Essays on Women's Control over Income, Maternal Cash Transfers, and Rainfall Shocks Evidence from India and Malawi

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Abstract

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Doctor of Philosophy in Public Policy & Management

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In this dissertation, I conduct three studies on women's economic empowerment in India and Malawi. The first study examines the effect of an Indian maternal cash transfer program on child nutrition. The second study explores variation in women's control over income by income type and family structure in Malawian households. Also in Malawi, the third study analyzes the effect of rainfall deficits on women's control over income. In my first chapter, I ask: 1) What are the effects of a universal maternal cash transfer program "Mamata Scheme" in Odisha, India on child nutrition? 2) To what extent do program effects vary by household wealth? I use a triple differences estimation and nationally representative survey data from the National Family Health Survey to test the effect of the Mamata Scheme on standardized height and weight measures for children under five. I find improvements in some, but not all, measures of child nutrition following the implementation of the Mamata Scheme. I find evidence of wealth heterogeneities

in the program's effects. Improvements in child nutrition are concentrated in children from non-poor households. Taken together, the results suggest that maternal cash benefits improve child nutrition, but universal schemes such as Mamata may need to offer additional incentives and/or improve targeting for children from poor households to realize program benefits.

In the second chapter, I ask: 1) Does women's control over household income differ by income type? 2) Is there a relationship between family structure, women's demographic characteristics, and women's control over income? I use the Fourth Malawi Integrated Household Survey (IHS-4) to examine women's control over various sources of household income, including public and private transfers, farm, and non-farm earnings. Using descriptive and multivariate logistic regression analyses, I find that in households with both adult men and women, women have higher odds of having sole control over transfer income, compared to income from farm and non-farm sources. I also find that the presence of a male spouse (versus another adult man) in the household is associated with significantly lower sole female control over transfers. Further, I find that female characteristics, especially age, divorce, and widowhood increase the probability of controlling transfers. The results shed important light on women's financial decision-making patterns in agricultural households. Specifically, household income received through remittances and transfer programs is associated with higher female decision-making authority, a key insight for policy interventions aimed at increasing women's control over financial resources.

In the third chapter I ask: 1) How do negative rainfall shocks affect women's control over household income? 2) Do effects vary by income type? Using three rounds of the Malawi Integrated Household Panel Survey (IHPS), I employ a household-year fixed-effects identification to test whether female control over farm, nonfarm, and transfer income changes in

response to drought shocks. In dual-adult households, a drought shock increases women's control over farm income, while there is no change in female control over total household income. I also find that rainfall shocks increase the probability of a household having a farm plot that is solely managed by a woman. The results suggest that drought alters intra-household decision-making, particularly related to the farm. While control over income is typically used as a proxy for women's economic empowerment, the findings suggest that changes in control over income in response to climatic factors such as rainfall variability may not reflect an absolute improvement in women's empowerment.

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INTRODUCTION

Women's empowerment is an important policy objective internationally. Achieving gender equality and empowering women and girls is a UN Sustainable Development goal (The United Nations, 2015), and multi-lateral organizations, foundations, and governments have made substantial financial commitments to gender equality. A sizable literature from low and middle-income countries (LMICs) shows that women's economic empowerment, i.e., the process through which women gain the skills, resources, and the ability to participate in the labor market, earn and control income, and make economic decisions (UN Women, 2018), has positive effects on household, child, and women's outcomes. For instance, women's economic empowerment is linked with improvements in household food security, child nutrition, health and education, and in women's health, labor force participation, and freedom of movement (Cunningham et al., 2015; Doss, 2013; Duflo, 2012; Malapit et al., 2015; Sraboni et al., 2014).

Control over income is a crucial aspect of women's economic empowerment. Access to financial resources by itself does not mean a woman has control over income. For instance, it may be a social norm for men to control household income, or a woman's income may be captured by other household members. Control over income is a woman's ability to decide how earnings are used, whether for savings, investments, or consumption (Njuki et al., 2019). Among all dimensions of household decision-making, women typically have the least control over income (Anderson et al., 2017). In light of the potential benefits of women's economic empowerment, many LMICs have implemented female-centric social protection and financial inclusion programs. For example, programs such as cash transfer schemes, self-help groups, microcredit, bank account provision and public works often explicitly target female beneficiaries. These programs and policies are based on the dual assumptions that they will benefit women themselves, and also that women are more likely to invest additional income in family wellbeing. But if women do not control income, potential program benefits may not be realized. Drawing on these ideas, my dissertation consists of three studies on women's control over income and its patterns, drivers, and associated outcomes.

In the first study in this dissertation, I examine the impact of a financial incentive targeted to women on children's nutritional outcomes in India. In 2011, Odisha state in eastern India introduced a universal conditional cash transfer named "Mamata Scheme". Intended as partial wage compensation for pregnant and lactating women, the program aims to improve the health

and nutrition status of pregnant and lactating mothers and their infants, and contribute to reducing maternal and infant mortality (Govt. of Odisha, Women and Child Development). Examining the long-run effects of the program is important, given increases in national budgetary allocations and implementation of similar conditional maternity benefit schemes throughout India since 2017. Examining these questions in the Indian context is particularly important, as child undernutrition persists in India on a large scale, despite rapid economic growth. In 2015-16, 38% of children under the age of 5 in the country were stunted, and 21% suffered wasting (NFHS-4, 2015), representing over 70 million children.

Using two cross-sections of the India National Family Health Survey (NFHS), I estimate the effect of the Mamata Scheme on children's nutrition (standardized measures of height and weight for children under 5). I employ a triple differences estimation that exploits variation in the program's eligibility rules by a child's birth order, mother's age, and state of residence. I find that being eligible for the Mamata Scheme is associated with an increase of 0.30 standard deviations (S.D.) in weight-for-height z-scores (WHZ) for children between 0-5 years of age in Odisha, which is a 37% increase from the preprogram mean WHZ. Additionally, the program is associated with a 7 percentage-point reduction in the probability of child wasting. Preprogram, 18% of children in the state suffered from wasting, so this is a 39% improvement. Also, the program reduces child stunting by 5 pp. (a 13% reduction from the preprogram mean), although this is not statistically significant. Notably, I find no significant improvement in children's height-for-age z-scores (HAZ).

Disaggregated analyses show that there is substantial wealth heterogeneity in program effects across all four measures of child nutrition. Improvements in nutritional outcomes are concentrated among children in wealthier households in the state (top two national wealth quintiles). The program improves WHZ by 0.21 S.D. more and HAZ by 0.48 S.D. more for children from non-poor households, compared with children from poor households. The binary nutrition measures also reflect this wealth heterogeneity. The reduction in the probability of wasting for children from non-poor households is 23 pp. higher than for children from poor households. Similarly, the reduction in the probability of stunting is 16 pp. higher for children from non-poor households. These findings suggest the need for improving the Mamata Scheme's targeting mechanisms, as women from poorer households may be facing several difficulties in program access, from fulfilling health conditionalities to receiving bank transfers.

Through an examination of the long-run effects of a non means-tested conditional cash transfer, my study furthers the understanding on the relationship between a cash transfer program design where beneficiaries are not selected based on wealth and children's outcomes. My study contributes to the literature on cash transfers and nutrition and health in LMICs, a majority of which are means-tested. This literature finds that cash transfers are associated with improvements in first-order outcomes such as food and health expenditure, intermediate outcomes such as household dietary diversity and use of health services, but the evidence on third order or "final" outcomes such as child anthropometry (height and weight) is limited and mixed (ibid.), and the pathways are not well understood (Bastagli et al., 2019, 2016; Carneiro et al., 2020; Groot et al., 2017).

My study also adds to the evidence base on the importance of early-life circumstances and a child's future health (Case et al., 2005; Currie & Almond, 2011; J. Hoddinott et al., 2008; J. F. Hoddinott et al., 2011a; Victora et al., 2008). Specific to nutrition, literature across disciplines, from demography, economics, and public health shows if nutritional deficits occur in-utero and at the start of life, these are especially detrimental for human capital including educational attainment, height, and wealth in adulthood. Hence, interventions introduced in-utero and during early childhood (first 1000 days of life) are important and recommended. Studies using data for a short duration may not be able to detect effects on stunting, which is a cumulative effect of poor nutrition and disease. My study contributes to the literature on the long-run effects of early-life interventions with data that span a decade, a sufficiently long duration to examine effects on stunting.

In the second study, I analyze the patterns of women's control over household income from different sources in Malawi. Households in LMICs often earn income from multiple sources. Hence, it is important to examine the factors that make women more or less likely to control income, particularly the role of family structure, income source, and female demographic characteristics. The prevalence of targeted public transfers and remittances in LMICs highlights a need to examine the extent to which women control transfers in comparison with farm and nonfarm income, prior to targeting policy interventions. My study draws on the development and behavioral economics literature on why individuals treat transfers differently from other income sources, and extends these ideas to intrahousehold behavior in an LMIC context. I test two hypotheses using data from the Fourth Malawi Integrated Household Survey (IHS-4). First, that men cede more

control over transfers than other income sources to women; and second, that men are more likely to constrain women's control over income when in a spousal relationship. Malawi is an excellent case study for examining women's control over income disaggregated by source, since households have multiple income sources, including income from the farm, non-farm earnings, and public and private transfer sources Malawi also has both matrilineal and patrilineal kinship, which is reflected through a variety of household structures in the country. This includes male-headed households as well as female-headed households, both with and without adult men present. This diversity of household structures is useful in understanding how household composition relates to women's control over income.

My analysis focuses on households with adult men present at the time of the survey, and I employ descriptive statistics and logistic regression analyses to document a) that women are more likely to control transfers than other income sources, and b) that male spouses constrain women's control over income to a larger extent that other male relatives. Women in households with at least one adult man have 79% higher odds of having sole control over a transfer income stream, compared to farm and nonfarm income streams. This relationship holds irrespective of whether the transfer accrues from a public or private source. In female-headed households (FHHs), the presence of a male spouse (as opposed to other men) is associated with a 23 pp. reduction in the fraction of transfers solely controlled by the female household head. This is a substantial reduction, given that on average, female household heads have sole control over 80% of transfer income. The presence of a male spouse in FHH (as opposed to other men) is also associated with a 25 pp. reduction in the fraction of total household income under the female head's control. Again, this is a large reduction, as on average, female household heads have sole control over 50% of household income. I also find that women who are household heads have 14 times higher odds of controlling transfers than women who are spouses of the head. Divorced and widowed women in households with men have 5- and 3-times higher odds respectively of sole decision-making over transfers compared with monogamously married women.

My study presents an important first step in exploring how income type, household composition, and women's demographic characteristics relate to female control over income in a LMIC setting. Improving women's control over income is a desirable policy goal. Higher female control over income has beneficial outcomes for women themselves and for children, including a change in gender norms, higher female autonomy, increases in female labor supply in the long run

(Field et al., 2021) and better children's educational and nutritional status (Doss, 2013; Haddad, 1999; Holland & Rammohan, 2019). My finding that women are more likely to control transfers than other income sources, even in the presence of men, suggests that transfers to women may yield benefits for households in LMICs. This finding is in line with other experimental and quasi-experimental evidence that finds that cash and in-kind transfers consistently increase women's household decision-making power and provides evidence in support of designing female-centric transfer programs.

The third chapter examines the effect of drought shocks on women's control over household income in Malawi. Using three rounds of survey data from the Malawi Integrated Household Panel Survey (IHPS), I employ household-year fixed-effects identification to test whether female control over total, farm, nonfarm, and transfer income changes in response to drought shocks. I find that in households with both men and women, a drought shock (defined as one standard deviation or more below the historical 30-yr annual average rainfall) is associated with a 46 percent increase in women's sole control over farm income and a 7 percentage-point increase in the probability that a household farms a plot solely managed by women. I also find that joint control over non-farm income, but not farm income, increases after drought shocks. I find suggestive evidence for higher male participation in off-farm labor following drought as the mechanism explaining these results. Notably, I do not find conclusive evidence of a drop in total household income and consumption following a drought shock, suggesting the presence of a pathway other than income loss that mediates this effect. The findings of this paper suggest that climate shocks alter intra-household decision-making, particularly related to the farm, and highlight the integral role of women in maintaining household resilience in agrarian economies. The study highlights that highlights that while control over income is typically used as a proxy for women's economic empowerment, changes in female control over income in response to climatic factors such as rainfall variability may not reflect an absolute improvement in women's empowerment, if there is higher workload for women on the farm and at home. Hence, it is important to examine the drivers of female decision-making over income to understand the pathways that lead to changes in decision-making, and how well this reflects women's empowerment

CHAPTER 1: MATERNAL CASH TRANSFERS AND CHILD NUTRITION: EVIDENCE FROM INDIA

Section 1: Introduction

Globally, around 144 million children under the age of five are stunted, and an estimated 47 million worldwide suffer from wasting (WHO, 2019). In India, child undernutrition in the form of wasting and stunting persists, despite rapid economic growth following economic liberalization in 1991. In 2015-16, 38% of Indian children under the age of 5 were stunted, and 21% suffered wasting (NFHS-4, 2015) representing over 70 million children (Global Nutrition Report, 2018). To address this large but solvable problem, Central and state governments in India have adopted various policies to improve child well-being, among which cash transfers (CTs) targeted to pregnant and lactating women have gained prominence in recent years. In this paper, I examine the impact of financial incentives provided under a maternal cash transfer program in Odisha, India on child nutrition.

In 2011, the state government of Odisha launched the "*Mamata Scheme*", a conditional cash transfer (CCT) program intended to serve as partial wage compensation for pregnant and nursing mothers. The Mamata Scheme aims to improve the health and nutrition status of pregnant and lactating mothers and their infants, by combining a cash incentive with ante- and postnatal care and counselling towards infant & young child feeding practices. All pregnant and lactating women in the state aged 19 or older receive a cash payment for their first two children upon fulfilling health-related conditionalities. The program operates in all districts in the state and is not means-tested, unlike many other CTs. Between 2011 and 2019, more than USD 242 million was disbursed to around 3.9 million pregnant and lactating women in Odisha through the Mamata Scheme (Pragativadi, 2019). At the time of the study in 2016, I approximate program uptake to be at 44% of women in Odisha[1].

Programs that target pregnant and nursing mothers are important, as poor maternal health has adverse consequences on child mortality and nutrition (Black et al., 2013), and women in low

[1] Odisha's female population was 20 million per the 2011 Indian Census. Of these, 9.5 million women were in the reproductive age group of 15 – 49 years. Extrapolating from the Odisha NFHS sample, I estimate that 5.7 million women were eligible for the Mamata Scheme in 2016, based on their age and number of children. There were 2.5 million program beneficiaries in 2016 (Orissa Post, 2020). Hence, I calculate program uptake as 2.5 million / 5.7 million = 43.8 %.

and middle-income countries (LMICs) often face barriers to accessing crucial maternity care services (Hunter & Murray, 2017). Further, a large body of evidence in demography, economics, and public health shows that nutritional deficits that both occur in-utero and at the start of life are especially detrimental for human capital outcomes including educational attainment, height and wealth in adulthood (J. R. Behrman, 2016; Bleakley, 2010; Case et al., 2005; Currie & Almond, 2011; Glewwe et al., 2001; Victora et al., 2008). Thus, interventions introduced in-utero and during early childhood (first 1000 days of life) are recommended to reduce cognitive impairments and improve economic productivity in adulthood (Hoddinott et al., 2008).

Exploiting exogenous variation in program eligibility, I investigate the long-run effects of the Mamata Scheme on children's nutrition (standardized weight and height measures for children under 5). The main source of identification comes from program eligibility criteria which stipulate that a) only mothers aged 19 and above are eligible for the cash benefit and b) cash benefits are limited to first and second-born children. Using two repeated cross-sections of nationally representative survey data from the National Family Health Survey (NFHS), I assign each child under the age of 5 to a treatment and comparison group, based on their mother's age, child birth order and state of residence. To account for the non-random nature of the program's rollout, I use a difference-in-differences analysis, which rests on the assumption of common trends between treated and non-treated states, and a triple difference analyses which relaxes this assumption. I estimate the intent-to-treat program effects on wasting and stunting for children under 5 years of age, controlling for birth year and month fixed effects.

With this paper, I contribute to the literature on cash transfers and child development in three ways. First, my paper provides novel evidence on the impact of a non means-tested CT targeted at pregnant and lactating mothers on child nutrition. Existing work examining CTs and health and nutrition largely focuses on means-tested programs in Latin America and sub-Saharan Africa, most of which do not restrict recipient status to pregnant and nursing mothers. This raises the issue of the extent to which targeting pregnant and nursing women through non-means-tested programs affects children's outcomes.

Second, I contribute to the scant literature on cash transfers and nutrition in the Indian context, using nationally representative data. Although India has the largest number of undernourished children globally, the impact of cash transfer schemes on child nutrition remains underexplored. To the best of my knowledge, Sinha and Yoong (2009) is the only other study that

examines cash transfers and children's anthropometric outcomes in India. However, in the 'Apni Beti Apna Dhan' program that the authors examine, both immediate and deferred cash incentives were offered to parents of girl children born in socially disadvantaged and/or poor families. Unlike the Mamata Scheme, the program did not target the first 1000 days of life or have health-related conditionalities that are important for impacts on child nutrition.

Third, by exploiting repeated cross-sectional data spanning a decade (2005-6 – 2015-16), my paper furthers evidence on CTs and third-order or final nutritional outcomes. The literature on CTs and health and nutrition largely finds improvements in first-order outcomes such as food and health expenditure, and intermediate outcomes such as household dietary diversity and use of health services (see Bastagli et al., 2016 for a review). However, as a body of work, evidence on third order or "final" outcomes such as child anthropometry remains inconclusive (ibid.), and the pathways of impact are not well-understood.

The results of my study suggest that the Mamata Scheme is associated with small improvements in nutritional outcomes among eligible children. For children of women exposed to the program, there is an increase of 0.30 standard deviations (CI: 0.09 to 0.51) in the weight-for-height z-score (WHZ), a measure of wasting, i.e., acute malnutrition. I estimate an effect of -0.01 S.D. (CI: -0.22 to +0.2) for the height-for-age z-score (HAZ), a measure of stunting, i.e., chronic malnutrition. For both WHZ and HAZ, I also find evidence of heterogenous effects by household wealth, an important finding as the Mamata Scheme is universal. For children from households in the bottom three wealth quintiles of a national classification, the program effect on WHZ is 0.21 S.D. lower than those belonging to higher wealth quintiles. For HAZ, the program effect is 0.48 S.D. lower for children from poorer households. The program reduces the odds of child wasting by 35% and child stunting by 20% respectively. Here too, there are wealth heterogeneities in the effects. The program is almost four times more likely to reduce the odds of wasting, and almost twice as likely to reduce the odds of stunting for children from households in the top two wealth quintiles, compared to children in households in the bottom three quintiles.

The program improves HAZ more for girls than boys (0.19. S.D higher), in the line with the broader literature on cash transfers and height-for-age which finds that girls benefit more from cash transfers than boys (Manley et al., 2013). Interestingly, I find that the program is almost two times as likely to reduce wasting for boys than girls, and boys also experience 0.26 S.D. higher improvements in weight-for-height (WHZ). Finally, I analyze program effects for children

younger and older than 2 years separately, since including older children may underestimate the effects on HAZ/stunting reduction for younger age groups. I find that the program reduces the odds of stunting in children in the 0 – 2 age group by 42%, but not in the older age group. This is an important finding since including older children may underestimate the effects on HAZ/stunting reduction for younger age groups. Overall, my findings suggest that conditional cash transfers targeted to pregnant and nursing mothers are associated with moderate improvements in children's height and weight in the Indian context.

The rest of my paper is organized as follows. The next section reviews the literature on cash transfers and early-childhood nutrition. Section 3 describes the Mamata Scheme. Section 4 discusses the data. Section 5 and 6 present the identification strategy and results, respectively. Section 7 describes robustness checks, and Section 8 concludes.

Section 2: Nutrition in Early Childhood and Cash Transfer Programs

The first 1000 days from conception to 2 years of age provide a key window of opportunity to shape a child's future health outcomes (Victora et al., 2010; http://www.thousanddays.org). A large body of research in demography, economics and public health shows that nutritional deficits during the first 1000 days negatively affect a range of human capital outcomes in later life, including educational attainment, height, wealth, mental and physical health (J. R. Behrman, 2016; Bleakley, 2010; Case et al., 2005; Currie & Almond, 2011; Glewwe et al., 2001; Victora et al., 2008). For nutritional deficits that occur in-utero or at the start of life, the effects on a child's mental (Grantham-McGregor et al., 1999; Pollitt, 1990) and physical growth (Christian & Dillon, 2018) and mortality (Moore et al., 1997) are particularly adverse. Further, these effects may manifest at different stages in the life course, starting from later childhood (Sigman et al., 1991) to adolescence (Mendez & Adair, 1999) and adulthood (Hoddinott et al., 2011). Thus, interventions introduced during pregnancy and the post-natal period are likely to be effective in reducing cognitive impairments and economic well-being in adulthood (Dewey, 2016; Hoddinott et al., 2008)

A growing number of low and middle-income countries (LMICs) continue to adopt CTs as part of their social protection strategy to improve children's nutrition and health outcomes. As of 2016 (Bastagli et al., 2016), some 130 LMICs had at least one UCT, and 63 countries had at least one CCT program. My paper adds to the literature by providing new evidence on the impact of a

maternal cash benefit scheme in India. A large body of work examines the effect of cash transfers on maternity care services (see Hunter & Murray, 2017 for a review). A few studies also examine the effect of broader programs that include a maternal CT component on health service use (Benedetti et al., 2015) or birthweight (Saville et al., 2018). However, to the best of my knowledge, there is no study that investigates the effect of a non means-tested CT which only targets pregnant and nursing mothers on child nutrition. Unlike many other programs, the Mamata Scheme is not means-tested in any of the treated districts in Odisha. This raises the issue of the extent to which beneficiary selection based on wealth affects children's outcomes. Stunting is a cumulative effect of poor nutrition and disease, hence changes in stunting may require a longer period to detect than that covered by studies using data for a short time period. Leveraging repeated cross-sectional data that spans a decade (2006-16), allows me to make an important contribution to the literature on the impact of CT program design on long-run effects.

Recent evidence on Indian CT programs focuses on the "Janani Suraksha Yojana (JSY)", a national CCT program aimed at increasing institutional delivery and use of reproductive and child-health related services. JSY evaluations have demonstrated positive impacts on institutional births and receipt of antenatal care (Lim et al., 2010; Randive et al., 2013), although evidence also points to poor service quality and targeting and unintended consequences on fertility (Nandi & Laxminarayan, 2016; Powell-Jackson et al., 2015). In 2017, the Central Government of India launched the "Pradhan Mantri Matru Vandana Yojana (PMMVY)", a national CCT program targeted to pregnant women and nursing mothers in all districts in the country. As of 2019-2020, the central government allocation to PMMVY is over USD 300 million (Shukla & Kapur, 2019). Against this backdrop of large annual budgetary allocations to the national CCT program, the question whether CCTs targeted to pregnant and lactating women affect children's nutrition remains underexplored.

Section 3: The Mamata Scheme

3.1: Background

Odisha (formerly Orissa) is a state in eastern India. With a population of over 42 million in 2011 and an estimated poverty rate of 32.6% (Thomas et al., 2015), Odisha is one of the poorest states in India. However, over the last 30 years, Odisha has made significant gains in reducing child undernutrition (stunting) and improving health service delivery, compared to many other

economically better off states in the country. Political leadership that enabled policy implementation, combined with financial and technical assistance from several international development partners contributed to strong implementation of different national programs (Kohli et al., 2017). These include the Integrated Child Development Scheme (ICDS) which delivers supplementary nutrition, health education, immunization and health check-ups to pregnant women, lactating mothers, adolescent girls and children under 6 years through community health centres; the multi-pronged National Rural Health Mission (NHRM), which included the introduction of Accredited Social Health Activists (ASHAs) as community health educators and a conditional cash transfer (Janani Suraksha Yojana) to incentivize institutional deliveries and the Public Distribution System (PDS), a national food grain subsidy program.

3.2: Program Description

Launched in 2011 by the Odisha state government, "Mamata Scheme" is a CCT program. In September 2011, the state government approved program implementation with a budgetary allocation of INR 2 billion[2] (~USD 27 million at current exchange rates) for the fiscal year 2011/12, based on an estimated 800,000 female beneficiaries (Ministry of Women & Child Development Odisha, 2011). Program coverage has expanded from 200,000 women in January 2012, to 1 million in mid-2013, 2.5 million in 2017 and to 4 million in 2020 (Ministry of Women & Child Development Odisha 2013; Orissa Post, 2020). Intended as a partial wage compensation for pregnant and nursing mothers, the program aims to increase health service utilization and improve infant & young child feeding practices, and ultimately, to improve maternal and child nutrition and reduce maternal and infant mortality. As of 2016, the scheme consisted of cash transfers of INR 5000 (USD 70) made in four installments[3] to the beneficiary, starting with the end of the second trimester up to 9 months of age for the infant. The cash benefit of INR 5000 forms about 5% of average annual per capita income in the state (Odisha Economic Survey, 2020). Per Odisha government guidelines, all women over the age of 19 years with up to two live births

[2] 1 USD = ~74 INR at 2021 exchange rates.

