HOUSEHOLD BEHAVIOUR AND INTRAHOUSEHOLD RESOURCE ALLOCATION: AN EMPIRICAL ANALYSIS

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Economics)
in The University College London
2012

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I, Aminur Rahman, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

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This thesis analyses intrahousehold resource allocation issues related to nutrition and food distribution, nutrient demand, and child health and nutrition outcomes in rural Bangladesh using relevant microeconometric methods and their application to household surveys. Using a measure of bargaining power — spouses' assets at marriage — that is culturally relevant and (weakly) exogenous to household decision making process, I find strong evidence of intrahousehold bargaining on nutrient allocation and on distribution of food from relatively expensive sources. In this regard, a wife's bargaining power positively affect the allocation of the adult females at the expense of that of adult males. The bargaining effects are significant even after controlling for unobserved household characteristics and potential health-nutrition-labour market linkages. Spouses' preference and bargaining also tend to vary at different income levels. At the low income level, a wife prefers preschooler boys to preschoolers girls while the preschooler girls to preschooler boys at the middle income level in intrahousehold food distribution. Son-preference in intrahousehold food distribution is also guided by cultural norms and appears to be prominent in non-poor households as opposed to poor households in Bangladesh. Using a characteristic demand framework, I also find that individuals' intakes of calorie, macronutrients, and a set of micronutrients are inelastic to implicit calorie price while the own and cross implicit price elasticities for a range of critical micronutrients are highly elastic to implicit micronutrient prices. Calorie intake appears to be highly inelastic for both poor and non-poor while both the macro and micronutrient intakes of the poor compared to that of the non-poor are more responsive to implicit macro and micronutrient prices. Finally, analysing the effect of household structure on child outcomes, I find that child education, but not health outcomes, to be substantially better in nuclear families than in extended families. These findings have important implications in terms of malnutrition, food policy, and human capital formation in a poor rural economy.

With deep appreciation and gratitude, I dedicate this Thesis to my wife, Lisa, my daughters, Azrin and Arin, my parents, and my late father-in-law,

A. M. M. A. Khaliq

ACKNOWLEDGEMENTS

I am grateful to Richard Blundell, my principal supervisor for making this thesis possible. I am also grateful to Andrew Chesher, for being my co-supervisor. I have been benefited enormously from the supervision and comments from Richard and Andrew. I am grateful to Lena Edlund for her collaboration on Chapter 6. I would like to thank Hidehiko Ichimura, Andrew Newman, and Ian Preston for the many helpful discussions and suggestions at the early stages of this research. Thanks also to Giacomo De Giorgi for his comments and responding patiently to my numerous questions and requests. I would like to thank IFPRI, and particularly, Howarth Bouis, Agnes Quisumbing, and Wahid Quabili for sharing the data and responding to my endless queries about the survey and the data. Chapter 4 is a by-product of my research with Howarth. I am grateful to Sonia Bhalotra and Imran Rasul for their detailed, thoughtful and inspiring comments and feedback.

UCL, and particularly its Economics Department is a very friendly and stimulating environment for learning, and I am indebted to the College and the Department for providing that environment. Along with the excellent sets of PhD Courses and Seminar Series at UCL, I benefited from the LSE Development Economics Course of Tim Besley and Robin Burgess, and the UCL-LSE Development Economics Seminar Series.

I gratefully acknowledge the financial contributions from British Chevening Scholarship, Frederick Bonnart-Braunthal Scholarship of UCL, and the Royal Economic

Society Junior Fellowship. I must mention that I was moved by Colonel Bonnart-Braunthals deep interest in my thesis, and am honored that he always made an effort to meet with me at UCL and took great interest to learn about the progress of my research.

I am grateful to my parents, my sister and her family, and my mother-in-law for their constant motivation and encouragement to complete this thesis. After all, this thesis is all about family. Many thanks to Albab Akanda for his editorial review and comments, and to Tanjila Sultana for her comments and suggestions.

Being an economist by himself, my father-in-law was always an eager reader of my work, and very much looked forward to the completion of this thesis. Sadly, he passed away during the course of my research. Even in his last days, he was very eager to learn about the progress of the thesis. He would have been a very happy person to see this thesis.

Finally, I am deeply indebted to my wife and two little daughters for their incredible patience, constant inspirations, and endless sacrifices of family moments without which I could not have completed this thesis. Indeed, the thesis is dedicated to them, my parents, and the memory of my father-in-law.

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CHAPTER I

Introduction

The thesis analyses intrahousehold resource allocation issues related to nutrition and food distribution, individual demand for nutrients, and household structure and child health and nutrition outcomes in rural Bangladesh using relevant microeconometric methods and their application to household surveys. Chapter 2 analyses the role of gender in intrahousehold nutrient allocation in a bargaining framework, while Chapter 3 focuses on the role of intrahousehold bargaining on the distribution of food from different sources varying in terms of costs and nutrient contents. Chapter 4 analyses the role of culture in son-preference in intrahousehold food distribution by analysing the case of two agrarian economies —- Bangladesh and the Philippines — with contrasting cultural norms related to gender. Chapter 5 shifts the focus from intrahousehold food distribution to individual nutrient demand using a characteristics demand framework to analyse demand for nutrients after eliminating the non-nutritive features of food. Finally, Chapter 6 moves away from food and nutrition, and focuses on child health and education outcomes in nuclear and extended families that vary in headship – an important feature of family formation in poor countries like Bangladesh. While the thesis focuses on Bangladesh, the case of the Philippines is used in Chapter 4 as an identification purpose regarding the role of culture in intrahousehold resource allocation. Each of the thesis topics bear important policy implications for individual wellbeing in Bangladesh where poverty often shows itself in malnutrition leading to low level of human capital formation and growth, and thus repeats the cycle of poverty.

In the last few decades, the intrahousehold resource allocation literature has advanced substantially[1]. However, the progress has been limited on understanding the role of intrahousehold bargaining on individual food allocation, which is an important area in light of the growing concern of micronutrient malnutrition as a serious public health problem. Limited exploration in this area is primarily driven by the unavailability of individual dietary intake data and reliable measures of intrahousehold bargaining that are exogenous to household decision making processes. Chapters

[1] Specific citations are kept at the minimum in this introductory chapter to maintain brevity and to avoid duplication with the literature review of subsequent chapters.

2 and 3 attempt to fill this gap in the literature. Another area of limited progress is the lack of application of a single analytical framework across different socio-cultural contexts to understand the role of the later on intrahousehold resource allocation. Chapter 4 attempts to contribute to the literature in this regard.

While the literature on food demand is rich, it does not explore to what extent demand for food is driven by the nutrient contents of food vis-à-vis its non-nutritive aspects, such as taste, aroma, and class appeal. This understanding is important for designing effective and efficient food policies to fight hunger and malnutrition. While there is an extensive literature on characteristics demand, this topic is not explored in that literature either. Chapter 5 attempts to bridge the gap between these two streams of demand literature and highlights important policy implications for food-subsidy policies in a poor country like Bangladesh. Finally, while the topic of extended family has been analysed in the literature, Chapter 6 adds a different dimension by examining the effect of headship on child outcomes in nuclear and extended families.

Household Surveys

The thesis uses a number of innovative features of a unique household survey in rural Bangladesh conducted by the International Food Policy Research Institute (IFPRI). The IFPRI survey was conducted in four rounds at four month intervals during 1996-97 in 47 villages from three sites covering four districts of Bangladesh. The objective was to evaluate the impact of commercial vegetable production in Saturia (site 1), polyculture fish production in household-owned ponds in Mymensingh (site 2), and polyculture fish production in group-managed ponds in Jessore (site 3) on household income, nutrition, and time allocation of individual household members. Along with the usual information related to demography and household composition, health, education, morbidity, household expenditure, landholding, agricultural production, and other income earning opportunities, a key feature of IFPRI survey that is utilised in Chapters 2-5, is the individual food intake data collected using a 24-hour recall methodology. Similar information on individual dietary intake is also used from another IFPRI survey of 448 households (consisting 2,880 individuals) in the predominantly rural southern providence of Bukidnon, Philippines for the analysis in Chapter 4.

While the objective of most development policies is individual wellbeing, that wellbeing is often inferred from the household aggregates due to lack of individual information in the household surveys. For private goods like food, such an inference could be misleading amidst intrahousehold inequality. In this regard, the IFPRI survey is particularly useful.

Apart from the few exceptions of natural experiments that aim to use public policy changes to identify the effect of bargaining power on intrahousehold resource allocation, the literature on intrahousehold resource allocation faces the challenge of finding convincing measures of bargaining power. Various proxy measures of bargaining power used in the literature include the income share of women, unearned income, current assets, inherited assets, spouses' education, and assets brought to marriage. However, most of these measures suffer from various degrees of endogeneity. Moreover, appropriate indicators of bargaining power should not only be exogenous to household decision making processes, but also be culturally relevant.

The IFPRI Bangladesh survey is useful in this context as it collects information about assets at marriage by the head and his spouse using a marriage module in one round of survey. The module also collects a range of information on head's and spouse's marriage history and their parental backgrounds, such as parents' landholdings and education. Moreover, a qualitative survey was undertaken that led the development of the quantitative marriage module, and the findings of that survey indicates that the assets brought to marriage is a culturally relevant indicator for intrahousehold bargaining in Bangladesh. Both in Chapters 2 and 3, I argue that assets at marriage is an attractive proxy for bargaining power because apart from their cultural relevance, these proxies are (weakly) exogenous to decisions made within marriage, such as intrahousehold nutrient allocations. While they could be correlated to unobserved characteristics of the head and his spouse that might led to household formation, to a great extent these unobserved household specific effects that tend to be time invariant can be removed through household fixed effect estimation due to multiple rounds of the survey - another useful feature of IFPRI survey.

Combining individual food intake data with the food expenditure data on hundreds of finely disaggregated food items consumed by different households in 47 villages over four different rounds enables me to use the spatial variation in village prices of food items and to analyse people's demand for nutrients in a hedonic demand framework in Chapter 5. Finally, the marriage module of the survey enables me to create a number of instruments to predict devolution of headship in Chapter 6, and thus to measure the effect of household structure on child outcomes using instrumental variable approach in addition to OLS method.

