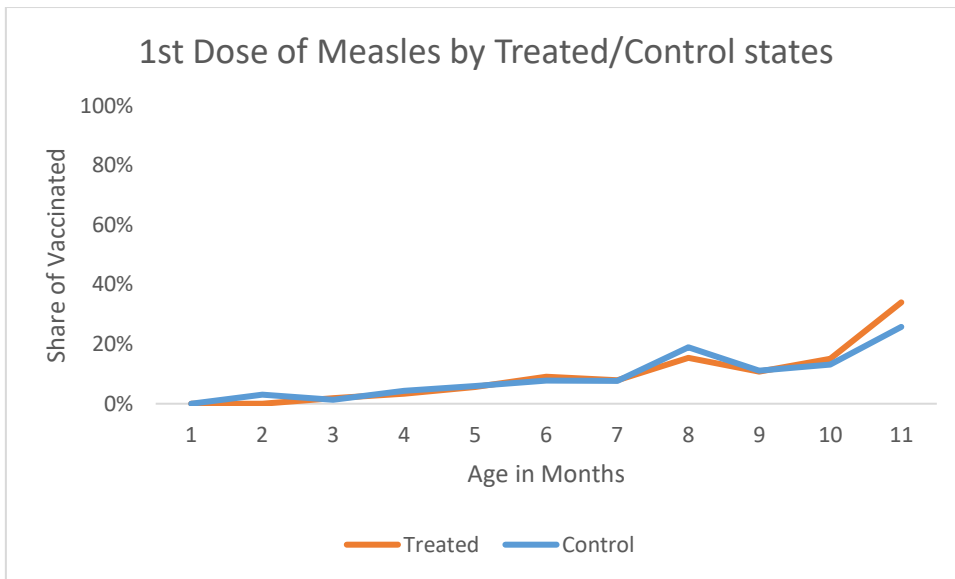
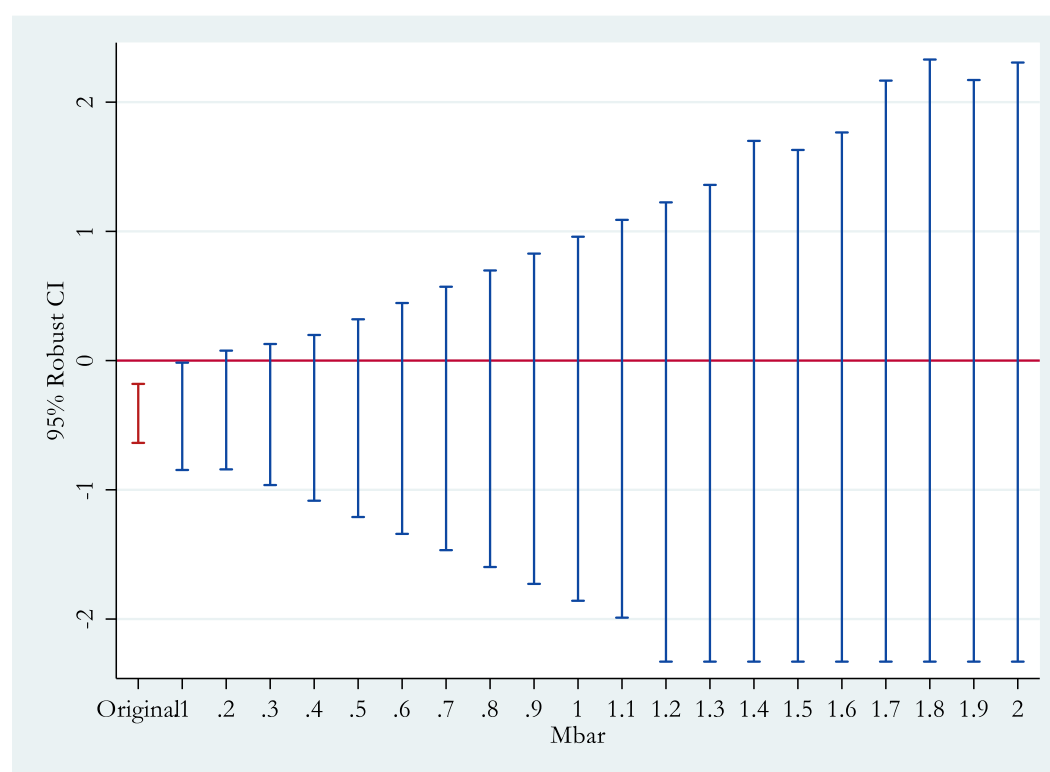


Figure 3.6: Rambachan and Roth's breakdown value of parallel trends



Child Rights Act (additional details)

Clauses in the Child's Rights Act:

The history of the Child Rights Act (CRA) has been discussed in the main body of the paper; it is a detailed piece of legislation with a total of 278 clauses. The legislations focus can be broadly classified as improving the health of children, the banning of exploitative practices against children such as Child Labour and Child Marriage with the imposition of strong penalties if the act is violated and in certain cases, the right to revoke the guardianship of the child if deemed necessary by the relevant authorities. The most relevant clauses which would affect the health of children are below

Section 13: The Right to health and healing services:

Subsection 13(2): Every..parent..guardian...responsible for the care of a child to provide for the child the best attainable state of health

Subsection 13(3:b): Ensure the provision of necessary medical and health care with emphasis on the development of primary health care

Subsection 13(3:e): Combat Disease and Malnutrition with the aid of primary health care

Subsection 13(4): Every Parent, Guardian having the care of a child under the age of two years shall ensure the child is provided with full immunization

Subsection 13(5): Every Parent, Guardian who fails to ensure commits an offence and is liable
(a) For a first offence, a fine not exceeding 5000 NR

(b) A second offence, in respect of the same child or another child in their care to imprisonment for a term of a maximum of one month

(c) The court may substitute any of the above penalties to compel the parent/guardian to ensure the immunization of the child

Section 41: Child Assessment Orders:

Subsection 41(1): A state government may apply for a child assessment order

Subsection 41(1b): An assessment of the state of the health or development of the child, in which the child is established to be either suffering or likely to suffer significant harm

Subsection 41(c1): A court will treat an application under this section as an emergency protection order with the power to revoke guardianship of the child if necessary

Enforcement of law:

In 2009, Police charged five men with murder after the group's leader said in a television documentary he had killed 110 children he believed to be possessed by evil spirits. Sunday Okon William, locally known as Bishop Ulup-Aya, and six others in his group were arrested in Akwa Ibom state in December after the documentary was shown internationally. "He and four others were charged with murder yesterday. He confessed to a foreign-based media house that he killed 110 children," state information commissioner Aniekan Umanah said. William has since recanted his statement, saying he only killed the "witchcraft spirit" in the children. A federal court hearing was scheduled on June 6th, 2009 in Akwa Ibom.

In 2013, The National Human Rights Commission in Nigeria, NHRC, said it received 54 cases of human rights violation in Akwa Ibom where some were related to witchcraft accusations. The state NHRC Coordinator, Tony Iji said that the state office was currently embarking on an enlightenment campaign in schools in the state to educate the students on the Child Rights Law 2008. "You see not many of these students know their rights under the Child Rights Law enacted in the state in 2008, so we decided to embark on enlightenment campaign among secondary schools," Mr. Iji said.

In January 2020, the CRA was cited in a case of parental care and protection in a domestic dispute in Abuja by a collation of local rights groups led by the Coalition for Women and Children Rights Protection which cited a breach of clause 14 where a biological mother was denied custody of her four children. The court is still being processed in courts which the CRA has set up for arbitration.

Nigeria National Immunization Schedule:

Vaccine	Schedule
Bacillus Calmette-Guerin (BCG)	Birth
Diphtheria, pertussis and tetanus (DPT) I	6 weeks
Oral polio vaccine (OPV) I	6 weeks
Diphtheria, pertussis and tetanus (DPT) II	10 weeks
Oral polio vaccine (OPV) II	10 weeks
Diphtheria, pertussis and tetanus (DPT) III	14 weeks
Oral polio vaccine (OPV) III	14 weeks
Measles	9 months

Chapter 4: Commodity Prices and Household food security: Evidence from Nigeria

4.1 Introduction

Africa is home to a third of the world's undernourished population (Carvalho, 2021). 346 million people in Africa are severely food insecure (Boye et al., 2022), 50 million of which require emergency aid annually. Sub-Saharan Africa (SSA) receives the most food aid globally and 60% of the World Food Program's active programs are focused on Africa (Aboboa, 2021). There are a number of reasons why SSA continues to suffer from food insecurity ranging from falling agricultural yields, a lack of mechanization, food price variability and a high dependence on food imports (Juma et al., 2021). Food price fluctuations which are related to the agricultural cycle have been extensively studied in the literature with the key finding that food prices are higher in the lean season and lower in the harvest season (Cardell & Mitchellson, 2022, Kaminski et al., 2016). Interventions to reduce the adverse effects of food price seasonality vary from easing liquidity and credit constraints (Kadjo et al., 2018, Burke et al., 2019, Fink et al., 2018) to providing storage options (Huss et al., 2021) and encouraging seasonal migration (Mobarak et al., 2014). Food prices might fluctuate due to seasonality or due to other factors such as market failure (Timmer, 2017), climate change (ODI, 2001), political instability (Areziki and Buckner, 2011), weak institutions (Goderies & Collier, 2007) and import dependency (UNDP, 2023) amongst others. The effect of food price changes on household food security remains an important topic of inquiry.

Increases in the price of household staple goods and its relationship to household food security depends on the characteristics of the household such as its wealth. The theoretical literature applicable to price changes and its effect on household food security can be viewed from the lens of Engel's Law (1895) which states that as household income increases, the share of expenditure allocated to food falls. An increase in the price of staple goods should therefore lead to a comparatively larger increase in the food share of a lower- and middle-income households compared to a high-income household. While Bennett's Law (1941) finds that wealthier households consume a more diverse diet compared to less wealthy households, Upton et al. (2018) discover that as incomes increase, diets first improve in quantity and then quality. This suggests that increases in prices of staple goods will have a differential effect depending on wealth of the household.

It is important to mention the effects of price changes of key consumption items will vary depending on a household's status as a net seller or a net buyer of that item. A household that is a net buyer will suffer due to an increase in the price of a key consumption item and a net seller household will gain due to an increase in the price of a key consumption item (Vergez, 2007). However, this classification is complicated by a change in status depending on the season. Poorer households may be net sellers in the post-harvest season but net buyers in the lean (post planting season), net selling households can also store food to consume or sell during the lean season. Since the cost of savings is high, the expected price of the food in the future will determine the degree to which savings can be used to smoothen consumption (Isik-Dikmelik, 2005).

This paper investigates the relationship between price changes and household food security. The key questions it seeks to answer are (1) Are food price fluctuations of a key dietary staple associated with changes in household food security, (2) Does the impact of price changes vary by household characteristics such as the wealth level of a household or its status as a producer or consumer of the commodity.

To investigate these questions, I use a panel of households in Nigeria from 2010 to 2016 combined with historical price data. I focus on Domestic and International Cassava prices, Cassava is a dietary staple in Nigeria, 7 out of 10 Nigerians consume cassava at least once a day (Njoku and Muoneke, 2008). I use two measures of household food security: (1) The Household Diversity Score (HDDS) and (2) The food share of a household's expenditure on food. My primary estimation model is Ordinary Least Squares (OLS); however, I use alternative models such as the Poisson and a fractional probit in the robustness section. I find that an increase in the price of domestic and imported cassava is negatively associated with household food security measures and the effect varies depending on the wealth classification of a household, at baseline households which are classified as being wealthy are impacted by imported cassava prices more than poor and medium wealth households as measured by the Household Diversity Score (HDDS), while imported cassava prices impact the average (medium) wealthy households the most as measured by the share of food expenditure. These empirical results are consistent with the predictions of the theoretical models of Engel and Bennett's price increase impacts on households.

Both Producers and consumers see an increase in food insecurity markers associated with an increase in the price of domestic and imported cassava, the effect is stronger for consumers but demonstrates an increase in food insecurity for cassava producing households. These findings for household food in-security echo the findings on household food security in different contexts as measured by the number of lean months (Bacon et al, 2017; Morris et al, 2013) and self-reported measures of annual food scarcity (Rogan & Reynolds, 2017).

It is important to note that making causal claims in relation to price changes is difficult because unobservable factors may be correlated with both household food security and cassava prices, while I include various controls on observable factors, time varying unobservable factors such as global macroeconomic shocks, trade frictions and financial crisis may impact household's differently (Wooldrige, 2010). Therefore, the estimates in this paper should be seen as conditional correlations rather than causal estimates.

This study contributes to a few different strands of literature. First, it contributes to the growing literature of commodity price pass throughs to consumers and producers due to an increase in integration of global supply chains (Goldberg and Pavcnik, 2007). Importantly, as supply chains are not constrained by national boundaries, changes in global conditions can have important consequences at a local level. This study uses international commodity by-product prices as a proxy for the import price which is novel to the existing literature on commodity price pass through, the existing literature relies on the raw material prices as a source of exogenous variation. In situations where using the raw commodity price is unfeasible due to the perishable nature of the commodity, the use of by-product prices is an alternative way to capture changes in the price of import and export commodities conditional on its passthrough to households. Second, this study considers farmers which plant crops primarily for consumption as an important source of food intake and contributes to the debate around “hungry farmers” in developing countries (Bacon et al, 2017; Morris et al, 2013; Rogan & Reynolds, 2017). Lastly, this study contributes to the effect of food price changes on Net food importers (See for example; Blom et al, 2021 and Kebede, 2020). Nigeria is a particularly suitable context for this study given its high levels of food insecurity and economic volatility due to its dependence on oil exports. The country continues to experience a turbulent exchange rate regime, high levels of conflict and political instability, low agricultural productivity, instability in food prices, and abrupt policy changes (Shittu et al., 2021).