[3] Since 2017, the total amount of INR 5000 is disbursed in two installments with similar accompanying conditionalities (Department of Women & Child Development, Government of Odisha). This change does not affect the present analysis which examines outcomes as of 2015-16.

are eligible for receiving the cash transfer[4], upon fulfilment of several accompanying conditions. These vary by installment stage and include pregnancy and childbirth registration, antenatal check-ups, mother and child immunization, counseling towards Infant and Young Child Feeding (IYCF) practices, children's weight checkups, exclusive breastfeeding for 6 months, introduction of age-appropriate complementary foods and receipt of IFA tablets and Vitamin A dose. The scheme is funded by the state government of Odisha. Table 1.1 outlines the stage wise conditionalities and timing of the cash transfers under the Mamata Scheme, as of 2016.

Table 1.1: Mamata Scheme Conditionalities

Installment 1 (end of second trimester: INR 1500) • Register pregnancy at AWC • Receive at least one ANC (optimal 3) • Receive IFA tablets • Receive at least one TT vaccination (optimal 2) • Receive at least one counseling session at the AWC/Village Health and Nutrition Day (VHND) *Verification* • MCP Card • Scheme Register	*Installment 2 (3 months after delivery: INR 1500)* • Register child's birth • Child has received BCG vaccination • Child has received Polio 1 and DPT-1 vaccination • Child has received Polio 2 and DPT-2 vaccination • Child has been weighed at least 2 times since birth (optimal 4) • Mother has attended at least two IYCF counseling sessions at the AWC/ VHND/ Home visit (optimal 3) *Verification* • MCP Card • Scheme Register
Installment 3 (6 months after delivery: INR 1500) • Child has been exclusively breastfed for first 6 months (self-reported by mother) • Child has been introduced to complementary foods upon completing 6 months • Child has received Polio 3 and DPT-3 vaccination	*Installment 4 (9 months after delivery: INR 1000)* • Child has received measles vaccine before one year • Child has received first dose of Vitamin A before one year • Age appropriate complementary feeding is introduced and continuing • Child has been weighed at least two times between 6 and 9 months

[4] Starting in 2014, women in Particularly Vulnerable Tribal Groups (PVTG) were exempted from both eligibility criteria, and became universally eligible. While in theory this may bias econometric estimation results downwards, as these women cannot be identified in the data, I do not expect any significant effects given that PVTG women form less than 1% of the sample.

• Child has been weighed at least 2 times between 3 and 6 months (optimal 3) • Mother has attended at least two IYCF counseling sessions between 3 and 6 months of lactation at the AWC/ VHND/ Home visit (optimal 3) *Verification* • MCP Card • Scheme Register • Self-certification on MCP card	*Verification* • MCP Card • Scheme Register • Self-certification on MCP card

Reproduced from (Aswathy et al., 2014). Notes - MCP: Mother Child Protection; AWC: Anganwadi Center; AWW: Anganwadi Worker; IFA: Iron Folic Acid; ANC: Antenatal Care; TT: Tetanus Toxoid; DPT: Diptheria, Pertusis (Whooping Cough); BCG: Bacillus, Calmette and Guerin; IYCF: Infant and Young Child Feeding

The transfer amount is similar to other Indian cash transfers such as the Janani Suraksha Yojana (JSY) or the Pradhan Mantri Matritva Vandana Yojana (PMMVY) that are targeted at pregnant and lactating women and aim to improve maternal and child health outcomes and in which the transfer amount is between INR 4000 – 6000. The transfer size per child is small compared to means-tested maternal cash transfers in other countries. For example, Indonesia's Keluarga Harapan program targets poor households with pregnant and lactating mothers or young children and adolescents, and has a cash benefit of around 200,000 Indonesian rupiahs i.e. ~ USD 140 annually for 6 years. Zambia's Child Grant program targets poor households with children under 5 years, and pays 60 kwacha (~USD 11) on a bi-monthly basis for a minimum of 3 years. Red de Proteccion, a CCT targeted at poor households in Nicaragua with young children and/or pregnant women provides ~USD 240 annually for up to five years.

Service delivery in the Mamata Scheme occurs through the over 72,000 Anganwadi Centers (AWCs) in Odisha. Auxiliary Nurse Midwives (ANMs), Anganwadi Workers (AWWs) and Accredited Social Health Activists (ASHAs) are the key frontline workers responsible for service delivery. AWWs are responsible for pregnancy registration at the AWC, maintaining beneficiary documentation related to bank details and conditionalities, maintaining scheme registers, and are supported by the Anganwadi helper. ANMs conduct antenatal checkups, provide vaccination services and IYCF counseling. ICDS Supervisors provide direct management support. Anganwadi staff receive a monetary incentive of INR 100 – 200 per beneficiary upon completion of all cash transfer installments due to a beneficiary. The scheme utilizes a Mother-Child

Protection (MCP) card supplied by the Health and Family Welfare Department as a tracking tool for program conditionalities.

Funds are transferred directly to beneficiary women's bank accounts through an electronic bank transfer. The Mamata Scheme uses the State Bank of India's (SBI) 'Vistaar' platform for these direct benefit transfers (Ministry of Women & Child Development Odisha, 2017). At the district level, the Child Development Project Officer (CDPO) is responsible for these e-transfers. As of 2015-16, 56% of women in Odisha had a bank account they used (NFHS-5). The scheme also involves community participation and monitoring for maintaining transparency in operations. Odisha formed "Jaanch" (Oversight) Committees consisting of multiple stakeholders (one government employee, two self-help group (SHG) Secretaries, a community member with a disability, chairperson of the 'Mothers Committee' and President of the Village Education Committee) to verify Mamata Scheme payment schedules**.**

Analysis of the Mamata Scheme is of particular interest as several of its program design components may be "enabling" towards achieving longer-term nutrition gains. First, the cash transfer forms a significant amount (5%) of average annual per capita income in Odisha state (Odisha Economic Survey, 2020). Second, the program is targeted at pregnant and lactating mothers, which covers a period within the first 1000 days of life for children, when cash transfers may have larger potential to improve anthropometric measures. Third, conditionalities include behavior change components such as counselling sessions and micronutrient supplements. These program design features align with related evidence on CT design and implementation that highlights the relevance of transfer size (Manley et al., 2015), timing (Bhatia et al., 2013), recipient gender (Yoong et al., 2012) and complementary actions such as nutritional supplements and behavior change training (Bastagli et al., 2016) for positive impacts on child anthropometry.

3.3: Potential Pathways

In this section, I outline the different pathways through which the Mamata Scheme may affect child nutrition in Odisha, drawing on the theoretical framework in Groot et al. (2017). First, by increasing household disposable income, the Mamata Scheme may improve the quality and quantity of household food consumption during the crucial phase of pregnancy and lactation. Cash may also be spent on improving household health resources such as sanitation facilities, housing

conditions, drinking water supply, preventative medicines etc. resulting in health benefits for children.

Second, through program conditionalities for ante and postnatal care, the Mamata Scheme may incentivize the higher use of preventative health inputs such as maternal and child immunization and micronutrient supplement intake. These are important in the context of child nutrition, as maternal undernutrition is associated with reduced fetal growth, which increases the risk of neonatal deaths and stunting by 2 years of age (Black et al., 2013). Counseling sessions with healthcare workers, as part of program conditionalities, may promote healthy behaviors including exclusive breastfeeding and the introduction of age-appropriate complementary foods for infants. Inadequate breastfeeding has been shown to increase mortality risk in the first 2 years of life (ibid.).

Third, the Mamata Scheme may affect children's health outcomes through it effect on maternal labor supply. Recent evidence from economics (Chari et al., 2019), and medicine and epidemiology (Cai et al., 2020; Takito et al., 2009) demonstrates that work-related stress during pregnancy is associated with adverse birth outcomes in an LMIC context. By providing partial wage compensation, the Mamata Scheme may contribute to a reduction in excessive work-related physical activity and exertion during pregnancy, which translate to health benefits for children. Previous literature (Klasen et al., 2019) suggests that rural women's labor force participation in LMICs is driven by economic necessity, with women leaving the labor force as soon as this becomes affordable. Additional income from the CCT may incentivize women to reduce labor supply during pregnancy and lactation. This may enable women, especially those working in physically strenuous jobs in the informal sector, to provide better ante and postnatal care during this period. Alternatively, income from the cash transfer may be associated with higher women's empowerment and/or the ability to utilize additional childcare for beneficiaries, which may serve as other pathways to improved child nutrition.

Fourth, the program may affect child nutrition either positively or negatively through its effect on birth spacing. The cash incentive is available for only first and second-born children, which may result in parents reducing the birth intervals between the first and second child to receive the incentive. Reduced birth intervals are linked to stunting in India; second-born children face a height disadvantage in case of birth intervals lesser than three years (Dhingra & Pingali, 2021). Alternatively, the program-mandated counseling sessions with frontline health workers

which focus on child "quality" may result in higher birth spacing. If the Mamata Scheme improves women's intrahousehold bargaining power, either through the direct cash transfer to women or through IYCF counseling, this may also increase birth spacing.

Finally, although the Mamata Scheme is universal within Odisha, its effects may vary by individual and household characteristics. A priori, I expect that children from households that are poor, rural, or that belong to a disadvantaged caste (Scheduled Caste/Tribes) will experience higher marginal benefits, unless they are unable to access the program. Also, I expect that girls will experience higher marginal benefits from the Mamata Scheme than boys. This is based on the broader literature on cash transfers and height-for-age which finds that girls benefit more from cash transfers than boys (Manley et al., 2013), and evidence from India on female nutritional disadvantage during early childhood due to son preference and parental underinvestment in girls (Jayachandran & Pande, 2017).

Section 4: Data

4.1: Survey

The data used in this study is from two cross-sections of the National Family Health Survey India (NFHS-3 and NFHS-4). NFHS is a nationally representative, repeated cross-sectional survey of households throughout India conducted in four waves between 1992 and 2016. Following the format of demographic and health surveys conducted worldwide, its main purpose is to provide information on maternal and child health, nutrition, and family welfare in India. The International Institute of Population Studies, Mumbai is the nodal agency coordinating the NFHS, with funding for different rounds provided by the Government of India, USAID, UNICEF, DIFD and the Bill and Melinda Gates Foundation.

The third round of NFHS (NFHS-3), conducted 5-6 years prior to the implementation of the Mamata scheme in Odisha, is considered as the baseline survey in this study. NFHS-3 was carried out in two phases from November 2005 to August 2006 in all 29 Indian states. Nationally, 109,041 households were sampled. The Odisha sample for NFHS-3 consists of 3910 households and is representative at the urban, rural, and state level. 4540 women between 15-49 years and 1592 men aged 15-54 years were interviewed from all the selected households. NFHS-3 includes household-level, women's, and men's questionnaires. The household questionnaire includes

details on child anthropometry, the outcome variable of interest in this study. This covers height and weight measurements for all children born after 2001.

NFHS-4, carried out in two phases from January 2015 to December 2016, sampled 601,509 households nationally. Within Odisha state, it covered a representative sample of 30,242 households, interviewing 33,721 women aged 15-49 and 4,634 men aged 15-54. NFHS-4 includes four questionnaires: household, women, men, and a separate module for biomarker measurements. Conducted 4-5 years after Mamata was implemented in Odisha, NFHS-4 is the endline survey for this paper. NFHS data include sampling weights, which I use for all analyses in this paper to ensure estimates are representative of the population. Figure 1.1 depicts the timeline of NFHS data collection vis-à-vis the introduction of the Mamata Scheme.

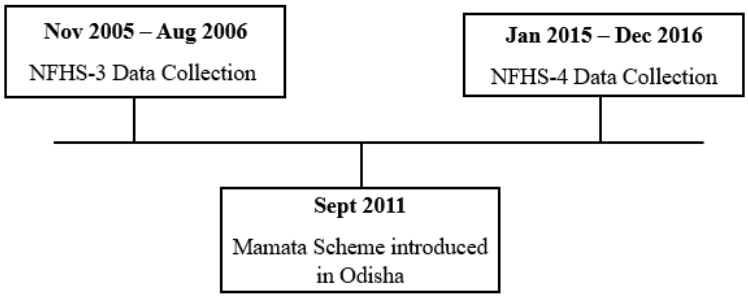


Fig 1.1: Timeline - Mamata Implementation and NFHS Survey Data Collection

4.2: Sample

The unit of observation in the analysis is an individual child. Mamata eligibility criteria include women who are a) residents of Odisha, b) are 19 years and older and c) have two or fewer children[5][6] (Table 1.2). Thus, the treatment group comprises of children with birth order 1 or 2, born to women in Odisha who are 19 and older. The analysis covers children from 0 – 4 years 11 months of age, as the NFHS includes height and weight measurements only for children upto 5 years of age. In the present study, the first cohort of eligible children was born in January 2012.

[5] Starting in 2014, women in Particularly Vulnerable Tribal Groups (PVTG) were exempted from both eligibility criteria, and became universally eligible. While in theory this may bias econometric estimation results downwards, as these women cannot be identified in the data, I do not expect any significant effects given that PVTG women form less than 1% of the sample (Census of Odisha, 2001).

[6] Government employees and their wives are not eligible for Mamata cash benefits. However, the survey instrument does not allow for identification of government employees. While in theory this may bias econometric estimation results downwards, I do not expect any significant effects given that government employees form less than 1% of the Odisha's population (Census of Odisha, 2001).

Table 1.2: Mamata Scheme Eligibility (Odisha Residents)

Eligible	Ineligible
Age of mother: 19 – 49 years AND Child's Birth Order: 1, 2	Age of mother: 15 – 18 years OR Child's Birth Order: 3 and higher

As the first installment of Mamata benefits was made available to eligible women at the end of 6 months of pregnancy, the earliest cohort of eligible children would be born 3 months after the program started in September 2011. This assumes a typical gestational length of 9 months. In NFHS-4, 64% of children from the full Odisha sample are eligible for Mamata Scheme benefits. The dataset for my empirical analysis consists of 36,257 children in five states (Odisha and comparison states of West Bengal, Jharkhand, Chhattisgarh, and Andhra Pradesh[7]). Together, these states account for 23% of India's population (Census of India, 2011).

4.3: Main Variables

The primary outcome of interest in the analysis is child nutrition. Both NFHS-3 and NFHS-4 include height and weight measurements for all children under 5 years of age. I define child nutrition outcomes per World Health Organization (WHO) standards. Per WHO guidelines (WHO, 2014), a child suffers from wasting, if their weight-for-height z-score is two or more standard deviations (S.D) below the WHO Child Growth Standards Median. A z-score of three or more S.D. below the reference median is considered as severe wasting. A child is considered as stunted, if their height-for-age z-score (HAZ) is two or more S.D below WHO medians for well-nourished populations (ibid.). I calculate child-specific z-scores for both height-for-age and weight-for-height, following WHO's (World Health Organization, 2006) methodology for computation of z-scores. This also includes adjustments for z-scores beyond ± 3 S.D., to better reflect the population distribution. In addition, I include binary measures for the probability of stunting and wasting, to examine whether the program specifically affects undernourished children. I also use child, mother, and household level characteristics from the survey as covariates.

[7] This refers to Andhra Pradesh, including regions created as Telangana state in 2014

4.4: Summary Statistics

Mamata eligibility for women in Odisha centered around two main criteria, age of mother (>=19yrs) and number of live births (<2). This allows me to construct two different comparison groups. First, a comparison group consisting of children with birth order 1 and 2, born to mothers older than 19 years from Odisha's neighboring states, West Bengal, Jharkhand, Chhattisgarh, and Andhra Pradesh. I also construct a second comparison group with children in Odisha with birth order 3 and higher or born to mothers younger than 19 years, i.e., both conditions which make the mothers ineligible to receive program benefits. Table 1.3 compares average characteristics and nutrition outcomes for the treatment and two different comparison groups from the neighboring states and Odisha.

Table 1.3: Summary Statistics for Treatment and Comparison Groups
(Sample limited to households with children under 5 years)

	Treatment Group (Odisha Eligible) mean/sd	Comparison Group 1 (Neighbor State Eligible) mean/sd	T-test	Comparison Group 2 (Odisha Ineligible) mean/sd	T-test
Child-Level Characteristics					
Gender of child (Girl=1)	0.49	0.49		0.48	
	(0.50)	(0.50)		(0.50)	
Child age in years	2.42	2.38	**	2.53	***
	(1.13)	(1.14)		(1.11)	
No. of vaccines received	7.07	7.13	**	6.63	***
	(2.12)	(1.72)		(2.51)	
Months of breastfeeding	18.81	15.77	***	19.41	**
	(13.87)	(12.88)		(13.98)	
Child been breastfed at least 24 months	0.74	0.65	***	0.73	
	(0.44)	(0.48)		(0.44)	
Mother-Level Characteristics					
Mother's age in years	26.70	25.74	***	27.85	***
	(3.96)	(3.63)		(6.45)	
Mother completed secondary education	0.65	0.62	***	0.34	***
	(0.48)	(0.49)		(0.47)	
No. of tetanus injections mother	2.00	2.08	***	1.93	***
received during pregnancy	(0.62)	(0.67)		(0.70)	
Age of Mother at marriage (yrs)	20.21	19.26	***	17.35	***
	(3.36)	(3.24)		(3.16)	
Body mass index (BMI) of Mother	20.96	20.60	***	19.89	***
	(3.79)	(3.59)		(3.18)	
No. of children born to Mother	1.62	1.75	***	2.88	***
	(0.60)	(0.62)		(1.35)	

Household-Level Characteristics					
Household size	5.31	6.13	***	5.92	***
	(2.20)	(2.87)		(1.94)	
Household Wealth Index (1-Poorest to 5-Richest)	2.42	2.67	***	1.77	***
	(1.29)	(1.42)		(1.03)	
Rural	0.81	0.69	***	0.85	***
	(0.40)	(0.46)		(0.35)	
Household head is female	0.10	0.09		0.08	**
	(0.30)	(0.29)		(0.27)	
Household head completed secondary education	0.52	0.50	***	0.33	***
	(0.50)	(0.50)		(0.47)	
Scheduled Caste/Tribe	0.80	0.81		0.89	***
	(0.40)	(0.39)		(0.31)	
Hindu	0.94	0.81	***	0.91	***
	(0.24)	(0.40)		(0.28)	
Health facility is too far	0.36	0.35		0.45	***
	(0.48)	(0.48)		(0.50)	
In-house access to piped drinking water	0.09	0.17	***	0.04	***
	(0.29)	(0.38)		(0.19)	
Household has electricity	0.86	0.88	***	0.73	***
	(0.35)	(0.32)		(0.44)	
Fraction of households with own toilet	0.31	0.36	***	0.17	
	(0.46)	(0.48)		(0.37)	
Nutrition Outcomes					
WHZ	-0.98	-1.19	***	-1.26	***
	(1.34)	(1.36)		(1.29)	
HAZ	-1.25	-1.41	***	-1.69	***
	(1.59)	(1.63)		(1.56)	
Observations	5495	12902		3359	

Notes: Summary statistics are created using data from NFHS-3 and NFHS-4. NFHS constructs household wealth index quintiles based on a household asset index. *** p<0.01, ** p<0.05, * p<0.1

At the child level, covariates include age and gender. Mother-level characteristics include mother's age, age at marriage, education, and number of live children born. Finally, household-level characteristics that I use include household size and wealth, gender, and education of the household head, whether the household is rural, household religion and caste. I also include measures of distance to health facilities and access to sanitation, electricity, and piped drinking water as these are likely to affect children's nutritional outcomes. While summary statistics for breastfeeding duration, number of vaccines for both women and children, mother's BMI, number of children born to a mother, and household wealth quintile are shown in the summary statistics, I

am careful to not include these as covariates in the difference-in-differences specifications, as they are endogenous and likely to be affected by the program.

As Table 1.3 demonstrates, eligible children in Odisha are on average older, receive fewer vaccines and more breastfeeding than the comparison group of neighboring states. Eligible mothers in Odisha are on average older, receive fewer vaccines, and are older at marriage. At the household level, the two groups differ on a number of observables, primarily household size, education of head, wealth, and location (rural/urban). Eligible households in Odisha also are more likely to be Hindu, and have less access to piped drinking water and sanitation compared to the comparison group of neighboring states. Turning to the second comparison group in Odisha, eligible children are on average older, receive more vaccines, and fewer months of breastfeeding. Eligible mothers have, on average, higher education and age at marriage, more vaccines, and a higher BMI. Reflective of the definition of this comparison group, there is also a difference in the number of children born to a mother and age of the mother. At the household level, eligible households in Odisha are more urban, have on average a lower household size, a higher wealth index, more educated household heads, shorter distance to a health facility, and higher access to piped drinking water, sanitation, and electricity. Ineligible households in Odisha are also more likely on average to belong to a scheduled caste or tribe, be non-Hindu, and less likely to be female-headed.

4.5: NFHS-2 Data

I also use data from the previous round of the NFHS, which was conducted from 1998-1999 mainly to examine the parallel trends assumption, both in visual and formal tests. NFHS-2 is representative and the national and state levels, and the primary outcome variable of interest from this survey round is child anthropometry, as in consequent rounds.

Section 5: Identification Strategy

Mamata targeted women in Odisha state who were 19 and older and had fewer than 2 live births. Based on these criteria, I estimate the Intent-to-Treat effect of the program on first and second born children of women who are 19 and older. Since program assignment is not strictly "random", merely comparing outcomes for first and second born children of women aged over 19 in Odisha to first and second born children of women aged over 19 in comparison states or ineligible children

within Odisha (based on mother's age and/or birth order) would not yield accurate estimates of program effects. Hence, I exploit the variation in program eligibility by mother's age, child birth order, and state of residence to estimate a difference-in-differences model, using Odisha's neighboring states as a comparison group. I then add a comparison group of ineligible children in Odisha for a triple difference estimation.

The comparison group for the difference-in-differences analysis consists of children in Odisha's neighboring states, with birth order 1 or 2, or who were born to women older than 19 years at the time of the child's birth. The choice of the neighboring states of West Bengal, Jharkhand, Chhattisgarh, and Andhra Pradesh is justifiable based on shared geographical border, socio-cultural similarities, and no similar state-level CCT program in these states during the same timeframe. This comparison group comprises of children who would qualify for Mamata benefits based on their birth date, birth order, and mother's age, had the program been offered in the neighboring states during the same period. Although visually, I find parallel outcome trends between Odisha and neighboring states in the pre-program period, there may have been time-varying unobservables that trended differently between the treatment and comparison states. This includes state-specific factors in the health and nutrition programming landscape that may differ between Odisha and the neighboring states and affect the outcome. Thus, I also use a second comparison group consisting of children within Odisha who are ineligible for program benefits, either on account of having a higher birth order (>3) or due to being born to a mother younger than 19 years at the time of the child's birth for a triple difference estimation. I provide more details for the estimation strategy in the next section.

5.1: Difference-in-differences (DID)

Consider child *i*, born to woman *j* at time *t*. I estimate a difference-in-differences specification as below:

$$Y_{ijt} = \beta_0 + \beta_1 \left(Odisha * Post\right)_{jt} + \beta_2 \left(Odisha\right)_{jt} + \beta_3 (Post) + \gamma \mathbf{X}_{ijt} + \eta_t + \varepsilon_{ijt} \qquad (1)$$

Yijt is the outcome (HAZ, WHZ) for child *i*, born to woman *j* at time *t*. β_1 is the DID estimate that indicates the change in nutritional outcomes for eligible children, between the pre- and post-Mamata periods in Odisha, accounting for changes in nutritional outcomes for the comparison group from neighboring states during the same period. $Odisha_{jt}$ indicates whether child *j* belongs to the treatment group (= 1) or the comparison group (= 0) during time *t*. $Post_{jt}$ is a dummy variable

which is equal to 1 if child *i* belongs to the dataset after the implementation of the Mamata program (NFHS-4), and zero otherwise. η_t are birth year x birth month fixed effects, which include a dummy for each month and year of birth for child *i*. These control for time-varying unobservables that are common to treatment and comparison groups. ε_{ijt} is the error term and $\mathbf{X}_{ijt}$ is a vector of control variables that are plausibly exogenous to the program: namely, child gender and age; mother's age, age at marriage and education; household size, caste, religion, gender and education of household head, location (rural/urban), distance to health facility, access to electricity, piped drinking water and sanitation. Standard errors are clustered at age of woman *j*, as treatment assignment is based on a mother's age. This will account for correlation between outcomes for children born to mothers of similar age. The sample for the difference-in-differences analysis consists of "eligible" children under the age of 5 years in Odisha and West Bengal. The primarily underlying assumption of the difference-in-differences strategy is that nutritional outcomes for children in the treatment and comparison groups would have followed the same trend, in the absence of the program. In Section 7, I perform visual and formal tests of this assumption.