Findings and Implications

Pitt, Rosenzweig, and Hassan, 1990, henceforth PRH, is an influential work on intrahousehold food distribution. Based on the individual food intake data of rural Bangladesh, they argue that individual calorie[2] intake is a sufficient statistic for different nutrient intakes of individuals given the simplicity of the Bangladeshi diet and find no indication of intrahousehold inequality in food distribution. The focus on total calorie intake, unfortunately, does not explain the growing problem of micronutrient malnutrition and its gender dimensions. Several billion people around the world

[2]Throughout the thesis energy and calorie (a measure of energy) is used interchangeably.

suffer from micronutrient malnutrition in one form or another, and Bangladesh is no exception where 40 million people (27% of its population) suffer from micronutrient malnutrition (?). Women and children are particularly prone to micronutrient malnutrition because of their higher requirement due to reproductive functions and growth.

Chapter 2 illustrates that the calorie is neither a sufficient statistic for other nutrients nor a good metric to understand micronutrient malnutrition or intrahousehold inequality in food distribution. This is because, as the nutrition literature argues, given the wide range of food sources to meet one's calorie need, under normal circumstances an individual can satisfy his/her calorie needs, which in turn motivates the principle of calculating the calorie-adequacy ratio in the nutrition literature (WHO 1985). Moreover, while calorie intake is a direct function of calorie expenditure, the intakes of other nutrients are not; hence, the difference in energy intensity of different activities of males and females of different ages does not necessarily explain the differences in intakes of the nutrients (other than total calorie intake) for different age-gender groups.

Converting food intake data into individual intakes of calorie and different nutrients and comparing these intakes to age-gender specific requirements and using spouses' assets at marriage as measures of bargaining power, Chapter 2 demonstrates the evidence of intrahousehold bargaining for the allocation of a range of critical nutrients in rural Bangladesh. While there is lack of sex disparity in calorie adequacy ratio, the disparity is prominent in the allocation for many of these nutrients within children, adolescents, and adult groups. Pregnant and lactating women also tend to receive much less of these nutrients compared to their requirements. A wife's bargaining power, as opposed to her husband's, significantly and positively affects the allocation of different nutrients for children and adolescents of both sexes and of adult females. The bargaining effects are significant even after controlling for unobserved household characteristics and the potential nutrition-health-labour market linkage. Individual fixed effect estimates of health technology also tend to imply that perhaps the nutrition-health-labour market linkage as a key explanation for intrahousehold food distribution in rural Bangladesh has been overemphasised in the previous literature.

The policy implication of Chapter 2 fundamentally differs from that of PRH, and for that matter past literature, based on the unitary framework. While the latter seeks to resolve intrahousehold inequality in food distribution through increasing (energy-intensive) labour market opportunities for women or to achieve economic development by transforming work activities (of males and females) to those in which linkages between food consumption and productivity are weak. Conversely, I argue that for any given level of economic development and household income, gender disparity (both between the sexes and within the adult women group) will be reduced through increased women's bargaining power within the household achieved through various legal and policy changes that grant women more control of resources. Consistent with a number of studies on intrahousehold bargaining and resource allocation, Chapter 2 thus brings a new dimension in addressing micronutrient malnutrition problems in Bangladesh through the lens of the role of gender within the household.

In a similar bargaining set-up and focusing beyond the total calorie intake, Chapter 3 explores another dimension of intrahousehold food distribution – the allocation of food from relatively expensive and inexpensive sources. The chapter argues that total calorie intake, the focus of many previous studies, does not necessarily reveal the household behaviour of intrahousehold food distribution. For example, consider an extreme case of a two-member household, in which two identical members receive exactly the same amount of calories but the cost and content of their calories are quite different. One may consume a larger share of calories from the cheap and/or poor-tasting foods, while the other may consume a larger share of calories from food items that are more expensive, better tasting, of better quality, and/or have more class appeal. This type of discrimination, as is reflected in various ethnographic studies in Bangladesh, is not revealed if only the total calorie but not its content or composition are the focus of analysis. Focusing on individuals' actual food intakes from different sources, and using a number of measures of food distribution, Chapter 3 demonstrates evidence of significant intrahousehold bargaining between adult males and females on the allocation of calories from animal and dairy products, which are the most expensive sources of calories. A wife's assets positively affects adult females' allocation but negatively affects adult males' allocation from the animal and dairy sources. Intrahousehold bargaining is also evident to some extent for the food allocation for elderly and pregnant women within the household. These effects are significant both with and without the control for health and occupational proxy measures to account for the potential nutrition and labour market linkages and unobserved household fixed effects.

How does this gender disparity in food distribution vary across different levels of household income? While a few studies have attempted to explore this question, a key deficiency there is that those studies used some aggregate measure of inequality (such as Gini coefficient) and hence, did not examine which demographic groups in particular are in a disadvantaged position within the household, and whether and how their wellbeing improves with the improvement of aggregate household wellbeing. Dividing the households into low, middle, and high income groups based on their monthly per capita expenditure, Chapter 3 finds that at the low income level, the wife's bargaining power favors sons to daughters within the preschooler group, while at the middle income level, daughters are favoured over sons. Similarly, a wife's bargaining power positively affects the allocation from expensive food group for adult females, and negatively affects the allocation for adult males at low income level, but such bargaining is not evident as the household income increases.

These findings also have nutritional implications as animal, fish, dairy, and plant products are much richer sources of micronutrients than cereals. In this connection, the findings of Chapter 3 is consistent with that of Chapter 2 that demonstrates strong evidence of intrahousehold bargaining on the allocation of protein and a range of critical micronutrients, particularly for the adult females within the household.

Chapter 4 takes a different angle in evaluating intrahousehold inequality by focusing solely on the children and analysing the evidence from Bangladesh and the Philippines in a case-study setting.

Focusing on children eliminates the potential effects of labour market outcomes on intrahousehold food distribution as elaborated in the literature. The chapter argues that both intrahousehold allocation and bargaining power can be influenced by extrahousehold parameters, such as cultural norms related to gender. For instance, cultural norms can dictate a woman's mobility and the ability to possess and control resources, which in turn affect her bargaining power within the household. While the past literature on intrahousehold resource allocation focuses on the effect of intrahousehold bargaining, the absence of replication of a single analytical framework across different cultural settings (with a few exceptions) limits our understanding on how the effects of the bargaining power of a husband vis-*à*-vis a wife vary in different cultural contexts. Rejection of the unitary model suggests that targeting policy to husband or his wife can have differential effects within the household. However, it is equally important to know how these differential effects vary in different cultural settings.

Based on the cost and content of individual calorie intake, Chapter 4 finds evidence of son-preference in food distribution in rural Bangladesh and not in the rural Philippines, which is consistent with the contrasting cultural norms about females in these two agrarian economies. In Bangladesh, consistent with purdah culture, few females participate in the labour market and gender difference in wage rate is prominent, while transfer at marriage from a bride's family exceeds that from a groom's family. There, village wage rate of adult female positively and that of adult male negatively affect a girl's allocation from animal food group, while village average value of transfers from grooms' families in recent marriages positively affect a girl's allocation. In contrast to previous literature, gender disparity seems not due to scarcity. While a higher birth ordered child fare worse than a lower birth ordered one in both countries, a higher birth ordered girl does worse than a higher birth ordered boy in Bangladesh but not in the Philippines. Finally, the chapter finds that a village access to television in Bangladesh - a proxy for liberal social norms towards females, positively affects girls' allocation from animal group.

Chapter 5 focuses on a different but interrelated issue, i.e., the responsiveness of people's nutrient intakes to nutrient prices. This issue is important to analyse for at least four reasons : (i) to design and implement effective government policies to prevent hunger and malnutrition and to evaluate various government price subsidy and nutrition intervention programmes, in which a substantial amount of resources are devoted in many developing countries including Bangladesh; (ii) to fight against micronutrient malnutrition; (iii) to determine the agricultural marketing potential of foods produced through new technologies; and (iv) to achieve better endowed human capital for overall economic development.

Using a characteristics demand framework and utilising spatial and time variation in household unit values of food items as proxy for village food prices, the chapter estimates implicit nutrient prices and analyses the responsiveness of individual nutrient intakes to implicit nutrient prices controlling for unobserved individual fixed effects. It finds that individual intakes of calories, macronutrients, and a set of micronutrients are inelastic to implicit calorie price, while the own and cross implicit price elasticities for a range of critical micronutrients are highly elastic to implicit micronutrient prices. Moreover, comparing the nutrient intake behaviour of poor and non-poor, it finds that calorie intake is highly inelastic for both groups, while micronutrient intakes are not. Both the macro and micronutrient intakes of the poor compared with that of the non-poor are more responsive to implicit macro and micronutrient prices. These findings suggest that the conventional way of addressing people's hunger and nutrition needs by subsidising one or two key staples should be revisited.

The thesis concludes with Chapter 6, which focuses beyond food and nutrition and on the effect of headship on child education and health outcomes. The chapter compares child outcomes in nuclear families with that in extended families using both OLS and 2SLS. This is an important topic in the context of a developing country, where a great number of children live under the rubric of the extended family for at least a part of their childhood.

The nuclear family has long characterized the European family. In Asia, by contrast, the extended family has been the norm. An important but unexplored difference between these two family forms is the allocation of headship vested in a child's father in the nuclear family, but in the child's grand-father in the extended family. The chapter explores whether children are better off in nuclear than extended families. A reason this might be the case is that the father is more likely to be around when the child reaches adulthood, and therefore better positioned to benefit from investments made in the child's human capital, than the grand-father. On the other hand, extended families may provide better household public goods as discussed in the past literature. The chapter finds child education, but not health, to be substantially better in nuclear families. These findings are potentially important for the literature as the past literature has noted that the extended family provides for the elderly, while its consequences for investments in child human capital has received little attention.

CHAPTER II

Does A Wife's Bargaining Power provide more Micronutrients to Females? Evidence from Rural Bangladesh

Abstract: Using spouses' assets at marriage as measures of bargaining power, I find evidence of intrahousehold bargaining for the allocation of a range of critical nutrients in rural Bangladesh. While there is lack of sex disparity in calorie adequacy ratio, the disparity is prominent in the allocation for many of these nutrients within children, adolescents, and adult groups. Pregnant and lactating women also tend to receive much less of these nutrients compared to their requirements. A wife's bargaining power, as opposed to her husband's, significantly and positively affects the allocation of different nutrients for children and adolescents of both sexes and of adult females. The bargaining effects are significant even after controlling for unobserved household characteristics and the potential nutrition-health-labour market linkage. Individual fixed effect estimates of health technology also tend to imply that perhaps the nutrition-health-labour market linkage as a key explanation for intrahousehold food distribution in rural Bangladesh has been overemphasised in the previous literature.