The next section (4.2) outlines the background of Food and Cassava production in Nigeria and presents the data. Section 4.3 lays out the empirical strategy; the results are presented in section 4.4. Section 4.5 discusses robustness checks and Section 4.6 concludes.

4.2 Background & Data

4.2.1 Food and Cassava production in Nigeria

Food production in Nigeria is a complicated mix of factors which leaves the market susceptible to macroeconomic headwinds (Shittu et al., 2021). Local food producers in Nigeria face flooding, fluctuations in rainfall, pest invasions, conflict between farmers and herders, domestic terrorism, high costs of production, post-harvest losses and limited access to external funding (Jamison et al., 2018). Nigeria bridges the gap in food demand through imports which are susceptible to changes in international market fluctuations. This dependency on food imports has broad effects on household welfare and food security (Jamison et al., 2018; Shittu et al., 2021).

The Nigerian government has attempted to reduce domestic food market volatility through various policies and investments. In 2011, the government launched the Agricultural Transformation Agenda (ATA) to boost agricultural production, it also introduced various safety net programs and created the Nigeria Incentive-based Risk Sharing System for Agricultural Lending. The efficacy of these policies has not been investigated and despite policy efforts to improve food production, Nigeria faces a net food gap which it bridges through food imports.

Nigerian households consume a diverse diet, Cassava demonstrates the complex nature of the Nigerian food market. 80% of Nigerian's consume cassava at least once a day in the form of its by-products (Garri, Flour, Fufu, Chips) (Salau et al, 2019). At baseline, on the basis of 30-day food expenditure, roots and tubers constitutes 14% of total household expenditure on food items, the 4th highest share after Meats (18%), Fish (18%) and Rice (18%).

Cassava production has increased in Nigeria over time, in 1971 Nigeria produced 9.1 million tonnes which increased to 60 million tonnes in 2020. In 1970 Nigerian Cassava was 5% of

global market output, in 2020 Nigeria's share of the global market output in the world was 20% (Adenegan, 2020). Nigeria exports 3.2 million tons annually of Cassava⁷⁷, it is a major staple crop which is responsible for the livelihood of over four million farmers and provides food for over a 100 million people (Adenegan, 2020). Cassava production occurs all across Nigeria, however the largest Cassava producing states are 11 states which are recognized as major cassava producing states in Nigeria, these are Benue, Kogi, Enugu, Imo, Cross-River, Ondo, Ogun, Delta, Anambra, Edo and Taraba (Adenegan et al, 2020). Cassava trees are perennial in nature and can last 3 seasons, the length of when Cassava is able to be harvested depends on what purpose it is used for, if cassava is used as a vegetable, then tubers are harvested within 12 months to avoid fibrous tubers, but cassava used for starch processing are left to reach full maturity, often up to 18 to 24 months after planting (FAO, 1997). Cassava tends to be intercropped with other crops and is planted through pieces of stem, in a study in Thailand it was estimated the total production cost of planting field Cassava ranged from 320 USD to 600 USD per hectare (Howeler, 2000). Cassava is intercropped mainly with yams, maize, or legumes⁷⁸. Cassava is exported in three forms: as a human food, as a starch, and as an animal feed ingredient⁷⁹ (Morgan, 2016). Cassava chips for example have different applications such as being a key ingredient in animal feed and as a human food, the process to convert raw Cassava tubes into Chips can be performed manually without machines (Krissana, 2015). Cassava is difficult to be stored in raw form due to its perishable nature, processing raw cassava into chips is seen as the easiest and least mechanized way to convert raw cassava into a storable commodity (Oladejo, 2012).

A large proportion of cassava crops are grown on marginal lands with bad topography that are usually not competitive and not tractor friendly. (Akinwumju et al., 2020). Nigeria is the largest producer of cassava in the world, however more than 90% of cassava produced in Nigeria is consumed within the local economy (Denton et al., 2004). Thailand, Indonesia, Vietnam and Ghana are the highest cassava exporting countries while Nigeria does not fall within the top 10 largest Cassava exporters globally (FAOSTAT, 2019). Nigeria is unable to meet domestic demand for Cassava due to a lack of domestic supply. This demand-supply gap for Cassava Flour which is used in domestic consumption is 485,000 tonnes per annum and for Cassava Starch which is used in industrial settings the demand-supply gap is 290,000 metric tonnes

⁷⁷ Nigeria's top exports are Crude Petroleum (\$30B), Petroleum Gas (\$5.89B), Scrap Vessels (\$1.29B) and Special Purpose Ships (\$775M). Agricultural exports are small compared to its export of oil and oil related materials. However, Nigeria's largest agricultural exports are Cocoa, Sesame seeds and Cashew nuts.

⁷⁸ 95% of households at the beginning of the panel (2010) report intercropping Cassava with other crops

⁷⁹ Further details on the varieties of Cassava by-products are provided in the appendix

(PwC, 2020). There are several causes of this gap such as a reliance on traditional methods of farming which results in low yields, post-harvest losses and losses along the value chain. Since Nigeria is the largest net food importer in Sub Saharan Africa, the price of imported cassava affects Nigerian households in the form of higher prices for a key dietary staple. The government of Nigeria has attempted to undertake various programs to reduce Nigeria's reliance on imported cassava. For example, in 2002 the Presidential Initiative on Cassava required bakers to use a minimum of 5% cassava flour in bread and in 2011 the Nigerian government spent \$400 million on agricultural research to optimize cassava breeding (Enesi et al, 2022). Despite these domestic policies, Nigeria depends on food imports, this study is motivated by the complex nature of domestic food production in Nigeria and its reliance on food imports.

4.2.2 Data

I combine household panel survey data with international and domestic price data to estimate the relationship between price changes, and household level outcomes.

4.2.3 Household Survey Data

My main data source is the Nigeria General Household Survey (NGHS) conducted by the National Bureau of Statistics Abuja in conjunction with the World Bank, this is the first longitudinal dataset created for Nigeria which provides information from 2010-2016 captured in three survey waves. The GHS-Panel is a randomly selected sub-sample of the GHS cross-section consisting of 5000 households; it covers three periods: August 2010/April 2011 (first wave), September 2012/April 2013 (second wave), and August 2015/May 2016 (third wave)⁸⁰. In each wave, surveys are conducted in the post planting and post-harvest time of the farming calendar⁸¹. In the remaining paper, the following terms are used: waves refer to the 3 aggregate collection cycles, rounds refer to the 6 rounds and season refers to the post planting and post-harvest collection phases. The range of attrition is low in the three waves (93% of household are present in the first wave and third wave). If attrition of households is related to my variables

⁸⁰ The first wave's post-planting survey was collected between August and October of 2010, followed by the post-harvest survey between February and April 2011. The post-planting surveys in the 2012–2013 and 2015–2016 waves were collected between September and November, while the post-harvest surveys were similarly collected between February and April

⁸¹ As I pair these data with prices, I do not expect that the differences in duration and time of the post-planting data collection across waves to impact the analysis.

of interest, this may bias the estimates presented in this paper. Therefore, I investigate the causes of attrition bias (see tables 4A.1 to 4A.3 in the appendix) and use IPW (Inverse probability weighing) recommended by Nijman and Verbeek (1996) as a robustness check for the main analysis. The main analysis is run on an unbalanced panel of 4,650 households across the six rounds, 350 households are excluded due to missing observations.

Household food security is of a multi-dimensional nature and there is a plethora of different indicators which measure Household food security (INDDEX) Project, 2023). Following the theoretical underpinnings of Engel (1895) and Bennett (1941) and to capture the dynamic nature of food security, I use two measures of food security; the Household Dietary Diversity Score (HDDS) and the food share of expenditure of a household over 30 days. The HDDS is used as an indicator for household food security consumed at the household level over a reference period (International Dietary Data Expansion (INDDEX) Project, 2023). I create 12 food groups aggregations which are classified under one of the following categories cereals; roots and tubers; vegetables; fruits; meat, poultry, and offal; eggs; fish and seafood; pulses, legumes, and nuts; milk and milk products; oils and fats; sugar and honey; and miscellaneous (Coates, 2013). It is important to note the HDDS does not measure individual access to food nor how it is distributed within the household but is considered a valid measure of household level access to food, a higher score indicates more diverse and hence better diets (FAO, 2023). The HDDS however does not adequately reflect the quality of food intake since it includes 3 food groups (Honey and Sugar; Oils and Fats and condiments/beverages (classified under miscellaneous) which do not improve household micronutrient uptake despite contributing calories (Ballard et al, 2015). Therefore, in the robustness section I exclude these groups and find the results robust to their exclusion.

The second measure I use of household food security is the share of expenditure spent on food (food share) divided by the total expenditure on food and non-food items over 30 days⁸². The expenditure reported is converted into an Adult Equivalent scale to reflect how consumption is distributed amongst different members of the household, the scale used here is the OECD modified scale⁸³. The share of expenditure of food is considered a viable alternative to the

⁸² A more representative measure would be to use annual food share, the NGHS unfortunately does not report annualized food expenditure

⁸³ $1 \times \text{First Adult} + 0.5 \times \text{Subsequent Adults} + 0.5 \times \text{Child aged: 15 and over} + 0.3 \times \text{Child aged: 0-14}$

HDDS (Kinabo et al, 2016) with a high score viewed as being indicative of higher levels of food insecurity (Smith et al, 2017).

4.2.4 Price Data

I merge price data from the Food and Agriculture Organization of the United Nations (FAO) for the period 2010-2016 for international prices for Cassava Chips and domestic farm gate prices for Cassava. I use the Food Price and Monitoring Analysis (FPMA) tool to determine the price of Cassava Chips which are reported via the Thai Tapioca Association which represent the price of Cassava chips in import/export markets. These prices are reported in USD per tonne, I convert them into Naira⁸⁴ and then deflate the prices using the annual CPI reported in Nigeria into real 2010 values. To align the price with the survey period it relates to, I use the deviation in price during the time period the survey asked questions in relation to. For example; if someone is interviewed in January 2019, the price which applies is from 12 months prior (i.e: January to December 2018). Therefore, I use the lagged price of the 12 months preceding the survey which is standardized using the available data over the survey period (2010-2019). Therefore, the key explanatory price variable is interpretable in standard deviations from the mean price.

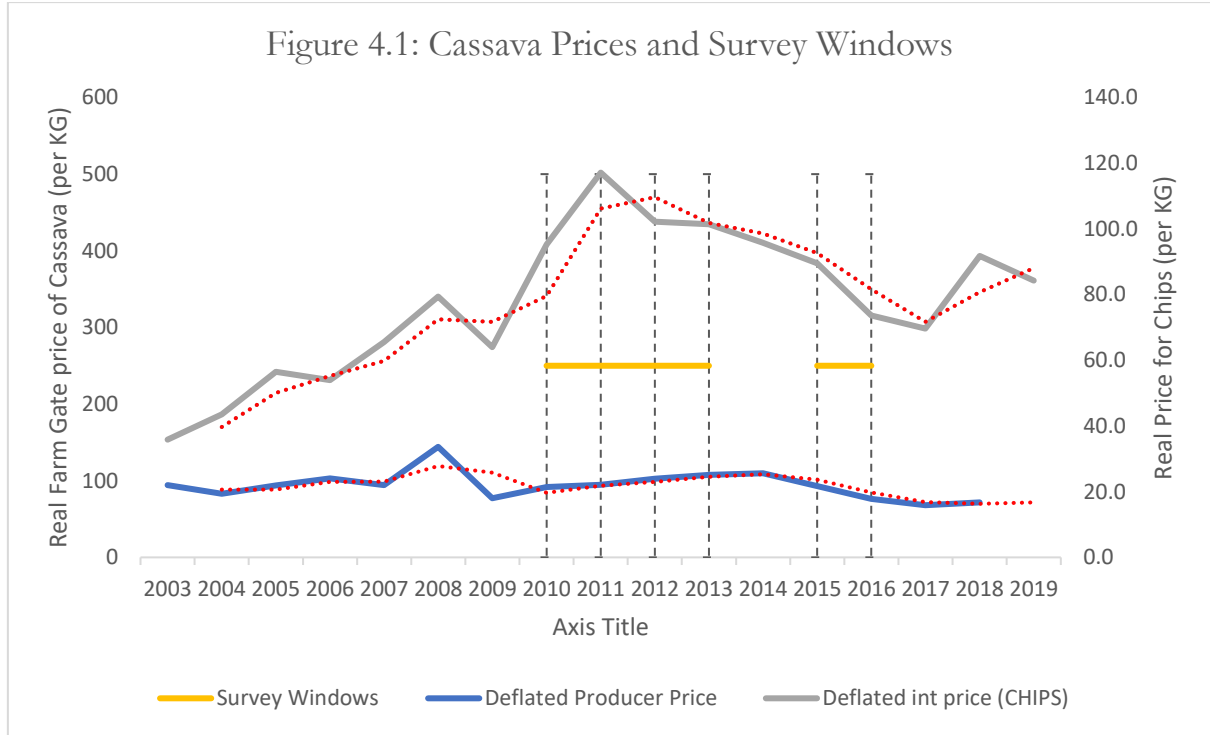
The horizontal yellow bars indicate the months when the data collection for the survey occurred. For the year preceding the survey rounds of 2010, 2015 and 2018 cassava chip prices were relatively low and for the year preceding the survey rounds of 2011, 2012 and 2019 cassava chip prices were relatively higher. As an illustration of the variability in the prices, the price of chips in the 12 months preceding the 2015 survey was 50% higher compared to the 12 months preceding the 2010 survey. Not all price jumps are of that degree but exhibit high variability.