5.2: Triple Difference (DDD)

Using difference-in-differences analysis with a comparison group from neighboring states raises the concern of state-level unobservables that may be trending differently between the treatment and comparison states, for instance, improvements in the healthcare infrastructure and health and nutrition service delivery. Using difference-in-differences analysis with a comparison group of ineligible children from Odisha accounts for state-level confounders, but raises a concern of birth order effects on nutritional outcomes. These are particularly pertinent in this context, as the literature shows a height advantage for higher birth order children in Indian households (Jayachandran & Pande, 2017). To account for both state-level and birth-order confounding effects, I employ a triple difference specification which takes advantage of the variation in eligibility rules by birth order, mother's age, and state of residence. This expands the sample to include children under 5 years of age from Odisha who are not eligible for the Mamata Scheme. The triple difference is given as below, and is my preferred estimation of program impact on child nutrition.

$$Y_{ijt} = \beta_0 + \beta_1 (Odisha * Eligible * Post)_{ijt} + \beta_2 (Odisha * Eligible)_{ijt} + \beta_3 (Odisha * Post)_{ijt} + \beta_4 (Eligible * Post)_{ijt} + \beta_5 (Odisha)_{ijt} + \beta_6 (Eligible)_{ijt} + \beta_7 (Post)_{ijt} + \gamma \mathbf{X}_{ijt} + \eta_t + \varepsilon_{ijt} \quad (2)$$

Section 6: Results

In this section, I present the results for the impact of the Mamata Scheme on child anthropometry. The estimations control for observed child, mother and household characteristics and include child birth year and birth month fixed effects, with clustering at the level of mother's age. In addition, I evaluate the heterogenous impacts of the Mamata Scheme by household wealth, location, caste, and child gender.

Although the Mamata Scheme is not a means-tested program, program participation may be higher among poorer households in the state, given the size of the monetary incentive (INR 5000 = ~ USD 70). Hence, I interact "Poor" with the DDD estimates. This includes households in the bottom three quintiles of a national level classification of "Poor" or "Poorest", and covers around 75% of all sample households in Odisha in 2015. A data limitation here is that the NFHS does not ask for household income, which may be a better instrument to understand program effects on poor households. Son preference is well documented in the Indian context. Hence, I also interact child gender with the DDD estimates to examine whether program effects are concentrated by a child's gender. The Mamata Scheme is not geographically targeted, and covers both urban and rural areas in the state. However, the majority of the beneficiaries (~ 70%) are in rural areas (Women and Child Development Department, Govt. of Odisha). Hence, I disaggregate results by a household's geographical location. Caste, an important social identifier in India, may affect households' access to nutrition and health programs. Scheduled Castes (SC) and Tribes (ST) are historically disadvantaged groups in India. NFHS-4 data shows that SC children have higher stunting prevalence compared to other groups, and ST children have both, higher stunting and wasting. Hence, to examine whether the program's effect on nutritional outcomes vary by household caste, I include interactions for "Scheduled Castes/Tribes" in my estimations.

6.1: Main Results

Difference-in-Differences: Table 1.4 presents results from the DID specification with neighboring states as the comparison group. The dependent variables in Columns 1 and 2 are the z-scores of weight-for-height, a measure of wasting and height-for-age, a measure of stunting. Columns 3 and 4 present odds ratios from a logistic regression with a binary dependent variable indicating that a child classifies as wasted and stunted, respectively. Results from the DID specification for WHZ find a positive and statistically significant effect size of 0.31, indicating that being eligible for the

Mamata Scheme is associated with an improvement of 0.31 S.D. in children's weight-for-height (CI: 0.15 to 0.47). In a similar vein, the results for HAZ indicate a positive and statistically significant effect size of 0.13, suggesting that Mamata Scheme eligibility is associated with an increase of 0.13 S.D. in children's height-for-age in Odisha (CI: -0.02 to 0.27). As Model 3 demonstrates, the program reduces the odds of a child being wasted by 34% (CI 0.49 to 0.89), and reduces the odds of a child being stunted by 29% (CI: 0.57 to 0.90) (Model 4).

Table 1.4: Mamata and Child Nutrition: DID Regression of Treatment (Odisha) vs. Comparison Group (Neighbor states)
Dependent Variables: Weight-for-height and height-for-age z-scores, Probability of wasting and stunting for children under 5 years of age

	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting
Odisha x Post	0.31***	0.13*	0.66***	0.71***
	(0.08)	(0.07)	(0.10)	(0.08)
Odisha	0.02	0.13**	0.99	0.97
	(0.08)	(0.07)	(0.15)	(0.11)
Post	-1.40***	2.15***	2.24	1.84
	(0.32)	(0.25)	(2.41)	(1.36)
Observations	17,688	17,688	17,685	17,544
R-squared	0.08	0.17	0.05	0.08
Mean of the dep. var	-0.82	-1.40	0.18	0.38

Notes: The table presents estimates of β_1 from equation (1). Columns 1 and 2 present results from a linear regression estimation. Columns 3 and 4 present odds ratios from a logistic regression estimation. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. The sample includes 1st and 2nd born children under the age of 5 years from the treatment group (Odisha) and a comparison group of neighbor states, born to mothers older than 19 years. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Triple Difference:

Table 1.5 presents results from the triple difference specification for the same set of outcomes as in Table 1.5, but using both comparison groups (neighbor states and ineligible children in Odisha). The results in Model 1 suggest that the Mamata Scheme had a positive impact on children's weight-for-height, with a positive and statistically significant point estimate of 0.30 (CI: 0.09 to 0.51) which is similar in magnitude to the DID estimation. The co-efficient for HAZ drops to -0.01 (CI: -0.2 to +0.2), which is smaller than the DID estimate of 0.13, but there is substantial overlap between the confidence intervals of both estimations. The DDD estimation finds that the program reduces the odds of wasting by 35% (CI: 0.45 to 0.94), a co-efficient magnitude similar to the DID estimation. For stunting, DDD results find a 20% reduction in the odds of stunting (CI: 0.58 to 1.09), lower than the DID point estimate. These results on wasting and stunting suggest

that the Mamata Scheme is beneficial for undernourished children, i.e. children whose weight and height measurements are more than 2 s.d. below WHO standards. Since DDD accounts for more confounding factors than the DID, the results are also suggestive of an upward bias in the DID specification.

Table 1.5: Mamata and Child Nutrition: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variables: Weight-for-height and height-for-age z-scores, Probability of wasting and stunting for children under 5 years of age

	(1)	(2)	(3)	(4)
VARIABLES	WHZ	HAZ	Wasting	Stunting
Odisha x Eligible x Post	0.30***	-0.01	0.65**	0.80
	(0.11)	(0.11)	(0.12)	(0.13)
Odisha x Eligible	-0.07	0.10	1.13	1.09
	(0.10)	(0.09)	(0.20)	(0.16)
Odisha x Post	0.01	0.16**	1.05	0.89
	(0.07)	(0.08)	(0.13)	(0.10)
Eligible x Post	-0.20***	-0.06	1.27**	1.15*
	(0.05)	(0.05)	(0.12)	(0.10)
Odisha	0.09	0.03	0.85	0.88
	(0.06)	(0.07)	(0.10)	(0.08)
Eligible	0.16***	0.16***	0.82**	0.77***
	(0.05)	(0.05)	(0.07)	(0.06)
Post	0.04	4.67***	3.40	1.54
	(0.18)	(0.19)	(4.22)	(0.75)
Observations	31,861	31,861	31,853	31,646
R-squared	0.07	0.16	0.05	0.08
Mean of the dep. var	-0.82	-1.40	0.18	0.38

Notes: The table presents estimates of β_1 from equation (1). Columns 1 and 2 present results from a linear regression estimation. Columns 3 and 4 present odds ratios from a logistic regression estimation. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. The sample includes 1st and 2nd born children under the age of 5 years from Odisha and neighbor states, born to mothers older than 19 years. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 1.6 presents heterogenous effects from the triple difference specification for WHZ. In Model 2, there is a negative co-efficient of -0.21 (CI: -0.69 to 0.28) on the interaction term for poor households (defined as the bottom three quintiles of a national wealth classification). The co-efficient on child gender (female=1) in Model 3 is -0.26 (CI: -0.64 to 0.12). This suggests that there is wealth and gender heterogeneity in the program effects. Children in households in the lower wealth quintiles may experience lower gains in WHZ than children in the upper wealth quintiles, and girls may experience lower gains in WHZ than boys.

The point estimate in Model 4, which adds an interaction for household location (rural/urban) is negative (-0.14), but not statistically significant. Here, the wide confidence interval (CI: -0.69 to 0.42) means that it is difficult to comment on heterogeneity for children in rural households. Model 5 adds an interaction term for scheduled caste households. Here, the point estimate drops to 0.03, but the width of the confidence interval (CI: -0.47 to 0.54) makes it difficult to comment on heterogeneity by household caste. Overall, this suggests that although the Mamata Scheme improves weight-for-height among young children in Odisha on average, children in poor households and girls see lower improvements.

Table 1.6: Mamata and Child WHZ: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variable: Weight-for-height z-score for children under 5 years of age

	WHZ				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Odisha x Eligible x Post	0.30***	0.42*	0.43***	0.39	0.28
	(0.11)	(0.23)	(0.15)	(0.24)	(0.23)
Poor x Eligible x Odisha x Post		-0.21			
		(0.25)			
Female x Eligible x Odisha x Post			-0.26		
			(0.20)		
Rural x Eligible x Odisha x Post				-0.14	
				(0.28)	
Scheduled Caste x Eligible x Odisha x Post					0.03
					(0.26)
Observations	31,861	31,861	31,861	31,861	31,861
R-squared	0.07	0.07	0.07	0.07	0.07
Mean of the dep. var	-0.82	-0.82	-0.82	-0.82	-0.82

Notes: The table presents estimates of β_1 from equation (2). Columns 2, 3, 4 and 5 present results for children belonging to households in the bottom three wealth quintiles, girls, children in rural and scheduled caste households, respectively. All coefficients are odds ratios. The sample includes children under the age of 5 years from Odisha and neighbor states. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses.
*** p<0.01, ** p<0.05, * p<0.10.

Table 1.7 presents heterogenous effects from the triple difference specification for HAZ. In Model 2, the point estimate for poor households is -0.48 (CI: -1.06 to 0.10). In Model 3, the co-efficient of the interaction term for girls is 0.19 (CI: -0.23 to 0.61). Similarly, the point estimate for the interaction term for rural is 0.24 (CI: 0.29 to 0.78). It is difficult to precisely comment about the point estimate in Scheduled Caste (Model 5). Although the co-efficient is negative (-0.09), there is a large standard error (CI: -0.62 to 0.43). Overall, the DID results for HAZ suggest that although

the Mamata Scheme is associated with little improvement in height-for-age among young children in Odisha on average, there is heterogeneity by household wealth and location and child gender. Gains in HAZ are lower among children in households in the bottom three wealth quintiles compared to children in households in the upper two wealth quintiles. The program improves girls' HAZ more relative to boys, in line with other evidence showing that girls height-for-age shows higher improvements as a result of cash transfers (Manley et al., 2013). Also, children in rural households experience higher gains in HAZ than those in urban households, which may be reflective of primarily rural program uptake.

Table 1.7: Mamata and Child HAZ: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variable: Height-for-age z-score for children under 5 years of age

	HAZ				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Odisha x Eligible x Post	-0.01	0.39	-0.10	-0.23	0.06
	(0.11)	(0.27)	(0.15)	(0.24)	(0.23)
Poor x Eligible x Odisha x Post		-0.48			
		(0.29)			
Female x Eligible x Odisha x Post			0.19		
			(0.21)		
Rural x Eligible x Odisha x Post				0.24	
				(0.27)	
Scheduled Caste x Eligible x Odisha x Post					-0.09
					(0.27)
Observations	31,861	31,861	31,861	31,861	31,861
R-squared	0.16	0.17	0.16	0.16	0.16
Mean of the dep. var	-1.40	-1.40	-1.40	-1.40	-1.40

Notes: The table presents estimates of β_1 from equation (2). Columns 2, 3, 4 and 5 present results for children belonging to households in the bottom three wealth quintiles, girls, children in rural and scheduled caste households, respectively. The sample includes children under the age of 5 years from Odisha and neighbor states. All coefficients are odds ratios. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table 1.8 includes the heterogenous program effects on the probability of wasting. Analogous to the models for WHZ, we see heterogenous effects by household wealth. The program is almost four times more likely to reduce the odds of wasting for children from non-poor households, compared to poor households (Model 2, CI: 1.16 to 12.25). The program is 1.7 times more likely to reduce the odds of wasting for boys (CI: 0.82 to 3.55), compared to girls (Model 3). In addition,

Column 5 suggests that there is caste heterogeneity. The program is two times more likely (CI: 0.82 to 6.41) to reduce the odds of wasting for children from households that do not identify as scheduled castes.

Table 1.8: Mamata and Child Wasting: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variable: Probability of wasting for children under 5 years of age.

VARIABLES	(1)	(2)	(3)	(4)	(5)
Eligible x Odisha x Post	0.65	0.21***	0.51***	0.49*	0.33**
	(0.12)	(0.12)	(0.13)	(0.21)	(0.15)
Poor x Eligible x Odisha x Post		3.77**			
		(2.27)			
Female x Eligible x Odisha x Post			1.70		
			(0.64)		
Rural x Eligible x Odisha x Post				1.41	
				(0.70)	
Scheduled Caste x Eligible x Odisha x Post					2.29
					(1.20)
Observations	31,853	31,853	31,853	31,853	31,853
Pseudo R-squared	0.05	0.05	0.05	0.05	0.05
Mean of the dep. var	0.18	0.18	0.18	0.18	0.18

Notes: Logit estimation. The table presents estimates of β_1 from equation (2).
The sample includes children under the age of 5 years from Odisha and neighbor states. Columns 2, 3, 4 and 5 present results for children belonging to households in the bottom three wealth quintiles, girls, children in rural and scheduled caste households, respectively. All coefficients are odds ratios. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 1.9 presents heterogenous program effects on the probability of stunting. Model 2 indicates that there are heterogenous effects by household wealth. The program is almost twice as likely (CI: 0.72 to 5.27) to reduce the odds of stunting for children in households in the upper two wealth quintiles, compared to children in the bottom three wealth quintiles. Although the odds ratio is close to 1 (i.e., no change), it is difficult to draw a conclusion on the direction of the effect for gender due to a large standard error (CI: 0.53 to 1.94) in Model 3. Interestingly, there is evidence of heterogeneities by household location. The program is 56% less as likely (CI: 0.26 to 1.20) to reduce the odds of stunting for children in rural households, compared to those in urban households (column 4). The large CI (0.53 to 2.73) for the interaction term of scheduled caste means that the direction of the effect cannot be certain, although the point estimate is 1.2 (odds ratio).

Table 1.9: Mamata and Child Stunting: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variable: Probability of stunting for children under 5 years of age

	Stunting				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Eligible x Odisha x Post	0.80	0.43*	0.79	1.34	0.66
	(0.13)	(0.20)	(0.18)	(0.45)	(0.25)
Poor x Eligible x Odisha x Post		1.94			
		(0.99)			
Female x Eligible x Odisha x Post			1.01		
			(0.34)		
Rural x Eligible x Odisha x Post				0.56	
				(0.21)	
Scheduled Caste x Eligible x Odisha x Post					1.20
					(0.50)
Observations	31,646	31,646	31,646	31,646	31,646
Pseudo R-squared	0.08	0.08	0.08	0.08	0.08
Mean of the dep. var	0.38	0.38	0.38	0.38	0.38

Notes: Logit estimation. The table presents estimates of β_1 from equation (2). The sample includes children under the age of 5 years from Odisha and neighbor states. Columns 1, 2, 3, and 4 present results for children belonging to households in the bottom three wealth quintiles, girls, children in rural and scheduled caste households, respectively. All coefficients are odds ratios. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 1.10 presents DDD results broken down by age group. Previous research highlights the importance of early life (first 1000 days) for preventing stunting. Hence, we may expect to see larger improvements in HAZ for the 0-2 age group. Examining effects on HAZ in the full sample, which combines children between 0 and 5 years may underestimate effects on stunting for younger children (Attanasio et al., 2015.; Ferré & Sharif, 2014). As Table 1.10 shows, the point estimate for HAZ is higher in the 0-2 age group, with eligible children seeing a rise of 0.04 S.D (CI: -0.33 to 0.41), while effects in the older age group are smaller in magnitude (-0.05 S.D., CI: -0.32 to 0.22). However, it is difficult to compare the two point estimates, given the overlapping confidence intervals. On the other hand, improvements in WHZ seem to increase with age. There is a 0.22 S.D. (CI: -0.14 to 0.57) increase in WHZ for the 0 -2 year age group versus a 0.36 S.D. rise (CI: 0.12 to 0.60) for older children. The magnitude of the co-efficients is suggestive of an age specific trend in WHZ, but not HAZ. Turning to the binary outcomes, the results show that the odds of stunting reduce by 42% in the 0-2 age group, but do not change significantly among older children (age 2-5).

Table 1.10: Mamata and Child Nutrition: DDD Regression of Treatment (Odisha) vs. Comparison Groups **(**Neighbor states & Odisha Ineligible) split by child age
Dependent Variables: Weight-for-height and height-for-age z-score for children under 5 years of age

	Child Age: 0 - 2 years				Child Age: 2-5 years			
VARIABLES	WHZ	HAZ	Wasting	Stunting	WHZ	HAZ	Wasting	Stunting
Odisha x Eligible x Post	0.22	0.04	0.60*	0.58**	0.36***	-0.05	0.68	0.95
	(0.18)	(0.19)	(0.18)	(0.16)	(0.12)	(0.14)	(0.17)	(0.21)
Odisha x Eligible	-0.04	0.12	1.26	1.31	-0.09	0.11	1.03	0.96
	(0.16)	(0.17)	(0.34)	(0.32)	(0.12)	(0.12)	(0.23)	(0.19)
Odisha x Post	0.04	0.18	1.18	0.98	-0.01	0.15*	0.98	0.86
	(0.13)	0.143	(0.25)	(0.19)	(0.08)	(0.09)	(0.15)	(0.12)
Eligible x Post	-0.20**	-0.01	1.41***	1.24	-0.18***	-0.10	1.14	1.11
	(0.08)	(0.10)	(0.18)	(0.18)	(0.06)	(0.06)	(0.15)	(0.11)
Odisha	0.10	-0.04	0.75	0.91	0.07	0.06	0.95	0.88
	(0.11)	(0.13)	(0.14)	(0.15)	(0.08)	(0.07)	(0.14)	(0.10)
Eligible	0.23***	0.06	0.71***	0.82	0.10*	0.21***	0.95	0.77***
	(0.07)	(0.08)	(0.09)	(0.11)	(0.05)	(0.06)	(0.11)	(0.07)
Post	0.64**	4.48***	3.87	0.71	-0.96***	2.09***	4.44	6.21
	(0.31)	(0.52)	(6.18)	(0.54)	(0.18)	(0.16)	(5.51)	(7.03)
Observations	12,573	12,573	12,565	12,358	19,288	19,288	19,287	19,287
R-squared	0.08	0.26	0.05	0.15	0.05	0.08	0.03	0.05
Mean of the dep. var	-0.89	-1.25	0.22	0.38	-0.75	-1.51	0.15	0.38

Notes: The table presents estimates of β_1 from equation (2). The sample includes children under the age of 5 years from Odisha and neighbor states. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

6.2: Health Inputs

Table 1.11 presents results for the impact of the Mamata Scheme on a number of health inputs. Cash receipt in the Mamata Scheme is contingent upon the woman meeting a set of health-related conditionalities. Prior to childbirth, this involves pregnancy registration at the Anganwadi Center, receipt of iron and folic acid tablets, and at least one antenatal checkup, tetanus vaccine and prenatal counseling session. Post-delivery, conditionalities for continued receipt of the cash benefit include birth registration, polio, DPT and measles vaccination for the child, continued IYCF counseling sessions for the mother, a Vitamin A dose for the child before 1 year of age, exclusive breastfeeding for 6 months (self-reported by mother), weight checkups for the child and the introduction of age-appropriate complementary feeding. The results indicate that Mamata Scheme eligibility is associated with a significant increase of 0.64 ($p<0.01$) in the number of vaccines received by a child. The program also increases the odds of a child receiving a Vitamin

A dose by 45% ($p<0.05$). This suggests that higher immunization and Vitamin A may act as the mediating pathways for the effects on child anthropometry.

Table 1.11: Mamata and Health Inputs: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)

VARIABLES	ANC (1)	Breastfd. (2)	Vaccine (3)	Counsel. (4)	Vit A (5)	IFA (6)
Odisha x Eligible x Post	0.06	-0.79	0.60***	0.81	1.45**	1.08
	(0.21)	(0.85)	(0.20)	(0.21)	(0.26)	(0.27)
Odisha x Eligible	-0.16	2.11***	-0.48***	0.99	0.73**	1.00
	(0.18)	(0.74)	(0.18)	(0.24)	(0.12)	(0.22)
Odisha x Post	1.04***	2.78***	-0.14	3.05***	1.13	0.97
	(0.13)	(0.66)	(0.14)	(0.53)	(0.14)	(0.14)
Eligible x Post	-0.62***	-0.20	-0.44***	1.09	0.77***	0.82*
	(0.11)	(0.41)	(0.08)	(0.17)	(0.06)	(0.09)
Odisha	-0.21**	-1.35**	-0.14	0.44***	1.79***	1.82***
	(0.10)	(0.53)	(0.12)	(0.07)	(0.18)	(0.23)
Eligible	0.65***	-0.64*	0.45***	0.97	1.32***	1.24**
	(0.11)	(0.37)	(0.07)	(0.14)	(0.10)	(0.12)
Post	-12.45***	-30.81***	-4.88***	1.41	0.00***	0.00***
	(0.42)	(2.07)	(0.30)	(1.60)	(0.01)	(0.00)
Observations	31,861	31,861	31,861	18,860	31,844	24,923
R-Squared	0.21	0.15	0.10	0.04	0.11	0.10
Mean of the dep. var	3.55	20.91	6.13	0.31	0.67	0.89

Notes: The sample includes children under the age of 5 years from Odisha and neighbor states. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Columns 1,2, and 3 are linear regression estimates. Columns 4,5, and 6 present odds ratios from logit estimations. ANC is the number of antenatal care visits during pregnancy. Breastfd. is the number of months of breastfeeding. Vaccine indicates the number of vaccines received by a child. Couns., Vit A. and IFA are dummy variables for whether a mother received counseling after her child was weighed, whether a child ever received a Vitamin A dose, and whether a mother received IFA tablets during pregnancy, respectively. Standard errors clustered at level of mother's age in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

6.3: Birth Spacing

Table 1.12 includes the program effects on birth spacing. Column 1 shows that the program increases the birth interval between the first and second child by 5 months ($p<0.01$). This is a 13.5% increase over the mean birth interval of 37 months. Model 2 shows that the program increases the odds of a large birth interval (>3 years) between the first and second-born child by 86% ($p<0.01$). Birth intervals shorter than three years are linked to stunting in the Indian context (Dhingra & Pingali, 2021). While Mamata Scheme's targeting of first and second-born children raises the concern of shorter birth intervals, these estimates suggest that the parents do not reduce birth intervals between the first and second child in anticipation of the cash benefit. In fact, the

program is associated with larger birth spacing, which is associated with better child outcomes in the long run.

Table 1.12: Mamata and Birth Spacing: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)

	Number of months between 1st and 2nd born child	Birth interval between 1st and 2nd born > 36 months
VARIABLES	(1)	(2)
Odisha x Eligible x Post	4.99***	1.86***
	(1.43)	(0.40)
Odisha x Eligible	-0.18	0.81
	(1.18)	(0.15)
Odisha x Post	1.13	1.21
	(1.06)	(0.22)
Eligible x Post	-0.42	0.83*
	(0.69)	(0.09)
Odisha	-0.41	1.03
	(0.91)	(0.16)
Eligible	12.78***	5.30***
	(0.74)	(0.60)
Post	0.50	1.09
	(0.47)	(0.10)
Observations	18,320	18,320
R-squared	0.12	0.34
Mean of the dep. var	37.12	0.61

Notes: Models 1 and 2 present co-efficients from OLS and odds ratios from logit estimations, respectively. The sample includes women over the age of 19 years from Odisha and neighbor states with at least 2 children. The regression controls for mother and household level characteristics. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Section 7: Robustness Checks

Given the long time gap between the pre and post survey rounds of NFHS, I conduct the following robustness checks to support the validity of the DID findings.