2.1 Introduction

Micronutrient malnutrition is a critical problem in many developing countries[1], and Bangladesh is no exception. Women and children are most vulnerable due to their elevated micronutrient requirements for reproduction and growth. Approximately 60% of Bangladeshis suffer from various micronutrient deficiencies, of which deficiencies in vitamin A (a prime cause of night blindness), iron, and iodine are the most common (Government of Bangladesh, 1997). There is a growing concern about riboflavin, vitamin C, vitamin D, and zinc deficiencies (IFRPI-BIDS-INFS, 1998). About 70% of the women of age 15-45 years and children of 0-14 years, and 80% of the pregnant and lactating women have blood hemoglobin levels below the acceptable limit and suffer from anemia (Government of Bangladesh, 1995), which accounts for about 25% of all female deaths in Bangladesh (IFRPI-BIDS-INFS, 1998).

To better understand the age-gender dimension of micronutrient malnutrition, it is important to understand how nutrients are allocated within the household. Viewing calorie[3] as a sufficient statistic for nutrients, Pitt, Rosenzweig, and Hassan, 1990 (henceforth, PRH), an influential work on intrahousehold food distribution in rural Bangladesh, argue that gender inequality in calorie distribution is due to gender inequality in energy-intensity of occupations. In a subsistence economy, men engage in energy-intensive occupations in which health and food consumption influences productivity and wage rates (Strauss, 1986; Deolalikar, 1988), while women are mostly confined in (less energy-intensive) household activities. These gender-segregated occupational choices (given by social norms) in turn influence a household's decision to allocate more calories to men as opposed to women, while there is not much gender disparity in calorie allocation among children. PRH estimates also imply that the households are inequality averse as men, despite being involved in energy-intensive activities, compensate their nutrient allocations in favor of women.

Although useful, PRH framework does not provide much insights to the micronutrient malnutrition problem. Contrary to PRH view, as this chapter demonstrates, calorie is not a sufficient statistic for different nutrients[4]. Calorie adequacy often exists alongside micronutrient deficiency

[1]Nearly three billion people (including 56% of the pregnant and 44% of the nonpregnant women) suffer from iron deficiency anemia (IDA), and one-third of the world's population suffer from zinc deficiency[2]. Twenty percent of the maternal deaths in Africa and Asia are due to IDA (Ross and Thomas, 1996). One in every three preschool-aged children in the developing countries are malnourished (Smith et al., 2003). Undernutrition, coupled with infectious diseases, accounts for an estimated 3.5 million deaths annually (See, Scaling Up Nutrition, A Framework for Action, available at http://siteresources.worldbank.org/NUTRITION/). At levels of malnutrition found in South Asia, approximately 5% of GNP is lost each year due to debilitating effects of iron, vitamin A, and iodine deficiencies alone (World Bank, 1994).

[3]While calorie is a measure of energy, I use calorie and energy interchangeably throughout the thesis. Calorie implies kilocalories (kcal).

[4]The simple rice-dominated diet with low intakes of vegetables, animal and dairy products, typically consumed by rural Bangladeshis, meets the calorie need of the people but does not fulfill all the micronutrient requirements as

(Bouis et al., 1992). Moreover, while calorie intake is a direct function of calorie expenditure, as the principles of nutrition suggest, the intakes of various macro- and micro-nutrients are not (World Health Organization, 1985). Despite men's (as opposed to women's) engagement in energy-intensive activities, the requirements for many micronutrients are higher for women, particularly, for pregnant and lactating women, and children than men due to reproduction and growth requirements.

Moreover, PRH and previous studies on intrahousehold nutrient allocation have applied a unitary framework. A number of studies in recent decades fail to accept the fundamental assumption of the unitary model —- resource pooling —- in a range of outcomes, such as household expenditure, agricultural production, schooling, and health in developed and developing countries.

Applying a bargaining framework[5], I demonstrate that (i) while there is lack of gender disparity in calorie adequacy ratio, for a range of critical nutrients, the disparity is prominent within children, adolescents, and adult groups; (ii) pregnant and lactating women receive much less of these nutrients vis-a-vis their requirements; (iii) there is evidence of significant intrahousehold bargaining with a wife's bargaining power, as opposed to her husband's[6], significantly and positively affecting the allocation of various nutrients for children and adolescents of both sexes and adult females; and (iv) these findings combined with the estimates of health technology imply that perhaps the nutrition-health-labour market linkage as a key explanation for gender disparity in PRH is overemphasised.

I thus attempt to contribute to the literature in four ways. First, I expand PRH analysis from calorie allocation to the allocation of a number of critical nutrients. While calorie has been the focal point in previous literature, it neither addresses the growing concern of micronutrient malnutrition, nor provides adequate understanding of gender-role in alleviating malnutrition. Although, some studies (Behrman, 1988b; Behrman and Deolalikar, 1990) focused on nutrients other than calorie, they applied a unitary framework. If individuals have different preferences, and the household decision-making process is affected by the bargaining power of different members, then designing policies relying on a unitary framework can be misleading. My second contribution is the demonstration of intrahousehold bargaining (in addition to typical income and price effects) on nutrient allocations. Third, previous studies have demonstrated intrahousehold bargaining on various outcomes other than individual nutrient intakes. I add to this literature by focusing on nutrient intakes using an innovative panel dataset of rural Bangladesh. Fourth, with the exception of a few natural experiments, previous studies have used bargaining measures that are endogenous to decisions made within marriage. While my measure of bargaining power—husband's and wife's

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rice is not a significant source of many essential nutrients, such as, vitamin A, vitamin C, iron, calcium, and zinc (IFRPI-BIDS-INFS, 1998).

[5]To the best of my knowledge, this is one of the first exercises that applies a bargaining framework to analyse intrahousehold nutrient allocation based on actual individual dietary intakes.

[6]I use household head or husband and his wife or spouse interchangeably throughout the thesis unless otherwise specified.

asset at marriage—-is culturally relevant and exogenous to the decisions made within marriage, it can be endogenous to marriage due to marriage market selection. Failure to control for such effect can result in erroneous rejection of unitary model (Foster, 1998). A number of standard covariates (in the empirical literature of unitary or collective framework), such as, household size and composition could be also potentially correlated with unobserved household characteristics, such as fertility preference. Applying household fixed effect estimates (henceforth, HFE), I thus demonstrate evidence of intrahousehold bargaining that should not be contaminated by marriage market selection effect and other unobserved household characteristics.

The rest of the chapter is organized as follows. Section 2.2 briefly reviews the literature. Section 2.3 discusses the theoretical framework. Section 2.4 lays out the econometric methodology. Section 2.5 describes the data and provides descriptives. Section 2.6 discusses the empirical results, and section 2.7 concludes the chapter.

2.2 Related Literature

Gender disparity in nutrition is a salient feature of many low-income economies, particularly in Asia (Bardhan, 1974; Sen and Sengupta, 1983; Sen, 1984; Behrman, 1990). Although South Asia (SA) perform better than Sub-Saharan Africa (SSA) on many long-accepted determinants of child nutrition (i.e., national income, democracy, food supplies, health services, and education), the malnutrition prevalence is much higher in SA than SSA. Women's low status in SA is viewed as a key cause for such regional disparity in malnutrition (Ramalingaswami et al., 1996; Smith et al., 2003). Girls (boys) seem to be nutritionally favored than boys (girls) in SSA (SA). Arguably, this is due to the dowry system in SA that requires families to pay bridegrooms to marry their daughters as opposed to the norm in SSA that bridegrooms pay a bride-price (Quisumbing, 2003).

Using a unitary framework (Becker, 1973), several studies attempt to explain this gender disparity. As mentioned, PRH explain that gender differences in calorie consumption is due to men's engagement in more energy-intensive occupations than women. While occupational choices can be endogenous, PRH view that these choices are given by social norms. Bardhan (1974) and Rosenzweig and Schultz (1982) demonstrate the relationship between sex differences in infant mortality rates and sex differences in labor-market participation rates. However, Behrman (1988b) does not find any relationship between expected labour market opportunities and sex disparity in children's nutrient consumption. Behrman (1988b) finds that households compensate for girls' nutrient allocations during the agricultural surplus season, but reinforce boys' endowments during lean seasons, which is more evident for lower-caste households. Behrman and Deolalikar (1990) find that females eat less when food is scarce and the marginal value of food is high, and vice versa.

Considerable evidence against the unitary framework (Strauss and Thomas, 1995; Haddad et al.,

1997) has made collective framework (Chiappori, 1988, 1992; Bourguignon et al., 1993, 1994) attractive. Using the latter, Thomas (1990) finds a mother's unearned income has greater impact on daughters' anthropometric outcomes than that of sons, while a father's unearned income has the opposite effect. Using household food expenditure data, he also finds that the estimated impact of women's unearned income is about seven times that of men's unearned income for (per capita) calorie and protein consumptions. Schultz (1990) finds that women's unearned income has significantly different effect (i.e., reduces more) than men's unearned income on women's labour supply, and women's but not men's unearned income has a significant positive effect on fertility. Hallman (2003) uses maternal shares of current assets, premarital assets, and marriage payments as proxy measures for resource controls, and finds that a mother's assets are generally more beneficial for girls and a father's for boys as far as child morbidity is concerned, which is consistent with (Thomas, 1994). She further finds that a greater share of marriage payments directed towards the husbands reduce child morbidity, regardless of the child's sex. This is consistent with Rao (1997), who shows that lower dowries increase wife-beating and reduce child calorie intake during marriage. Targeting mothers for cash-transfers seem to significantly increase secondary school enrollment, particularly girls, and has positive effects on child's health, nutrition, and food consumption (Skoufias and McClafferty, 2003; Adato et al., 2003). Pitt and Khandker (1998) find that household consumption and child nutritional status and education are significantly better when the micro-credit borrowers are women. None of these studies using collective framework, however, focus on individual nutrient intakes, which is the topic of this chapter.

While collective models provide useful insights, often it is difficult to distinguish (empirically) their predictions from those of unitary model (Behrman, 1990, 1997). For instance, a unitary model will predict that better schooled women are more efficient in household production and knowledgable about health and child bearing technology. A collective model will argue that the better schooled women bargain more effectively over household resources, and that women are more interested in nutrition than their husbands. Empirically, it is often difficult to distinguish between these alternative mechanisms. Moreover, sometimes education of spouses may be correlated with other unobserved factors, such as marriage market selection (Foster, 1998), and may pick up unobserved wealth or income effects. Similarly, using a unitary framework, Rosenzweig and Schultz (1982) empirically demonstrate the existence of a relationship between sex differences in infant mortality rates and sex differences in labor-market participation rates, while Folbre (1984) argues that this relationship is supportive of a non-unitary framework in which women who have greater incomes have greater influence in intrahousehold allocations that leads to greater investments in daughters.