International prices of Cassava are influenced by a range of factors such as prevailing weather conditions, demand and supply, seasonality, expectations about prices and national policy (Krissana, 2015), these factors are difficult to ascertain and nearly impossible to predict combined with the small size of Nigerian land holdings⁸⁵ effectively means that international

⁸⁴ Using National Accounts data from the UN statistics division which provide historical exchange rates for USD to Naira

⁸⁵ Nigeria's small farmers own 0.5 hectares of land on average (FAO, 2018), in my sample the average land holding is 0.6 hectares

Cassava byproduct prices are exogenous to farmers in Nigeria. In this paper, I use the world price of Cassava Chips as a proxy for imported cassava prices and the Farm Gate price as a proxy for domestic cassava prices, the fluctuations in Domestic and International Cassava prices are shown in figure 4.1⁸⁶.



4.3 Estimation strategy

To investigate the effects of cassava prices on household food security, I model household level outcomes using the following estimation.

$$Y_{j,t} = \alpha + \beta_1 Std_Cassprice_{t-1} + \sum_{x=1}^6 \beta_2 Sub_Price_{t-1} + \lambda'(X_{j,t}) + \beta_s + \alpha(X_l) + \beta_l + \varepsilon_l \quad [4.1]$$

⁸⁶ Using an alternative cassava by-product price such as flour yields identical results (these results are not shown but available upon request) since both price series are positively correlated, the correlation between both the price series is 0.5 during the duration of this study. The choice of Chips is due to the fact that chips are the easiest and least mechanized way for cassava to be stored for consumption or to be exported. Domestic farm gate prices may be endogenous due to the existence of farming cooperatives which may negotiate higher prices for small farmers (Oladejo, 2012)

Where $Y_{j,l,t}$ represents, the 2 food security measures (HDDS and Food Share) for a household j , in local governance area l , in year t . The price as discussed earlier is the standardized value of the price of cassava (Domestic and International) in the 12 months preceding the survey, this is the same for all households within a given year. Hence, β_1 measures the effect of a 1 standard deviation change in the price of domestic and international cassava and its effect on the household food security. β_2 is the standard deviation of the price of substitute commodities for cassava which are, domestic and imported rice, maize, sorghum, millet and soya (Adenegan et al, 2020). The vector $X_{j,t}$ includes controls for the household such as age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings and the Tropical livestock Units (TLU) held by the household (Afeju et al, 2020, Blom et al, 2021, Shittu et al, 2017). Seasonal (Post harvest/Post planting) fixed effects are included by the term β_s . To account for spatial heterogeneity over time, I include local governance area time trends (X_l), local governance area fixed effects are shown by β_l and finally I cluster the standard errors at the level of the local governance area (LGA) of which are there 774, which is the lowest governance area in Nigeria⁸⁷

To investigate if the effect of cassava prices on household food security differentially impacts wealthier households, I construct a wealth index using Principal Component Analysis (PCA) and re-estimate equation 4.1 for each wealth tercile sub-sample. The wealth index is constructed at baseline using household characteristics which are the number of rooms, the type of material used for the walls, roof and floor, the source of water during the wet and dry season, access to a landline, the type of toilet and bin facility, the cooking and lighting fuel used and electricity access (Mckenzie, 2005, WFP 2017, Blom et al, 2017). Each of these variables (except the number of rooms) is classified as improved or not improved.

To investigate if cassava price changes impact producers and consumers of cassava differentially I use a gross categorization of cassava producers as net sellers and cassava consumers as net buyers following Isik-Dikmelik and Aksoy (2008) and Upton et al (2021). I define cassava producers as households that plant cassava (but may also consume cassava) and cassava consumers as households that consumer cassava (in its raw form or as a byproduct) but do not plant any cassava, these classifications are made at baseline. Classifying households in this way

⁸⁷ In the robustness section, I cluster standard errors at a higher level (state) and show my results are robust to this change despite a small cluster size of 37 states

can be viewed conceptually as follows; since cassava producers are the only ones who can sell cassava by definition; only this group can *possibly* be net sellers of cassava. Cassava consumers do not produce any cassava but consume cassava and therefore can only be *possibly* net buyers. If a household is neither a producer or consumer then they are non-participants. I examine the effects of domestic and imported cassava changes on producer and consumer groups by including an interaction term with β_1 which designates a household producer or consumer status at baseline (HH_Status).

$$Y_{j,l,t} = \alpha + \beta_1 * Std_Cassprice_{t-1} * HH_Status_j + \sum_{x=1}^6 \beta_2 Sub_Price_{t-1} + \beta_3 Std_Cassprice_{t-1} + \beta_4 HH_Status_j + \lambda'(X_{j,t}) + \beta_s + \beta_l + \alpha(X_l) + \varepsilon_l \quad [4.2]$$

I am cognizant that this aggregate classification is not perfectly aligned with how net sellers and buyers are classified (World Food Program, 2019), however the nature of the NGHSS survey does not permit a meaningful way to calculate the net status using weight or value of net sales/purchases. Sales data is only provided in the post-harvest wave⁸⁸ and purchase data is provided for 30 days⁸⁹. In order to calculate the Net Present quantity of a household's purchases, I have to assume that 30-day purchase values are representative of the year. As a check of my aggregate classification, I calculate net buyer and seller status with these assumptions and find at baseline that 80-94% of these classifications are aligned (Table 4A.4 and 4A.5).

4.4 Results

4.4.1 Summary statistics

Table 4.1 shows summary statistics at baseline. Column 1 shows the total sample averages and Columns 2 to 4 show the statistics demarcated by wealth quantile. The HDDS is the highest for rich households and lowest for the poorest households which is consistent with Bennett's law. Swindale and Bilinsky (2006) classify food secure households which consume more than 8 different food groups and food insecure households that consume less than 4 different groups, between 4-8 food group consumption is considered moderate levels of food insecurity. Using

⁸⁸ The specific question asks "What are the sales of (crop) have you done since the new year"

⁸⁹ The units of purchase used to measure quantity vary from household to household, price data is absent when no purchases are made

this classification, at baseline wealthy households are food secure and poor households are moderately food insecure.

The share of expenditure allocated to food is lowest for wealthier households and highest for poor households which is consistent with Engels law. Smith and Subandoro (2007) classify households that spend less than 50% of total household expenditure as food secure, 75% or more is considered food insecure and between 50 to 75% as moderately food insecure. Using this classification, at baseline the average household is moderately food insecure with the wealthier households being food secure and poor households being moderately food insecure. For all households at baseline, 8% are food insecure using the HDDS measure and 40% are food insecure using the food share measure (not shown).

The number of females in a household is higher for poor households compared to richer households. The dependency ratio and Tropical Livestock units are higher for poor households. On average, 25% of households are producers and 40% are consumers, the remaining 35% are non-participants in Cassava.

Table 4.1: Summary Statistics (at baseline, FY 2010/2011: Wave 1)

	(1) (Total)	(2) (Poor)	(3) (Middle)	(4) (Wealthy)
Household Diversity Score	7.73 (2.41)	6.81 (2.17)	7.82 (2.17)	8.74 (2.35)
Food Share	0.54 (0.23)	0.63 (0.23)	0.55 (0.22)	0.44 (0.20)
Number of Females in the household	2.62 (1.76)	2.74 (1.83)	2.73 (1.80)	2.35 (1.57)
Household Size	5.21 (2.99)	5.59 (3.03)	5.41 (3.16)	4.66 (2.67)
Dependency ratio	0.32 (0.29)	0.33 (0.28)	0.33 (0.29)	0.28 (0.29)
Age of Head	46.5 (18.0)	46.5 (18.0)	47.43 (18.3)	45.66 (18.3)
Tropical Livestock Units	0.125 (0.44)	0.25 (0.63)	0.10 (0.35)	0.02 (0.11)
Cassava Producer	0.25 (0.44)	0.27 (0.44)	0.32 (0.44)	0.19 (0.39)
Cassava Consumer	0.40 (0.49)	0.27 (0.44)	0.36 (0.48)	0.61 (0.48)
Non-Participant	0.35 (0.47)	0.48 (0.49)	0.31 (0.46)	0.19 (0.39)
Household Structure (Polygamous HH)	0.31 (0.46)	0.27 (0.44)	0.35 (0.47)	0.35 (0.47)
Observations	9,913	3,071	3,067	3,067

Notes: Table 4.1 reports summary statistics at baseline (FY 2010/2011). Tropical livestock units is used to calculate aggregate holdings of animals, one TLU is normally an animal with a weight of 550 pounds. I classify TLU on the basis of the convention created by Jahnke (1982) where the TLU is 1 for large animals such as a cow or bull, while smaller animals such as a pig are given a TLU of 0.2. Standard deviation is reported in parentheses.

4.4.2 Results

The general results of the impact of international and domestic cassava prices are shown in Table 4.2. A one standard deviation increase in international chip prices leads to a reduction in the HDDS by -0.26 and an increase in the share of expenditure spent on food by 2.1%. While a one standard deviation increase in domestic chip prices leads to a reduction in the HDDS by -1.2 and an increase in the share of expenditure spent on food by 10.1%. These general effects demonstrate that increases in both international and domestic cassava prices are associated with an increase in food insecurity. However, the effect is larger for domestic cassava prices. These results are expected given Cassava's status as a key dietary staple in Nigeria.

Table 4.2: Cassava prices and household food security

Dependant Variables	(1) (HDDS)	(2) (Food Share)
International Prices (Std)	-0.259*** (0.018)	0.021*** (0.002)
Domestic Prices (Std)	-1.240*** (0.085)	0.101*** (0.009)
Observations	22,215	22,215
R-squared	0.357	0.288
Number of HHID's	4,650	4,650
Number of clusters	459	459

Notes: Table 4.2 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU), local governance area and seasonal fixed effects. Standard errors are clustered at the LGA level. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

I next disaggregate the results by the wealth tercile of the household at baseline in Table 4.3. I find that effect of cassava price varies depending on the wealth status of the household, for the HDDS wealthier households are the most effected by both international and domestic cassava price increases (with domestic cassava prices having stronger effects). As shown in the baseline summary statistics, the HDDS is higher for wealthier household therefore the effect of changes in price are more pronounced on wealthier households. This is expected because of the existence of a Dietary diversity “floor” that poorer household operate from (Osho et al, 2020),

since poorer households consume a less diverse diet to begin with the impact of price changes of Cassava are limited. In the robustness section, I exclude the 3 low micronutrient food groups and find the results are similar (i.e: wealthier households are more adversely affected by cassava price changes as measured by the HDDS).

Looking at the results for the Food Share of a household, average (middle) income households are most effected by cassava price changes. These changes are consistent with the theoretical model prediction of Engels law, when the prices of international and domestic cassava price increases this leads to a fall in real income and through this income channel, household spend a higher proportion of their income on food. The effects are largest for the average income households for both domestic and imported cassava.

Table 4.3: Cassava prices and household food security by Wealth tercile

Dependant Variables	(HDDS)			(Food Share)		
	(1) (Poor)	(2) (Medium)	(3) (Wealthy)	(1) (Poor)	(2) (Medium)	(3) (Wealthy)
Subsample						
International Prices (Std)	- 0.279*** (0.035)	- -0.315*** (0.028)	- 0.420*** (0.034)	0.018*** (0.003)	0.025*** (0.003)	0.021*** (0.003)
Domestic Prices (Std)	- 1.335*** (0.166)	- -1.506*** (0.135)	- 2.005*** (0.161)	0.087*** (0.017)	0.120*** (0.013)	0.100*** (0.014)
Observations	7,222	7,128	6,989	7,222	7,128	6,989
R-squared	0.288	0.301	0.248	0.214	0.251	0.276
Number of clusters	271	271	271	271	271	271

Notes: Table 4.3 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) local governance area and seasonal fixed effects. Standard errors are clustered at the LGA level. Wealth terciles are calculated at baseline using PCA, each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

In Table 4.4 I investigate if the effects of cassava prices change depending on the producer/consumer status of the household and find that both producers and consumers see an increase in food in-security as measured by the HDDS and Food share. The effects are larger for consumers compared to producers and demonstrate that increases in the price of cassava are associated with higher levels of food insecurity as measured by both the HDDS and food share for both groups. The point estimate is lower for producers since they can sell or consume some portion of their cassava harvest. These results are supportive of the findings of Bacon et al (2017), Morris et al (2013) and Rogan & Reynolds (2017) which find an increase in seasonal hunger and self-reported food shortages⁹⁰ for different commodities.