7.1: Testing Parallel Trends

DID: DID is based on the common trends assumption between the treatment and comparison groups. Figure 1.2 depicts median nutritional outcome trends for the treatment group and comparison groups using NFHS-2, 3 and 4. As annual data are not available for nutritional measures, I rely on two previous NFHS rounds to validate this assumption. A visual inspection of

these trends supports the parallel trends assumption in the pre-Mamata period (prior to 2011). For a formal test of the parallel trends assumption, I estimate leads and lags of program effects, following the methodology in (Chari et al., 2019). NFHS-2 data are used to calculate the lead effects while NFHS-4 serves to estimate the lag effect of Mamata Scheme on child nutritional outcomes. The DID specification with "Neighbor States" as the comparison group is shown below:

$$Y_{ijt} = \beta_0 + \beta_{+1}\left(Odisha * 2015\right)_{jt} + \beta_{-1}\left(Odisha * 1998\right)_{jt} + \gamma \mathbf{X}_{ijt} + \eta_t + \varepsilon_{ijt} \quad (3)$$

Odisha is the treatment indicator, equal to 1 for children in Odisha. β_{-1} is the lead program effect and β_{+1} is the lag effect, relative to the omitted lag of NFHS-3 (2005). If outcome trends are similar between the treatment and comparison groups in the pre-Mamata period, and there are no changes in the outcome variables that anticipate the program implementation, the lead effect will be small and statistically insignificant. The magnitude and statistical significance of the point estimate for WHZ and wasting probability for the lead program effect (β_{-1}) suggests the presence of a trend in the pre-program period (Table 1.13).

DDD: The triple difference specification is shown below:

$$Y_{ijt} = \beta_0 + \beta_{+1}\left(Odisha * Eligible * 2015\right)_{jt} + \beta_{-1}\left(Odisha * Eligible * 1998\right)_{jt} + \gamma \mathbf{X}_{ijt} + \eta_t + \varepsilon_{ijt} \quad (4)$$

Here Odisha*Eligible is the treatment indicator, equal to 1 for eligible children in Odisha. As with the DID specification, β_{-1} is the lead program effect and β_{+1} is the lag effect, relative to the omitted lag of NFHS-3 (2005). Table 1.14 shows that the point estimate for the lead program effect (β_{-1}) is small in magnitude and statistically insignificant for all nutritional outcomes. The point estimates for the lag program effect (β_{+1}) are larger and statistically significant, as expected. This result lends support to the parallel trends assumption for the triple difference estimation, aid in ruling out pre-program trends, and lend credibility to the identification.

7.2: Placebo Program Implementation

As another robustness test for the parallel trends assumption, I run placebo DID and DDD regressions using data from the previous NFHS rounds (2 and 3). Since the Mamata Scheme did not exist during these periods, I expect that the point estimates will not be statistically significant

if there are no confounding trends that differ between the treatment and comparison groups in the pre-Mamata periods**.** Table 1.15 (see appendix) presents results from the placebo DID specification. While the coefficients on HAZ and stunting are not statistically significant, I cannot rule out the existence of pre-trends based on the magnitude of the point estimate and standard errors**.** Table 1.16 (see appendix) shows results from the placebo DDD specification**.** With the exception of HAZ, the placebo DDD effects are small in magnitude, lending credence to the empirical strategy. All outcomes are not statistically significant.

7.3: Synthetic Control

In addition to the classic DID, I use the synthetic control method (SCM), following Abadie et al. (2010). SCM is used to examine the impact of policy interventions that are implemented at an aggregate level (such as countries, regions, cities). Instead of arbitrarily choosing a single comparison group, this method constructs a "synthetic" control group as the linear combination of all untreated groups. SCM uses pre-program values of a set of predictors and the outcome variable to estimate non-negative weights for each potential comparison group (otherwise known as the "donor pool"), such that the weighted average of all comparison groups approximates the pre-program values of the treatment group.

Mathematically, this may be expressed as follows:

$$Y_t^{synthetic} = \sum_{i=1}^{N_{donor}} w_i Y_{it} \approx Y_t^{treatment}$$

$Y_t^{treatment}$, $Y_t^{synthetic}$ and Y_{it} are the outcome variable values for treatment group, synthetic control group and control group *i*, respectively, at time *t* in the pre-intervention period. w_i is the weight for control group *i* and takes a value between 0 and 1, and N_{donor} is the number of potential comparison groups in the donor pool. Specifically, I create a "synthetic Odisha" that approximates the values of the predictors of child nutrition in Odisha before the introduction of the Mamata Scheme. State weights are chosen to minimize the pre-program difference between Odisha and "synthetic Odisha" for a set of predictors that determine child nutrition. For this, I use previous rounds of the NFHS (2 & 3). I use a set of covariates, namely mother's age and education, child age, gender and birth order, household location, size, religion, caste, gender and education of household head, access to sanitation, electricity, piped water, and distance to health facility, as the

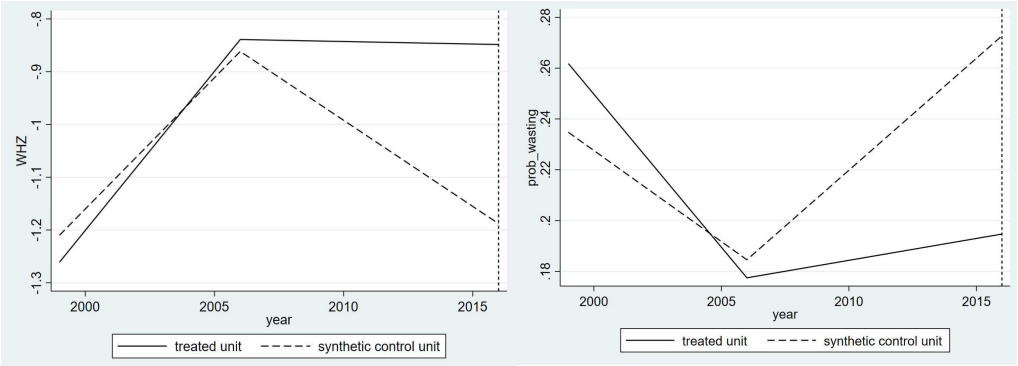
predictor variables and also add two years of lagged nutritional outcomes (1999, 2006), as well the lagged values of the outcome variables in two previous years (1999 and 2006). I estimate the effect of the Mamata Scheme on weight-for-height, probability of wasting, height-for-age, and probability of stunting as the difference in the WHZ, wasting probability, HAZ and stunting probability between Odisha and "synthetic Odisha" in the period following the launch of the Mamata Scheme.

$$\tau_t = Y_t^{treatment} - Y_t^{synthetic}$$

Where $Y_t^{treatment}$ and $Y_t^{synthetic}$ are the outcome variable values for Odisha and Synthetic Odisha respectively, and τ_t is the estimated program effect at time *t* in the post-intervention period. In this case, there is a single post-intervention period (2016). The goal of creating a synthetic Odisha is to mirror nutritional outcomes that would have been observed in Odisha in the absence of the Mamata Scheme. The state of Tamil Nadu implemented its own maternity-benefit scheme "Dr. Muthulakshmi Maternity Assistance Scheme" in 1987. Hence, I exclude Tamil Nadu from the donor pool states. I also exclude the 8 Union Territories, as information on nutritional outcomes for Union Territories is not available in NFHS-2 and since Union Territories are geographically small and centrally administered (similar to Washington DC). The donor pool consists of the remaining 28 states. The results are robust, however, to the inclusion of Tamil Nadu.

Figure 1.3 shows the trends in WHZ and probability of wasting for Odisha and synthetic Odisha during the period of 1998 – 2016. In Figure 1.3 panel a) we can see that synthetic Odisha follows the trend of Odisha quite closely before the implementation of the Mamata Scheme, providing a good approximation to what children's WHZ would have been in Odisha between 1999 - 2016 in the absence of the Mamata Scheme. The difference between the solid and dashed lines represents the effect of the Mamata Scheme on WHZ in Odisha, which is essentially the difference between WHZ in Odisha and synthetic Odisha after the introduction of the Mamata Scheme. While the WHZ scores between the Odisha and synthetic Odisha match closely for the two pre-treatment year (1999 and 2006), we see a large gap between the two in the post-treatment year. The results suggest that the WHZ improved by 0.34 S.D. in Odisha. In Figure 1.3 panel b) , the difference between the solid and dashed lines represents the effect of the Mamata Scheme on the probability of child wasting in Odisha. The fit in the pre-treatment years is not as close for

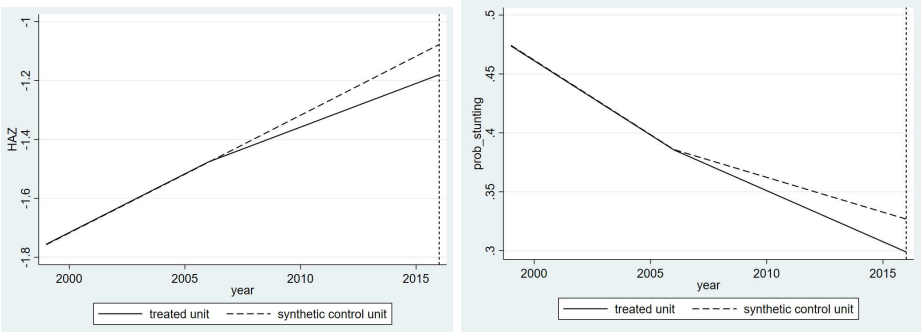
Odisha and synthetic Odisha as for WHZ, but we see a gap between the two in the post-treatment year. The results suggest that the probability of wasting reduced by 8 percentage points in Odisha.



Panel (a) Panel (b)

Fig. 1.3: Odisha vs. synthetic Odisha trends for (a) WHZ and (b) Probability of Wasting

Figures 1.4 shows the trends in HAZ and probability of stunting for Odisha and synthetic Odisha during the period of 1998 – 2016. The results in Figure 1.4 panel a) suggest that the program reduced HAZ by 0.11 S.D in Odisha. Figure 1.4 panel b) shows that there was a 2 pp. reduction in the probability of child stunting in Odisha.

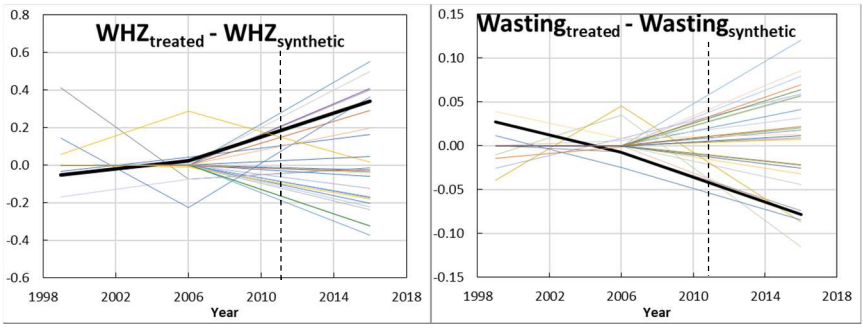


Panel (a) Panel (b)

Fig. 1.4: Odisha vs. synthetic Odisha trends for (a) HAZ and (b) Probability of Stunting

Inference: To assess the significance of the results, I run placebo tests by running the synthetic control for states that did not implement a cash transfer scheme aimed at improving maternal and child health and nutrition during the sample period, following the procedure in Abadie et al. (2007). This test re-assigns the treatment to each one of the donor pool states iteratively and calculates the gaps between the treated and synthetic control groups for the pre and post-treatment periods.

Figure 1.5 shows the results of the placebo test for WHZ and wasting probability. The colored lines represent the gap for each of the 28 runs of the test. That is, the colored lines show the difference in WHZ/Wasting between each state in the donor pool and its corresponding synthetic version. The black line denotes the gap for Odisha. As seen in the figure, the estimated gap for Odisha during the 1999-2016 period is not unusually large in magnitude relative to the distribution of the gaps for the states in the donor pool. This suggests that the analysis does not provide significant evidence of the positive effect of the Mamata Scheme on WHZ. Also, the gaps in WHZ and wasting for several states in the donor pool in the pre-treatment period show substantial deviation from zero, suggesting that the synthetic control method does not provide an excellent fit for these outcomes prior to the Mamata Scheme. Since pre-treatment data is limited to two survey rounds, obtaining a good fit (similar to Abadie et al.) for all states in the donor pool may be difficult.

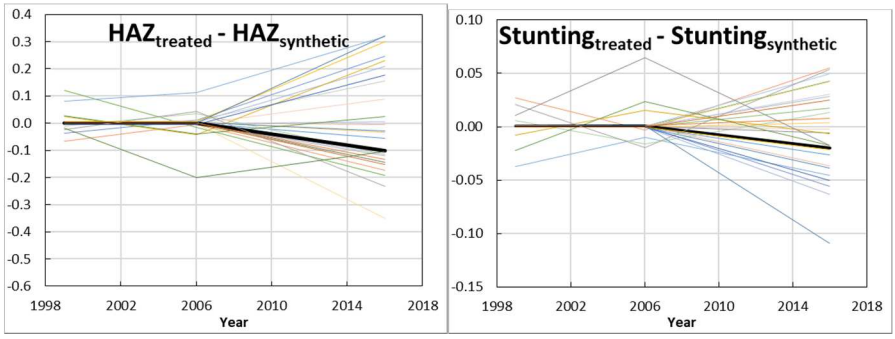


Panel (a) Panel (b)

Fig 1.5: WHZ and Wasting Probability Gaps (Difference between Treated and Synthetic) in Odisha and Placebo Gaps in all 27 Control States (Solid black line is Odisha. Dashed vertical line is 2011, year of intervention. Colored lines are 27 control states)

Figure 1.6 shows the results of the placebo test for HAZ and stunting probability. The colored lines represent the gap for each of the 28 runs of the test. That is, the colored lines show the difference in HAZ/Stunting between each state in the donor pool and its corresponding synthetic version. The black line denotes the gap for Odisha. As seen in the figure, the estimated gap for Odisha during the 1999-2016 period is not unusually large in magnitude relative to the distribution of the gaps for the states in the donor pool. This suggests that the analysis also does not provide significant evidence of the positive effect of the Mamata Scheme on HAZ and stunting probability. Similar

to the WHZ and wasting outcomes, synthetic control is unable to provide as good a fit as demonstrated in Abadie et al.



Panel (a) Panel (b)

Fig 1.6: HAZ and Stunting Probability Gaps in Odisha and Placebo Gaps in all 27 Control States (Solid black line is Odisha. Dashed vertical line is 2011, year of intervention. Colored lines are 27 control states)

Finally, another technique to evaluate the Odisha gap compared to the gaps from the placebo runs is to examine mean squared prediction error[8] (MSPE) ratios post/pre Mamata Scheme. Based on post/pre ratio of MSPE values, Odisha ranks 7 out of 28 states for HAZ and 24 out of 28 states for WHZ (Rank 1 has the largest ratio). Hence p-values are 7/28 = 0.25 and 24/28 = 0.85 following Abadie et al.

Section 8: Conclusion

In this study, I use nationally representative survey data to examine the effect of a CCT program intended as partial wage compensation for women during pregnancy and lactation on children's nutrition. Using a triple difference intent-to-treat (ITT) estimation, I analyze the impact of "Mamata Scheme", a conditional cash transfer program in Odisha, India on children's anthropometric measures. I find that being eligible for the Mamata Scheme is associated with an improvement in children's weight-for-height for children aged 0-5 years. The program also reduces the odds of child wasting and stunting. The results build on previous literature on cash

[8] MSPE is the average of the squared differences between nutritional outcomes (WHZ/wasting/HAZ/stunting) in Odisha and synthetic Odisha during 1999 – 2016.

transfers and nutrition (see Bastagli et al. 2016 for a review), which has hitherto found mixed results for program effects on child anthropometry.

Since the Mamata Scheme is not means-tested, I further examine heterogenous effects by household wealth. Given the existence of son preference in Indian families, I also disaggregate my results by child gender. Since program beneficiaries primarily reside in rural areas, I break down the results by a household's geographical location. In light of existing evidence on caste-based nutritional disparities in India, I investigate heterogenous program effects by household caste.

For both weight-for-height (WHZ) and height-for-age (HAZ), I find evidence of heterogeneity in program effects by household wealth. The program effect on children in poorer households is substantially lower for both WHZ and HAZ, compared to non-poor households. For the binary outcomes of wasting and stunting, I find that program is disproportionately more likely to reduce the odds of wasting and stunting for children in households in the top two wealth quintiles in the state. This suggests that the Mamata Scheme, which is currently universal, may need to target poorer areas for these children to realize program benefits. The program improves HAZ more for girls than boys, in the line with the broader literature on cash transfers and height-for-age which finds that girls benefit more from cash transfers than boys (Manley et al., 2013). Interestingly, I find that the program is more likely to reduce wasting for boys than girls, and boys also experience higher improvements in weight-for-height (WHZ). Future work would do well to investigate these relationships in the Indian context, especially as existing evidence from India suggests that there is a female nutritional disadvantage during early childhood due to son preference and parental underinvestment in girls (Jayachandran & Pande, 2017).

Further, I find evidence of caste heterogeneity in the Mamata Scheme's impact on wasting. The program reduces the probability of wasting primarily for children from upper-caste households. For the other outcomes (WHZ, HAZ, stunting), large standard errors make it difficult to make a precise statement about the direction of the effect for children in disadvantaged caste households. The program improves HAZ and reduces the odds of stunting more for children in rural compared with urban households, likely reflective of the uptake pattern.

Since changes in stunting usually take longer to manifest, studies that examine anthropometry measures for shorter durations often fail to find reduction in stunting. With data that spans a decade, I am able to overcome this limitation and include children up to 5 years of age in my sample. Since including older children may underestimate the effects on HAZ / stunting

reduction for younger age groups, I separately analyze program effects for children younger and older than 2 years. The odds of stunting reduce only in the younger age group (0-2yrs). However, I find no conclusive evidence that improvements in HAZ occurs primarily in 0-2 age group.

CCTs continue to gain in popularity in India, as evidenced by the introduction of the national maternity benefit scheme in 2017. Overall, the results of this paper suggest that maternal cash transfers are associated with modest improvements in child anthropometry, but that there are important wealth heterogeneities in the program's impact. The Odisha government may consider improved targeting for poorer households and also to make investments in complementary factors such as maternal education, access to clean water and sanitation and health care, in addition to budgetary allocations for maternal cash benefit programs.

Appendix

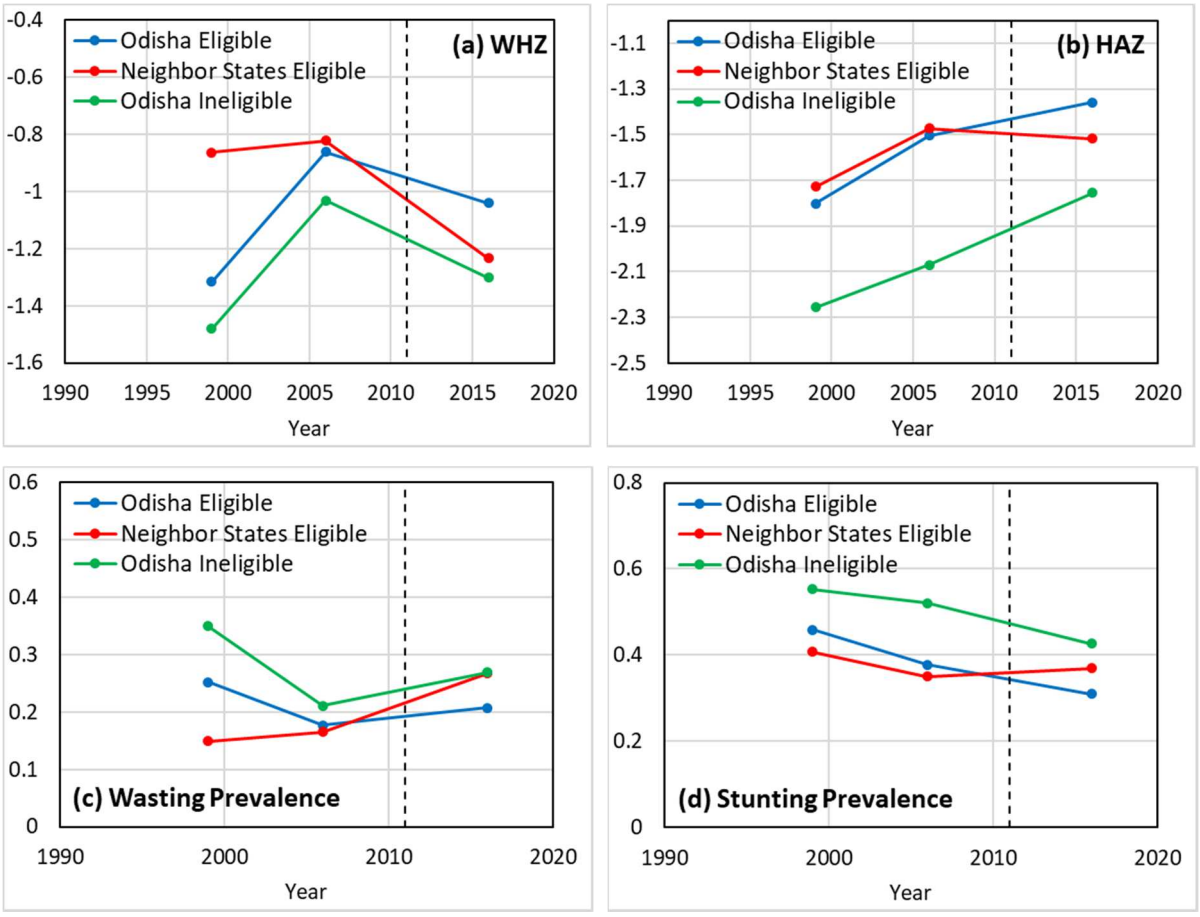


Fig 1.2: Child Nutrition Outcomes for Treatment (Odisha Eligible) and Comparison Groups (Neighboring States Eligible and Odisha Ineligible) across NFHS 2, 3 and 4. Dotted black line highlights 2011, the start of the Mamata Scheme

Table 1.13: Testing Parallel Trends – Difference-in-differences (DID) regression using leads and lags.

VARIABLES	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting
Odisha x 1998	-0.19**	-0.02	1.43**	1.20
	(0.08)	(0.08)	(0.22)	(0.17)
Odisha x 2015	0.33***	0.26***	0.65***	0.70***
	(0.03)	(0.03)	(0.04)	(0.03)
Observations	19,025	19,025	19,021	18,815
R-squared	0.08	0.19	0.06	0.09
Mean of dep. var	-1.11	-1.38	0.23	0.36

Notes: The table presents estimated leads and lags of the Intent-to-Treat (ITT) effects of the Mamata Scheme on child nutrition. All effects are relative to 2005-6, which is the period before program implementation. Columns 1 and 2 present results of a linear estimation, Columns 3 & 4 are odds ratios from a logit estimation The sample includes 1st and 2nd born children under the age of 5 years from Odisha and neighboring states, born to mothers older than 19 years. The regression includes controls for child, mother and household level characteristics and fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses.*** p<0.01, ** p<0.05, * p<0.1

Table 1.14: Testing Parallel Trends – Triple Differences (DDD) regression using leads and lags.