Finding convincing measures of bargaining power is a challenge. The measures should reflect bargaining power but should be exogenous to the outcomes under consideration. Income share of women (Hoddinott and Haddad, 1995), unearned income (Schultz, 1990; Thomas, 1990), current assets (Doss, 1999), inherited assets (Quisumbing, 1994), spouses' education (Quisumbing and Maluccio, 2003), and assets at marriage (Thomas et al., 2002; Quisumbing and Maluccio, 2003) are used as bargaining measures in the literature. A few studies also use natural experiments to identify the effect of bargaining power on intrahousehold resource allocation (Lundberg et al., 1997; Qian, 2008).

With the exception of natural experiments, the above measures are arguably endogenous. Women's income includes labour income that reflects time allocation and labour force participation decision of the household, and is thus endogenous to the household decision-making processes. Unearned income, as observed in Thomas (1990) and Schultz (1990), may include income from pensions, social security, unemployment benefits, or earnings from accumulated assets, which are related to past labour market activities and thus wages and productivity. Moreover, women's unearned income on recent fertility (as measured in terms of co-resident children under five years of age) in Schultz (1990) may reflect reverse causality if women with younger children do not participate in the labour market and are likely to be compensated by transfers from their families and other sources (Behrman, 1997). Similarly, current asset holdings are affected by the asset accumulation decisions made during marriage. While inherited assets and assets at marriage are less likely to be influenced by decisions within marriage, these are also problematic if correlated with individual unobserved characteristics (such as taste, human capital) that tend to influence the outcomes under study (Strauss and Thomas, 1995). These measures could be also endogenous to marriage due to marriage market selection (Foster, 1998).

2.3 Theoretical Framework

Consider a collective model where preferences of husband (h) and wife (w) matter. Each cares about his/her own and other $N-1$ ($i \in N$) household members' consumption of nutrients ($\mathbf{C}$), health outcomes ($\mathbf{H}$), and effort level (e). Thus, husband's and wife's utility functions are:

$$U_h = U_h(\mathbf{C}_i, \mathbf{H}_i, e_i; \mathbf{Z});$$
$$U_w = U_w(\mathbf{C}_i, \mathbf{H}_i, e_i; \mathbf{Z});$$

where, $\mathbf{Z}$ is a vector of household characteristics[7]. For all Pareto-efficient outcomes, there exists some weight λ for which the household's objective function becomes:

$$Max \qquad \lambda U_h(\mathbf{C}_i, \mathbf{H}_i, e_i; \mathbf{Z}) + (1-\lambda) U_w(\mathbf{C}_i, \mathbf{H}_i, e_i; \mathbf{Z}) \tag{2.1}$$

[7]Bold-faced arguments in the utility functions are in vector notations

where, λ, also known as the sharing rule, is a function of husband's and wife's relative bargaining power:

$$\lambda = \lambda(a_h, a_w)$$

The higher is the bargaining power of the individual, the greater the weight his/her utility function carries in the household's maximisation problem[8]. The household maximises its objective function subject to the following constraints:

$$\mathbf{H}_i = H(\mathbf{C}_i, e_i, \mu_i) \tag{2.2}$$

$$w_i = w(\mathbf{H}_i, e_i) \tag{2.3}$$

$$v + \sum_i w_i = Y = \sum_i \mathbf{PC} \tag{2.4}$$

The health outcomes of an individual i (equation 2.2) are functions of intakes of different nutrients, his/her effort level (assumed to deplete health), and his/her health endowment (μ_i). Individuals are differentiated by their health endowments, which are known to all household members. Wage (w_i) equation (2.3) implies that effort is rewarded in the labour market with returns to effort increasing with individual's health status. Equations 2.2 and 2.3 capture the essential assumption of the efficiency wage literature that food consumption affects labour market productivity through health (Stiglitz, 1976; Leibenstein, 1957). While the efficiency wage literature assumes purely technological relationship between effort, health and food consumption, these are choice variables in the above framework. Finally, in household's budget constraint (equation 2.4), Y is total household income, v is total unearned household income, $\mathbf{P}$ is the price vector for different nutrients and leisure, and total labour time is normalized to 1.

Maximising household's objective function, subject to these constraints yields a set of reduced form nutrient demand functions:

$$\mathbf{C}_i = f(\mathbf{P}, Y, \lambda; \mathbf{I}, \mathbf{Z}) = f(\mathbf{P}, Y, \lambda(a_h, a_w); \mathbf{I}, \mathbf{Z}) \tag{2.5}$$

[8]Equation 2.1 converts to a unified household utility function:

$$U = U(\mathbf{C}_i, \mathbf{H}_i, e_i; \mathbf{Z}); \forall i = 1, ..., N$$

when one person is the dictator (i.e., λ is 0 or 1) or when both persons have the identical preferences, $U_h = U_w$. The household decision making process in the collective framework can also be viewed as a two-stage budgeting process, in which at the first stage, the individuals pool all their income and allocate it according to the weight or sharing rule, λ. Then, at the second stage, each individual maximises his/her own utility given his/her share or weight within the household.

where, $\mathbf{I}$ is a vector of individual characteristics, such as, age, gender, endowment, etc., and $\mathbf{Z}$ is a vector of household characteristics, such as, household size and composition.

As is well-known, the key difference between these reduced form demand function of the collective framework with those of the unitary framework is that in the case of the former, the sharing rule and thus the bargaining power of individuals become an explanatory variable for individuals' demand for nutrients (and for other outcomes) in addition to total household income. Since income pooling implies that controlling for household income, individual bargaining power does not affect the demand functions of the household members, using measures of bargaining power of a husband and a wife, one can test the key assumption of the unitary model – income pooling – vis-à-vis – intrahousehold bargaining – for nutrient allocation:

$$\frac{\partial \mathbf{C}_i}{\partial a_i} = 0; i = h, w \tag{2.6}$$

In the case of income pooling, $\frac{\partial \mathbf{C}_i}{\partial a_i} = 0$, whereas in the presence of intrahousehold bargaining, $\frac{\partial \mathbf{C}_i}{\partial a_h} \neq \frac{\partial \mathbf{C}_i}{\partial a_w}$.

2.4 Econometric Framework

To analyse intrahousehold bargaining in nutrient allocation, I use the following empirical specification of equation 2.5:

$$\begin{aligned} lny^k_{ijvst} = {} & \alpha^k_0 + \alpha^{\mathbf{k}}_{\mathbf{1}}\mathbf{A}_{ijvst} + \alpha^k_2\kappa_{ijvs} + \alpha^{\mathbf{k}}_{\mathbf{3}}\mathbf{X}_{hjvst} + \alpha^{\mathbf{k}}_{\mathbf{4}} ln\mathbf{P}_{vst} + \alpha^{\mathbf{k}}_{\mathbf{5}}\mathbf{R}_t + \alpha^{\mathbf{k}}_{\mathbf{6}}\mathbf{S}_s \\ & + \alpha^{\mathbf{k}}_{\mathbf{7}}\mathbf{X}_{mjvs} + \alpha^{\mathbf{k}}_{\mathbf{8}}\mathbf{X}_{wjvs} + \alpha^{\mathbf{k}}_{\mathbf{9}}(\mathbf{A}_{ijvst} \times \mathbf{X}_{mjvs}) + \alpha^{\mathbf{k}}_{\mathbf{10}}(\mathbf{A}_{ijvst} \times \mathbf{X}_{wjvs}) + \epsilon^k_{ijvst} \end{aligned} \tag{2.7}$$

where, k indexes a nutrient (e.g., calorie, protein, iron, etc.), i individual, j household, v village, s survey location ($v \in s$), t survey round, and ln, natural log. The dependent variable, y^k is an individual's adequacy ratio of nutrient k (see section 2.5 for variables' definitions and descriptives). The covariates are: a vector of dummy variables indicating the age-sex group (with adult male as omitted category) and pregnancy and lactating status of an individual ($\mathbf{A}_{ijvst}$), a measure of individual's health endowment, κ_{ijvs} (described below), which, based on PRH, is used to control for any potential nutrition, health, and labour market linkages, time variant and invariant household characteristics ($\mathbf{X}_{hjvst}$), village food prices ($\mathbf{P}_{vst}$), dummy variables for survey round ($\mathbf{R}_t$) and sites ($\mathbf{S}_s$), and characteristics of household head ($\mathbf{X}_{mjs}$) and his wife ($\mathbf{X}_{wjs}$).

Controlling for individual and household characteristics, gender difference in nutrients' adequacy ratios will be reflected in the coefficient vector $\alpha^{\mathbf{k}}_{\mathbf{1}}$. Controlling for household composition, any potential household scale (dis)economies (Deaton and Paxson, 1998) that might make individuals of larger household (worse)better-off in nutrient consumption (at the same level of per capita expenditure) will be captured by household size. Controlling for aggregate household resources, spouses' characteristics are of interest from intrahousehold bargaining perspective.

2.4.1 Health Endowment and Occupation

A challenging issue is to obtain consistent estimate of an individual's unobserved health endowment to control for nutrition-health-labour market linkage. I follow PRH approach of estimating endowment through a residual approach first used by Rosenzweig and Schultz (1983) in which the health technology (equation 2.2) is estimated directly and based on the technology parameter estimates and actual resources consumed or expended by individuals, individual-specific endowments are computed. However, in estimating the technology, I differ from PRH in terms of econometric method. A problem with the residual approach, as PRH argued, is that the consistent estimates of the technology parameters could not be obtained using OLS as estimated technology parameters could be biased if $\mathbf{C}_i$, and e_i are correlated with unobserved individual endowment, μ_i in equation 2.2. So PRH followed a 2SLS approach to estimate a health production function similar to the following form:

$$ln(h_{ijst}) = \beta_1 + \beta_2 lnc_{ijst} + \beta_{\mathbf{3}}\mathbf{D_{ijst}} + \beta_{\mathbf{4}}\mathbf{X_{hjst}} + \beta_5(age_{ijst}) + \beta_6(age^2_{ijst}) + \beta_7 sex_{ijs} + \beta_8(sex \times age)_{ijst} + \eta_{ijst} \tag{2.8}$$

where,

$$\eta_{ijst} = \mu_{ijs} + \gamma_{js} + \theta_{ijst}$$

The notations for i, j, s, and t are the same as above, h is an individual's weight for height, c is calorie intake, $\mathbf{D}$ is a vector of dummy variables indicating whether or not individual's occupation is highly energy intensive and whether the individual is pregnant or lactating, $\mathbf{X}$ is a vector of household characteristics, and θ_{ijst} is a random error term. In terms of household characteristics, PRH used household's drinking water source. While the error term, η_{ijst} could contain unobserved time-invariant household specific effect (γ_{js}), such as spouses' taste and fertility preference, which can affect both calorie allocation and health outcome, PRH estimated equation 2.8 instrumenting calorie intake, energy intensity of occupation, pregnancy, and lactating status by household head's age and schooling, household landholding, and their interactions with food prices to address the correlation between individual endowment (μ_{ijs}) and the covariates ignoring unobserved household characteristics embodied in η_{ijst}.