Table 4.4: Cassava prices and household food security by producer/consumer status

Dependant Variables	(Producers)		(Consumers)	
	(1) (HDDS)	(2) (Food Share)	(1) (HDDS)	(2) (Food Share)
International Prices (Std)	-0.350*** (0.035)	0.021*** (0.003)	-0.406*** (0.029)	0.026*** (0.003)
Domestic Prices (Std)	-1.673*** (0.166)	0.101*** (0.015)	-1.941*** (0.137)	0.125*** (0.013)
Observations	5,764	5,764	8,936	8,936
R-squared	0.044	0.047	0.092	0.054
Number of hhid	1250	1250	2000	2000
Number of clusters	219	219	398	398

Notes: Table 4.4 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.2. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) and seasonal fixed effects. A producer is categorized as a household which produces cassava and can also consume it while a consumer is a household that consumes cassava but does not produce any cassava. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

⁹⁰ Bacon et al (2017) use the number of lean months and Rogan & Reynolds (2017) use how often a household reports hunger over 12 months as the key dependant variable. Both are self-reported measures which may be overreported (Jacobs, 2009), the selection of the HDDS and Food share partially mitigates the risk of mis-stating true food dependency.

4.5 Robustness checks

I consider a number of checks to test the robustness of my findings.

I first consider alternative model choices, since HDDS is a count variable I estimate the HDDS models using a Poisson model. Using OLS assumes a normal distribution for the outcome variable which is the case for the HDDS⁹¹, Poisson model selection is appropriation for non-negative integer values which measure counts (Wooldridge, 2010). Hence, I show the HDDS outcomes using a Poisson model. In the case of food share which is a variable between 0 and 1, I employ a Fractional Probit model to estimate food share outcomes. These alternative models and their comparison to the OLS model is shown in Table 4.5 for the general results. The point estimates for Poisson for HDDS are smaller in magnitude for both domestic and international cassava prices but still significant at identical levels, the point estimates from the fractional probit model are identical in magnitude and significance to the OLS estimates. The results for producers and consumers (shown in Table 4A.7 in the appendix) using alternative models shows smaller magnitudes for the HDDS with identical levels of significance and using the fractional probit gives identical point estimates and levels of significance.

Table 4.5: Cassava prices and household food security using Poisson and Fractional Probit models

	(HDDS)		(Food Share)	
Model	(1) (OLS)	(2) (Poisson)	(1) (OLS)	(2) (Frac Probit)
International Prices (Std)	-0.259*** (0.018)	-0.031*** (0.002)	0.021*** (0.002)	0.021*** (0.002)
Domestic Prices (Std)	-1.240*** (0.085)	-0.150*** (0.010)	0.101*** (0.009)	0.101*** (0.001)
Observations	22,215	22,215	22,215	22,215
R-squared	0.357	-	0.288	-

Notes: Table 4.5 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, Tropical livestock Units (TLU), local governance area and seasonal fixed effects. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

⁹¹ See figures in the appendix

Second, it's possible that outcomes are correlated at a higher level than the local governance area such as the state level. To account for this, the analysis is re-run with standard errors clustered at the state level, the results are robust to the re-aggregation of standard errors. The results are reported in the appendix in table 4A.6. The point estimates and associated significance level remain unchanged with the state level clustering of the standard errors⁹².

Third, the HDDS is viewed as an imprecise measure of food security (Ballard et al, 2014) particularly for households that have a highly diversified diet to begin with. Hence, I demarcate the level of diversification by a household using the HDDS at baseline and re-estimate the model for each tercile, the results are shown in Table 4.6. I find that an increase in the price of international and domestic cassava effects the least diversified households the most in terms of their diversity of consumption. For food share, moderately diversified households are the most effected by international and domestic cassava price changes. These results indicate the general results in Table 4.1 for HDDS are driven by low diversity households and the main results for food share are driven by the average (moderately) diversified households (for international and domestic cassava prices).

Table 4.6: Cassava prices and household food security by household diversification

Dependant Variables	(HDDS)			(Food Share)		
	(1) (Least)	(2) (Moderately)	(3) (High)	(1) (Least)	(2) (Moderately)	(3) (High)
International Prices (Std)	- 0.515*** (0.033)	-0.336*** (0.028)	- 0.257*** (0.030)	0.080*** (0.016)	0.109*** (0.013)	0.107** *
Domestic Prices (Std)	- 2.460*** (0.160)	-1.607*** (0.135)	- 1.228*** (0.142)	0.017*** (0.003)	0.023*** (0.003)	0.022** *
Observations	6,335	8,700	7,965	5,978	8,431	7,806
R-squared	0.331	0.208	0.215	0.249	0.284	0.343
Number of clusters	343	343	343	343	343	343

Notes: Table 4.6 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) , local governance area and seasonal fixed effects. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels. Standard errors are clustered at LGA level.

⁹² The results for producers and consumers give identical point estimates with the standard errors aggregated at state level, these results are not shown but available upon request

The HDDS has also been criticized as being an imprecise measure of food insecurity because it captures quantity of consumption but not the quality of the consumption because of its inclusion of three low micro-nutrient groups (Sugar/Honey, Miscellaneous and Oils and Fats) (Haile et al, 2021). If cassava price increases are associated with a lower consumption of these low nutrient food groups suggesting higher food in-security this does not imply a decrease in food quality intake. To get a better sense if the quantity and quality of food consumption both decline due to cassava price increases, I exclude these groups and re-estimate the core results using a HDDS measure with 9 high quality food groups for the total sample and each wealth tercile sub-sample. The point estimate should provide evidence that cassava price increases cause a reduction in the quality of food consumed and not merely the quantity. The results are shown in Table 4.7, the results substantiate the previous results that domestic and international cassava prices are associated with an increase in food security as measured by a reduction in HDDS_9, the point estimates for general effects are marginally lower compared to the results in Table 4.2. These results are driven by wealthier households similar to the findings in Table 4.3. In the appendix in Table 4A.8 I show the results for consumers and producers and find similar results to the HDDS with 12 groups with lower point estimates and similar levels of significance.

Table 4.7: Cassava prices and household food security by Wealth tercile

Dependant Variable	(HDDS_9)			
	(1)	(2)	(3)	(4)
Sample	(All)	(Poor)	(Medium)	(Wealthy)
International Prices (Std)	-0.242*** (0.017)	-0.138*** (0.026)	-0.222*** (0.023)	-0.340*** (0.027)
Domestic Prices (Std)	-1.158*** (0.080)	-0.661*** (0.124)	-1.063*** (0.111)	-1.624*** (0.129)
Observations	22,215	7,222	7,128	6,989
R-squared	0.362	0.335	0.331	0.266
Number of clusters	271	271	271	271

Notes: Table 4.7 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) local governance and seasonal fixed effects. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels. Standard errors are clustered at LGA level.

Lastly, I consider the missing households from a survey round and investigate the causes of their missingness by looking at the probability of a household not being present in one of the 3 rounds, the results are shown in table 4A.2 and table 4A.3. I find that the age, the education level, gender and religion of the household head are predictors of attrition. Therefore, I use the inverse probability weight technique proposed by Nijman and Verbeek (1996), I generate the predicted value for the pooled regression and weigh the regression using the predicted values from the pooled regression (Caldera, 2019). I estimate the core results using the generated weights and re-run the analysis which is shown in Table 4.8. The point estimates for HDDS are larger and significant at identical levels and the food share estimates are smaller compared to table 4.2, however the main results still hold⁹³.

Table 4.8: Cassava prices and household food security with inverse probability weights

Dependant Variables	(1) (HDDS)	(2) (Food Share)
International Prices (Std)	-0.287*** (0.023)	0.017*** (0.003)
Domestic Prices (Std)	-1.372*** (0.111)	0.082*** (0.014)
Observations	22,215	22,215
R-squared	0.382	0.329
Number of clusters	459	459

Notes: Table 4.8 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1 and applying inverse probability weights. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU), local governance area and seasonal fixed effects. Standard errors are clustered at the LGA level. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

4.6 Conclusion

⁹³ I re-estimate the results for producers and consumers (not shown) using IPW and find the results shown in Table 4.4 to hold

This study investigated the effects of cassava price fluctuations on a panel of Nigerian households from 2010 to 2016 on their levels of food security. This paper focused on the effects of cassava prices by looking at two different measures of food security to gain insight on the general effects of cassava price changes at household level and its heterogeneous effect by characteristics of a households (wealth, level of initial food diversity and producer/consumer status). I found increases in domestic and imported cassava prices were generally associated with higher levels of household food in-security. For households which were wealthy at baseline increases in cassava prices were associated with lower household food diversity and households of average (medium) wealth saw an increase in the food share of expenditure associated with increases in cassava prices. These empirical results are in-line with the theoretical predictions of Engel and Bennett's law. Ex ante one might expect producers to benefit from a higher price of cassava but the results in the paper find that cassava farmers are also negatively affected by cassava price increases due to an increase in food in-security markers, the mechanism by which this negative effect occurs is left for future research. This research suffers from some limitations which are important to note, firstly I use farm gate prices as a proxy for domestic prices and export cassava prices as a proxy for import prices. Second, the use of gross categorization of net buyers and sellers as consumers and producers means I cannot directly test for how cassava price changes would impact net buyers and sellers, while I provide evidence of their alignment at baseline, a true categorization would need data specifically designed to capture the dynamic nature of food purchases and sales which is not feasible with this study. There is limited research on net buyers and sellers since they were first introduced to the literature likely due to data limitations of calculating them accurately with little to no assumptions of household behavior. In summary, this paper has found that increase in the price of key dietary staple is associated with high measures of food in-security for households which produce and consume the commodity with the effect varying depending on the characteristics of the household such as its wealth. This research broadly supports the idea of hungry Cassava farmers in Nigeria which suffer from seasonal food insecurity. It demonstrates the importance of recognizing that increases in staple food prices have negative effects on household food security thus requiring policies to limit their adverse effects.

Chapter 4 Appendix:

Tables:

Table 4A1: Descriptives on attrition by wave

Households	Mean (%)
Present in wave 1, 2 and 3	95
Present in wave 1 and 2	96
Present in wave 2 and 3	95
Present in wave 1 and 3	93

Notes: Table 4A.1 shows percentage of households which are present in each wave of the survey. Each row shows overlap of the number of households which are present in each wave. All values are percentages.

Table 4A.2: Linear model for Attrition (Pooled Sample)

Dependant Variable	(1) (Attrition)
Age of Household head	-0.002*** (0.000)
Education level of Head	0.003*** (0.000)
Gender of Head (Male)	0.014** (0.006)
Religion of head: Christianity	-0.178*** (0.058)
Religion of head: Islam	0.015*** (0.003)
Religion of head: Traditional	0.007 (0.055)
Polygamous Household	0.002 (0.003)
Household location (Urban/Rural)	0.006 (0.008)
Observations	28,612
R-squared	0.496
Number of clusters	468

Notes: Table 4A.2 reports estimates for the probability of attrition, attrition is 1 for a household if a household is not present in all survey rounds, the sample here is a pooled sample for all waves. Each column includes local governance area and seasonal fixed effects. ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 4A.3: Linear model for Attrition (by wave)

Wave	(1)	(2)	(3)
Dependant Variable		(Attrition)	
Age of Household head	-0.0003** (0.0001)	-0.0001 (0.0001)	-0.0001** (0.0001)
Education level of Head	0.0000 (0.0001)	0.0003*** (0.0001)	-0.0002*** (0.0000)
Gender of Head	0.0142** (0.0061)	0.0100* (0.0053)	0.0035 (0.0028)
Religion of head: Christianity	-0.1778*** (0.0580)	-0.0434 (0.0405)	-0.0192 (0.0277)
Religion of head: Islam	0.0147*** (0.0033)	0.0026 (0.0017)	0.0029 (0.0021)
Religion of head: Traditional	0.0069 (0.0554)	-0.0335*** (0.0103)	0.0489 (0.0516)
Polygamous Household	0.0022 (0.0026)	-0.0027 (0.0020)	0.0022* (0.0012)
Household location (Urban/Rural)	0.0059 (0.0077)	0.0029 (0.0067)	0.0011 (0.0032)
Observations	8,869	9,514	9,162
R-squared	0.001	0.001	0.001
Number of clusters	403	403	403

Notes: Table 4A.3 reports estimates for the probability of attrition, attrition is 1 for households if a household is not present in each wave, each column is a sub-sample of each wave. Each column includes local governance area and seasonal fixed effects. ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 4A4: Producer/Consumer status vs Net buyer/Seller status at baseline

	Net Sellers	Net Buyers
Producers (%)	94	20
Consumers (%)	6	80
N	129	1927

Notes: Table shows percentage of households which are classified as producers and consumers compared to the net seller/net buyer classification. The net categorization is based on the net purchase quantity (WFP, 2023) which is calculated using (Purchases - Sales), 30-day purchases are assumed to be representative of the entire year and re-scaled to an annual value and the sales valued is re-scaled to an annual value on the basis of the reported period.