VARIABLES	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting
Odisha x Eligible x	-0.07	0.02	1.04	1.08
1998	(0.06)	(0.07)	(0.13)	(0.13)
Odisha x Eligible x	0.28***	0.25***	0.69***	0.71***
2015	(0.03)	(0.03)	(0.03)	(0.03)
Observations	34,964	34,964	34,955	34,664
R-squared	0.07	0.19	0.05	0.09
Mean of dep. var	-1.18	-1.56	0.25	0.41

Notes: The table presents estimated leads and lags of the Intent-to-Treat (ITT) effects of the Mamata Scheme on child nutrition. All effects are relative to 2005-6, which is the period before program implementation. Columns 1 and 2 present results of a linear estimation, Columns 3 & 4 are odds ratios from a logit estimation. The sample includes children under the age of 5 years from Odisha and neighboring states. The regression includes controls for child, mother and household level characteristics and fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses.*** p<0.01, ** p<0.05, * p<0.1

Table 1.15: Testing Parallel Trends - DID placebo regression (NFHS 2 & 3)

VARIABLES	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting
Odisha x 2005	0.07	0.19	0.98	0.83
	(0.12)	(0.12)	(0.24)	(0.17)
Odisha	-0.04	-0.05	1.04	1.27
	(0.10)	(0.11)	(0.18)	(0.23)
2005	-3.88***	4.73***	93.97***	5.00
	(0.55)	(0.57)	(165.16)	(6.97)
Observations	4,021	4,021	4,018	3,898
R-squared	0.11	0.26	0.08	0.15
Mean of dep. var	-1.12	-1.69	0.25	0.46

Notes: The table presents estimated Intent-to-Treat (ITT) effects of a placebo implementation of the Mamata Scheme on child nutrition. Placebo implementation is assumed to start between 1999 and 2005. Columns 1 and 2 present results of a linear estimation, Columns 3 & 4 are odds ratios from a logit estimation. The sample includes 1st and 2nd born children under the age of 5 years from Odisha and neighbor states, born to mothers older than 19 years. The regression includes controls for child, mother and household level characteristics and fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 1.16: Testing Parallel Trends - DDD placebo regression (NFHS 2 & 3)

VARIABLES	(1) WHZ	(2) HAZ	(3) Wasting	(4) Stunting
Odisha x Eligible x	-0.05	0.19	0.95	0.97
2005	(0.15)	(0.14)	(0.26)	(0.22)
Odisha x Eligible	0.00	-0.09	1.13	1.13
	(0.10)	(0.11)	(0.22)	(0.21)
Odisha x 2005	0.04	-0.03	1.00	0.81
	(0.10)	(0.11)	(0.18)	(0.14)
Eligible x 2005	-0.01	-0.06	1.39**	1.01
	(0.08)	(0.08)	(0.22)	(0.12)
Odisha	0.02	0.05	0.95	1.17
	(0.08)	(0.09)	(0.13)	(0.17)
Eligible	0.12	0.17**	0.66***	0.89
	(0.07)	(0.07)	(0.09)	(0.10)
Post	-1.48	8.75***	15.16*	0.11
	(1.11)	(1.22)	(23.10)	(0.18)
Observations	9,322	9,322	9,316	9,193
R-squared	0.10	0.23	0.08	0.12
Mean of dep. var	-1.12	-1.69	0.25	0.46

Notes: The table presents estimated Intent-to-Treat (ITT) effects of a placebo implementation of the Mamata Scheme on child nutrition. Placebo implementation is assumed to start between 1999 and 2005. The sample includes children under the age of 5 years from Odisha and neighbor states. The regression includes controls for child, mother and household level characteristics and fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

Table 1.17 : Synthetic Control Weights: WHZ

Weight	State
1	Maharashtra

Table 1.18 : Synthetic Control V Weights: WHZ

Variable	Weight
WHZ (1999)	0.87
WHZ (2006)	0.10
Mother's Education	0.002
Household has own toilet	0.002
Child is first-born	0.0001
Female Head	0.003
Hindu	0.003
Distance to health facility	0.0005
Scheduled Caste	0.0002

Table 1.19: Synthetic Control Balance: WHZ

Covariate	**Odisha**	**Synthetic Odisha**
Mother's Age (Yrs)	25.49	24.89
Mother completed secondary education	0.48	0.74
Fraction of Rural Households	0.87	0.50
Fraction of households with own toilet	0.19	0.34
Fraction of households with shared toilet	0.03	0.24
Child age in years	2.18	2.16
Gender of child (Girl=1)	0.46	0.46
Fraction of First Born Children	0.45	0.47
Household Size	6.41	6.63
Household head is female	0.07	0.07
Household head completed secondary education	0.44	0.68

Religion of Household (Hindu=1, Others=0)	0.97	0.77
Health facility is too far	0.19	0.05
Scheduled Caste/Tribe	0.67	0.51
Household has electricity	0.51	0.90
In-house access to piped drinking water	0.05	0.56
WHZ (1999)	-1.26	-1.21
WHZ (2006)	-0.84	-0.86

Table 1.20 : Synthetic Control Weights: Wasting Probability

Weight	State
0.113	Jharkhand
0.887	Maharashtra

Table 1.21 : Synthetic Control V Weights: Wasting Probability

Variable	Weight
Wasting probability (1999)	0.3946
Wasting probability (2006)	0.6053

Table 1.22: Synthetic Control Balance: Wasting Probability

Covariate	**Odisha**	**Synthetic Odisha**
Mother's Age (Yrs)	25.49	24.85
Mother completed secondary education	0.87	0.53
Fraction of Rural Households	0.19	0.33
Fraction of households with own toilet	0.03	0.22
Fraction of households with shared toilet	2.18	2.15
Child age in years	0.46	0.47
Gender of child (Girl=1)	0.45	0.47
Fraction of First Born Children	0.48	0.71

Household Size	6.41	6.67
Household head is female	0.07	0.07
Household head completed secondary education	0.44	0.65
Religion of Household (Hindu=1, Others=0)	0.97	0.77
Health facility is too far	0.19	0.07
Scheduled Caste/Tribe	0.67	0.55
Household has electricity	0.51	0.85
In-house access to piped drinking water	0.05	0.51
Probability of Wasting (1999)	0.26	0.23
Probability of Wasting (2006)	0.18	0.18

Table 1.23 : Synthetic Control Weights: HAZ

Weight	State
.029	Andhra Pradesh
.026	Arunachal Pradesh
.07	Assam
.033	Bihar
.033	Chhattisgarh
.03	Delhi
.032	Goa
.027	Gujarat
.041	Haryana
.037	Himachal Pradesh
.043	Jammu & Kashmir
.049	Jharkhand
.03	Karnataka
.036	Kerala
.03	Madhya Pradesh
.032	Maharashtra
.033	Manipur
.026	Meghalaya
.03	Mizoram
.025	Nagaland
.038	Punjab

.104	Rajasthan
.033	Sikkim
.038	Tripura
.025	Uttar Pradesh
.033	Uttarakhand
.038	West Bengal

Table 1.24 : Synthetic Control V Weights: HAZ

Variable	Weight
HAZ (1999)	0.71
HAZ (2006)	0.29

Table 1.25: Synthetic Control Balance: HAZ

Covariate	Odisha	Synthetic Odisha
Mother's Age (Yrs)	25.49	25.52
Mother completed secondary education	0.87	0.69
Fraction of Rural Households	0.19	0.46
Fraction of households with own toilet	0.03	0.13
Fraction of households with shared toilet	2.18	2.17
Child age in years	0.46	0.47
Gender of child (Girl=1)	0.45	0.45
Fraction of First Born Children	0.48	0.57
Household Size	6.41	6.71
Household head is female	0.07	0.10
Household head completed secondary education	0.44	0.54
Religion of Household (Hindu=1, Others=0)	0.97	0.70
Health facility is too far	0.19	0.13
Scheduled Caste/Tribe	0.67	0.59
Household has electricity	0.51	0.75
In-house access to piped drinking water	0.05	0.30

HAZ (1999)	-1.76	-1.76
HAZ (2006)	-1.48	-1.48

Table 1.26 : Synthetic Control Weights: Stunting Probability

Weight	State
.026	Andhra Pradesh
.018	Arunachal Pradesh
.054	Assam
.117	Bihar
.03	Chhattisgarh
.025	Delhi
.018	Goa
.025	Gujarat
.045	Haryana
.038	Himachal Pradesh
.029	Jammu & Kashmir
.058	Jharkhand
.025	Karnataka
.021	Kerala
.031	Madhya Pradesh
.03	Maharashtra
.023	Manipur
.025	Meghalaya
.03	Mizoram
.017	Nagaland
.027	Punjab
.137	Rajasthan
.025	Sikkim
.031	Tripura
.029	Uttar Pradesh
.033	Uttarakhand
.032	West Bengal

Table 1.27 : Synthetic Control V Weights: Stunting Probability

Variable	Weight
Stunting (1999)	0.67
Stunting (2006)	0.33

Table 1.28: Synthetic Control Balance: Stunting Probability

Covariate	Odisha	Synthetic Odisha
Mother's Age (Yrs)	25.49	25.22
Mother completed secondary education	0.87	0.71
Fraction of Rural Households	0.19	0.41
Fraction of households with own toilet	0.03	0.12
Fraction of households with shared toilet	2.18	2.17
Child age in years	0.46	0.47
Gender of child (Girl=1)	0.45	0.44
Fraction of First Born Children	0.48	0.53
Household Size	6.41	6.90
Household head is female	0.07	0.10
Household head completed secondary education	0.44	0.51
Religion of Household (Hindu=1, Others=0)	0.97	0.74
Health facility is too far	0.19	0.14
Scheduled Caste/Tribe	0.67	0.61
Household has electricity	0.51	0.70
In-house access to piped drinking water	0.05	0.28
Probability of Stunting (1999)	0.47	0.47
Probability of Stunting (2006)	0.39	0.39

Table 1.29: Mamata and Child Underweight: DDD Regression of Treatment (Odisha) vs. Comparison Groups (Neighbor states & Odisha Ineligible)
Dependent Variable: Weight-for-age z-score for children under 5 years of age

	WAZ				
VARIABLES	(1)	(2)	(3)	(4)	(5)
Odisha x Eligible x Post	0.16**	0.41	0.22	0.16	0.22
	(0.07)	(0.17)	(0.12)	(0.17)	(0.15)
Poor x Eligible x Odisha x Post		-0.33*			
		(0.19)			
Female x Eligible x Odisha x Post			-0.10		
			(0.13)		
Rural x Eligible x Odisha x Post				-0.02	
				(0.19)	
Scheduled Caste x Eligible x Odisha x Post					-0.07
					(0.17)
Observations	31,861	31,861	31,861	31,861	31,861
Pseudo R-squared	0.37	0.38	0.38	0.37	0.37
Mean of the dep. var	-0.87	-0.87	-0.87	-0.87	-0.87

Notes: The table presents estimates of β_1 from equation (1). Columns 2, 3, 4 and 5 present results for children belonging to households in the bottom three wealth quintiles, girls, children in rural and scheduled caste households, respectively. The sample includes children under the age of 5 years from Odisha and neighbor states. The regression controls for child, mother, and household level characteristics, and includes fixed effects for child birth year and month. Standard errors clustered at level of mother's age in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

CHAPTER 2: INCOME SOURCE AND FAMILY STRUCTURE AS PREDICTORS OF WOMEN'S CONTROL OVER INCOME: EVIDENCE FROM MALAWI

Section 1: Introduction

Women's economic empowerment (WEE) is a process through which women gain the skills, resources, and ability to participate in the labor market, earn and control income, and make economic decisions (Laszlo et al., 2020a). A sizable body of evidence shows that WEE yields economic benefits for households and communities (Anderson et al., 2021; Duflo, 2012; The World Bank, 2011), and policymakers often emphasize WEE in low and middle-income countries (LMICs) for its potential to deliver economic growth. Social protection and financial inclusion programs including cash transfer schemes, self-help groups, microcredit, bank account provision and public works often explicitly target female beneficiaries, with the aim of correcting gender gaps in human capital, economic opportunities, earnings, and productivity.

Female-centric policymaking is based on the underlying assumptions that there is a difference in male-female preferences and that women have control over household income, permitting them to exercise these preferences. But if women do not control income, either due to restrictive social norms or income capture by other household members (Chang Wei et al., 2020), potential program benefits may not be realized. Existing literature on WEE largely treats control over income either as a single dimension of a multi-dimensional index[9], uses female income or asset shares, i.e., not whether women actually *control* income, or examines women's income as an aggregate. This includes the sizable literature on the effect of cash transfers on women's empowerment, studies based on the WEAI[10], and research that analyzes the effect of policy interventions including public works, microcredit, group-based programs on women's empowerment.

[9]For example, the Women's Empowerment in Agriculture Index (WEAI) categorizes female decisionmaking into decisions about agricultural production, productive resources, control over income, leadership, and time use in the context of households in LMICs (Alkire et al., 2013).

[10]The Women's Empowerment in Agriculture Index (WEAI) categorizes female decisionmaking into decisions about agricultural production, productive resources, control over income, leadership, and time use in the context of households in LMICs (Alkire et al., 2013).

Given that current development programming has a large focus on WEE, examining the factors that make women more or less likely to control household income is an important endeavor. However, the extent to which the type of household income, family composition, and a woman's own demographic characteristics affect women's control over income is less studied in the literature. The popularity of targeted public transfers and the prevalence of remittances in LMICs also means that is important to examine the extent to which women retain control over transfer sources in comparison with farm and nonfarm income, prior to targeting policy interventions.

In this paper, I examine the patterns of female control over different sources of household income using the Fourth Malawi Integrated Household Survey (IHS4). IHS4 is a nationally representative cross-sectional survey and is part of the World Bank's Living Standards Measurement Study - Integrated Surveys on Agriculture (LSMS-ISA) initiative (n=11,031). Malawi is an excellent case study for studying this question, as households derive income from a variety of sources including farm income, nonfarm earnings, and public and private transfers. Drawing on the development and behavioral economics literature on income use and intrahousehold behavior, I test two hypotheses. First, that men cede more control over transfers than other income sources to women; and second, that men are more likely to constrain women's control over income when in a spousal relationship. I find support for both hypotheses using descriptive statistics and logistic regression analyses. Women residing in households with at least one adult man have 79% higher odds of having sole control over a transfer income stream, compared to farm and nonfarm income streams. This relationship holds irrespective of whether the transfer accrues from a public or private source. In female-headed households (FHHs), the presence of a male spouse (as opposed to other men) is associated with a 23 pp. reduction in the fraction of transfers solely controlled by the female household head. This is a substantial reduction, given that on average, female household heads have sole control over 80% of transfer income. The presence of a male spouse in FHH is also associated with a 25 pp. reduction in the fraction of total household income under the female head's control. Again, this is a large reduction, as on average, female household heads have sole control over 50% of household income.

My paper contributes to the existing literature in the following ways. First, to my knowledge, this is the first study to examine variation in female control over household income by whether income accrues from farm and non-farm earnings versus transfer sources. Second, I consider family composition as integral to understanding women's control over income. I

differentiate between households with and without adult men, instead of the traditional dichotomy between male-headed (MHH) and female-headed households (FHH). In doing so, I account for the possibility that female headship may be "nominal" in case of FHH, and that when present, adult men may make decisions about use of household income. This is the first empirical paper[11] to adopt this expanded definition of household headship in the context of women's control over income or otherwise. Third, my paper highlights that the extent to which men constrain female decision-making over income depends on their relationship, spousal or otherwise, which the literature has previously not considered.

In the next section, I review the existing literature conceptualizing and measuring women's control over income, highlight the relevance of income type to women's control over income, and hypothesize on how female control over income is likely to vary by income type and household composition. Section 3 discusses the case of Malawi. Section 4 describes the data. Section 5 presents the empirical results and Section 6 concludes.

Section 2: Literature Review

2.1 Women's Control over Income

Women's control over income is typically conceptualized as a woman's ability to decide how earnings are used, whether for savings, investments, or consumption (Njuki et al., 2019). Through the lens of Kabeer's (1999) seminal work, control over income corresponds to the "agency" dimension[12] of empowerment. More recent work on conceptualizing WEE classifies women's control over income[13] as a "direct" measure[14] of WEE (Laszlo et al. 2020). My paper focuses narrowly on women's control over income, given that this is likely the "last frontier" of women's decision-making power within a household. Amongst the multiple domains of women's decision-making authority within a household, women typically have the least control over income

[11] The Women's Empowerment in Agriculture Index (WEAI) was developed using a sample of dual-adult households, rather than female or male-headed households.

[12] Kabeer (1999) delineates three interconnected dimensions of women's empowerment: access to resources, ability to exercise choice or agency, and achievements or outcomes.

[13] Recent literature on conceptualizing WEE (Laszlo et al., 2020a) builds on Kabeer (1999)'s definition, and distinguishes between "direct" measures which "directly influence a woman's ability to assert her own preferences or ability", and "indirect" measures that relate to "outcomes of the decision-making process. Examples of direct measures include household decision-making over income, production and consumption, and women's mobility. Examples of indirect measures are women's labor force participation, education, incidence of intimate partner violence (Chang Wei et al., 2020; Doss, 2013).

[14] I use the term 'decision-making over income' and 'control over income' interchangeably".

(Anderson et al., 2017). Social norms dictating that men serve as primary financial decision-makers within the family (Chang Wei et al., 2020) mean that access to financial resources does not automatically translate to higher control over income for women.

To measure control, household surveys usually ask for the identity of household members who have a say in keeping or deciding what to do with earnings from a particular source. Alternatively, women may be asked if they make decisions about various sources of household earnings alone, jointly with their husbands, or have no say. Empirical work on household decision-making has mostly relied on data reported by a single spouse or household head, but this may mask disagreement between spouses. Recent studies suggest that husbands and wives often differ on who holds authority over various household production and consumption decisions (Acosta et al., 2019; Alwang et al., 2017; Anderson et al., 2017). Although these studies cover a broader gamut of decision-making domains than just income, as a body of work they find that husbands and wives tend to have differing perceptions of control over these decisions. Men tend to report lower levels of women's decision-making (both sole and joint) compared to women's reports of the same (Acosta et al., 2019). Women may also report joint decision-making even though their male partners have the final say (ibid.), suggesting that while indicative of some "agency", joint decision-making may not be truly reflective of women's empowerment. Thus, a policy or program that focuses on joint decision-making as a lever for women's empowerment may not yield the desired results. Whether sole female decision-making is more empowering than joint decision-making with a spouse depends on several factors including geographical context, decision-making domain, preferences and prevailing social norms (Seymour & Peterman, 2018). Given the complex interpretation of joint decision-making with a male spouse, I employ a more restrictive definition of female control over income in this paper. Specifically, I consider income to be under female control if it is controlled *only* by women, either solely or jointly.

Till date, most literature on women's control over income uses aggregate income, disaggregates income sources into farm and nonfarm or daily vs. major household purchases, or considers control over income as a single dimension of a multi-dimensional index[15] (See Appendix Table 2.13 for a selected review of empirical evidence). Closer to my paper, Njuki et al.

[15] The Women's Empowerment in Agriculture Index (WEAI) categorizes female decision-making into decisions about agricultural production, productive resources, control over income, leadership and time use in the context of households in LMICs (Alkire et al., 2013)

(2019) examine women's control over crop, livestock, wage, and nonfarm enterprise income in three African countries: Ghana, Mozambique, and Rwanda. Across countries, women have higher decision-making over nonfarm (nonfarm enterprise and wage) than farm (crop and livestock) income. In Bangladesh, Anderson and Eswaran (2009) find that women's wage income earned outside the farm has a larger effect on autonomy than income earned on the husband's farm or unearned income in the form of inheritance and marriage payments.

Njuki et al. do not include transfer income in their analysis. Anderson & Eswaran make a distinction between earned and unearned income; however the study includes only inheritance and dowries brought by women at the time of marriage as 'unearned' income, and not public and private transfers. Given that public transfers often target women and remittances are an important source of private transfers in LMICs, it is important to examine the distinction between women's control over transfer versus non-transfer income.

2.2 Why Income Source Matters

The theoretical and empirical literature in behavioral economics and applied psychology offers a variety of explanations for why individuals and households treat transfers differently from other income sources. Mental accounting theory (Thaler, 1994) hypothesizes that individuals maintain separate "mental accounts" for different income sources, and voluntarily spend money differently based on which mental account it belongs to. Across geographical contexts, studies find evidence for a "labeling effect", i.e., a tendency to adhere to externally imposed labels, for both public and private transfers. In study of Dutch households, Kooreman (2000) finds that child tax benefits increase expenditures on children's clothing compared to other income sources. Remittance money may also have implicit or explicit conditions attached to its use (Davies et al., 2009). If associated with the hard work and perception of the migrant sender, remittances are likely to be put 'productive use' such as education, health and savings (Waidler, 2016). In Malawi, remittances are associated with a lower marginal propensity to consume compared to salary and farm income, and with higher educational expenses and household savings (Davies et al., 2009). External labels may also be in the form of social norms that restrict the pattern of income use. In the Ivory Coast, households increase spending on education and food for additional income from yams, considered an "appreciated crop"(Duflo and Udry 2004).

Studies diverge on how the manner of income acquisition affects mental accounting. One line of inquiry finds that unearned income is likely to be spent on less basic consumption goods like alcohol, tobacco, non-staples or "frivolous" consumption (Henderson & Peterson, 1992), while earned income is more likely to be spent on basic consumption like staple food and education (Christiaensen & Pan, 2012). This supports the notion that the effort level associated with obtaining income is associated with the manner of spending it. More recent work draws on the permanent income hypothesis of Friedman (1957) to theorize that individuals consider earned income as more permanent or anticipated and "fungible", making it likely to be used for consumption (Ghimire & Kapri, 2020). Conversely, endowed money is seen as transitory or unanticipated and is more likely to be saved. Variability of an income source is also related to how it is spent or saved. In Pakistan, Adams (2002) finds a higher marginal propensity to save out of remittances than for other income sources, and attributes this to the variable and uncertain nature of remittances. Other-regarding behavior is yet another facet of decision-making that varies by the earned or endowed nature of income. Cherry (2001) demonstrates that in a one-shot dictator game, bargainers are more likely to display other-regarding behavior when money is allocated vs. when it is earned by participants.

The concepts of the labeling effect, the manner of income acquisition, and other-regarding behavior all explain why individuals consider transfers[16] differently from earned income**.** My paper extends these ideas to women's decision-making over income in LMICs**.** Drawing on the literature that endowed money is associated with saving and other-regarding behavior, I theorize that in households with both adult men and women, men cede more control over both public and private transfers than other income sources to women. I further hypothesize that men are more likely to constrain their female spouses' decision-making over household income than that of other female relatives.

H1: *Ceteris paribus*, men are more likely to cede control over transfer than non-transfer income to women in the household.

H2: Male spouses are more likely to constrain women's control over income than other male relatives.

[16] I categorize 'transfers' as money received by households through both public and private transfers, based on literature that shows similar "labeling" effects for both of these transfer types.

In the next section, I describe the case of Malawi.

Section 3: Income Sources and Social Organization in Malawi

Malawi is a landlocked country in Southeastern Africa with an estimated population of 17.5 million people (WFP, 2017), expected to double by 2038. With a purchasing power parity (PPP) adjusted per capita GDP of around USD 1000 (The World Bank, 2018a), Malawi is one of the poorest countries in the world. More than 80 per cent of the population in the country are small-scale producers, and over 90% of cultivated land is rainfed. Maize is a staple food in Malawi and the most commonly cultivated crop, constituting about two-thirds of smallholder agricultural output (FAO, 2015). While chronic hunger is prevalent in Malawi (Anderson et al., 2018), both rural and urban households in Malawi are also vulnerable to seasonal food shortages (Vaitla et al., 2009) in the annual "lean" season. This occurs in the months preceding harvest when household food stocks are near depletion. Anderson et al. (2018) find that 57% of rural and 36% of urban households suffer from seasonal hunger in the pre-harvest months, and that households are twice as likely to be facing seasonal rather than chronic hunger. Households employ several coping strategies in response to these seasonal food deficits (ibid.), including reliance on non-farm income. Non-farm income diversification may be through wage or self-employment. "*Ganyu*", i.e. relatively unskilled daily wage labor often performed for relatives, friends, neighbors etc. is also very common (Orr et al., 2009; Simtowe, 2010).

Given its susceptibility to climate shocks, persistently high poverty and food insecurity, social protection plays an important role in the Malawian context. "Social protection" may be defined as formal government programs that provide social assistance, i.e. protection against poverty, social insurance, i.e. protection against vulnerability and social equity or protection against discrimination (Devereux, 2016). Prominent social protection programs in Malawi include the Social Cash Transfer Program (SCTP) which is an unconditional transfer for ultra-poor and labor-constrained households; the Farm Input Subsidy Program (FISP), which provides discounted fertilizer to small farmers; School Meal and Nutritional Supplementation programs that target children and mothers; the Food Insecurity Response Plan (FIRP) which provides direct food and cash to households during the lean season and Public Works Programs through the Malawi Social Action Fund (MASAF) which consist of various cash-for-work, food-for-work and input-for-work programs.

Households in low and middle-income countries (LMICS) with family members who reside outside natal villages/towns often rely on remittances to smooth consumption. As private transfers, remittances are not "formal" social safety nets. In addition to being an ex-post coping strategy (Davies, 2007), there is also an "inheritance" motivation to remit as in Malawian culture, the eldest child (son or daughter) is not the automatic heir. Rather, residence in the natal village and surviving relatives' perception of a child having done her/his duty towards the deceased parents are determining factors in inheritance (Takane, 2008).

Both matrilineal and patrilineal systems exist in Malawi. Around 75% of the population belongs to matrilineal tribes (J. A. Behrman, 2017; Berge et al., 2014). Central and Southern Malawi has predominantly matrilineal kinship, while the Northern region is primarily patrilineal (Takane, 2008). These kinship norms affect various rules of marriage and residence (ibid.), for example, whether the husband resides in a wife's village or vice versa, whether inheritance follows through the male or female line, whether bride wealth is paid to the wife's family as well as land rights. Matrilineal traditions are linked higher female ownership of land, an important income source in rural agrarian economies (Peters, 2010). Land ownership is also correlated with higher female control over agricultural income in SSA (Njuki et al., 2019). Compared to other countries in the region such as Uganda, Tanzania and Ethiopia, women in Malawi report higher sole and joint ownership of land (Doss et al., 2015). However, documented or *de jure* sole ownership of land is lower than 1% of all household land for both men and women in Malawi (ibid.). In addition to strong matrilineal kinship and customary land tenure, formal law in Malawi provides women and men equal rights to own land, individually or jointly with others. However, formal land titling programs and agricultural policies have had mixed effects on women's land ownership (Peters, 2010), and despite matrilineal kinship, men are reported to exert primary control over agrarian decision-making (Djurfeldt et al., 2018).

Farm, non-farm, and public and private transfer sources each contribute significantly to household income in the country. This makes Malawi a suitable geographical context for my paper that examines women's control over income disaggregated by source. The presence of both matrilineal and patrilineal kinship is reflected through a variety of household structures in the country. This includes male-headed households as well as female-headed households, both with and without adult men present. This diversity of household structures is useful in understanding how household composition relates to women's control over income.