While PRH did not present any analysis of the strength and validity of their instruments, many of these instruments, such as household landholding and head's schooling could directly affect individual's health outcome (such as in the conceptual framework in Behrman (1990)) and these could be correlated with wife's schooling and age (not controlled for and thus are embodied in η_{ijst}), which could also influence health outcomes. Effect of spouses' characteristics on individuals' health and nutrition could be also biased due to marriage market selection effects. Similarly, pregnancy (which in turn influences lactating status) of individuals could be influenced by household's unobserved fertility and sex-preference (arguably, in this case, age and sex of children are also endogenous), which could also influence allocations for individuals' nutrients and health outcomes. Spouses' bargaining power (embodied in their characteristics, observed and unobserved) can affect fertility decision ((Rasul, 2008)) and thus household size and composition as well as individuals' health and nutrition outcomes. It is thus difficult to obtain valid instruments to account for endogeneity of the above variables.

Hence, instead of a 2SLS, I estimate the health technology using individual fixed effect estimate (IFE), which should eliminate all individual, household, and location fixed effects and provide consistent estimates for calorie intake coefficient[9]. However, the downside of IFE is that the effect of individual characteristics (i.e., sex) and time invariant household characteristics on health outcome will remain unmeasured. To go around this problem, I measure the technology parameters separately for males who are engaged in highly energy-intensive occupations and those who are not, and for females. Obtaining an estimate for endowment through this approach, however, relies on a number of assumptions. First, I assume that as far as individual's attributes are concerned, other than his/her unobserved health endowment, calorie intake, age, sex, pregnancy and lactating status, and occupation, there is no other individual characteristics that affect his/her weight-for height in the short-run. Second, similar to PRH, I assume that occupational choices are predetermined[10]. While occupational choice can be endogenous, PRH argued that they are given by social norms that limit females' outside labour market participation, while men are engaged in energy-intensive labour market activities. Thus, few women are engaged in plowing in India, while in Bangladesh no women are observed to pull rickshaw[11]. As a consequence of gender-segregated occupations,

[9]Weight-for-height in the short-run is supposed to be influenced by only calorie intake and calorie expenditure. PRH demonstrated that controlling for calorie intake, other nutrient intakes do not have significant influence on this short-term measure of health.

[10]I require these PRH assumptions of predetermined gender-segregated occupational choices because an individual's occupation data is collected only once in the survey (in first round and for new members only in subsequent rounds when they first appear in the household). If I had time-varying occupation data, I could obtain consistent estimate of its impact on health using IFE without these assumptions.

[11]Morris (1997) find that traditions in Bangladesh often inhibit a woman's ability to obtain employment outside the home. Purdah, or female seclusion, is an Islamic tradition routinely practiced in Bangladesh among the Muslim majority. Purdah literally means "curtain" or "veil," but the term is used figuratively to designate the proper mode of behavior for women. Its strictest adherents are confined to their homes. When they leave, they are veiled from head to toe. This "protects" the women's modesty, while also protecting her husband's family's "izzat" (respectability). Occupational purdah or the types of work considered "appropriate" and "respectable" severely restrict women to seek wage labor. Chapter 4 of this thesis cites more literature on "purdah" culture that limits women's labour market

as PRH demonstrated, health endowment in the labour market matters only for males. Behrman and Deolalikar (1989) and Sahn and Alderman (1988) also find health and calorie consumption to have significant positive effects on the wage rates for men but not for women. So for females, I estimate the technology without differentiating them based on the energy-intensity of their occupation. Moreover, consistent with PRH assumption, there are only a very few females engaged in high energy intensive occupations in the data (see Section 2.5). Thus, for each of these three categories, I estimate the following health technology function using IFE:

$$\Delta ln(h_{ijst}) = \beta_{1_{IFE}} + \beta_{2_{IFE}} \Delta ln(age_{ijst}) + \beta_{3_{IFE}} \Delta [ln(age_{ijst})]^2 + \beta_{\mathbf{4_{IFE}}} \Delta \mathbf{X_{hjst}} + \sum_t \gamma_t \Delta R_t + \Delta u_{ijst} \tag{2.9}$$

where, household characteristic vector, $\mathbf{X_{hjst}}$, includes monthly per capita expenditure and its square, per capita household landholding, and household size, all in logs, share of different demographic composition of the household, R_t are survey round dummies to control for any potential seasonal effects on health outcomes, and Δ indicates deviation of an individual's observation in a given round from its mean (over four rounds). In estimating equation 2.9 for females, I also include pregnancy and lactating dummies.

Applying IFE estimates of the parameters for calorie intake, age and its square, and household characteristics from equation 2.9 to the individual data of the corresponding variables, I obtain estimated log weight for height ($ln\hat{(h)}$) for each individual who belongs to any of the three above sex-occupation categories. Deducting this estimated value from the observed value of log weight for height (lnh) yields a health measurement that includes an individual's unobserved health endowment (μ) and an aggregate unmeasured effect of time-invariant household characteristics (ρ) (e.g. the effect of spouses' characteristics, such as education, assets, unobserved preferences, and household landholding, short-run time-invariant living and hygiene conditions, drinking water source, etc. as discussed above):

$$ln(h) - ln\hat{(h)} = \mu + \rho = \kappa$$

As I have four rounds of data for an individual, I average κ over four rounds and use it as a proxy measure for an individual's health endowment in equation 2.7. Obviously, estimating equation 2.7 using OLS will be problematic as the health measure κ will include the effect of unmeasured household characteristics, but these should be eliminated by estimating equation (2.7) using household fixed effect. Thus, the measure κ along with other factors discussed below motivates HFE estimation of equation 2.7.

participation and provide evidence from this survey data about limited labour market participation of females.

2.4.2 Test of Unitary Model and Household Fixed Effect

Based on OLS estimate of equation 2.7, a test for unitary model will be the tests of the restrictions that for an individual's nutrient allocation (conditional on individual and household characteristics), the effect of a head's characteristics will be same as the effect of the corresponding characteristics of his wife. Thus, for the adult male (omitted category), the restrictions are:

$$\alpha^k_{7_e} = \alpha^k_{8_e}, e = assets, education \tag{2.10}$$

for each of the remaining age-gender category ($g \in G$):

$$\alpha^k_{7_e} + \alpha^k_{9_{e_g}} = \alpha^k_{8_e} + \alpha^k_{10_{e_g}} \tag{2.11}$$

for adolescent (adolf) and adult (adulf) pregnant (preg) and lactating (lact) women:

$$\alpha^k_{7_e} + \alpha^k_{9_{e_d}} + \alpha^k_{9_{e_p}} = \alpha^k_{8_e} + \alpha^k_{10_{e_d}} + \alpha^k_{10_{e_p}}, d = adolf, adulf; p = preg, lact \tag{2.12}$$

and, for each of the age-gender-pregnancy-lactating category, relative to adult males:

$$\alpha^k_{9_{e_g}} = \alpha^k_{10_{e_g}} \tag{2.13}$$

$$\alpha^k_{9_{e_d}} + \alpha^k_{9_{e_p}} = \alpha^k_{10_{e_d}} + \alpha^k_{10_{e_p}}$$

The OLS estimates, however, have a number of econometric concerns, which in turn motivate HFE estimation. In addition to the effect of ρ in the endowment measure κ, household size and composition could be potentially endogenous to household's unobserved fertility preference that could also influence the nutrient allocation decisions. If households have preference for sons and follow a male-biased stopping rule that could influence household size and composition resulting girls living in bigger families (with more siblings) than boys (**?**). As already mentioned, bigger families may have scale (dis)economies that can affect individuals' nutrient intakes. To the extent the unobserved fertility preference is time-invariant, it could be eliminated by HFE method. Household income (proxied by expenditure) is also potentially endogenous as both nutrient consumption and health endowment of individuals may affect household income. In the literature, household expenditure is often instrumented by household landholding. However, Behrman and Deolalikar (1990) distinguish the effect of current income vis-à-vis permanent income on nutrient intakes, arguing that if households protect their nutrient intakes from short-term fluctuations, the income elasticities of nutrient intakes would be biased downward relative to the true household response to permanent income changes. However, they find that the effect of nutrient intake responses to permanent income are also quite small. Following Behrman and Deolalikar (1990), I use both current and permanent income (proxied by per capita landholding) measures as explanatory variables. If a household's nutrient allocation decision based on individuals' endowment and labour market productivity is time invariant, then this unobserved household characteristic that might influence household income is eliminated in HFE estimates.

Spouses' assets and education at marriage could be correlated with their unobserved characteristics, such as their preference for children's (of particular sex) nutrition and health, which in turn could be correlated with household formation through marriage market selection. For instance, a man (woman) who wants healthy children may also choose an educated and/or wealthy wife (husband). So a wife's (man's) education and/or asset may appear to influence a child's nutrition, even if for the same man(woman) changes in wife's (husband's) assets or education would not affect the child's outcome. Thus effect of a wife's (husband's) bargaining measures on child's nutritional allocation will be overestimated if husband (wife) with a high taste for children's nutrition tend to choose educated and/or wealthier spouse, and thus could lead to erroneous rejection of unitary model in favor of intrahousehold bargaining. Thus, another motivation for HFE is to eliminate spouses' time-invariant unobserved characteristics that could be correlated with their bargaining measures and could influence individuals' nutrient allocations.