Table 4A.5: Net purchase quantity (Purchases-Sales) for producers and consumers by waves

	(1) Wave 1	(2) Wave 2	(3) Wave 3
Producers	-8,332	-9,051	-16,206
Consumers	599	440	451

Notes: Table 4A.5 shows the net purchase quantity of producer/consumer households. Production is only reported in the post harvest season, it is reported in various (non-standardized) units, to reduce error in interpretation only production reported in KG/litres is used. The net categorization is based on the net purchase quantity (WFP, 2023) which is calculated using (Purchases - Sales), 30-day purchases are assumed to be representative of the entire year and re-scaled to an annual value and the sales valued is re-scaled to an annual value on the basis of the reported period.

Table 4A.6: Cassava prices and household food security with State level SE's

Model	(HDDS)		(Food Share)	
	(1) (LGA SE)	(2) (State SE)	(1) (LGA SE)	(2) (State SE)
International Prices (Std)	-0.259*** (0.018)	-0.259*** (0.037)	0.021*** (0.002)	0.021*** (0.003)
Domestic Prices (Std)	-1.240*** (0.085)	-1.237*** (0.178)	0.101*** (0.009)	0.100*** (0.016)
Observations	22,215	22,215	22,215	22,215
R-squared	0.357	0.357	0.288	0.288
Number of clusters	459	37	459	37

Notes: Table 4A.6 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.1. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) local governance area and seasonal fixed effects. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels. Standard errors are clustered at state level in column 2 of each outcome.

Table 4A.7: Cassava prices and household food security by producer/consumer status with alternative models

Model Dependant Variables	(Producers)				(Consumers)			
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
	(OLS)	(Poiss on)	(OLS)	(Frac Probit)	(OLS)	(Poiss on)	(OLS)	(Frac Probit)
	(HDD S)		(Food Share)		(HDDS)		(Food Share)	
International Prices (Std)	- 0.337** *	- 0.040* **	0.022** *	0.021** *	- 0.380** *	- 0.045* ** (0.003)	0.023** *	0.023** *
	(0.036)	(0.004)	(0.003)	(0.003)	(0.029)		(0.003)	(0.003)
Domestic Prices (Std)	- 1.608** *	- 0.190* **	0.104** *	0.1***	- 1.817** *	- 0.132* ** (0.012)	0.111** *	0.111** *
	(0.173)	(0.021)	(0.015)	(0.014)	(0.138)		(0.014)	-0.013
Observations	5,764	5,764	5,764	5,764	8,936	8,936	8,936	8,936
R-squared	0.209	-	0.360	-	0.367	-	0.310	-
Number of hhid	1250	1250	1250	1250	2000	2000	2000	2000

Notes: Table 4A.7 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.2. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) local governance area and seasonal fixed effects. A producer is categorized as a household which produces cassava and can also consume it while a consumer is a household that consumes cassava but does not produce any cassava. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

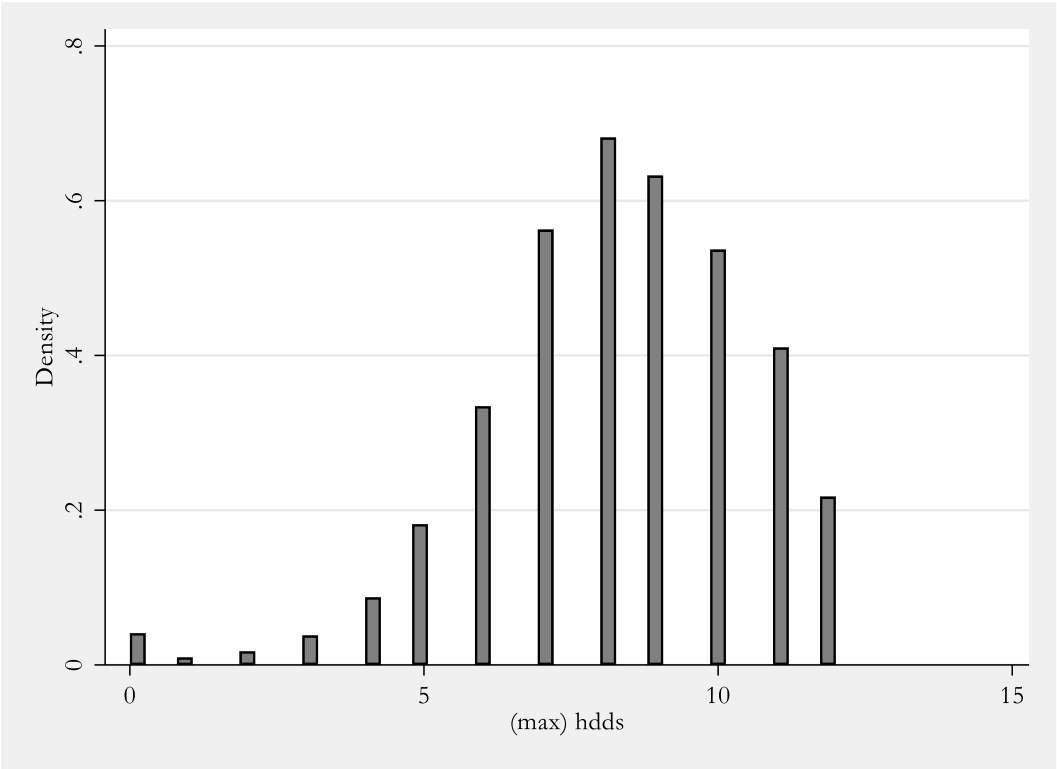
Table 4A.8: Cassava prices and HDDS_9 by producer/consumer status

	(Producers)	(Consumers)
	(1)	(2)
Dependant Variables	(HDDS_9)	
International Prices (Std)	-0.252*** (0.027)	-0.278*** (0.024)
Domestic Prices (Std)	-1.203*** (0.130)	-1.327*** (0.116)
Observations	5,764	8,936
R-squared	0.209	0.367
Number of hhid	1250	2000
Number of clusters	219	398

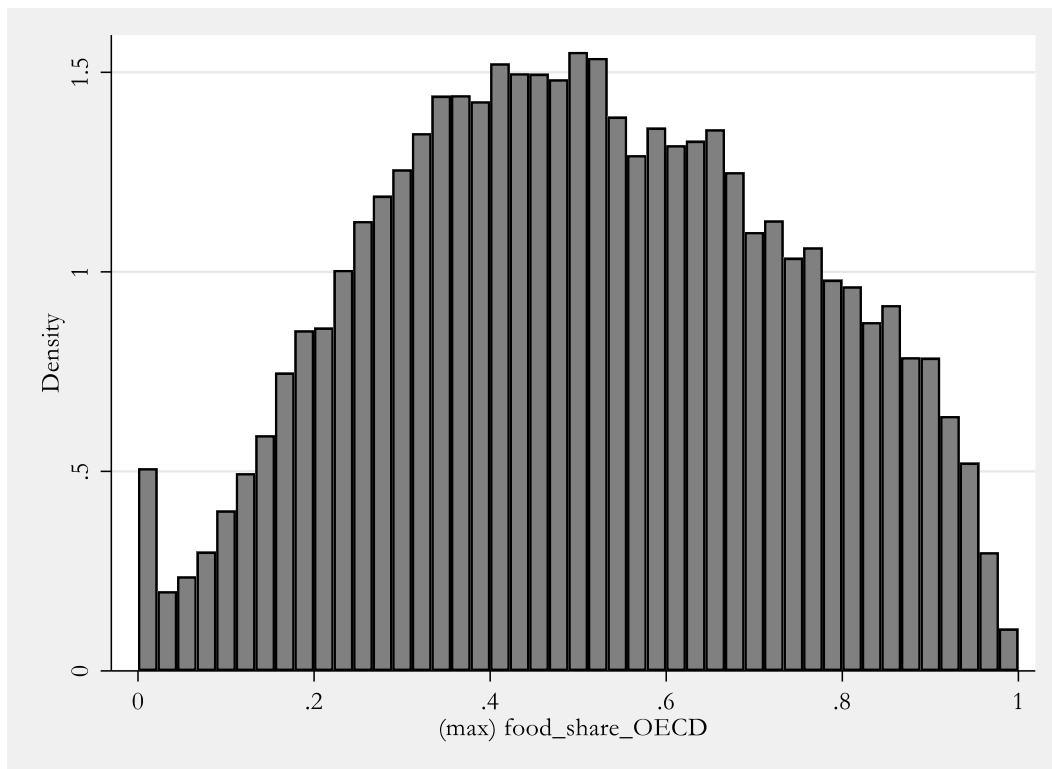
Notes: Table 4A.8 reports estimates for the effect of the cassava prices on household food security using the estimation shown in equation 4.2. Each column controls for age of the household head, the square of the age of the household head, if the household is urban/rural, the number of females in the house, household size, the dependency ratio, the use of informal savings, the Tropical livestock Units (TLU) , local governance area and seasonal fixed effects. A producer is categorized as a household which produces cassava and can also consume it while a consumer is a household that consumes cassava but does not produce any cassava. Each household contributes 1 observation per year; ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Figures:

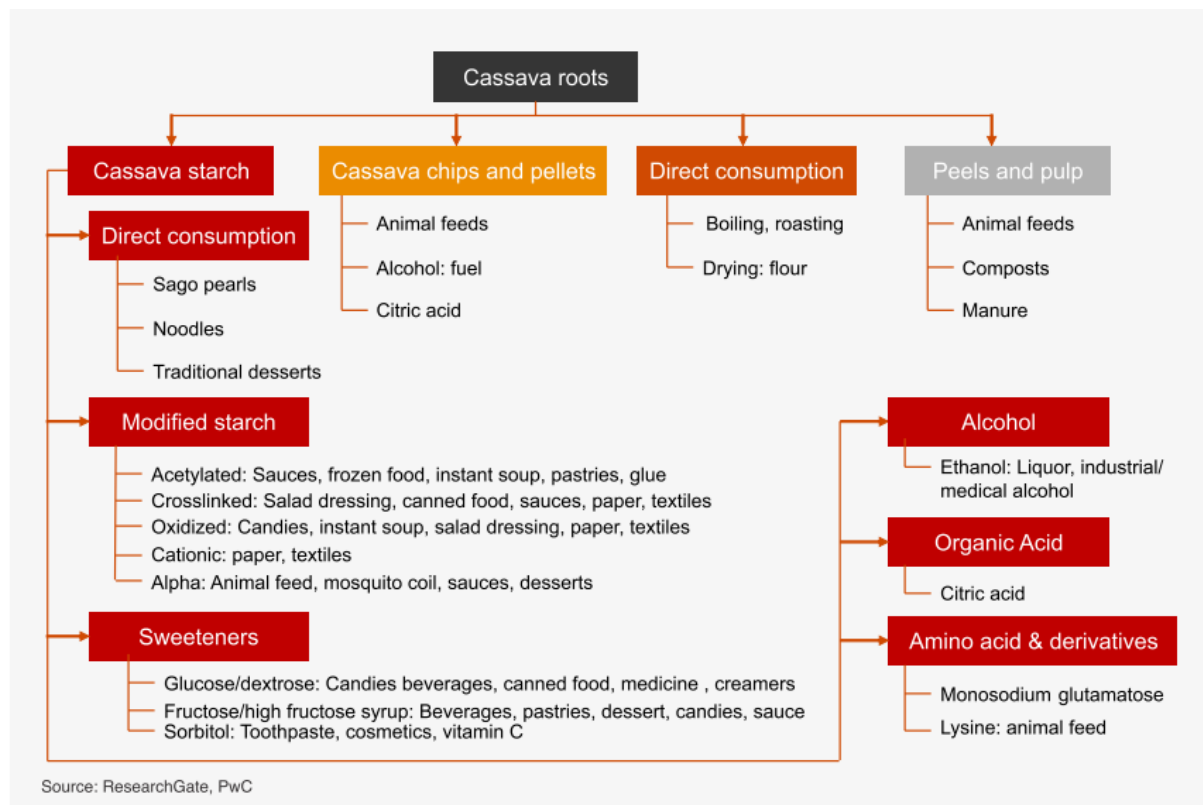
Distribution of HDDS:



Distribution of food share:



Cassava by-products



Chapter 5

General Conclusion

This thesis consists of three essays in Development Economics. In the first paper, we set out to study the link between long-run disease burden and witchcraft beliefs in SSA. Based on various psychological and economic mechanisms proposed in different strands of literature, we hypothesized that long-run exposure to a heavy disease burden promoted witchcraft beliefs. Our empirical findings are consistent with our hypothesis: historical malaria mortality is significantly and positively associated with contemporary witchcraft beliefs. This result applies to a sample of at least 7,000 individuals belonging to more than 200 ethnic groups for 17 countries in SSA. Although coverage is limited for some ethnic groups and regions in the sample countries, the dataset nevertheless spans a significant geographic area and share of the population in SSA. Gaining a better understanding of how beliefs are formed and how they change is, as noted by North (2008: 1005), “fundamental to a new social science”. Given the omnipresence and profound influence of witchcraft in present-day SSA, a deeper understanding of its origins and evolution could shed light on contemporary issues and dynamics. The witchcraft-disease relation in particular can provide historical context for recent upsurges of superstitious belief discourse following the AIDS and Ebola epidemics (BBC, 2014; IFRC, 2014; Kalichman and Simbayi, 2004; Thomas, 2007).