Section 4: Data

4.1 Survey

I conduct an empirical investigation of the correlates of women's control over income in Malawi, which requires detailed data on household income and women's decision-making. Hence, I leverage the Fourth Malawi Integrated Household Survey (IHS4). The Malawi IHS is a nationally representative repeated cross-sectional survey that is part of the World Bank's Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) initiative**.** I use the fourth cross-sectional survey round (IHS4) collected between April 2016 and April 2017.

IHS4 sampled 779 enumeration areas (EAs) throughout Malawi. Implemented by the National Statistical office (NSO) of the Government of Malawi, financial assistance for the survey was provided by the Government of Malawi (GOM), the United States Agency for International Development (USAID) through the World Bank LSMS-ISA and the Millennium Challenge Corporation. The final survey sample includes 12,447 households, and is representative at the urban/rural, regional, and national levels. A majority of IHS4 households are rural (81.7%).

4.2 Sample and Measures of Decision-making

I use IHS4 data to examine the patterns in female control over disaggregated income sources in Malawi. The household and agricultural survey modules collect details on household income by source and up to two household decisionmakers for each income source. Specifically, the survey asks, "*who in in the household decides/controls the use of earnings from [source]?*". Income sources covered in the survey[17] include farm, non-farm, and transfer sources. Farm sources include income from temporary and permanent crop sales, and livestock product sales; non-farm earnings derive from salaries, wages for casual labor and allowances, public works programs, pensions, savings & investments, and rental income. Transfer income sources include private remittances and public transfers in the form of food or cash assistance. These disaggregated income sources in the data allow for an analysis of female decision-making over different household income sources.

[17] I exclude "lumpy" income from asset sales, inheritance, and gambling as these are not steady income streams, and may skew the results. Household enterprise income is also excluded from the present analysis, due to data constraints that limit its extrapolation on an annual basis.

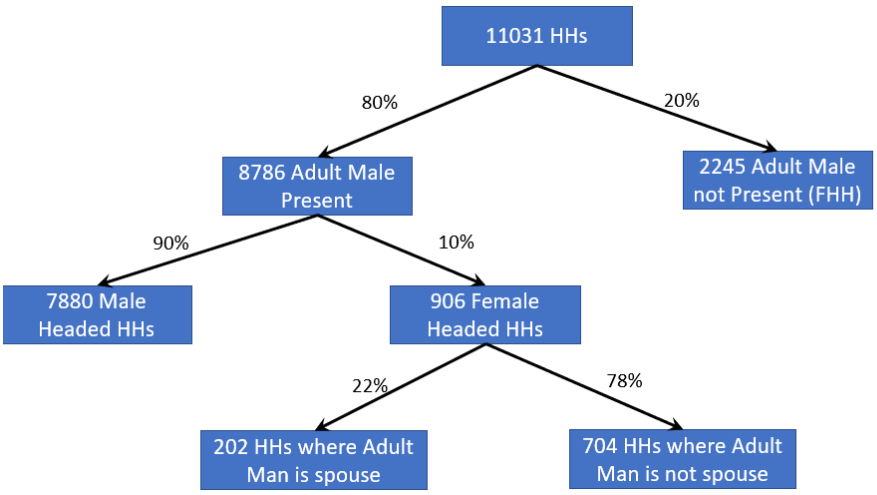


Figure 2.1: Family Structure in Malawi (IHS4)

The final cross-sectional sample in the present analysis consists of 11,031 households (see Figure 2.1). Of these 11,031 households, 80% have adult men present (AM), while there are no adult men (NAM) in 20% of households. As expected, a majority of households with adult men (90%) are male-headed. Among the 10% of female-headed households with adult men, 22% of households have adult men who are spouses, while the remaining 78% have men who are not spouses. Empirical studies generally examine household structure through male and female-headship, although some recent work in Malawi and Nepal distinguishes between *de facto* and *de jure* female headship (Djurfeldt et al., 2018; Rajkarnikar & Ramnarain, 2020). Given that the female control over income is central to this paper, I choose a different definition of a male-headed household, to include households with any resident adult male present at the time of the survey. In doing so, I account for the possibility that female headship may be "nominal" in case of these households, and that adult men may make decisions about use of household income. Further, given the complex interpretation of joint decision-making described above, I consider an income stream to be under female control if it is controlled *only* by women, either alone or jointly with another woman.

4.3 Income Sources in Malawi

42% of all households in the sample receive some income from farm sources, primarily from crop sales (author's calculations). Farm income comprises 15-20% of total household income in Malawi (excluding household enterprises) in 2016, depending on whether adult men are present in the

household. As shown in Table 2.1, income from farm sources is 20% of total household income for households with adult men, versus 15% of total household income in the case of households without adult men. Also, on average, a lower percentage of households with NAM receive farm income (Table 2.1). This difference suggests the presence of some barriers to women's market participation, which may be long distances to markets, time constraints due to daily responsibilities at home, or social norms favoring a husband's control over market-oriented production (Njuki et al., 2019).

A majority of households (85%) have some non-farm earnings, over 70% of which come from 'ganyu' labor (author calculations). Non-farm income comprises 60-70% of total household income in Malawi in 2016, depending on whether adult men are present in the household. As shown in Table 2.1, households with adult men receive a higher portion of household income from nonfarm sources than those without adult men. Also, the percentage of households receiving nonfarm income was 10 percentage points higher for households with adult men (Table 2.1).

At 0.6 % of GDP, average expenditure on safety nets in Malawi during 2011-2016 was half of the regional average of 1.2% (The World Bank, 2018b). However, as Table 2.1 demonstrates, income from transfer sources (both private and public) forms a sizeable chunk of a Malawian household's income stream. 35% of all households in the sample receive some transfer income, either private or public (author's calculations). Transfers constituted between 11 – 26% of household income in Malawi in 2016, depending on whether adult men were present (Table 2.1)[18]. As expected, households where there are no adult men rely more heavily on transfers. The average share of household income from transfer sources is more than twice in these households, compared to those with adult men. Also, the percentage of households receiving transfers was 15 percentage points higher for households with no adult men (Table 2.1). It is implicit that women control transfers if there are no adult men in the household, however an interesting question arises about the extent to which women control transfers over other income sources in households where adult men are present (Table 2.3).

[18] Appendix Table 2.9 presents a breakdown into public and private transfers

Table 2.1: Sources of Household Income and Household Structure in Malawi

	Fraction of Total HH income from		% of Households receiving Income from	
	Has Adult Male mean/sd	No Adult Male mean/sd	Has Adult Male mean/sd	No Adult Male Mean/sd
Farm	0.20	0.15	43.6	36.3
	(0.33)	(0.28)	(49.6)	(48.1)
Non-Farm	0.70	0.60	86.6	77.6
	(0.38)	(0.41)	(34.0)	(41.7)
Transfers	0.11	0.26	32.1	48.8
	(0.245)	(0.366)	(46.7)	(50.0)
Observations	8786	2245	8786	2245

Source: Malawi Integrated Household Survey (IHS4) 2016

Notes: Farm income includes income from crop and livestock sales; Nonfarm Income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Transfers include both public cash and food assistance and private remittances. Analysis excludes income from household enterprises.

Using IHS4 data, average household income in Malawi in 2016-17 was ~ 472,000 Malawi Kwacha (MK)[19], while average income from transfer sources in the same year was 17,600 MK. Primary transfer sources[20] in Malawi (see Table 2.2) include food assistance in form of free food and free maize and direct cash transfers, both from the government and other organizations, and remittances. 18% of all households receive food assistance in the form of free food or maize, and 5% of all households receive cash transfers from government and non-government sources (author's calculations from IHS4). A higher percentage of households where there are no men receive food assistance[21] (Table 2.2), which may be attributable to targeted in-kind transfers for female-headed households.

[19] 1 United States Dollar = 794 MK at current exchange rates.

[20] Public works programs (PWP) are a type of social protection program. In this paper, I include PWP as part of non-farm income as I make a theoretical distinction between nonfarm and transfer income

[21] Food assistance consists of free food and free maize. IHS4 asks for cash value of free food, which is combined with the cash value of free maize. Maize prices are imputed from total quantity of maize sold and total revenue from maize crop sales at the household level.

Table 2.2: Sources of Transfer Income and Household Structure in Malawi: Households with and without adult men

	Fraction of HH. Transfer Income from		Fraction of Total HH. Income from		% of HHs receiving Income from	
	Has Adult Male mean/sd	No Adult Male mean/sd	Has Adult Male mean/sd	No Adult Male mean/sd	Has Adult Male mean/sd	No Adult Male mean/sd
Food Assistance	0.45	0.38	0.04	0.07	17.0	24.1
	(0.47)	(0.45)	(0.14)	(0.20)	(37.6)	(42.8)
Direct Cash Transfers	0.11	0.12	0.02	0.04	4.2	7.6
	(0.30)	(0.31)	(0.10)	(0.15)	(20.0)	(26.5)
Remittances	0.44	0.50	0.05	0.14	16.3	29.2
	(0.47)	(0.47)	(0.18)	(0.30)	(37.9)	(45.5)
Observations	2825	1096	8786	2245	8786	2245

Source: Malawi Integrated Household Survey (IHS4) 2016.
Note: Food Assistance consists of Free Food and Free Maize; Cash Transfers are from the Government and Non-govt sources.

As private transfers, remittances are not formal social safety nets. However, households in low and middle-income countries (LMICS) with family members who reside outside the natal village or town often rely on remittances to smooth consumption. Around 19% of all households in Malawi receive remittances (author's calculations from IHS4), and these are primarily from adult children living outside of the natal village. 29% of households where there are NAM receive remittances, as opposed to only 16% of those with AM. For these households, remittances constitute between 5% of a household's total earnings in case of households with AM, and 14% of a household's total earnings in the case of NAM (Table 2.2). Overall, private transfers in the form of remittances are an important source of income for Malawian households.

4.4 Female Control over Income by Source

I now explore the extent of female control, defined as sole female decision-making over the three primary sources of income – farm, nonfarm, and transfer - in Malawi. Primarily of interest to this analysis are households where adult males are present. Descriptive statistics in Table 2.3 demonstrate that in households with AM, women have significantly higher sole control over private and public transfers, compared to income from farm and non-farm sources[22]. Since there

[22] Appendix Table 2.10 presents a breakdown into public and private transfers

are three income sources, ANOVA is suitable for testing the statistical significance of differences between female control over income sources.

Table 2.3: Female control over income by source (households with and without adult men)

	N	Fraction of Non-farm income under Female Control	Fraction of Farm income under Female Control	Fraction of Transfer income under Female Control	F-Test (Repeated -Measures ANOVA)
Adult Male Present (mean/sd)	8786	0.12 (0.32)	0.13 (0.29)	0.23 (0.41)	***
Adult Male Not Present (mean/sd)	2245	0.98 (0.12)	0.94 (0.20)	0.99 (0.09)	***

Notes: Test statistics significance are *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The variable of interest i.e. fraction of income from [source] under sole female control, is measured for the same households. Therefore, the three groups (farm, non-farm, and transfer sources) are not independent. A repeated-measures ANOVA[23] takes this group dependence on households into account by a) subtracting the variability due to inter-household differences from the within-group variability, and b) by adjusting the degrees of freedom that reflects the reduced number of independent observations. The F statistic value is large enough to reject the null hypothesis that there is no difference between the fraction of income under female control for all three income sources (farm, non-farm, and transfer).

The results in Table 2.3 lend support to the alternative hypothesis that women are more likely to have sole control of transfers compared to farm and non-farm income. This suggests that for women to have control over income, income may need to be "earmarked" for women in the form of targeted transfers. The results on farm income are in line with previous work showing that women working on their husband's farm have little decision-making over income they contribute to generating (Anderson & Eswaran, 2009). Unlike the former study, however, descriptive evidence here does not show that women have significantly higher control over nonfarm earnings.

[23] The sample for this ANOVA analysis is limited to households which have a non-zero income from all three sources (farm, nonfarm, transfer). This yields a sample size of 943 households. Repeated-measures ANOVA includes a sphericity correction to minimize Type 1 errors. These may occur if the variance of differences in the outcome variable (fraction of income under female control) between any pair of groups (income source) is not equal. The results are robust to multiple sphericity correction methods (results available upon request).

A further breakdown of transfer income by its sources (Table 2.4) reveals that women control an equal share of cash and food assistance and a slightly higher share of remittances. This suggests the type of transfer income (private vs. public) may not matter as much as for women's control over income, as much as its receipt as a 'transfer'.

Table 2.4: Female control over income (by source of household transfer income)

	Adult Male Present mean/sd	Adult Male Not Present mean/sd
Fraction of Remittance income under Female Control	0.27	1.00
	(0.43)	(0.07)
Fraction of Food Assistance income under Female Control	0.21	0.98
	(0.41)	(0.13)
Fraction of Direct Cash Transfer income under Female Control	0.21	0.99
	(0.41)	(0.08)
Observations	2825	1096

Source: Malawi Integrated Household Survey (IHS4) 2016.
Note: Food Assistance consists of Free Food and Free Maize; Cash Transfers are from the Government and Non-govt sources.

4.5 Intrahousehold Dynamics: Spouse vs. Non-Spouse

Next, I turn to the question of whether spouses constrain women's decision-making over income differently than other men. For this, I restrict the sample to female-headed households where at least one adult man is present. In Table 2.5, I present descriptive statistics, both for FHH where men are spouses and not spouses. As Table 2.5 demonstrates, female household heads control higher fractions of all income categories when the spouse is absent, suggesting that the presence of spouses constrains women's decision-making to a larger extent than other male relatives[24]. In both types of FHH, the fraction of transfer income under the female head's control are higher than farm and nonfarm income, providing further evidence in support of the hypothesis that women are more likely to control transfers than other income sources.

[24] Appendix Table 2.11 presents a breakdown into public and private transfers

Table 2.5: Household income controlled by female household head by source: Households with adult men

	Adult Male is Spouse mean/sd	Adult Male Not Spouse mean/sd
Fraction of Farm income under Female Head Control	0.36	0.84
	(0.48)	(0.35)
Fraction of Non-farm income under Female Head Control	0.33	0.51
	(0.41)	(0.41)
Fraction of Transfer income under Female Head Control	0.71	0.90
	(0.49)	(0.28)
Observations	202	704

Source: Malawi Integrated Household Survey (IHS4) 2016. Notes: Farm income includes income from crop and livestock sales; Nonfarm Income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Transfers include both public cash and food assistance and private remittances. Analysis excludes income from household enterprises.

Section 5: Methods

Logistic & OLS Regression Analyses

This section presents results from logistic regressions testing the relationship between household income type and women's control over income, as well as female control over transfers as a function of female characteristics. I also use OLS regressions to examine whether the presence of a male spouse in the household is associated with women's control over total income and transfers differently than the presence of other male relatives. Table 2.6 shows results of a logistic regression examining whether income source is associated with women's likelihood of controlling income, for women residing in households with at least one adult man. Column 1 shows that women have 1.79 times higher odds of having sole control over a transfer income stream ($p<0.01$), compared to farm and nonfarm income streams. This relationship does not depend on the size of the income stream, as evident from the odds ratio of 1.00 for the interaction term between transfer income stream and income amount (Column 1)[25]. Restricting the sample to income streams controlled by only married women (Column 3), i.e., excluding divorced, widowed, separated and single women, increases these odds. Married women have 2.87 times higher odds of controlling transfers (Model 3), compared with farm and non-farm income ($p<0.01$). As evidenced by the interaction term on transfer income stream and remittances (Column 2), whether the transfer income stream is a private

[25] Table 2.12 shows an estimation for public transfers vs. all other income sources, and has similar results.

remittance or public transfer (food or cash) does not significantly change the probability of sole female control.

Table 2.6: Logistic regression for female control over hh. income stream as a function of whether the income is from transfers (public and private) or farm and non-farm sources

Dependent Variable: Only women control a household income stream (=1)			
	(1)	(2)	(3)
Income stream is transfer (=1)	1.79***	1.78***	2.87***
	(0.17)	(0.19)	(0.38)
Income stream amount (Thousand MK)	1.00**	1.00**	1.00*
	(0.00)	(0.00)	(0.00)
Transfer income stream (=1) * Income stream amount	1.00	1.00	0.99
	(0.002)	(0.001)	(0.004)
Income stream is transfer (=1) * Income stream is remittance (=1)		1.01	
		(0.13)	
Matrilineal district (=1)	1.22***	1.22***	1.19**
	(0.08)	(0.08)	(0.10)
Only 1 household member controls income stream (=1)	33.68***	33.68***	155.0***
	(3.51)	(3.51)	(41.26)
Household size	1.23***	1.23***	1.19***
	(0.02)	(0.02)	(0.02)
Age of HH head (yrs)	1.01*	1.01*	0.99***
	(0.003)	(0.003)	(0.003)
HH head is male	0.10***	0.10***	0.42***
	(0.01)	(0.01)	(0.06)
Education of HH Head (yrs)	1.02**	1.02*	1.02
	(0.01)	(0.01)	(0.013)
Constant	0.02***	0.02***	0.002***
	(0.005)	(0.005)	(0.001)
Sample excludes income streams for divorced, separated, widowed, never married women	No	No	Yes
Pseudo-R^2	0.39	0.39	0.39
Observations	22,567	22,567	19,971

Notes: Income-Stream level regression, sample restricted to households with adult men (AM). Dependent variable is=1 if an income stream is solely controlled by one woman or jointly controlled with another woman in the household (not man). Standard errors clustered at Enumeration Area (EA) level in parentheses. Farm income includes income from crop and livestock sales; Nonfarm Income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Transfers include both public cash and food assistance and private remittances. *** p<0.01, ** p<0.05, * p<0.1

As expected, male household headship is associated with 2.5 – 10 times lower odds of sole women controlling an income stream (Table 2.6 Models 1 – 3). Residence in a matrilineal district is associated with 1.19 – 1.22 times higher odds of sole female control over an income stream (Table 2.6 Models 1 – 3). Sole female control over an income stream is also positively and strongly correlated with the probability of income being controlled by only one decision-maker (versus two decision-makers). This suggests that income that is "jointly" controlled is primarily with men, not with other women. The logistic regression is not causal in nature, with the main takeaway being that women in households with adult men are more likely to control an income stream accruing from transfers, compared with nonfarm and farm income.

Next, I turn to an investigation of whether women's marital and other characteristics are associated with the likelihood of controlling transfer income, for women residing with households with at least one adult man present. As Table 2.7 demonstrates, each additional year of age increases the odds of sole female control over transfers by 1% ($p< 0.01$). This finding is line with (Njuki et al., 2019), who find higher control over agricultural income for older women across three African countries. This correlation suggests that transfers targeted to younger women may not result in these women gaining control over income. Notably, the relationship between education and female control over transfer income is not statistically significant. This suggests that while older women may have a higher standing in the household, making them more likely to control transfer income, the same may not apply to just more educated women.

Even in the presence of adult men, the odds of sole control over transfers are over 14 times higher ($p<0.01$) for women who are household heads, compared to female spouses of male household heads. I find that women who are spouses of the household head have higher sole control over transfers than other women in the household, who may be mothers, daughters, granddaughters, nieces etc. of the head (10 times lower odds of controlling transfers than the spouse of the head ($p<0.01$)). Turning to marriage, divorced and widowed women in households with men have 5 ($p<0.05$) and 3 times ($p<0.10$) higher odds respectively of sole decision-making over transfers compared with monogamously married women. Widowed or divorced women have an 83% probability of being a household head, as opposed to only 6% for married women (author calculation based on IHS4 data). This disparity in the probability of household headship by marital status, combined with the finding that female household heads have significantly higher odds of

controlling transfers, helps explain why divorced or widowed women have higher odds of controlling transfers than married women**.**

Table 2.7: Logistic regression for female control over transfers as a function of female characteristics

Dependent Variable: Only women control a transfer income stream (=1)

VARIABLES	Fem. Control of Transfer Income
Age of woman in yrs	1.01***
	(0.005)
Education of woman in yrs	1.01
	(0.03)
Religion of woman = Christianity	0.70
	(0.18)
Relationship to Head	
Woman is HH head	14.37***
	(5.60)
Other relation to HH head	0.10***
	(0.08)
Spouse of HH head (reference)	
Marital Status	
Polygamously Married	0.57
	(0.22)
Separated	1.86
	(1.08)
Divorced	5.14**
	(3.35)
Widow	3.37*
	(2.35)
Never Married	2.13
	(1.58)
Monogamously Married (reference)	
Constant	0.17***
	(0.06)
Pseudo-R^2	0.31
Observations	2,526

Notes: Woman-level regression, sample restricted to women ages 18 and older in households with adult men (AM). Standard errors clustered at Enumeration Area (EA) level in parentheses. Transfers include both public cash and food assistance and private remittances. *** p<0.01, ** p<0.05, * p<0.1

A woman being in a polygamous union is associated with 1.75 times lower odds of her sole control over transfers compared to women who are monogamously married, although this is not

statistically significant. Overall, the logistic regression estimation in Table 2.7 demonstrates that women with certain characteristics are more likely to control transfers**.** Being a household head, widow or divorcee increases sole female decision-making over transfers, followed by being a household head's spouse**.**

Table 2.8 presents results from an OLS regression examining whether spouses affect women's control over income differently than other male relatives. Even within female-headed households (FHHs), having a male spouse present reduces the fraction of household income under the female head's sole control by 25 percentage points ($p<0.01$). This is a large decrease, given that on average, female household heads have sole control over 50% of household income. Specific to transfers, we see that the presence of a male spouse in a FHH is associated with a 23 pp. reduction ($p<0.01$) in the fraction of transfers solely controlled by the female household head. On average, female households heads have sole control over 80% of transfer income, so again this represents a sizable reduction. Together, these findings supports the hypothesis that spouses constrain female decision-making over income to a larger extent than other male relatives.

Table 2.8: OLS Regression for fraction of total household income controlled by female head as a function of presence of male spouse

Dependent Variable: Fraction of household income controlled by female head

VARIABLES	Fraction of HH Income controlled by Female Head	Fraction of Transfer Income controlled by Female Head
Adult male is spouse (= 1)	-0.25***	-0.23***
	(0.053)	(0.09)
Log (Household Income)	-0.05***	-0.02
	(0.02)	(0.02)
Matrilineal district	0.05	0.21***
	(0.04)	(0.06)
Household size	-0.02*	0.02
	(0.01)	(0.02)
Age of HH head (yrs)	0.001	0.01
	(0.002)	(0.00)
Education of HH head (yrs)	0.01**	-0.01
	(0.006)	(0.01)
Constant	0.79***	0.69***
	(0.13)	(0.18)
Observations	627	296

Adjusted R-squared	0.12	0.10

Notes: Sample restricted to female-headed households with adult men. Standard errors clustered at Enumeration Area (EA) level in parentheses. Excludes business income. *** p<0.01, ** p<0.05, * p<0.1

Section 6: Discussion

This paper presents an important first step in exploring how income type, household composition, and women's demographic characteristics relate to women's financial decision-making. I posit that women are more likely to control income from transfer sources, compared to farm and non-farm income, and further, that female decision-making over income is more likely to be constrained by a spouse than other male relatives. Drawing on the literature that joint male-female decision-making is often characterized by spousal discord, my preferred measure of female control over income is women's sole decision-making.

Descriptive analyses and logistic regressions lend support to both hypotheses. I find that women are more likely to have sole decision-making over income from remittances and public transfers, compared to farm and non-farm income. I also find that the presence of a male spouse in the household is associated with lower sole female control over total household income, as well as transfers. Further, I find that female characteristics, especially household headship, age, divorce, and widowhood increase the probability of controlling public and private transfers.

In sum, my findings highlight that female financial decision-making relates to women's' demographic characteristics, but importantly, also to the type of household income and family composition. By examining the distinction between women's control over transfer versus other income sources, my analysis extends the work of Njuki et al (2019), who examine the patterns in women's control over agricultural income in sub-Saharan Africa. Higher control over income have been linked with beneficial outcomes for women themselves and for children, including a change in gender norms, higher female autonomy, increases in female labor supply in the long run (Field et al., 2021) and better children's educational and nutritional status (Doss, 2013; Haddad, 1999; Holland & Rammohan, 2019). Thus, from a policy intervention perspective, improving women's control over income is a desirable goal. The finding that women are more likely to control transfers than other income sources suggests that direct transfers to women may be effective in increasing women's control over income, and provides support for programs designed as such targeted transfers.

These findings on the relevance of family structure to women's control over income merit additional consideration for policymakers designing food or cash transfer programs. My paper finds

that women have higher control over transfers than other income sources in households with men (primarily male-headed households). This suggests that targeting transfers to women in these households may also yield benefits, in addition to targeting female-headed households or households where men are absent. Additionally, my findings underscore the need for interventions designed to encourage women's control over income to recognize that having financial decision-making may be more difficult for younger women.

Finally, my analysis highlights the need for further research on the relationship between income source, family structure and female financial decision-making. Although I cannot examine individual reports of decision-making over various income sources due to data constraints, the LSMS provides rich details on both household income and decision-making. Future household surveys need to collect data from both spouses on decision-making over different income sources, to further investigate possible variation in intrahousehold dynamics by income source, and build on the growing body of work which finds intrahousehold discord in reports of decision-making.