The survey, as described in the next section, was conducted in four rounds. Using within household variation of individuals' nutrient intakes in different rounds, and variation of time varying household characteristics across rounds, I estimate the following HFE version of equation (2.7):

$$\Delta lny^{k}_{ijvst} = \alpha^{k}_{0_{FE}} + \alpha^{\mathbf{k}}_{\mathbf{1_{FE}}} \mathbf{\Delta A}_{ijvst} + \alpha^{\mathbf{k}}_{\mathbf{2_{FE}}} \mathbf{\Delta X}_{nijvst} + \alpha^{\mathbf{k}}_{\mathbf{3_{FE}}} \mathbf{\Delta X}_{hjvst} + \alpha^{\mathbf{k}}_{\mathbf{4_{FE}}} \mathbf{\Delta} ln\mathbf{P}_{vst}$$
$$+\alpha^{\mathbf{k}}_{\mathbf{5_{FE}}} \mathbf{\Delta R}_{t} + \alpha^{\mathbf{k}}_{\mathbf{9_{FE}}} \mathbf{\Delta}(\mathbf{A}_{ijvst} \times \mathbf{X}_{mjvs}) + \alpha^{\mathbf{k}}_{\mathbf{10_{FE}}} \mathbf{\Delta}(\mathbf{A}_{ijvst} \times \mathbf{X}_{wjvs}) + \Delta\epsilon^{k}_{ijvst} \quad (2.14)$$

where, Δ indicates deviation of observations from household mean. However, eliminating household fixed effects also eliminate time-invariant observable household characteristics, in my case which include spouses' bargaining measures. Therefore, to assess intrahousehold bargaining, I can now only test the restrictions in equation 2.13. Moreover, the data are collected over four rounds within a year, so there will be very limited variation of household size, demographic composition, and per capita landholding (as landholding data is only from first round) across rounds. So the effects of these variables could be imprecisely estimated. The HFE estimates will also be based on a restricted sample of households that have at least one member of each of the age-sex group under consideration. Also, the noise to signal ratio is likely to increase due to differencing.

Finally, as I analyse intrahousehold bargaining for a number of nutrients, the likelihood that no gender differences are found along any margin is very low and so the results might be biased towards finding discrimination. Moreover, individuals' consumptions of one nutrient may affect the consumptions of others as typically they consume a food-bundle in which different food items contain different nutrients in different proportions. To address these issues, adequacy ratio for all nutrients under level specification 2.7 and HFE specification 2.14 are estimated simultaneously in a seemingly unrelated regression (SUR) framework (henceforth, referred to as SUR_{LS} and SUR_{HFE}, respectively).

2.5 Data and Descriptives

I use an innovative household survey data from the International Food Policy Research Institute (IFPRI). The data comes from four rounds of surveys at four month intervals during 1996-97 (Round 1: June-September, 1996; Round 2: October-December, 1996; Round 3: February-May, 1997; and Round 4: June-September, 1997) in 47 villages from three sites in four districts of Bangladesh[12]. The survey objective was to evaluate the impact of commercial vegetable production in Saturia (site 1), polyculture fish production in household-owned ponds in Mymensingh (site 2), and polyculture fish production in group-managed ponds in Jessore (site 3) on household income, nutrition, and time allocation. In each site, villages were categorized into program villages (A villages) where the technology was already introduced and comparable control villages (B villages) where the technology was yet to be introduced. From each of these categories, surveyed A and B villages were randomly selected. A household census was conducted in all the randomly selected A and B villages, from which households of two categories (adopters and non-adopters in A villages, and households who expressed interest to adopt if the technology is introduced and who were uninterested in B villages) were selected.[13].

The survey questionnaire was administered to 5,541 individuals in 955 rural households in each round who were selected through this multi-stage sampling approach. The survey collected detailed information on demographic characteristics, agricultural production, other income-earning activities, expenditure patterns, time allocation, individual food intakes, health, morbidity, and education. It also collected information on family background, marriage history, assets at marriage, transfers at marriage, inheritance, women mobility, and empowerment.

IFPRI sampling required that the households were representative of adopters and non-adopter households in A villages and likely adopters and likely non-adopters in B villages, and not necessarily representatives of rural Bangladeshi households. Nonetheless, a comparison of IFPRI sample with that of 1995-96 National Household Expenditure Survey (HES) of Bangladesh Bureau of Statistics of the Government of Bangladesh indicates that the IFPRI sample is broadly comparable to nationally representative HES rural sample of 5,020 households based on household size, per capita expenditure, landholding, and poverty rates (Table 2.1).

[12] Bangladesh is divided into six divisions. A division is then divided into districts. A district is composed of several thanas. Thanas are divided into unions. A union is composed of several villages.

[13] The IFPRI evaluation concluded that adoption of these programs, had neither improved the micronutrient status of the adopting households through better quality diet nor increased their incomes. For a detailed description of the survey, see (IFRPI-BIDS-INFS, 1998).

2.5.1 Variables and their Descriptives

Table 2.1 provides the descriptive statistics of the variables used in the econometric analysis, and the variables are described below.

Survey round and site dummies: Survey round dummies (with 4th round omitted) are included to control for any agricultural seasonality that may affect nutrient consumption as in lean seasons there may be lack of food availability and labour market activities that can affect household food expenditure, and income. As there are two major rice cultivation seasons, there are also two lean seasons that reduce employment and income earning opportunities. The major lean season is from mid-September to mid-November preceding the Aman harvest, which falls in round 2. The other lean season falls in round 3, which is from mid-March to mid-April, prior to Boro harvest[14]. Site dummies (with Jessore as omitted site) are included to control for any location specific effects, such as infrastructure, location endowment, market condition, and health facility, etc., which may affect income earning opportunities, food availability and prices, health, and nutrition.

Village prices: The survey collected data on household food expenditure and quantity purchased of a wide range of food items, which were further classified into 17 different food groups. Village prices are proxied by village level mean unit value for each of these food groups, which are constructed by averaging the household level unit value of these food groups within each village[15]. I control for log village price of rice, pulses, big fish, small fish, and egg in regression functions[16]. Table 2.1 indicates substantial variation of village prices across rounds, while high and low prices of different food groups are observed in different time of the year. For instance, while the mean rice price is lowest in round 2 and highest in round 3, for pulses the highest is observed in round 2 and lowest in round 4, implying seasonality (if any) differs for different food groups.

Household size and composition: Household size is based on number of individuals present in the household in each round. Consistent with nutritional requirements at different stages of life-cycle and activity patterns, males and females are categorized into: children (<10 years), adolescents ($10 \leq age < 18$ years), and adults (≥ 18 years). Dummy for each of these six age-sex categories (with adult male as omitted category) and dummy for whether a female is pregnant or not, or lactating or not in a given round are used in econometric analysis. Log household size and share of males and females in each of these age groups (with adult males' share as omitted category) are used to control for household size and composition. Compared to HES sample, on average an IFPRI sample household is consists of 1-2 more people with highest share of individuals in the adult category. As expected, there is very limited variation of household size and composition

[14]Aman is the rice grown in monsoon season, while Boro is the rice grown in dry season.

[15]Chapter 5 provides evidence that village level unit values are reasonable proxy for village prices in this Bangladeshi sample of households.

[16]A comprehensive set of village prices were initially included. Subsequently, I have included the food prices that appear to be significant most of the times for the set of nutrients analysed in this chapter.

across rounds within one year. The lactating women outnumbered pregnant women and these statuses vary across rounds.

Household landholding, expenditure, and poverty: Household landholding is a time invariant variable for which information was collected in the first round. While the share of landless households (about 5%) are similar in IFPRI and HES samples, the distribution of landholding is less unequal in IFPRI sample compared with HES sample with higher share of households with 1-7.5 acres in IFPRI sample. The mean per capita landholding in IFPRI sample is 0.23 acre (which varies slightly across rounds due to limited variation in household size).

Both samples are also similar in terms of mean per capita monthly expenditure, which varies significantly across rounds (p-value of t-tests are not reported) in IFPRI sample with the lowest value observed in round 2 and highest value in round 3.

The absolute and hard core poverty lines based on direct calorie intake (DCI) method are 2122 kcal and 1805 kcal per person per day, based on which the poverty incidence is higher in IFPRI compared to HES sample. HES regional upper and lower poverty lines based on cost of basic needs (CBN) approach in 1995-96 are Takas 593 and 492 in site 1, 529 and 484 in site 2, 592 and 499 in site 3, and 591 and 499 for national rural households. Comparison of HES sample with site specific poverty incidence based on CBN gives a mixed picture with some sites in some rounds having higher poverty rates compared to national rural average and vice versa. Similar to monthly per capita expenditure, poverty incidence varies substantially across rounds. Based on CBN, the highest poverty incidence in all sites are observed in round 2, while based on DCI, the poverty peaks in round 3. As mentioned, round 2 contains the major lean season, while round 3 the minor one.

Spouses' characteristics - age, education, and assets at marriage: On average, husbands are about 8 years older than their wives. To focus on bargaining between husbands and wives, following Quisumbing and Maluccio (2003), I restrict the sample to monogamous households[17] with husband and wife present and with no change in marital status (i.e., divorce, separation, remarriage, death, etc.) during the survey period. The resulting sample selection bias (if any) would lead to a conservative estimates of bargaining effects as households in which the disagreement between the spouses are the strongest would be more likely to split and are thus absent in this sub-sample.

The marriage module of the survey asked the heads and their wives the assets they owned at the time of their wedding. These assets included land, cattle, housing, food items, and durable (jewelery, watch, clothes, and household utensils). The reported values of these assets at the time

[17] 1% of households have two wives, while 4.5% are female headed with no husband and 3% have head without his wife, and 91% households are intact with both head and his spouse. Based on data availability of assets at marriage, my analysis contains almost 98% of these intact households, or, roughly 89% of the all surveyed households.

of marriage were converted in 1996 taka using national consumer price index. Bangladeshi wives had far less assets at the time of their marriage than their husbands primarily because their value of landholding, housing, and cattle were much less than those of their husbands (see Table 2.1). The assets at marriage may suffer from measurement errors due to recalling information, particularly for longer marriages. One option is to instrument spouses' assets by their respective family background information, such as the wealth of their parents. However, those measures may also suffer from recall errors. Hence, I do not instrument these bargaining measures. To the extent the measurement errors are white noise, the evidence of bargaining (if any) will be an underestimation of the true bargaining effects. Education is measured by years of schooling. The mean years of schooling of husbands is almost double of that of wives.

While spouses' assets at marriage are my key bargaining measures, following Quisumbing and Maluccio (2003), in the empirical analysis, I also include spouses' age and age square to control for cohort effects and for the possibility that their age difference could be another source of bargaining power that may be correlated with the education and assets measures. While spouses' education are included as a potential bargaining source, its caveats are already discussed (see section 2.2). My focus, however, is not to evaluate intrahousehold bargaining based on education, but to control for any potential correlation between education and asset measures of bargaining.