In the second paper, I presented evidence that the introduction of formal protection to Children in Nigeria led to a reduction in stunting. The results also suggest that the Child Rights Act increased the uptake of preventive healthcare conditional on the wealth of the household and improved outcomes for children in utero. These findings may be of interest to policy makers in as far as they shed further light on how exactly parents in low-income countries make decisions regarding their children in environments characterized by adverse social traditions. The results regarding stunting, in particular, illustrate how changes in the environment can influence parental behavior. The size of the Child Rights Act effect on child welfare illustrates the importance of cultural and secular factors in determining how parents treat their children. This insight is important for anyone interested in designing policies aimed at improving child welfare. The results presented in this paper may also serve as an indication of the importance of child protection in low-income settings. Finally, although these findings pertain to one particular case study, there are reasons to believe that the results may also be relevant to other

contexts. The Child Rights Act introduced in Nigeria are based on the Convention of Child Rights, Child Rights in a variety of developing country settings are based on the same convention and thus likely to have common aspects (Britto and Ulker, 2012).

In the final chapter I studied the impact of changes in a key dietary staple on household food security in Nigeria. I found that increases in cassava prices were generally associated with higher levels of household food in-security. If a household was wealthy at baseline the negative effects of cassava prices meant lower household food diversity and the average household saw an increase in the food share of expenditure associated with increases in cassava prices. These empirical results are in-line with the theoretical predictions of Engel and Bennett's law. Ex ante one might expect producers to benefit from higher prices of cassava but the results in the paper find that cassava farmers are also negatively affected by cassava price increases due to an increase in markers of food in-security, the mechanism by which this negative effect occurs is left for future research. In summary, this paper has found that increase in the price of key dietary staple is associated with high measures of food in-security for households which produce and consume the commodity with the effect varying depending on the characteristics of the household such as its wealth. This research broadly supports the idea of hungry Cassava farmers in Nigeria which suffer from seasonal food insecurity. It demonstrates the importance of recognizing that increases in staple food prices have negative effects on household food security thus requiring policies to limit their adverse effects.

Overall, this thesis investigated two key facets of low-income countries; (1) the origins of superstitious belief in developing countries and national policies to circumvent negative effects of holding these beliefs and (2) the effect of commodity price fluctuations on households. In the first case, we found the origins of beliefs to be driven by the historical disease mortality and policies to some degree effective in circumventing the negative effects of harmful social norms. In the second case, I found that commodity prices can have negative effects on household food security for producers and consumers of that commodity.

Bibliography

- Acemoglu, D., Johnson, S., Robinson, J.A., 2002. The Colonial Origins of Comparative Development: An Empirical Analysis. *American Economic Review* 1369–1401.
- Akyeampong, E.K., 2006. Themes in West Africa's History. Ohio University Press.
- Albouy, D.Y., 2012. The Colonial Origins of Comparative Development: An Empirical Investigation: Comment. *American Economic Review* 102, 3059–3076. doi:10.1257/aer.102.6.3059
- Alesina, A., Giuliano, P., 2015. Culture and Institutions. *Journal of Economic Literature* 53, 898–944. doi:10.1257/jel.53.4.898
- Alsan, M., 2015. The Effect of the TseTse Fly on African Development. *American Economic Review* 105, 382–410. doi:10.1257/aer.20130604
- Asenso-Okyere, K., Asante, F.A., Tarekegn, J., Andam, K.S., 2011. A review of the economic impact of malaria in agricultural development. *Agricultural Economics* 42, 293–304. doi:10.1111/j.1574-0862.2010.00515.x
- Ambe et al, 2011 “Perceptions, beliefs and practices of mothers in sub-urban and rural areas towards measles and measles vaccination in Northern Nigeria?” *Journal of religion and health*. doi: 10.1177/004947550103100211
- Ajanwachuku & Philip, 2018 “The Nigerian Child Rights Act And Rights Of Children With Disabilities: What Hope For Enforcement?,” Petru Maior University, Faculty of Economics Law and Administrative Sciences and Pro Iure Foundation. RePEc:pmu:cjurid:v:72:y:2018:p:57-66
- Alsan & Wanamaker, 2018 "Tuskegee and the Health of Black Men," *The Quarterly Journal of Economics*, vol 133(1), pages 407-455. doi: 10.1093/qje/qjx029
- Alabi, 1990. Cultural practices in Nigeria. *News Inter Afr Comm Tradit Pract Affect Health Women Child*. PMID: 12157983
- Angrist & Pischke (2014) “Mastering 'Metrics: The Path from Cause to Effect”. Princeton Publishing
- Achadi et al, 2017. "Low birth weight was the most dominant predictor associated with stunting among children aged 12–23 months in Indonesia” *BMC Nutrition*, Volume 3. doi:10.1186/s40795-017-0130-x
- Alfano, M ,2022. "Islamic Law and Investments in Children: Evidence from the Sharia Introduction in Nigeria," *Journal of Health Economics*. doi: 10.1016/j.jhealeco.2022.102660
- Alamu et al (2019) “Evaluation of cassava processing and utilization at household level in Zambia”. *Food Security*. Doi: <https://doi.org/10.1007/s12571-018-0875-3>
- Adenegan et al, 2020. Cassava production in Nigeria: trends, instability and decomposition analysis (1970–2018). *Heliyon*. Doi: 10.1016/j.heliyon.2020.e05089
- Akinwimiju et al, 2020. Agro-Climato-Edaphic Zonation of Nigeria for a Cassava Cultivar using GIS-Based Analysis of Data from 1961 to 2017. *PubMed Central*. Doi: <https://doi.org/10.1038/s41598-020-58280-4>
- Aihounton, Ghislain B. D.; Henningsen, Arne, 2019. Units of Measurement and the Inverse Hyperbolic Sine Transformation. IFRO Working Paper, No. 2019/10, University of Copenhagen, Department of Food and Resource Economics (IFRO), Copenhagen
- Arezki, R and Brucker, M. 2011. Food prices and political instability. IMF e-library.
- Beck, J., Forstmeier, W., 2007. Superstition and belief as inevitable by-products of an adaptive learning strategy. *Hum Nat* 18, 35–46. doi:10.1007/BF02820845
- Ballard et al, 2015. Measuring the Food Access Dimension of Food Security: A Critical Review and Mapping of Indicators. International Nutritional Foundation. <https://doi.org/10.1177/0379572115587274>

- Béguin, A., Hales, S., Rocklöv, J., Åström, C., Louis, V.R., Sauerborn, R., 2011. The opposing effects of climate change and socio-economic development on the global distribution of malaria. *Global Environmental Change* 21, 1209–1214. doi:10.1016/j.gloenvcha.2011.06.001
- Bowles, S., 2009. Did Warfare Among Ancestral Hunter-Gatherers Affect the Evolution of Human Social Behaviors? *Science* 324, 1293–1298. doi:doi:10.1126/science.1168112
- Boyer, P., 2003. Religious thought and behaviour as by-products of brain function. *Trends in Cognitive Sciences* 7, 119–124. doi:10.1016/S1364-6613(03)00031-7
- Brown & Stern (2021) "The determinants of child labour: theory and evidence" Michigan Ann Arbor working Paper
- Briones Alonso, E., 2015. The impact of culture, religion and traditional knowledge on food and nutrition security in developing countries, in: *FoodSecure Working Paper Series*. pp. 1–81.
- Bassi and Rasul ,2017. "Persuasion: A case study of papal influences on fertility preferences and behavior" *American Economic Journal applied*. doi: 10.1257/app.20150540
- Bravo and Stegmann, 2021. "In Vaccines We Trust? The Effects of the CIA's Vaccine Ruse on Immunization in Pakistan". *Journal of the European Economic Association*, Volume 20, Issue 1. <https://doi.org/10.1093/jeea/jvab018>
- Bacon et al, 2019. "BACONDECOMP: Stata module to perform a Bacon decomposition of difference-in-differences estimation," *Statistical Software Components* S458676, Boston College Department of Economics, revised 21 Sep 2022.
- Borusyak et al (2021) "Revisiting Event Study Designs: Robust and Efficient Estimation" *Papers* 2108.12419. <https://doi.org/10.48550/arXiv.2108.12419>
- Boer, 2017. "Why Muslim Sharia Law Studies in Christian Muslim Relations" Belleville, Ontario, Canada, 2007. doi: 10.1016/s0277-9536(03)00152-7
- Benjamins, M. R., & Brown, C., 2004. Religion and preventative health care utilization among the elderly. *Social Science and Medicine*, 58, 109–118
- Beck et al ,2018. Commodity prices and intra household labour allocation. *American Journal of Agricultural Economics*. <https://doi.org/10.1093/ajae/aay082>
- Blom et al, 2021 .Food price volatility and household food security: Evidence from Nigeria. *Food Policy* 102. <https://doi.org/10.1016/j.foodpol.2021.102061>
- Boye et al ,2022. Reversing years for Global food security: A review of the food security situation in SSA. *International journal of Environmental health and research*.
- Carter, R., Mendis, K.N., 2002. Evolutionary and Historical Aspects of the Burden of Malaria. *Clinical Microbiology Reviews* 15, 564–594. doi:10.1128/CMR.15.4.564-594.2002
- Child Rights Act Nigeria (2018)
- Camilotti (2016) "Interventions to Stop Female Genital Cutting and the Evolution of the Custom: Evidence on Age at Cutting in Senegal". *Journal of African Economies*. <https://doi.org/10.1093/jae/ejv013>
- Cardell and Mitchelson, 2021. Why farmers prefer to sell at harvest: Evidence on price risk and storage from SSA. *American Journal of Agricultural Economics*. <https://doi.org/10.1111/ajae.12343>
- Case, T.I., Fitness, J., Cairns, D.R., Stevenson, R.J., 2004. Coping With Uncertainty: Superstitious Strategies and Secondary Control. *Journal of Applied Social Psychology* 34, 848–871. doi:10.1111/j.1559-1816.2004.tb02574.x
- Carr, Stephen J ,1993. Improving cash crops in Africa: factors influencing the productivity of cotton, coffee, and tea grown by smallholders. *World Bank technical paper*; no. WTP 216 Washington, D.C.: World Bank Group
- Carrilo et al, 2022. Economic Production and the spread of Supernatural beliefs. *Forthcoming in the Economic Journal*
- Cunningham, 2021. "Causal Inference: The Mixtape" Yale University Press

- Cislaghi & Heise (2018) Theory and practice of social norms interventions: eight common pitfalls. *Global Health* 14, 83. <https://doi.org/10.1186/s12992-018-0398-x>
- Chandler, T., 1987. Four thousand years of urban growth: an historical census.
- Chiao, J.Y., Blizinsky, K.D., 2010. Culture-gene coevolution of individualism-collectivism and the serotonin transporter gene. *Proceedings of the Royal Society B: Biological Sciences* 277, 529–537. doi:10.1098/rspb.2009.1650
- Chima, R.I., Goodman, C.A., Mills, A., 2003. The economic impact of malaria in Africa: a critical review of the evidence. *Health policy* 63, 17–36.
- Chiovelli, G., Cervellati, M., Esposito, E., 2015. Bite and Divide: Malaria and Ethnic Diversity. Working Paper.
- Ciekawy, D., 1999. Women's "work" and the construction of witchcraft accusation in coastal kenya, in: *Women's Studies International Forum*. Elsevier, pp. 225–235.
- Comaroff, J., Comaroff, J.L., 1999. Occult economies and the violence of abstraction: notes from the South African postcolony. *American ethnologist* 26, 279–303.
- Chaisemartin & D'Haultfoeulle (2022) "Two-Way Fixed Effects and Differences-in-Differences with Heterogeneous Treatment Effects: A Survey" SSRN working paper. <https://doi.org/10.1093/ectj/utac017>
- Central Bank of Nigeria (2022) "Nigeria imports 580 Million worth of Cassava by products annually" CBN internal report
- Coates, 2013. Build it back better: Deconstructing food security for improved measurement and action. *Global food security*. <https://doi.org/10.1016/j.gfs.2013.05.002>
- D'Angelo, L., 2014. Who owns the diamonds? The occult economy of diamond mining in Sierra Leone. *Africa* 84, 269–293. doi:10.1017/S0001972013000752
- Deconinck, K., Verpoorten, M., 2013. Narrow and scientific replication of "The slave trade and the origins of mistrust in Africa." *Journal of Applied Econometrics* 28, 166–169.
- Depetris-Chauvin, E. and Weil, D. N., 2017. Malaria and Early African Development: Evidence from the Sick Cell Trait. *Econ J*.doi:10.1111/ecoj.12433
- De Boeck, F. (2005). *The Divine Seed: Children, Gift and Witchcraft in the Democratic Republic of Congo*. Unpublished manuscript.
- Dempsey, A. F., Zimet, G. D., Davis, R. L., & Koutsky, L., 2006. Factors that are associated with parental acceptance of human papillomavirus vaccines: A randomized intervention study of written information about HPV. doi: 10.1542/peds.2005-1381
- Doyle & Aizer, 2018. "Economics of Child Protection: Maltreatment, Foster Care, and Intimate Partner Violence," *Annual Review of Economics*. doi: 10.1146/annurev-economics-080217 053237
- Doran, K.B., 2013. How Does Child Labor Affect the Demand for Adult Labor? Evidence from Rural Mexico. *Journal of Human Resources* 48 (3): 702–35. doi: 10.3368/jhr.48.3.702
- Dupas and Miguel, 2018. "Impacts and determinants of health levels in low-income countries" *Handbook of Economic Field Experiments*. <https://doi.org/10.1016/bs.hefe.2016.09.003>
- Evans-Pritchard, E.E., 1937. *Witchcraft, oracles and magic among the Azande*. Clarendon Press Oxford.
- Ekwochi et al, 2016. Food taboos and myths in South Eastern Nigeria: The belief and practice of mothers in the region. *Journal of Ethnobiology and Ethnomedicine*. doi: 10.1186/s13002-016-0079-x
- Emmanuel et al, 2020. Impact of the presidential cassava initiative on cassava productivity in Nigeria: Implication for sustainable food supply and food security. *Cogent Food and Agriculture*. <https://doi.org/10.1080/23311932.2017.1368857>
- Eric Y. Tenkorang, Stephen O. Gyimah, Eleanor Maticka-Tyndale & Jones Adjei (2011) *Superstition, witchcraft and HIV prevention in sub-Saharan Africa: the*