Appendix

Table 2.9: Sources of Household Income and Household Structure in Malawi

	Fraction of Total HH income from		% of Households receiving Income from	
	Adult Male Present mean/sd	Adult Male Not Present mean/sd	Adult Male Present mean/sd	Adult Male Not Present Mean/sd
Farm	0.20	0.15	43.60	36.30
	(0.33)	(0.28)	(49.60)	(48.10)
Non-Farm	0.70	0.60	86.60	77.60
	(0.38)	(0.41)	(34.0)	(41.70)
Public Transfers	0.05	0.11	20.20	29.50
	(0.17)	(0.24)	(40.10)	(45.60)
Private Transfers	0.05	0.14	16.30	29.20
	(0.18)	(0.30)	(36.90)	(45.50)
Observations	8786	2245	8786	2245

Source: Malawi Integrated Household Survey (IHS4) 2016

Notes: Farm income includes income from crop and livestock sales; Nonfarm Income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Public transfers include both public cash and food assistance, private transfers are remittances. Analysis excludes income from household enterprises.

Table 2.10: Female control over income by source (households with and without adult men)

	Adult Male Present mean/sd	Adult Male Not Present mean/sd
Fraction of Farm income under Female Control	0.12	0.98
	(0.32)	(0.12)
Fraction of Non-farm income under Female Control	0.13	0.94
	(0.29)	(0.20)
Fraction of Public transfers under Female Control	0.21	0.99
	(0.41)	(0.12)
Fraction of Private transfers under Female Control	0.27	1.00
	(0.43)	(0.07)
Observations	8786	2245

Source: Malawi Integrated Household Survey (IHS4) 2016

Notes: Farm income includes income from crop and livestock sales; Nonfarm income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Public transfers include both public cash and food assistance, private transfers are remittances. Analysis excludes income from household enterprises.

Table 2.11: Household income controlled by female household head by source: Households with and without adult men

	Adult Male is Spouse mean/sd	Adult Male Not Spouse mean/sd
Fraction of Farm income under Female Head Control	0.35	0.79
	(0.47)	(0.40)
Fraction of Non-farm income under Female Head Control	0.29	0.43
	(0.40)	(0.41)
Fraction of Public transfers under Female Head Control	0.60	0.83
	(0.50)	(0.38)
Fraction of Private transfers under Female Head Control	0.40	0.87
	(0.49)	(0.33)
Observations	202	704

Source: Malawi Integrated Household Survey (IHS4) 2016

Notes: Farm income includes income from crop and livestock sales; Nonfarm income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income. Public transfers include both public cash and food assistance, private transfers are remittances. Analysis excludes income from household enterprises.

Table 2.12: Logistic regression for female control over hh. income stream as a function of whether the income is from public transfers (cash and kind) or other sources

Dependent Variable: Only women control a household income stream (=1)

	(1)	(2)
Income stream is from public transfer	2.17***	2.65***
(=1)	(0.28)	(0.43)
Income stream amount (Thousand MK)	1.00**	1.00**
	(0.00)	(0.00)
Income stream is from public transfer	0.99***	0.98***
(=1) * Income stream amount	(0.00)	(0.01)
Matrilineal district (=1)	1.19***	1.18*
	(0.08)	(0.1)
Only 1 household member controls	33.05***	146. 84***
income stream (=1)	(3.36)	(38.73)
Household size	1.22***	1.16***
	(0.02)	(0.02)
Age of HH head (yrs)	1.01***	1.00
	(0.00)	(0.00)
HH head is male	0.10***	0.42***
	(0.01)	(0.07)
Education of HH Head (yrs)	1.03***	1.02*
	(0.01)	(0.01)

Constant	0.024*** (0.06)	0.00*** (0.00)
Sample restricted to income streams for only married women	**No**	**Yes**
Observations	22,567	19,971

Notes: Income-Stream level regression, sample restricted to households with adult men (AM). Dependent variable is =1 if an income stream is solely controlled by one woman or jointly controlled with another woman in the household (not man). Standard errors clustered at Enumeration Area (EA) level in parentheses. "Other" sources in this model include: (1) Farm income from crop and livestock sales; (2) Nonfarm Income from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income; and (3) private remittances. Public transfers include public cash and food assistance. Food Assistance consists of Free Food and Free Maize; Cash Transfers are from the government and non-govt sources. *** p<0.01, ** p<0.05, * p<0.1

Table 2.13: Selected Empirical Evidence Base on Women's Decision-making over Income in LMICs: 1990 - 2021 (Peer-reviewed publications only).

No	Authors	Year	Location	Data Source	Income Streams	Decision-making Measure	Household headship	Respondent
1.	Schultz	1990	Thailand	Socio-Economic Survey of Thailand	Earned; Unearned (Property, Transfers)	Unearned Income (Amount)	NA	NA
2.	Duflo & Udry	2004	Ivory Coast	Cote D'Ivoire Living Standards Measurement Study (CILSS)	Crop income; Total male and female income	Plot Decision-making (Female/ Male)	Dual Adult households	NA
3.	Anderson & Eswaran	2009	Bangladesh	Matlab Health & Socio-economic Survey (MHSS)	Farm, business, wage, inheritance, jewelry from dowry	'Some say in decisions'	Male	Only women (in absence of other hh. members)
4.	Alkire et al. (WEAI)	2013	Guatemala, Uganda, Bangladesh	Primary Survey; Qualitative interviews & case studies	Aggregate	Sole & Joint Decision-making	Only female adults; only male adults; male and female adults	Adult male and female

5.	Alwang et al.	2017	Ecuador	Primary Survey	Crop sales; pesticide purchase	Sole & Joint Decision-making	Dual	Only wife; only husband; both
6.	Anderson et al.	2017	Tanzania	Primary Survey	Cash crop; livestock	Sole & Joint Decision-making	Male	Principal Male & Female Decision-maker in HH.
7.	Behrman	2017	Malawi	Malawi Demographic & Health Survey (DHS)	Large and daily household purchases; partner's income	'Participation' in decisions	Dual Adult households (NA)	Only women
8.	Bonilla et al.	2017	Zambia	Primary Survey; Qualitative interviews	Daily and major household purchases; purchases for children own & partner's income,	Sole & Joint Decision-making	Male	Women (survey); women & men (interviews)
9.	Acosta et al.	2019	Uganda	Primary Survey, Focus Groups, Participant Observation	Crop, livestock; food, education, & major household expenses	Sole & Joint Decision-making	Male	Principal Male & Female Decision-maker in HH.
10.	Djurfeldt et al.	2018	Malawi	Primary Survey; Qualitative interviews; Focus Groups	Aggregate; Farm, nonfarm	Sole & Joint Decision-making	Gender of the farm manager	Self-identified farm manager - female or male (survey); Individual & key informant interviews

11.	Holland,& Rammohan	2019	Bangladesh	Bangladesh Integrated Household Survey (BIHS)	Income (Aggregate, based on WEAI)	Has input on income use from own activities	Male & Female	Not specified
12.	Njuki et al.	2019	Ghana, Rwanda, Mozambique	Feed the Future Surveys	Crop, Livestock, Nonfarm enterprise, Wage	Has input into most/all/ some/few/ no decisions	NA	Women & men
13.	Field et al.	2021	India	RCT	Purchase Index; Decision-making index:	Women sometimes / always uses funds for {activities}; has say in how own income is spent	Male	Only women

Notes: NA= Not available

CHAPTER 3: NEGATIVE RAINFALL SHOCKS AND WOMEN'S CONTROL OVER INCOME: EVIDENCE FROM MALAWI

Section 1: Introduction

The effect of rainfall shocks on women's decision-making over household income[26] receives scant attention in the literature. A link between rainfall shocks and adverse outcomes for women and girls has been established (Björkman-Nyqvist, 2013; Miguel, 2005; Rose, 1999; Sekhri & Storeygard, 2014), however the relationship between these shocks and women's household decision-making is not well understood. I aim to answer two questions in this paper: First, do drought shocks affect women's control over household income? Second, do changes in women's control over income, if any, vary by household income source and kinship structures?

Understanding the relation between rainfall shocks and women's decision-making over household income is important for the following reasons. First, many households in low and middle-income countries experience rainfall shocks, and these are often income shocks (Björkman-Nyqvist, 2013; Miguel et al., 2004; Rose, 1999) as livelihoods are highly dependent on agriculture. Climate variability is on the rise worldwide, and adverse weather conditions such as droughts and floods are becoming more prevalent (Cook, 2018; Ogunrinde et al., 2021; Ongoma et al., 2018). Households may not pool risk in response to these shocks, leaving women and girls to bear the brunt of adverse events such as drought. Examining the effect on women's decision-making over income helps understand if and how households reallocate resources in response to rainfall shocks. Second, if rainfall shocks affect women's decision-making over income, this may have implications for women and children's welfare. Women's access to monetary resources is linked to beneficial outcomes for the household, including for children and women themselves (Malapit et al., 2015; Cunningham et al., 2015). Improving women's control over income also has intrinsic value (Kabeer, 1999), as this is a direct measure of women's empowerment or the ability to assert preferences**.** Finally, understanding if the effect of rainfall shocks on women's control over income varies by income source can inform the choice of gender-sensitive policy interventions to improve women's well-being and productivity.

[26] I use the term 'decision-making over income' and 'control over income' interchangeably

A rainfall shock may affect women's control over household income for the following reasons. First, the adoption of consumption smoothing strategies in response to rainfall shocks varies by gender of household members. Socio-cultural norms restricting women's mobility (Jost et al., 2016) mean that men are more likely to migrate for seeking employment (Gray & Mueller, 2012). In the event of crop losses following rainfall shocks, men are also more likely to diversify income sources through non-farm or off-farm employment than women (Akampumuza & Matsuda, 2017; Ito & Kurosaki, 2009). Male outmigration and off-farm employment in response to rainfall shocks may leave women in charge of agricultural work and affect women's decision-making over agricultural income. Second, households in LMICs often rely on remittances sent by family and friends in order to smooth consumption following a rainfall shock (Jack & Suri, 2014; Riley, 2018; Yang & Choi, 2007). Women are more likely to control income from remittances (Patwardhan, 2022) than income from the farm and non-farm earnings. Thus, if remittances form a higher proportion of household income following a rainfall shock, we should expect to see a corresponding increase in women's control over household income. Finally, if crop losses and/or lower livestock productivity after rainfall shocks mean that households have scarcer resources, this may result in higher intrahousehold conflict (Heath et al., 2020), altering women's decision-making over income.

Previous literature on climate shocks and household welfare has examined effects on agricultural production (Letta et al., 2018) and income (Amare et al., 2018), as well as food security (Demeke et al., 2011), consumption (Asfaw & Maggio, 2018; Haile et al., 2018) and migration (Kubik & Maurel, 2016). Specific to the gendered impacts of rainfall shocks, studies link drought with excess female mortality (Rose, 1999), decreased school enrolment for girls (Björkman-Nyqvist, 2013), higher dowry related deaths and reported domestic violence (Sekhri & Storeygard, 2014) and a decrease in female land and non-land assets (Quisumbing et al., 2018). The effects of temperature shocks differ by gender as well. Two studies Asfaw and Maggio (2018) and Lee et al. (2021) examine the link between high temperature, per capita consumption, and labor supply. In Malawi, Asfaw and Maggio (2018) find that temperature shocks reduce household consumption, that negative effects are more pronounced in households with sole female plot management, and that the negative effect of sole female plot management on household welfare persists only in patrilineal districts. In Tanzania, Lee et al. (2021) find that heat stress reduces male but not female family agricultural labor, and that in households with only female adults, heat stress increases labor

supply. None of these studies, however, examine how rainfall shocks affect women's decision-making over income.

Existing research on climate shocks and household welfare considers gender differences at the household level, either by household headship or at the intrahousehold level, but rarely examines differences by kinship patterns. To my knowledge, Asfaw and Maggio (2018) is the only study that examines the variation in the effects of rainfall and temperature shocks on household consumption in Malawi by the matrilineal or patrilineal nature of the household. The authors find that temperature shocks decrease consumption in households where farm plots are managed solely by women, but that this effect is seen only in patrilineal districts. This difference is attributed to higher adoption of climate-resilient agricultural technologies including legume intercropping, hybrid seeds, soil and water conservation in matrilineal districts, potentially due to better land tenure security for women (ibid.).

The anthropology literature has long considered the "matrilineal puzzle" (Richards, 1950), i.e., the proposition that the existence of matrilineal kinship systems is puzzling, as spouses have lower cooperation and are less altruistic towards each other than under patrilineal kinship (Lowes, 2020). There are two primary explanations for this behavioral pattern in matrilineal social structures (ibid.). Higher female autonomy provides the wife with a better outside option and a lower fear of reprisal in case of non-cooperation with the husband. Also, men are obligated to financially support their sisters and sisters' children, while women maintain allegiance to their brothers who provide support. Given that the relationship between spouses under matrilineal kinship is characterized by lower cooperation and lower altruism, and that women have higher autonomy, the effect of rainfall shocks on household decision-making may differ from under patriliny. If drought shocks reduce cooperation between spouses to a larger extent in matrilineal societies compared with a patrilineal society, then we may expect to see more sole decision-making over household income by women following shocks. However, this has not been examined quantitatively.

I employ a household-year fixed effects estimation to examine the effects of drought shocks on women's control over household income, using three waves of nationally representative panel data (2013-16-19) from Malawi, merged with historical rainfall records from WorldClim. The results show that women's decision-making over income increases after drought shocks in Malawian households**.** Specifically, I find that drought shocks (defined as rainfall that is 1 or more

standard deviations (S.D.) below the 30-yr historical average) are associated with a statistically significant increase in women's sole control over agricultural income, primarily from crop sales. Additionally, joint decision-making over non-farm earnings increases significantly after a drought shock. This is accompanied by no significant decrease in the household's total income and an increase in annual non-food consumption following a drought shock. I find supportive evidence for an increase in male off-farm labor participation and female farm plot management following drought shocks, which may act as mechanisms for higher sole female control over farm income.

My paper contributes to the literature in following ways. First, to my knowledge, this is the first paper to examine the impact of drought shocks on women's decision-making over income in any context. My work makes an important contribution to the larger literature on women's economic empowerment. Control over income is typically used as a proxy for women's economic empowerment. My paper highlights that this relationship is more nuanced, and that examining the drivers of female decision-making over income is important to understanding the pathways that lead to changes in decision-making and how well this reflects women's empowerment. Second, I contribute to the literature by examining variations in the effect of drought shocks on women's control over household income by income source and kinship structure. Third, the panel nature of the dataset at the household and individual levels allows me to conduct within-household analyses over time, while controlling for unobserved time-invariant household and individual characteristics that cross-sectional or pooled cross-sectional analyses may not capture. I examine the relationship between drought shocks and women's control over income in Malawi, a Southeast African country with both matrilineal and patrilineal systems and with a variety of household income sources, including own farm income, off-farm earnings, and public and private transfers.

Section 2: Rainfall Shocks, Income Sources and Kinship in Malawi

Located in south-eastern Africa, Malawi is one of the poorest countries in the world, with high dependence on agricultural production, primarily maize. Agriculture contributes around one-third of Gross Domestic Product (GDP). More than 80 per cent of the population in the country are small-scale producers who cultivate on less than two hectares of land, and over 90% of cultivated land is rainfed. The average farm size is 1.12 hectares (ha), however over 70% of farmers have landholdings smaller than 1 ha (Asfaw & Maggio, 2018). The country is vulnerable to climate shocks, and in recent years, has faced a rising number of droughts and flooding (C. L. Anderson

et al., 2018; O'Grady, 2016). Crop losses from droughts and flooding are associated with an estimated GDP loss of over 1% annually (Pauw, et al., 2010). In addition to agricultural production, Malawian households also derive income from non-farm sources, including salaries, wages and 'ganyu' or casual off-farm labor and household enterprises. In 2016, a majority of Malawian households (85%) had some off-farm earnings (author calculations from IHS4). In the same year, around 19% of all households received remittances (author calculations from IHS4), primarily from adult children living outside of the natal village, and little over 20% received food and/or cash transfers (ibid.).

A majority of the population (around 75%) in Malawi follows a matrilineal social structure. Northern Malawi is primarily patrilineal (Takane, 2008), and the Central and Southern regions (J. A. Behrman, 2017; Berge et al., 2014) are mostly matrilineal. This social structure affects various rules of marriage and residence (ibid.), for example, whether the husband resides in a wife's village or vice versa, whether inheritance follows through the male or female line, whether bride wealth is paid to the wife's family, as well as women's land rights. Women in matrilineal societies in sub-Saharan Africa have higher land ownership (Peters, 2010) and control over agricultural income (Njuki et al., 2019). This is consistent with women in Malawi reporting higher sole and joint ownership of land (Doss et al., 2015), compared with to other countries in the region such as Uganda, Tanzania and Ethiopia. Despite matrilineal kinship and equal land rights under formal law, men are primary agrarian decision-makers (Djurfeldt et al., 2018).

Section 3: Data

I conduct an empirical investigation of the relationship between drought shocks and women's control over income in Malawi, which requires detailed data on household income and women's decision-making, as well as rainfall data. Hence, I leverage the Malawi Integrated Household Panel Survey (IHPS), combined with high-resolution rainfall data from WorldClim. The Malawi IHPS is a nationally representative panel survey that is part of the World Bank's Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) initiative. I use three rounds of data from the IHPS collected in 2013, 2016 and 2019.

The IHPS is implemented by the National Statistical office (NSO) of the Government of Malawi, with technical assistance from the World Bank. A sub-sample of 3246 households from the Integrated Household Survey (IHS 2010-11), a repeated cross-sectional survey conducted

under the LSMS-ISA umbrella, was selected to be retracked as part of the IHPS. 3104 of the baseline households (and split off households) were successfully resurveyed in 2013. IHPS 2016 tracked 2508 of the baseline households (and split off households) from IHPS 2013**.** The fourth round, surveyed in 2019-20 includes 3178 households**.** The data covers 102 Enumeration Areas (EAs) from the Northern, Central and Southern regions of Malawi. 16 sample households were selected from each EA. Household-level attrition was 3.78 % from Wave 1 to 2, 4% from Wave 2 to 3 and 5.6% from Wave 3 to 4. The survey includes sample weights to accurately represent the population.

Waves 2-4 (2013, 2016, 2019) of the IHPS collect details on household income by source and up to two household decisionmakers for various income sources, including income from temporary and permanent crop sales, and livestock product sales; non-farm earnings including salaries, wages for casual labor and allowances, public works programs, pensions, savings & investments, and rental income. Transfer income sources include remittances, and public food and cash assistance. I exclude Wave 1 (2010) as it does not contain decision-making measures for remittances and salary and wage income.

Outcome Variables: The household and agricultural survey modules collect details on household income by source. Specifically, the survey asks, "*who in the household decides/controls the use of earnings from [source]?*", with up to two household decisionmakers listed for each income source. I also examine women's control over farm decision-making, using the survey question "*Who in the household makes the decisions concerning crops to be planted, input use and the timing of cropping activities on this [PLOT]?"* I restrict my sample to households with both men (at least one adult man) and women in all panel waves, to capture meaningful variation in the outcome variable.

Table 3.1 shows patterns in control over household income in households with both men and women in all panel years. Women were sole decision-makers for 16% – 19% of total household income, depending on survey wave. Household income under sole male control reduced from 41% in 2013 to 34% in 2019. Income under joint control is sizable, with 43% to 47% income being controlled by both genders. Table 3.1 also displays the amount of income under sole and joint control of both women and men in Malawian Kwacha. Since I am interested in looking at variations in income control by source, I break down income categories into farm, non-farm, and transfers. As expected, men have sole control over a higher amount of household income than

women, but the amount under joint control is the highest. The difference in sole male and female control is primarily due to differences in the amount of farm (crop sales) and nonfarm (salaries & wages) income controlled by men and women. For transfers (both public and private), men and women exercise sole control over comparable income amounts over the panel years.

The main explanatory variable is whether a household experiences a shock due to deficit rainfall. Higher than average rainfall can improve crop yields unless it is an extremely high amount i.e. floods (Paxson, 1992; Suri, 2003). Also, a majority of existing literature on the gendered effects of weather shocks finds adverse effects to be related with dry shocks. Hence, I focus my analysis on drought shocks, which the literature largely correlates with lower crop yields and loss of income (Damania et al., 2017). The IHPS contains self-reported measures of shocks (including whether the household experienced a drought). This is a dummy variable that takes the value =1 if the household reports that they experienced this shock in the 12 months prior to the survey. Using these self-assessments of covariate shock measures can be prone to bias or measurement error. Hence, using the GPS coordinates of households in the IHPS, I merge the survey panel with data from WorldClim.org to construct a dry shock measure at the Enumeration Area (EA) level. WorldClim contains monthly temperature and precipitation data from 1960 - 2018. The spatial resolution is 2.5 minutes (~21 km2). A rainfall shock is defined as more than 1 standard deviation from the 30 year mean, as used in Riley (2018). Across the whole country, the historical average of annual rainfall (1981 – 2018) is 992mm and the historical standard deviation is 164mm. Thus, one standard deviation represents a substantial deviation, i.e., 17% away from the historical average annual rainfall in the country. My preferred specification is with the 1 standard deviation rainfall shock, although I also present the results with self-reported shocks (Appendix Table 3.12).

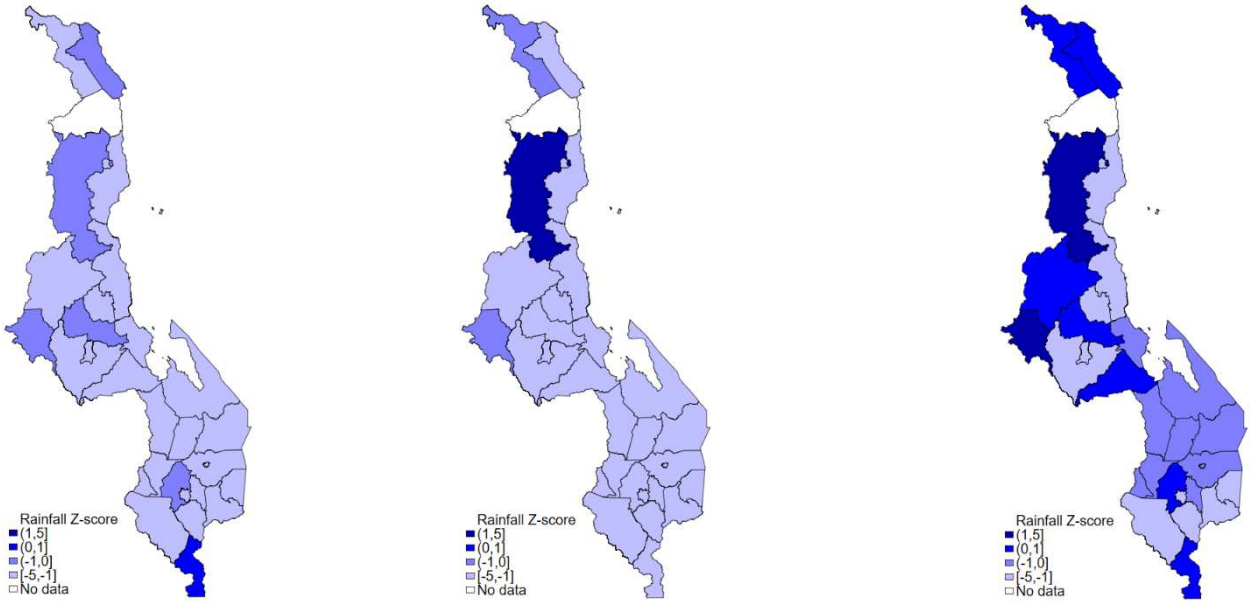
Table 3.1: Descriptive Statistics for Female Control over Income and Rainfall Shocks

	Wave 2 (2013) mean/sd	Wave 3 (2016) mean/sd	Wave 4 (2019) mean/sd
Control over Total Income (By Controller)			
Fraction of HH. Income under Sole Female Control	0.16	0.19	0.19
	(0.31)	(0.35)	(0.32)
Fraction of HH. Income under Sole Male Control	0.41	0.33	0.34
	(0.44)	(0.43)	(0.41)
Fraction of HH. Income under Joint Control	0.43	0.48	0.47
	(0.46)	(0.46)	(0.43)
Income Amount under Sole Female Control (By Category)			

Total HH income (Thousand MK)	38.57	69.04	160.84
	(312.65)	(505.39)	(1762.77)
Farm income (Thousand MK)	1.19	3.18	6.10
	(10.67)	(33.45)	(62.66)
Non-farm income (Thousand MK)	34.95	61.30	148.39
	(307.11)	(497.47)	(1759.61)
Transfer income (Thousand MK)	2.43	4.57	6.35
	(45.30)	(49.39)	(45.97)
Income Amount under Sole Male Control (By Category)			
Total HH. income (Thousand MK)	106.82	186.69	255.36
	(405.86)	(1594.85)	(944.63)
Farm income (Thousand MK)	5.76	49.93	21.55
	(36.67)	(1493.12)	(139.03)
Non-farm income (Thousand MK)	99.65	130.68	231.16
	(403.72)	(540.29)	(932.32)
Transfer income (Thousand MK)	1.41	6.08	2.66
	(14.98)	(161.96)	(30.11)
Income Amount under Joint Control (By Category)			
Total HH. income (Thousand MK)	96.47	229.95	365.37
	(402.31)	(1302.43)	(1441.79)
Farm income (Thousand MK)	18.32	63.23	31.97
	(86.48)	(839.61)	(146.44)
Non-farm income (Thousand MK)	75.66	158.26	323.51
	(393.80)	(896.00)	(1432.97)
Transfer income (Thousand MK)	2.48	8.45	9.89
	(14.22)	(98.41)	(59.04)
Rainfall Shocks			
Annual Drought Shock (< -1 S.D)	0.42	0.87	0.04
	(0.49)	(0.33)	(0.19)
Annual Drought Shock (Self-Reported)	0.27	0.42	0.31
	(0.45)	(0.49)	(0.46)
Annual Rainfall (mm)	839.42	693.14	1025.35
	(90.85)	(171.34)	(86.99)
Observations	1384	1384	1384

Source: Malawi Integrated Household Panel Survey, Waves 2-4.
Notes: Sample includes households with both men and women. Farm income includes income from crop and livestock sales; Nonfarm Income includes earnings from salaries, allowances, wages for casual labor, public works programs, pensions, savings & investments, and rental income; Transfers include remittances and public food and cash transfers.