Individual health and occupation: There is limited variation across rounds even in the short-term health outcome measure, an individual's weight (in kilograms) for height (in centimeters). Boys tend to do better than girls and adult males better than adult females, while this gender difference reverses for the adolescent group. This might be indicative of some transitory catch-up for females as they past childhood, which later disappears as they progress toward adulthood.

As mentioned before, individuals' occupation information were collected once in the survey. These were coded into 47 different occupations. Based on the metabolic constant (mc) provided for a detailed list of activities for male and female in World Health Organization (1985), I classify the energy intensity of occupations into high ($mc > 4$), medium ($2.5 < mc \leq 4$), and low ($mc \leq 2.5$) category[18]. Energy intensity of occupation of different age-sex group vis-a-vis their energy intake are further discussed below. As described in Section 2.4, both the energy intensity of occupation and health outcome are utilized to construct the health endowment measure.

Calorie intake and energy-intensity of occupation: A useful feature of IFPRI survey is that it provides individual food intake data for each round using a 24-hour recall methodology asking the person with primary responsibility for preparing meals, about recipes prepared, ingredients for

[18]PRH cited the same source for classification of energy intensity of occupations but did not describe different cut-off points of mc they used for their classification. Basal metabolic rate (BMR) for an individual is the amount of energy expended when the person is in sleep. Energy requirement for different activities per minute is BMR times the mc of that activity. For instance, mc for cleaning house for a female is 3, while that for digging earth for male is 5.7.

those recipes and amounts eaten by various family members and guests. The survey has information of quantity of individual intakes of about 200 food items (categorised into 17 food groups), which are converted into calories, protein, and micronutrients (vitamin A, vitamin C, vitamin D, niacin, riboflavin, thiamine, folate, iron, and calcium).

Calorie intake data broadly resembles to PRH claim that gender difference in calorie allocation is age-dependent and so is the gender difference in energy-intensity of occupations. To replicate PRH finding in IFPRI sample, I first use PRH's age-group classification ((age$<$6, 6$\leq$age$<$12, and age$\geq$12). The mean calorie consumption (averaged over four rounds) across age-groups are higher in IFPRI than in PRH sample (see Table 2.2). However, there is no significant gender difference for the group less than $<$6 years. Conversely, consistent with PRH, I find significant gender difference for the age-group $\geq$ 12 years. While PRH does not find any significant gender difference for the age-group 6-12 years, I find this difference is small but significant. In line with PRH, the within-household inequality in calorie distribution, measured by the coefficient of variation, is higher among males than females (the difference is significant) for age-group $\geq$ 12 years, while this inequality is not significant for the groups $<$6 years and $6-12$ years.

Based on my age-group classification, I find that boys have about 100 calories more than girls (the difference significant at 5% level). There is neither a marked difference in energy requirement of occupations for children, nor any significant difference between intrahousehold inequality among boys compared to the inequality among girls based on coefficient of variation. The gender difference in calorie allocation increases almost three-folds for adolescents compared with that of children. Compared to 1% adolescent females, 18% adolescent males are engaged in high energy-intensive occupation. Within household inequality for adolescent males is about 23% higher than that for the adolescent females (significant at 5% level). Adult males receive about 700 calories more than adult females, which reflects the fact that more than half of the adult males compared with only 2% adult females are engaged in high energy-intensive occupations. Thus, the broad linkages between work-activity and calorie distribution as observed by PRH tends to hold for these age-groups as well.

Nutrient Adequacy Ratio: While PRH's focus was only on individual calorie intake, individuals' intakes of calorie and different nutrients[19] are not very useful unless compared against their requirements. I thus construct nutrient adequacy ratio for each of the k nutrients:

$$y_i^k = \frac{C_i^k}{RDA_i^k}$$

[19]All foods are made up of a combination of macronutrients (protein, fat, carbohydrate) and micronutrients (vitamins and minerals). Macronutrients form the bulk of the diet and supply all the energy needed for the body for body functions, growth, and physical activities. Macronutrients provide different amounts of energy, expressed in kilocalories (loosely termed as calorie as well). Fat provides approximately twice as much energy (9Kcals/g) as the same amount of protein or carbohydrate (4Kcals/g).

where, y_i^k is individual i's adequacy ratio of nutrient k, C_i^k is his/her daily consumption of nutrient k, and RDA_i^k is his/her recommended daily allowance (or requirement) of nutrient k based on age, sex, pregnancy, and lactating status. The appendix provides a detailed description of how the RDA figures for calorie and different nutrients are constructed. As discussed in the appendix, for protein and iron, not only quantity but also quality matters. Protein from animal sources are good quality protein, while iron from animal sources (also termed as haem-iron) have high bio-availability and promotes bio-availability of iron from non-animal sources. Hence, in addition to individual's nutrient adequacy ratio, I also use an individual's intake of animal protein as a share of protein requirement and intake of haem iron as a share of total iron requirement as dependent variables in the empirical analysis.

2.5.2 Nonparametric Analysis

Sex difference in adequacy ratio of different nutrients at each age are nonparametrically (using locally weighted regression method, lowess with bandwidth 0.8) shown in Figures 2.1 and 2.2, which illustrate a number of points. First, sex disparity in adequacy ratio is least observed for calorie and among the micronutrients, for niacin. As mentioned, calorie requirement figures for children and adolescents are based on NCHS standard and not based on actual energy expenditure because of lack of data on time allocation for these age groups. Only for these groups, the adequacy ratio seems to be less than 1. This might imply that perhaps these groups are having calories based on their actual energy expenditure (which is unobserved in the data), but still they are having calories less than the NCHS standards to meet their full long-term growth potentials. On the other hand, for the adults for which the requirements are based on actual energy expenditure, the adequacy ratio for both males and females are at or above 1. Calorie intakes of all ages are also most stable (compared to other nutrients) across different rounds (as requirement figures are fixed, any movement in adequacy ratio across rounds implies fluctuation in intakes). All these are consistent with the view in nutrition literature that given the wide variety of sources to meet one's calorie need, in normal circumstances (i.e., without famine) an individual can always meet his/her calorie need (World Health Organization, 1985).

Second, for most of the other nutrients, sex disparity is prominent, persistent, and some times widens for adolescents and adults compared with children. Although for vitamin A and D in some rounds, at a relatively high age (above 70 or so), female adequacy ratio crosses over that of the male, the sample observations are very limited at those ages (with number of males higher than females). So this cross-over should be interpreted with due caution. Third, with the exception of protein and vitamin C, nutrient deficiency is prominent across ages for most of the other nutrients with adequacy ratio lower than 1. The situation is most alarming for iron, where both males and females across ages are in deficiency, with females' deficiency worse than males'. While protein adequacy ratio is above 1 across all ages (with males' ratio higher than females'), the good quality protein (i.e., protein from animal, dairy, and fish, jointly termed as animal protein) as a share of required protein is very low. The situation is even worse for haem iron. Finally, (vertical) shift of these age-adequacy profiles for most of the nutrients (and changes in shapes for some nutrients) across rounds imply variation of individual intakes of these nutrients across rounds.

To illustrate the role of bargaining in intrahousehold nutrient allocation, lowess graphs of calorie and calcium adequacy of different age-sex groups, as examples, are shown in Figure 2.3. The left (right) panel shows intakes of different age-sex group at different levels of wife's (head's) assets at marriage when head's (wife's) assets at marriage is zero. For calorie, most contrasting pattern is reflected for female child. Her calorie adequacy ratio tends to increase with wife's assets but declines with husband's assets. The rate of decline of female adolescent's adequacy ratio is also much faster with the increase in head's assets as opposed to his wife's assets. While male adult's adequacy ratio increases with the increase in head's assets, a v-shaped pattern appears for this adequacy ratio and wife's assets.

For calcium, adult female's intake initially increases and adult male's intake decreases with the increase in head's assets. After a point, the female's intake sharply declines while opposite is observed for the male's intake. Conversely, the initial rate of increase of adult female's intake is faster with the increase in wife's assets, and after a point the intake declines at a slower rate with the increase in wife's assets (compared to the increase in head's assets). Adult male's intake appears to be negatively related with wife's assets. While the male child's intake increases with head's assets, initially with the increase in wife's assets, it increases slightly and then tends to decline.

All these contrasting relationships between individuals' intakes and spouses' assets at marriage motivate a more detailed empirical analysis of intrahousehold bargaining on individual nutrient allocations in the following section.

2.6 Estimation

2.6.1 Calorie intake and health technology

Table 2.3 presents the estimates of the health technology (equation 2.9) for males engaged in highly energy intensive occupations (HEIO) (as defined in the preceding section) and males who are not, and for females. OLS estimates are presented along with IFE estimates for comparison purpose. The results imply three points. First, the role of calorie intake on individual's health outcome is much limited once unobserved individual and household fixed effects are accounted for. For each of the three categories of individuals, the effect of calorie intake on health outcome is much higher in OLS than IFE estimates, indicating upward bias in OLS estimates driven by unobserved individual endowment and household characteristics (such as spouses' tastes). For males in HEIO, doubling calorie intake will increase their weights for heights by 5% in OLS estimate, while the corresponding increase is only 0.67% in IFE estimate. Second, this effect of calorie intake varies only marginally across individuals based on their energy intensity of occupations. Doubling the calorie intake of males who are not engaged in HEIO and of females will increase their weight for height by 0.54% compared to the corresponding increase is 0.67% for males in HEIO based on IFE estimates. Third, comparison of IFE results with that of PRH (in which, doubling calorie intake will increase the weight for height of individuals by about 13.6% in 2SLS estimate and 3% in OLS estimate), implies that PRH's 2SLS estimate of calorie elasticity is potentially biased upward. Regarding the concern of the validity of PRH instruments (as discussed above), head's schooling seems to have a significant direct effect on males (not in HEIO) health outcome, while wife's education (not controlled in PRH) seems to positively and significantly[20] affect females' health outcomes in OLS estimates. These effects are not identifiable in IFE estimates as they are absorbed in household fixed effects. Another PRH instrument, household landholding seems to significantly affect males' (in HEIO) health outcomes in IFE estimate. All these in turn may imply that perhaps the inequality in calorie distribution due to inequality in energy intensity of labour market activities is overemphasized in PRH analysis.