- case of Ghana, *Culture, Health & Sexuality*, 13:9, 1001-1014, doi: 10.1080/13691058.2011.592218
- Enesi et al, 2022. Effects of expanding cassava planting and harvesting windows on root yield, starch content and revenue in southwestern Nigeria. *Field Crops Research*, Vol 286. <https://doi.org/10.1016/j.fcr.2022.108639>
- Fincher, C.L., Thornhill, R., Murray, D.R., Schaller, M., 2008. Pathogen prevalence predicts human cross-cultural variability in individualism/collectivism. *Proceedings of the Royal Society B: Biological Sciences* 275, 1279–1285. doi:10.1098/rspb.2008.0094
- Flückiger, M., Ludwig, M., 2017. Malaria Suitability, Urbanization and Economic Development in Sub-Saharan Africa.
- Federal Ministry of Agriculture and Rural Development Nigeria, 2022. Cassava Cultivation.
- Fafchamps & Hill, 2008. Price Transmission and Trader Entry in Domestic Commodity Markets. *Economic Development and Cultural Change* 56 (4): 729–66. <https://doi.org/10.1086/588155>
- Foster, G.M., 1976. Disease Etiologies in Non-Western Medical Systems. *American Anthropologist* 78, 773–782. doi:10.1525/aa.1976.78.4.02a00030
- FAO (2022) Free Access Data.
- FAO (2023). Household Dietary Diversity (HDDS)
- FAO, 2007. Rural income generating activities in developing countries. Food and Agriculture organization of the UN.
- FAO, 1971. Cassava Cultivation. FAO
- Ferrara et al, 2014. “Soap operas and fertility: Evidence from Brazil,” *American Economic Journal: Applied Economics*. doi: 10.1257/app.4.4.1
- Fouka, 2020. “Backlash: The Unintended Effects of Language Prohibition in U.S. Schools after World War I”. *The Review of Economic Studies*, Volume 87, Issue 1. <https://doi.org/10.1093/restud/rdz024>
- Federal Assembly of Nigeria (2020) “Parliamentary Proceedings”
- Gallup World Poll, 2009.
- Glodberg and Pavnick (2007) "Distributional Effects of Globalization in Developing Countries." *Journal of Economic Literature*, 45 (1): 39-82. Doi: 10.1257/jel.45.1.39
- Gelfand, M.J., Raver, J.L., Nishii, L., Leslie, L.M., Lun, J., Lim, B.C., Duan, L., Almaliaich, A., Ang, S., Arnadottir, J., Aycan, Z., Boehnke, K., Boski, P., Cabecinhas, R., Chan, D., Chhokar, J., D’Amato, A., Ferrer, M., Fischlmayr, I.C., Fischer, R., Fülöp, M., Georgas, J., Kashima, E.S., Kashima, Y., Kim, K., Lempereur, A., Marquez, P., Othman, R., Overlaet, B., Panagiotopoulou, P., Peltzer, K., Perez-Florizno, L.R., Ponomarenko, L., Realo, A., Schei, V., Schmitt, M., Smith, P.B., Soomro, N., Szabo, E., Taveesin, N., Toyama, M., Vliert, E.V. de, Vohra, N., Ward, C., Yamaguchi, S., 2011. Differences Between Tight and Loose Cultures: A 33-Nation Study. *Science* 332, 1100–1104. doi:10.1126/science.1197754
- Gennaioli, N., Rainer, I., 2007. The Modern Impact of Precolonial Centralization in Africa. *Journal of Economic Growth* 185–234.
- Gennaioli, N., Rainer, I., 2005. Precolonial Centralization and Institutional Quality in Africa, in: *Institutions and Norms in Economic Development*. MIT Press, Cambridge, MA, pp. 21–46.
- Gershman, B., 2022. Witchcraft beliefs and Subjective well being. American University working paper. <https://www.borisgershman.com/research/witchappy/happywitch.pdf>
- Gershman, B., 2022. Witchcraft beliefs around the world: an exploratory analysis. *Plos One* <https://doi.org/10.7910/DVN/MWC7BT>.
- Gershman, B., 2020. Witchcraft Beliefs as a Cultural Legacy of the Atlantic Slave Trade: Evidence from Two Continent. *European Economic Review* .<https://doi.org/10.1016/j.euroecorev.2019.103362>

- Gershman, B., 2016. Witchcraft beliefs and the erosion of social capital: Evidence from Sub-Saharan Africa and beyond. *Journal of Development Economics* 120, 182–208. doi:10.1016/j.jdeveco.2015.11.005
- Gershman, B., 2015. The economic origins of the evil eye belief. *Journal of Economic Behavior & Organization* 110, 119–144. doi:10.1016/j.jebo.2014.12.002
- Gardner, 2021. Two stage Differences in Differences. <https://doi.org/10.48550/arXiv.2207.05943>
- Geschiere, P., 2013. Witchcraft, intimacy, and trust: Africa in comparison. The University of Chicago Press, Chicago ; London.
- Geschiere, P., 2011. Witchcraft and modernity: perspectives from Africa and beyond, in: *Sorcery in the Black Atlantic*. The University of Chicago Press, Chicago and London, pp. 233–258.
- Geschiere, P., 1998. Globalization and the power of indeterminate meaning: witchcraft and spirit cults in Africa and East Asia. *Development and Change* 29, 811–837.
- Geschiere, P., 1997. *The Modernity of Witchcraft: politics and the occult in postcolonial Africa*. University of Virginia Press.
- Goodman Bacon, 2022. Differences in Differences with variation in treatment timing. *Journal of Econometrics*. <https://doi.org/10.1016/j.jeconom.2021.03.014>
- Gething, P.W., Smith, D.L., Patil, A.P., Tatem, A.J., Snow, R.W., Hay, S.I., 2010. Climate change and the global malaria recession. *Nature* 465, 342–345. doi:10.1038/nature09098
- Gorodnichenko, Y., Roland, G., 2010. Culture, Institutions and the Wealth of Nations. *Review of Economics and Statistics*. doi:10.1162/REST_a_00599
- Green, E.C., 1999. *Indigenous Theories of Contagious Disease*. Rowman Altamira.
- Guariso, A., Rogall, T., 2016. Rainfall inequality, political power, and ethnic conflict in Africa. Working Paper.
- Hadnes, M., Schumacher, H., 2012. The Gods Are Watching: An Experimental Study of Religion and Traditional Belief in Burkina Faso. *Journal for the Scientific Study of Religion* 51, 689–704.
- Helman, C.G., 2007. *Culture, health and illness*. CRC Press.
- Henrich, J., 2004. Cultural group selection, coevolutionary processes and large-scale cooperation. *Journal of Economic Behavior & Organization* 53, 3–35. doi:10.1016/S0167-2681(03)00094-5
- Henningson and Aihouton. 2019. Units of Measurement and the Inverse Hyperbolic Sine Transformation. IFRO working paper.
- Hruschka, D.J., Henrich, J., 2013. Economic and evolutionary hypotheses for cross-population variation in parochialism. *Frontiers in Human Neuroscience* 7. doi:10.3389/fnhum.2013.00559
- Hoop & Rosati, 2014. Cash Transfers and Child Labor. *World Bank Research Observer* 29 (2): 202–34
- Howeler (2017) “Cassava in Asia”. n Cassava’s potential in Asia in the 21st Century: Present situation and future research and development needs. *Proceedings 6th Regional Workshop*, held in Ho Chi Minh City
- Huss et al, 2021. Improved on-farm storage reduces seasonal food insecurity of smallholder farmer households – Evidence from a randomized control trial in Tanzania. *Food Policy*. <https://doi.org/10.1016/j.foodpol.2020.101891>
- Iannaccone, L.R., 1998. Introduction to the Economics of Religion. *Journal of economic literature* 1465–1495.
- IPUMS-Demographic & Health Surveys Nigeria (various) [2018, 2013, 2008 & 2003] Funded by USAID. Rockville, Maryland: ICF [Distributor]. <https://dhsprogram.com/data/>
- Iyer, Sriya. 2016. "The New Economics of Religion." *Journal of Economic Literature*, 54 (2): 395-441.” along with Iannaccone (1998) for a more recent survey of economics of religion.

- IFRC, 2014. Ebola, snakes and witchcraft: Stopping the deadly disease in its tracks in West Africa [WWW Document]. IFRC News stories Africa. URL <http://www.ifrc.org/en/news-and-media/news-stories/africa/sierra-leone/ebola-snakes-and-witchcraft-stopping-the-deadly-disease-in-its-tracks-in-west-africa-66215/> (accessed 6.23.17).
- Inglehart, R.F., 2016. Modernization, existential security and cultural change: Reshaping human motivations and society, in: Gelfand, M., Chiu, C., Hong, Y. (Eds.), *Advances in Culture and Psychology*. Oxford University Press, New York.
- Jedwab, R., Kerby, E., Moradi, A., 2017. History, Path Dependence and Development: Evidence from Colonial Railways, Settlers and Cities in Kenya. *Econ J* 127, 1467–1494. doi:10.1111/ecoj.12347
- Jamison et al (2018) “The Relationship between Conflicts, Economic Shocks, and Death with Depression, Economic Activities, and Human Capital Investment in Nigeria” Policy Research Working Paper No. 8685. World Bank.
- Jensen, G., 2007. Explaining Witch Hunts: Sacrifice, Persecution, and Scapegoat Theories, in: *The Path of the Devil: Early Modern Witch Hunts*. Rowman & Littlefield Publishers, Inc., New York.
- Johnson, T.M., Grim, B.J., 2015. World Religion Database [WWW Document]. URL http://worldreligiondatabase.org/wrd_default.asp (accessed 4.14.15).
- Kareem, 2021. Cassava, Yam, Maize rank top ten crops produced in Nigeria but not top 10 crops exported Dataphyte
- Kebede, 2021. Coffee Farmers in Ethiopia. World Bank working papers.
- Kalichman, S.C., Simbayi, L., 2004. Traditional beliefs about the cause of AIDS and AIDS-related stigma in South Africa. *AIDS Care* 16, 572–580. doi:10.1080/09540120410001716360
- Keinan, G., 2002. The Effects of Stress and Desire for Control on Superstitious Behavior. *Personality and Social Psychology Bulletin* 28, 102–108. doi:10.1177/0146167202281009
- Kiszewski, A., Mellinger, A., Spielman, A., Malaney, P., Sachs, S.E., Sachs, J., 2004. A Global Index Representing the Stability of Malaria Transmission. *The American Journal of Tropical Medicine and Hygiene* 70, 486–498. doi:10.4269/ajtmh.2004.70.486
- Kohnert, D., 2007. On the Renaissance of African Modes of Thought - The Example of the Belief in Magic and Witchcraft, in: Schmidt, B. (Ed.), *Witchcraft in Modern Africa: Witches, Witch-Hunts and Magical Imaginaries*, Veröffentlichungen Des Arbeitskreises Für Historische Hexen- Und Kriminalitätsforschung in Norddeutschland. Verlag Dokumentation & Buch (DOBU), Hamburg, pp. 39–61.
- Kohnert, D., 1996. Magic and witchcraft: Implications for democratization and poverty-alleviating aid in Africa. *World Development* 24, 1347–1355.
- Koning, N., 2013. Witchcraft Beliefs and Witch Hunts: An Interdisciplinary Explanation. *Human Nature* 24, 158–181. doi:10.1007/s12110-013-9164-1
- Leeson, P.T., Russ, J.W., 2017. Witch trials. *The Economic Journal*. doi:10.1111/ecoj.12498
- Leistner, E., 2014. Witchcraft and African development. *African Security Review* 23, 53–77. doi:10.1080/10246029.2013.875048
- Lowes and Montero, 2018. The Legacy of Colonial Medicine in Central Africa. *American Economic Review*. 111 (4): 1284-1314. DOI: 10.1257/aer.20180284
- LeMay-Boucher, P., Noret, J., Somville, V., 2013. Facing Misfortune: Expenditures on Magico-Religious Powers for Cure and Protection in Benin. *Journal of African Economies* 22, 300–322. doi:10.1093/jae/ejs032
- Liddell, C., Barrett, L., Bydell, M., 2005. Indigenous representations of illness and AIDS in Sub-Saharan Africa. *Social Science & Medicine* 60, 691–700. doi:10.1016/j.socscimed.2004.06.020