Table 3.1 shows that using the < -1 S.D. measure, 27% of households experienced a drought shock in 2013, which rose to 42% in 2016, before dropping to 30% in 2019. This number is indicative of the severe drought that Malawi experienced in 2015-16 (O'Grady, 2016). Self-reported drought shocks are on average lower than the < -1 S.D. measure in 2013 and 2016 and higher in 2019. Figure 3.1 shows rainfall deviations by z-score by year across Malawian districts.



(a) July 2012 – June 2013 (b) July 2015 – June 2016 (c) July 2018 – June 2019

Figure 3.1: Deviations from Average Rainfall, Z-scores

Appendix Table 3.7 shows average household characteristics of the sample. The average household has just over 5 people, household heads have between 7 and 8 years of education and the majority (~90%) of households with both men and women are male-headed. A little over 70% of households are rural, and the average landholding is under 2 acres (~0.6 ha). The average household is around 7 kilometers from a road over the panel years, but the distance to the nearest market drops from over 5 kms in Wave 2 and 3 to just 1 km in Wave 4. Households owned assets worth 137,000 Malawian Kwacha (MK)[27] or approximately USD 170 in 2013, which rose up to 194,000 MK (~USD 244) in 2016 and 359,000 MK (~USD 450) in 2019. Annual non-food consumption more than doubled from 16510 MK in 2013 to 36569 MK in 2019.

Estimating Equation

To empirically test the effect of EA-level drought shocks on women's control over household income, I estimate OLS fixed effect (FE) regressions of the form:

$$Log(y_{ht}) = \alpha + \gamma DroughtShock_{ht} + \varphi_h + \psi_t + \varepsilon_{ht} \quad (1)$$

[27] 1 United States Dollar = 794 MK at current exchange rates.

where Log (y_{ht}) is the natural logarithm value of the dependent variable (household income[28] under sole female control) for household *h* in wave *t*, φ_h and ψ_t are household and year dummies, $DroughtShock_{ht}$ is the drought shock for household *h* in wave *t*, and ε_{ht} is a household-specific error term. To examine the effect of drought shocks on sole male control and joint control, I estimate a similar FE regression, where Log (y_{ht}) is the natural logarithm value of income under sole male control and joint control, respectively. To test the effect of a drought shock on control over different income categories, I estimate separate household FE models with the predictor of interest ($DroughtShock_{ht}$) and with the outcome variables as the natural logarithm of farm income, non-farm employment income, and transfer income under sole female, sole male, and joint control, respectively. To test the effect of drought shocks on female decision-making over farm plot management, I estimate a regression of the form:

$$P(FemPlot_{ht}) = \alpha + \gamma DroughtShock_{ht} + \varphi_h + \psi_t + \varepsilon_{ht} \quad (2)$$

where $P(FemPlot_{ht})$ is the probability that household *h* in wave *t* has a farm plot under sole female control, φ_h and ψ_t are household and year dummies, $DroughtShock_{ht}$ is the rainfall shock for household *h* in wave *t*, and ε_{ht} is a household-specific error term. Following (Alam & Pörtner, 2018), I am careful to not include household-level covariates that are time-invariant and/or endogenous (for instance, yield), i.e., which may be affected by drought shocks.

Section 4: Results

4.1 Women's Control over Income

In Table 3.2 below, I find that drought shocks (defined as < -1 S.D. from the historical annual rainfall average) are associated with an annual increase of approximately 25,000 MK (~ USD 30) in sole female control over household income in households with both men and women, although this is not statistically significant (CI: -24370 to + 74,604). The distribution of household income controlled by women is highly skewed, since women do not have sole control over any household income in over 70% of households. Hence, I also present results from a logarithmic transformation

[28] Owing to data limitations and non-random selection into response, I prefer using the natural logarithm over an alternative construction of the dependent variable as the share of female-controlled income

of the dependent variable. The point estimate for the log estimate in column 2, although negative, suffers from a large standard error.

Table 3.2: The Effect of Drought Shocks on Women's Control over Household Income

VARIABLES	(1) Income under Sole Female Control	(2) Log (Income under Sole Female Control)
Drought Shock (< -1 S.D.)	25,117	-0.05
	(24,947)	(0.29)
Constant	19,615	2.96***
	(13,610)	(0.15)
Year FE	Yes	Yes
Household FE	Yes	Yes
Observations	4,094	4,094
Number of households	1,384	1,384
Mean of dep. var. (000' MK)	89.5	89.5

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Income is in Malawian Kwacha. 1 MK = 794 USD at 2021 exchange rates. Female Control refers to sole decision-making over an income by women. *** p<0.01, ** p<0.05, * p<0.1

Table 3.3 presents estimates of the effect of drought shocks on women's sole control over farm, nonfarm and transfer income. Drought increases sole female control over farm income by 46%. This is a substantial increase, given that in households with both men and women, women control an average of only 16% of farm income, across all survey waves (average control varies between 13% and 19% by survey year). There is no significant effect on women's sole control over nonfarm earnings and transfers.

Table 3.3: The Effects of Drought Shocks on Women's Control over Farm, Non-Farm and Transfer Income

Dependent Variable: Log (Income under Sole Female Control)

VARIABLES	(1) Farm	(2) Non-Farm	(3) Transfer
Drought Shock (< -1 S.D.)	0.46**	-0.17	0.01
	(0.22)	(0.23)	(0.14)
Constant	0.50***	2.26***	0.62***
	(0.11)	(0.13)	(0.08)
Year FE	Yes	Yes	Yes
Household FE	Yes	Yes	Yes

Observations	4,094	4,094	4,094
Number of households	1,384	1,384	1,384
Mean of dep. var. (000' MK)	3.5	81.5	4.5

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Female Control refers to sole decision-making over income by women. *** p<0.01, ** p<0.05, * p<0.1

Table 3.4 presents estimates of the effect of drought shocks on joint control over farm, nonfarm and transfer income. Drought increases joint control over total household income by 37%. This is a substantial increase, given that in households with both men and women, an average of 46% of income is jointly controlled, across all survey waves (average control varies between 43 and 47% by survey year). Drought also increases joint control over nonfarm earnings by 58% (p<0.10), while joint control over farm income also increases by 25% (n.s.).

Table 3.4: The Effects of Drought Shocks on Joint Control over Income

Dependent variable: Log (Income under Joint Control)

	(1)	(2)	(3)	(4)
VARIABLES	Total	Farm	Non-Farm	Transfer
Drought Shock (< -1 S.D.)	0.37	0.25	0.58*	-0.21
	(0.36)	(0.32)	(0.33)	(0.18)
Constant	5.43***	3.04***	2.86***	1.08***
	(0.19)	(0.18)	(0.16)	(0.11)
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Observations	4,094	4,094	4,094	4,094
Number of households	1,384	1,384	1,384	1,384
Mean of dep. var. (000' MK)	230	37.8	185.8	6.9

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Joint Control refers to joint decision-making over income by a woman and man. *** p<0.01, ** p<0.05, * p<0.1

Combined with the results in Tables 3.2 and 3.3, this suggests that whether a drought shock increases women's sole or joint control over income depends on whether income is from the farm or from non-farm earnings. In case of farm income, drought increases sole female control, while for non-farm income, drought only increases joint control with a male household member. In section 4.2, I examine whether this result is driven by an increase in male off-farm labor participation in response to drought shocks.

Appendix Table 3.8 presents estimates for sole male control over household income in response to drought, using the same panel data. The estimation suffers from large standard errors for total, nonfarm and farm income, but the point estimates for total and nonfarm income are small and not statistically significant, and the point estimates for farm and transfer income are negative. Overall, I do not find conclusive evidence that sole male control over income increases after a drought shock, contrary to the findings on sole female and joint control.

Appendix Table 3.11 shows the effect of drought shocks on household, farm, non-farm, and transfer income and annual non-food consumption for different drought magnitudes. Although most of the point estimates for income are negative, the estimation is imprecise due to large standard errors. Hence, it is difficult to conclude that there is a significant negative effect of drought shocks (of differing magnitudes) on household income. Additionally, there is a positive effect on non-food consumption, except in the case of most 'severe' drought.

4.2 Mechanisms

A proposed mechanism in this paper is that in the event of crop losses following drought shocks, men are more likely to diversify income sources through off-farm employment than women, and leave women in charge of agricultural work. Table 3.5 below shows the effect of drought shocks on male off-farm labor participation in households with both men and women. Column 1 shows that a drought shock increased the probability of men engaging in off-farm work[29] by 4 percentage points (CI: -0.01 to +0.10). Across all survey waves, 30% of households on average have men who engage in off-farm labor, so this is a substantial increase. Column 2 shows that drought shocks are associated with a 6% increase in the number of men's annual off-farm labor hours, although this estimate is not statistically significant. (CI: -0.23 to +0.36). Together, this provides suggestive evidence that men diversify income through off-farm labor in response to drought. I cannot explicitly reject male out-migration as an alternative mechanism explaining the increase in sole female control over farm income, due to data limitations in the Malawi IHPS. However, the sample for all regressions in my analyses is restricted to households with both men and women in all survey waves. Also, the increase in joint control over non-farm income (Table 3.4) suggests that men are not absent from the household. This allows me to cautiously conclude that higher

[29] This excludes 'Ganyu', i.e., hired farm labor.

male off-farm labor is one pathway through which drought shocks results in higher sole female control over farm income.

Table 3.5: Drought Shocks, Male Off-Farm Labor Participation & Women's Farm Decision-making

VARIABLES	(1) Hh. has a man engaged in off-farm labor	(2) Off-farm labor hours in last 12 months (log)	(3) Hh. has a farm plot under sole female control
Drought Shock (< -1 S.D.)	0.04*	0.06	0.07**
	(0.03)	(0.15)	(0.03)
Constant	0.26***	1.50***	0.12***
	(0.01)	(0.06)	(0.01)
Year FE	Yes	Yes	Yes
Household FE	Yes	Yes	Yes
Observations	1384	1384	1384
Number of households	4094	4094	4094
Mean of dep. var.	0.30	253	0.20

Notes: Household-year fixed effects regression. Column 1 is a linear probability estimation and Column 2 is a linear regression estimation. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Off-farm labor excludes "ganyu" or casual labor performed on other farms.

If men diversify income-generation activities in response to drought, either through higher off-farm labor or migration, this may leave women with higher farming responsibility. Hence, I test the effect of drought shocks on women's farm plot management. Column 3 in Table 3.5 shows drought shocks lead to a 7 percentage point increase in the probability that a household has a farm plot managed solely by women ($p<0.05$). This is a substantial increase, given that on average, only 20% of households have at least one farm plot under sole female management across all survey waves (percentage of households where women are sole managers of a farm plot varies between 15 and 28% by survey year).

4.3 Matrilineal Kinship

Next, I test whether matrilineal kinship, which is associated with higher women's land tenure security (Asfaw & Maggio, 2018), lower spousal cooperation, and higher female autonomy (Lowes, 2020), affects the relationship between drought shocks and women's control over farm plots and income. I classify a household as located in a matrilineal or patrilineal district, based on

the district classification in Berge et al. (2014) and re-estimate the specifications in Table 3.2 and 3.3 for this subsample. As the matrilineal classification of a district is a time-invariant variable, including it as a dummy in the main fixed effects specification would be infeasible. Column 1 of Table 3.6 shows that the point estimate for the effect of drought shocks on women's sole control over household income increases to 0.23 (from -0.05 in the full sample). That is, in matrilineal districts, drought increases sole female control over household income by 23%. The effect on farm income remains statistically significant ($p<0.05$) and the point estimate increases from 0.46 in the full sample to 0.65, i.e., drought shocks increase farm income under sole female control by 65%.

Table 3.6: Drought Shocks & Women's Control over Income in Matrilineal Districts

Dependent Variable: Log (Income under Sole Female Control)

VARIABLES	(1) Total	(2) Farm	(3) Non-Farm	(4) Transfer
Drought Shock (< -1 S.D.)	0.23	0.65**	-0.22	0.07
	(0.38)	(0.30)	(0.30)	(0.18)
Constant	3.07***	0.48***	2.43***	0.66***
	(0.18)	(0.13)	(0.15)	(0.08)
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Observations	3,464	3,464	3,464	3,464
Number of households	1,171	1,171	1,171	1,171
Mean of dep. var. (000' MK)	98.3	3.78	89.95	4.6

Notes: Household-year fixed effects regression. Columns 1 – 4 are linear regression estimations and Column 5 is a linear probability estimation. Sample restricted to households with adult men and women in matrilineal districts. Standard errors clustered at Enumeration Area (EA) level in parentheses. Female Control refers to sole decision-making over income by women. *** p<0.01, ** p<0.05, * p<0.1

Appendix Table 3.9 presents results for joint control in matrilineal districts. The co-efficient on joint control over non-farm earnings is similar in magnitude to the full sample, but drought increases joint control over farm income by 65% in matrilineal districts, as opposed to 25% in the full sample.

Section 5: Conclusion

My paper estimates the effect of drought shocks on women's control over household income in Malawi, using panel data spanning six years (2013-19). Household fixed-effects account for household-level time-invariant unobservables that may be correlated with women's control over

income. For instance, a household's ability to receive information and prevailing social norms are unobserved determinants of women's control over income, which may also affect resilience to drought shocks. Year fixed effects account for any idiosyncratic changes in women's control over household income over time. My main conclusion is that drought shocks increase women's sole control over farm income and joint control over nonfarm earnings. I find that drought shocks may not be significantly decrease household income and in fact, increase household non-food consumption, suggesting that a pathway other than income or consumption loss mediates the effects of these shocks on women's control over income. I present suggestive evidence that higher male off-farm labor participation and women's farm plot management act as channels for these results, with the caveat that current data do not allow me to rule out male outmigration as an alternative explanation. Future analyses should examine the role of male outmigration as well and intrahousehold conflict as mechanisms.

Women's formal labor force participation is decreasing in many low and middle-income countries, but the 'feminization of agriculture' is an increasing trend (Asadullah & Kambhampati, 2021; Slavchevska et al., 2016). Male outmigration and diversification into off-farm labor, combined with other factors including climate change, war and conflict, and diseases such as HIV that disproportionately affect men, contribute to an increasing role for women in agriculture. Given this context, examining rainfall variability as a driver of women's decision-making over different sources of income provides a new lens to understanding women's empowerment. Women's control over income is considered as an important dimension of women's economic empowerment (Laszlo et al., 2020b) and household surveys such as the Demographic and Health Surveys (DHS) and the Living Standards Measurement Study (LSMS) typically use measures of decision-making as proxies for women's economic empowerment. Improvements in women's control over income may also influence gender norms and increase female labor supply in the long run (Field et al., 2021). The extent to which the underlying determinants of control over income matter is relatively less studied. Changes in female decision-making over income in response to climatic factors such as rainfall variability may be accompanied with higher workload for women on the farm and at home, and may not reflect an absolute improvement in women's empowerment. To shape an understanding of decision-making over income as a dimension of women's economic empowerment, future research should further explore the relationship between women's empowerment and the drivers of women's decision-making over income.

Appendix

Table 3.7: Descriptive Statistics by Survey Wave for Household Characteristics

	Wave 2 (2013) mean/sd	Wave 3 (2016) mean/sd	Wave 4 (2019) mean/sd
Fraction of HH. Farm Income under Sole Female Control	0.13	0.15	0.19
	(0.33)	(0.35)	(0.38)
Fraction of HH. Non-Farm Income under Sole Female Control	0.17	0.21	0.19
	(0.32)	(0.37)	(0.33)
Fraction of HH. Transfer Income under Sole Female Control	0.30	0.32	0.33
	(0.45)	(0.46)	(0.46)
Value of hh. assets (Thousand MK)	137	194	359
	(808)	(891)	(1825)
Annual non-food consumption (MK)	16510	29429	36570
	(57627)	(100874)	(173460)
Total hh. income (Thousand MK)	777	1615	3074
	(2586)	(6107)	(9715)
Distance to nearest road (kms)	7.7	7.8	7.3
	(9.8)	(9.9)	(9.4)
Distance to nearest market (kms)	5.9	5.5	1.1
	(24.4)	(7.9)	(1.0)
Household Size	5.45	5.56	5.40
	(2.34)	(2.27)	(2.28)
Household head is male	0.92	0.91	0.90
	(0.27)	(0.28)	(0.30)
Age of household head (yrs)	41.7	44.4	47.0
	(14.3)	(14.00)	(13.9)
Education of household head (yrs)	7.6	7.3	7.8
	(3.9)	(3.8)	(4.0)
Male hh. member engaged in off-farm labor excluding ganyu (Yes/No)	0.31	0.33	0.27
	(0.46)	(0.47)	(0.44)
Male off-farm labor (non-ganyu) in past 12 months (hours)	284.10	250.85	203.31
	(666.59)	(620.97)	(542.07)
Acres owned	1.56	1.77	1.67
	(1.94)	(2.04)	(1.91)
Poultry (count)	3.78	3.09	3.46
	(9.04)	(10.39)	(7.73)
Other livestock (count)	2.02	2.38	2.50
	(7.32)	(9.06)	(9.59)
Rural	0.72	0.73	0.72
	(0.45)	(0.44)	(0.45)
Observations	1384	1384	1384

Source: Malawi Integrated Household Panel Survey, Waves 2-4. Notes: Sample includes households with both men and women.

Table 3.8: Drought Shocks and Sole Male Control over Household Income

VARIABLES	(1) Total	(2) Farm	(3) Non-Farm	(4) Transfer
Drought Shock (< -1 S.D.)	-0.04	-0.22	0.00	-0.18
	(0.35)	(0.22)	(0.33)	(0.18)
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Observations	4094	4094	4094	4094
Number of households	1384	1384	1384	1384
Mean of dep. var. (000' MK)	183	25.74	153.83	3.38

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Income is in Malawian Kwacha. 1 MK = 794 USD at 2021 exchange rates. Male Control refers to sole decision-making over income by men.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.9: Drought Shocks and Joint Control over Household Income in Matrilineal Districts

Dependent Variable: Log (Income under Joint Control)

VARIABLES	(1) Total	(2) Transfer	(3) Farm	(4) Non-Farm
Drought Shock (< -1 S.D.)	0.53	-0.11	0.63*	0.58
	(0.43)	(0.20)	(0.37)	(0.41)
Constant	5.20***	1.00***	2.72***	2.73***
	(0.22)	(0.12)	(0.20)	(0.19)
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Observations	3,464	3,464	3,464	3,464
Number of households	1,171	1,171	1,171	1,171
Mean of dep var. (000' MK)	240.1	6.43	40.57	193.1

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Income is in Malawian Kwacha. 1 MK = 794 USD at 2021 exchange rates. Joint Control refers to sole decision-making over income by a man and woman.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.10: Drought Shocks and Sole Male Control over Household Income in Matrilineal Districts

Dependent Variable: Log (Income under Sole Male Control)

VARIABLES	(1) Total	(2) Transfer	(3) Farm	(4) Non-Farm
Drought Shock (< -1 S.D.)	0.19	-0.13	0.10	0.14
	(0.41)	(0.19)	(0.26)	(0.39)
Constant	5.5***	0.51***	1.50***	4.52***
	(0.21)	(0.08)	(0.11)	(0.22)
Year FE	Yes	Yes	Yes	Yes
Household FE	Yes	Yes	Yes	Yes
Observations	3,464	3,464	3,464	3,464
Number of households	1,171	1,171	1,171	1,171
Mean of dep var. (000' MK)	240.1	6.43	40.57	193.1

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Income is in Malawian Kwacha. 1 MK = 794 USD at 2021 exchange rates. Male Control refers to sole decision-making over income by a man.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.11: Drought Shocks and Household Income

Dependent Variable: Log (Household Income) & Log (Annual Non-Food Consumption)

Drought Shock (Annual Rain)	(1) Total Income	(2) Farm Income	(3) Non-Farm Income	(4) Transfer Income	(5) Non-Food Consumption
< - 0.5. S.D.	-0.22	-0.36	-0.21	-0.38	0.47**
	(0.23)	(0.33)	(0.38)	(0.30)	(0.22)
< - 1 S.D.	0.02	0.05	0.50	-0.25	0.35*
	(0.27)	(0.43)	(0.33)	(0.24)	(0.21)
< - 1.5 S.D.	0.11	-0.12	0.52	-0.39	0.33
	(0.31)	(0.40)	(0.39)	(0.28)	(0.20)
< -2 S.D.	-0.13	-0.75**	0.01	-0.37	0.02
	(0.28)	(0.38)	(0.37)	(0.28)	(0.22)
Household FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	4094	4094	4094	4094	4152
Households	1384	1384	1384	1384	1384

Notes: Household-year linear fixed effects regression. Sample restricted to households with adult men and women. Standard errors clustered at Enumeration Area (EA) level in parentheses. Income is in Malawian Kwacha. 1 MK = 794 USD at 2021 exchange rates. Male Control refers to sole decision-making over income by a man.
*** p<0.01, ** p<0.05, * p<0.1

Table 3.12: Annual Self-Reported Drought Shocks and Women's Control over Household Income

VARIABLES	(1) Log (Total Income under Female Control)	(2) Log (Transfer Income under Female Control)	(3) Log (Farm Income under Female Control)	(4) Log (Non-Farm Income under Female Control)
Drought Shock (Self-Reported)	0.04	0.16	0.02	-0.03
	(0.21)	(0.13)	(0.15)	(0.19)
	(0.19)	(0.13)	(0.18)	(0.15)
Constant	2.99***	0.59***	0.70***	2.25***
	(0.13)	(0.08)	(0.11)	(0.11)
Household FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	4,095	4,095	4,095	4,095
Number of households	1,384	1,384	1,384	1,384

Table 3.13: Drought Shocks by Survey Wave

	No of Households experiencing drought shock (%)		
Drought Shock (Annual Rain)	2013	2016	2019
< - 0.5 S.D.	66%	91%	15%
< - 1 S.D.	42%	87%	4%
< - 1.5 S.D.	21%	77%	3%
< -2 S.D.	8%	39%	0.7%
Self-Reported	27%	42%	31%
Households	1384	1384	1326

RESEARCH AND POLICY IMPLICATIONS

The first study's findings on wealth heterogeneities in the Mamata Scheme's impact suggests that depending on the context, governments and other funders may consider targeting marginalized groups. Recent evidence on cash transfer and child nutrition from Nigeria (Carneiro et al., 2020) demonstrates that a higher frequency, size and duration of transfer, as well as geographical targeting may be instrumental in improving child nutrition in the long run. The lack of improvement in HAZ following the implementation of the Mamata Scheme suggests that for improvements in long-run nutrition (stunting), investments in complementary factors such as maternal education, access to clean water and sanitation and health care are important, in addition to budgetary allocations for maternal cash benefit programs.

The second study's findings that women retain higher control over transfers than other income sources, even when men are present, suggests that targeting transfers to women in dual-adult or male-headed households may yield benefits (in addition to targeting female-headed households or households where men are absent). This is line with other experimental and quasi-experimental evidence that finds that cash and in-kind transfers consistently increase women's household decision-making power, in contrast to access to financial resources through jobs and employment, microcredit, and savings groups (JPAL, 2020).

Finally, the third study's results suggest that if increases in women's control over farm income and decision-making are driven by climatic factors, this needs to be accompanied by policies to improve women's wellbeing and productivity. Female farmers tend to have lower access to information on climate change and climate-smart-agriculture practices (Slavchevska et al., 2016), leading to lower adoption rates compared to men. Interventions to improve women's land tenure security, access to agricultural inputs, and safety nets including cash transfers can play an important role in motivating women to adopt practices water-soil-conservation, hybrid seeds , intercropping and improve agricultural productivity.

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