- Le Rossignol et al. (2021). Traditional Supernatural Beliefs and Prosocial behavior. NBER working Paper. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4021789
- Ludwig ,2008. Christian: Muslim Relations in Northern Nigeria since the Introduction of Shari'ah in 1999. *Journal of the American Academy of Religion*. <https://doi.org/10.1093/jaarel/lfn058>
- Lele et al, 2016. Measuring Food and Nutrition Security: An Independent Technical Assessment and User's Guide for Existing Indicators. Tufts working paper.
- Mastorocco and Ornaghi ,2020. "Who Watches the Watchmen? Local News and Police Behavior in the United States," Trinity Economics Papers tep0720, Trinity College Dublin, Department of Economics. RePEc:tcd:tcduee:tep0720
- Maslove, D.M., Mnyusiwalla, A., Mills, E.J., McGowan, J., Attaran, A., Wilson, K., 2009. Barriers to the effective treatment and prevention of malaria in Africa: A systematic review of qualitative studies. *BMC International Health and Human Rights* 9, 1–10. doi:10.1186/1472-698X-9-26
- Matsuda, 2002. "Beliefs About Immunization and Children's Health Among Childbearing Mothers in Nepal". Stanford University internal publications.
- Maluccio, 2005. Coping with the Coffee Crisis in Central America: The Role of the Nicaraguan Red de Proteccion Social FCND Discussion Paper 188, International Food Policy Research Institute (IFPRI).
- Mbiti, J.S., 1990. African religions & philosophy, 2nd edition. ed. Heinemann, Oxford.
- McCann, J., 2011. Deposing the Malevolent Spirit: A Historical Cultural Ecology of Malaria in Northwest Ethiopia. African Studies Center, Boston University.
- McNeill, W.H., 1976. Plagues and peoples. Anchor Books, New York.
- Michalopoulos, S., 2012. The Origins of Ethnolinguistic Diversity. *American Economic Review* 102, 1508–1539. doi:10.1257/aer.102.4.1508
- Morgan and Choct, 2016. Cassava: Nutrient composition and nutritive value in poultry diets. Pubmed Central. Doi: 10.1016/j.aninu.2016.08.010
- Muller et al, 2018. Community perception regarding childhood vaccinations and its implications for effectiveness: a qualitative study in rural Burkina Faso. *BMC Medical Health* 18: 324. Doi: 10.1186/s12889-018-5244-9
- Michalopoulos, S., Naghavi, A., Prarolo, G., 2012. Trade and Geography in the Origins and Spread of Islam (NBER Working Paper No. 18438). National Bureau of Economic Research.
- Michalopoulos, S., Papaioannou, E., 2014. National Institutions and Subnational Development in Africa. *The Quarterly Journal of Economics* 129, 151–213. doi:10.1093/qje/qjt029
- Michalopoulos, S., Papaioannou, E., 2013. Pre-Colonial Ethnic Institutions and Contemporary African Development. *Econometrica* 81, 113–152. doi:10.3982/ECTA9613
- Miguel, E., 2005. Poverty and witch killing. *The Review of Economic Studies* 72, 1153–1172.
- Mokyr, J., 2014. Culture, Institutions, and Modern Growth. *Institutions, Property Rights, and Economic Growth: The Legacy of Douglass North* 151–191.
- Muela, S.H., Ribera, J.M., Tanner, M., 1998. Fake malaria and hidden parasites? the ambiguity of malaria. *Anthropology & Medicine* 5, 43–61. doi:10.1080/13648470.1998.9964548
- Murdock, G.P., 1967. *Ethnographic atlas*. University of Pittsburgh Press, Pittsburgh.
- Murdock, G.P., 1959a. *Tribal Map of Africa*. McGraw-Hill, Inc., New York.
- Murdock, G.P., 1959b. *Africa: its peoples and their culture history*. McGraw-Hill, Inc., New York.
- Murray, D.R., Schaller, M., 2010. Historical Prevalence of Infectious Diseases Within 230 Geopolitical Regions: A Tool for Investigating Origins of Culture. *Journal of Cross-Cultural Psychology* 41, 99–108. doi:10.1177/0022022109349510
- North, D.C., 2008. What is Missing from Political Economy, in: Wittman, D.A., Weingast, B.R. (Eds.), *The Oxford Handbook of Political Economy*. Oxford University Press.

- Nunn, N., 2012. Culture and the Historical Process. *Economic History of Developing Regions* 27, S108–S126. doi:10.1080/20780389.2012.664864
- Nunn, N., 2010. Religious Conversion in Colonial Africa. *The American Economic Review* 100, 147–152.
- Nunn, N., 2008. The Long-term Effects of Africa's Slave Trades*. *The Quarterly journal of economics* 123, 139–176.
- Nunn, N., Sanchez de la Sierra, R., 2017. Why Being Wrong can be Right: Magical Warfare Technologies and the Persistence of False Beliefs (No. w23207), NBER Working Paper. National Bureau of Economic Research.
- Nunn, N., Wantchekon, L., 2011. The Slave Trade and the Origins of Mistrust in Africa. *American Economic Review* 101, 3221–3252. doi:10.1257/aer.101.7.3221
- Olson, J.S., 1996. *The peoples of Africa: an ethnohistorical dictionary*. Greenwood Publishing Group.
- Olsson, O., 2004. Unbundling Ex-Colonies: A Comment on Acemoglu, Johnson, and Robinson 2001 (No. 146), Working Paper in Economics. Göteborg University, Göteborg, Sweden.
- Omonzejele, P.F., 2008. African Concepts of Health, Disease, and Treatment: An Ethical Inquiry. *Explore: The Journal of Science and Healing* 4, 120–126. doi:10.1016/j.explore.2007.12.001
- O'Neill, S., Gryseels, C., Dierickx, S., Mwesigwa, J., Okebe, J., d'Alessandro, U., Grietens, K.P., 2015. Foul wind, spirits and witchcraft: illness conceptions and health-seeking behaviour for malaria in the Gambia. *Malaria Journal* 14, 167. doi:10.1186/s12936-015-0687-2
- Oster, E., 2004. Witchcraft, weather and economic growth in Renaissance Europe. *The Journal of Economic Perspectives* 18, 215–228.
- Oster, 2016. Does disease cause vaccination? disease outbreaks and vaccination response. Doi: 10.1016/j.jhealeco.2017.10.003
- Oladejo, J.A. and Adetunji, M.O., 2012. Economic Analysis of Maize Production in Oyo State of Nigeria. *Agricultural Science Research Journal*, 2, 77-83.
- Osho & Obayelu, 2020. How Diverse are the diets of low-income urban household in Nigeria. *Journal of Agriculture and Food Research*. <https://doi.org/10.1016/j.jafr.2019.100018>
- Parrinder, E.O., 1956. African ideas of witchcraft. *Folklore* 67, 142–150.
- Pew Research Centre, 2009. *Tolerance and Tension: Islam and Christianity in Sub-Saharan Africa*.
- Piel, F.B., Patil, A.P., Howes, R.E., Nyangiri, O.A., Gething, P.W., Williams, T.N., Weatherall, D.J., Hay, S.I., 2010. Global distribution of the sickle cell gene and geographical confirmation of the malaria hypothesis. *Nature Communications* 1, 104. doi:10.1038/ncomms1104
- PWC (2020) "Harnessing the Economics Potential of Cassava Production in Nigeria" PWC report
- Platteau, J.-P., 2014. Redistributive pressures in Sub-Saharan Africa: Causes, consequences, and coping strategies, in: Akyeampong, E., Bates, R.H., Nathan Nunn, Robinson, J.A. (Eds.), *Africa's Development in Historical Perspective*. pp. 153–207.
- Philip, 2018. The Nigerian child's rights act and rights of children with disabilities: what hope for enforcement. *Petru Maior University, Faculty of Economics Law and Administrative Sciences and Pro Iure Foundation*, vol. 72, pages 57-66.
- Peters et al, 2009. *Agricultural Commodity Price Spikes in the 1970s and 1990s: Valuable Lessons for Today*. US Department of Agriculture.
- Page and Hewitt, 2023. *World Commodity Prices and their Impact on Developing Countries*. Paris Global Finance Summit.

- Rasul et al, 2020. The Impacts of a Multifaceted Pre-natal Intervention on Human Capital Accumulation in Early Life. *American Economic Review*, 111 (8): 2506-49. doi: 10.1257/aer.20191726
- Rogan (2017) "Food poverty, hunger and household production in rural Eastern Cape households" *Development South Africa*.
https://doi.org/10.1080/0376835X.2017.1358602
- Sun and Abraham, 2021. Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*.
https://doi.org/10.1016/j.jeconom.2020.09.006.
- Sachs, J., Malaney, P., 2002. The economic and social burden of malaria. *Nature* 415, 680–685. doi:10.1038/415680a
- Salau et al, 2019. Effect of Cassava Products Consumption on Food Security of Farming Households in Kwara State, Nigeria. *Journal of Agricultural Economics*.
- Schaller, M., Murray, D.R., 2008. Pathogens, personality, and culture: Disease prevalence predicts worldwide variability in sociosexuality, extraversion, and openness to experience. *Journal of Personality and Social Psychology* 95, 212–221. doi:10.1037/0022-3514.95.1.212
- Shaw, R., 1997. The Production of Witchcraft/Witchcraft as Production: Memory, Modernity, and the Slave Trade in Sierra Leone. *American Ethnologist* 24, 856–876.
- Simons, G.F., Fennig, C.F. (Eds.), 2016. *Ethnologue: Languages of the World*, Twentieth edition.
- Snow, R.W., Omumbo, J.A., 2006. Chapter 14: Malaria, in: Jamison, D.T., Feachem, R.G., Makgoba, M.W., Bos, E.R., Baingana, F.K., Hofman, K.J., Rogo, K.O. (Eds.), *Disease and Mortality in Sub-Saharan Africa*. The International Bank for Reconstruction and Development / The World Bank, Washington, D.C.
- Snow and College, 2017. Explaining Abuse of "Child Witches" in Africa. *Journal of religion and society*. Volume 19
- Stoop, N., Verpoorten, M., mimeo. Risk, envy and magic in DRC's artisanal mining sector: insights into the "Modernity of Witchcraft."
- Stoop, N., Verpoorten, M., Deconinck, K., 2017. Voodoo, Vaccines and Bed Nets. *Economic Development and Cultural Change* forthcoming.
- Shelton et al , 2011. HPV Vaccine Decision-Making and Acceptance: Does Religion Play a Role *Journal of religion and health*. Doi: 10.1007/s10943-011-9553-x
- Stobart, 2006. Child Abuse Linked to Accusations of Possession and Witchcraft. *Research Report*.
- Shittu et al, 2017 .Women empowerment and adoption of climate-smart agricultural practices in Nigeria. *African Journal of Economic and Management studies*.
- Smith et al, 2017. Who are the World's Food Insecure? New Evidence from the Food and Agriculture Organization's Food Insecurity Experience Scale. *World Development*, Issue 93
- Thomas, F., 2007. "Our Families are Killing Us": HIV/AIDS, Witchcraft and Social Tensions in the Caprivi Region, Namibia. *Anthropology & Medicine* 14, 279–291. doi:10.1080/13648470701612679
- Thornhill, R., Fincher, C.L., Aran, D., 2009. Parasites, democratization, and the liberalization of values across contemporary countries. *Biological Reviews* 84, 113–131. doi:10.1111/j.1469-185X.2008.00062.x
- Treesilvattanakul (2016). Deterministic Factors of Thai Cassava Prices: Multi-Uses of Cassava from Food, Feed, and Fuel Affecting on Thai Cassava Price Volatility. *KnE Life Sciences*, 3(3), 12-16.
- Taiwo & Fasoyiro, 2015. Women and Cassava Processing In Nigeria. *International Journal of Development Research*

- Thornton, J., 2003. Cannibals, Witches, and Slave Traders in the Atlantic World. *The William and Mary Quarterly* 60, 273–294. doi:10.2307/3491764
- van de Grijsparde, H., Voors, M., Bulte, E., Richards, P., 2013. Who believes in witches? Institutional flux in Sierra Leone. *African Affairs* 112, 22–47. doi:10.1093/afraf/ads077
- Vansina, J., 2012. *How Societies Are Born: Governance in West Central Africa before 1600*. University of Virginia Press.
- Udry, C, 1995. Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria. Vol 61, No 3.
- UNDP, 2023. *Commodity Dependence and International commodity prices*.
- Webb, J.L.A.J., 2006. Ecology & Culture in West Africa, in: Akyeampong, E.K. (Ed.), *Themes in West Africa's History*. Ohio University Press, Athens, pp. 33–51.
- Wimmer, A., Cederman, L.-E., Min, B., 2009. Ethnic politics and armed conflict. A configurational analysis of a new global dataset. *American Sociological Review* 74, 316–337, 2009.
- Wlodarczyk, N., 2009. *Magic and Warfare: Appearance and reality in contemporary African Conflict and Beyond*. Springer.
- Wild et al ,2015. mycotoxin control in low- and middle-income countries. PMID: 27030861 Bookshelf ID: NBK350558
- WHO, 2019. Experts caution against stagnation of immunization coverage in Africa. WHO publications.
- Yamba et al, 2003. Cultural childbirth practices and beliefs in Zambia. *Journal of Advanced Nursing* 43(3), 263–274. doi: 10.1046/j.1365-2648.2003.02709.x