As regards other variables, economies of scale (in terms of household size, holding the household composition constant) in health production is observed for males (particularly for those who are in HEIO) but not for females. Health outcomes for males in HEIO only slightly worsens (by 3%), while that for males not in HEIO and females slightly improves (by 1-3%) in round 1 and 2 compared with round 4 (results not shown). As discussed above, IFE estimates of the coefficients of the health technology are used to construct a measure of unobserved health endowment, κ, which is used in the nutrient demand equations discussed below.

2.6.2 Intrahousehold Bargaining and Nutrient Allocation

Calorie, Protein, and Vitamin A: Table 2.4 presents the SUR_{LS} and SUR_{HFE} estimates of intrahousehold bargaining and allocation of calorie, protein, protein from animal sources (i.e., good quality protein), and vitamin A for boys, girls, male adolescents, female adolescents, female adults, male adults (omitted category), pregnant and lactating females. As SUR_{LS} estimates could be biased (see Section 2.4), the analysis focuses on SUR_{HFE} estimates, while SUR_{LS} estimates are provided for comparison purposes. Spouses' assets at marriage and schooling are interacted with each of these age-gender-physical status categories to analyze whether head's bargaining measures have significant different effects on the allocation of these nutrients for each of these categories of individuals than the corresponding effects of wife's bargaining measures. Given the caveats

[20]Throughout the thesis, "significant" implies statistical significance at 10% level or lower, unless specifically mentioned otherwise.

associated with education as a bargaining measure, my analysis focuses on bargaining based on assets measures although I use spouses' education and their interactions with each of the age-gender-physical status categories to control for any potential correlation between education and assets of spouses. While boys' calorie adequacy ratio is about 29% lower than that of the adult males in SUR_{HFE} estimate, girls' calorie adequacy ratio is 26% lower than that of the adult males, implying girls have about 3% higher calorie adequacy ratio than boys. While adolescent males' calorie adequacy ratio are about 5% lower than that of the adult males, there is no significant difference among the adequacy ratio of adolescent females, adult females and adult males. This pattern of within age-group gender difference, however, reverses for the allocation of protein, good quality protein[21] and vitamin A. Within each of the age-groups, female's adequacy ratio is significantly lower than that of the male for each of these nutrients. Compared to calorie adequacy ratio, the adequacy ratio for each of these nutrients of pregnant and lactating women are much lower compared to the corresponding adequacy ratio of adult males (with the exception of pregnant women's vitamin A adequacy ratio). A wife's assets significantly and positively affect the calorie and protein adequacy ratio of girls, calorie adequacy ratio of male adolescents, protein and vitamin A adequacy ratio and allocation of good quality protein for female adolescents, and protein and vitamin A adequacy ratio of female adults. For example, doubling a wife's assets would increase the allocation of good quality protein for female adolescents by 6%. A head's assets, on the other hand, negatively and significantly affect the allocation of good quality protein for boys, girls, male adolescents, and female adolescents, and calorie adequacy ratio of male adolescents. For instance, doubling a head's asset would reduce the allocation of good quality protein for girls by 3% in household fixed effect estimates. Tests of unitary model for the equality of the effects of head's and wife's assets [22] (bottom panel of Table 2.4) provide evidence of significant intrahousehold bargaining for allocation of calorie, protein, and good quality protein for girls, calorie and good quality protein for male adolescents, total protein and good quality protein for female adolescents, and calorie and total protein for female adults with a positive association between a wife's assets and these allocations.

The effect of individual health endowment (κ) implies compensation for protein and vitamin A allocations with no significant effect on calorie allocation. Doubling an individual's endowment will roughly reduce the adequacy ratio of protein by 1.7% and vitamin A by 1.6%. Apart from vitamin

[21]The term "adequacy ratio" is loosely used for good quality protein and haem-iron, for which it measures intake of good quality protein as a share of total protein requirement, and intake of haem iron as a share of total iron requirement.

[22]I test the complete set of restrictions for bargaining described in equations 2.10, 2.11, 2.12, and 2.13 for education and asset measures for each of the age-sex-pregnancy-lactating group, which are available upon request. As already mentioned, the chapter focuses on assets as the key bargaining measure, and thus the analysis concentrates on the restrictions in equation 2.13 based on assets as they are comparable between OLS and FE estimates in SUR framework.

A, at the initial level of income, individual intakes of these nutrients increase with the increase in household income. The increase is most prominent for good quality protein. Although inelastic, the expenditure elasticity at the initial level of income is higher for total protein than total calorie intake. Household economies of scale appears to be significant for individuals' calorie and protein (in OLS estimates) and for vitamin A (in HFE estimates). In terms of agricultural seasonality, individuals' intakes of calorie, protein and good quality protein appears to be lowest in round 3.

Vitamin C, D and Iron: Table 2.5 presents the results of intrahousehold bargaining and individual allocation of vitamin C, D, iron, and haem iron. The adequacy ratio of all the age-sex groups and pregnant and lactating women are significantly lower than that of adult males for each of these nutrients. Within each age-group, the adequacy ratio of males are significantly higher than that of females for each of these nutrients, while pregnant and lactating women have significant lower adequacy ratio than that of the adult males. For instance, based on fixed effect estimates adult females' iron adequacy ratio are about 93% lower than that of adult males, while the former's allocation of haem iron as a share of total iron requirement is 108% lower than that of adult males. A pregnant woman's iron adequacy ration is 170% lower than that of an adult male, while her haem iron allocation (as a share of her total iron requirement) is about 177% lower than the corresponding allocation for an adult male. Similarly, a female adolescent's iron adequacy ration is about 18% lower than that of a male adolescent, while her allocation of haem iron as a share of her total iron requirement is about 24% lower than the corresponding share of a male adolescent. This degree of sex-disparity regarding iron is comparatively lower within children as a boy's iron adequacy ration is about 6% higher than that of a girl, while his haem iron share is about 9% higher than that of a girl. Within children, the magnitude of sex-disparity appears to be higher for vitamin C and D than iron adequacy ratio.

Based on the p-values of equality of restrictions of the effect of a wife's and head's assets at marriage (bottom panel of Table 2.5), significant intrahousehold bargaining is observed for the allocation of haem iron as a share of individual's total iron requirement for boys, male and female adolescents, and for lactating adolescents. A head's assets negatively affect the haem iron allocation for boys and adolescents, while a wife's assets has the opposite effect. While both head's and wife's assets are positively associated with the haem iron allocation for lactating adolescents, the effect of wife's assets is about 6 times higher than that of head's assets. Similarly, while doubling wife's assets would increase the haem iron (as a share of total iron requirement) by 10% for female adolescents, the corresponding increase in head's assets would decrease it by 1.5%.

The effect of κ implies that households tend to compensate for lower endowments. Doubling an individual's endowment would reduce his/her adequacy ratio of vitamin C by 1%, vitamin D by 2%, iron by 3%, and haem iron share by 2%, approximately. Among these nutrients, the expenditure elasticity seems to be highest for vitamin D at the initial level of income, while household economies of scale appears to be significant for vitamin C and iron intakes. Consumption of vitamin C appears to be significantly lower in all three rounds compared with round 4, while consumption of vitamin D is about 16% lower in round 1, and 39% lower in round 3 compared to that in round 4. while Households appears to compensate for individual endowments.

Calcium, Niacin, Riboflavin, Thiamin, and Folate: Table 2.6 presents the results for these last set of nutrients. Based on fixed effect estimates, calcium adequacy ratio of boys' are 15% higher than that of girls, that of male adolescents are 11% higher than that of female adolescents, and adult females' adequacy ratio are 32% lower than that of adult males. Compared with adult males, the situation of pregnant (83% lower) and lactating females (74% lower) are even worse. While female adults' niacin adequacy ratio are not significantly different from that of male adults, both pregnant and lactating women have 19% and 14% lower niacin adequacy ratio than that of adult males. Sex disparity is also significant with males having higher niacin adequacy ration than females within children and adolescent groups. While pregnant women's riboflavin adequacy ratio are not significantly different from that of adult males, lactating women's adequacy ratio are 8% lower and female adults' ratio 13% lower than that of adult males. Boys' and male adolescents' adequacy ratio are 9% and 11% higher than girls' and female adolescents', respectively. Similar pattern of sex disparity across all age-sex-physical status groups observed for thiamin and folate as well. For folate, while girls' adequacy ratio is not significantly different from that of adult males, boys' adequacy ratio are about 10% higher than that of adult males (and girls).

Evidence of significant intrahousehold bargaining appears (bottom panel of Table 2.6) for calcium allocation for male and female adolescents and female adults and riboflavin and thiamin allocations for male adolescents. A wife's assets as opposed to head's assets, positively affect each of these allocations. For instance, doubling a wife's assets would increase the calcium adequacy ratio for adult females by 4%, while the effect of corresponding increase in head's assets is not significantly different from zero.

Similar to the case of other nutrients, allocation of these set of nutrients also imply that households tend to compensate for low individual health endowments. Although inelastic, intakes of niacin and thiamin are positively associated with the increase in household expenditure at lower level of expenditure. OLS estimates also indicate significant economies of scale for individual consumption of these nutrients within the household. There does not appear to be a consistent pattern of seasonality, perhaps because seasonality varies for different foods. Compared to round 4, calcium intake is about 6% higher in round 1, niacin intake is about 7% higher in round 2 and 4% higher in round 3, riboflavin intake is 6.5% lower in round 3, folate intake is about 13% lower in round 3, and thiamin intake is about 9% higher in round 3.

2.7 Summary and Conclusion

In light of growing concern of micronutrient malnutrition as a critical public policy issue, this chapter attempts to extend the previous literature on intrahousehold food distribution by analysing intrahousehold nutrient allocation in a bargaining framework. While the focus of the previous work has been on calorie allocation, this chapter attempts to demonstrate that calorie intake may not necessarily be a sufficient metric of nutrient adequacy as micronutrient deficiency can co-exist with calorie adequacy. The gender disparity is more prominent in the allocation of a range of critical nutrients than in calorie allocation within the household. Pregnant and lactating women appear to be most vulnerable as their intakes fall far short of their elevated requirements, which in turn might lead to nutrient deficiency of the newborns.

Previous work on intrahousehold food distribution has adopted a unitary framework, which has been rejected empirically for a wide range of outcomes in recent decades. PRH, an influential work in this genre, further have demonstrated that food distribution in a poor economy like Bangladesh is due to gender-disparity in energy intensity of labour market activities in which health influences labour market productivity and returns for males but not for females. However, the individual fixed effect estimates of health technology in this chapter indicate that PRH claim might be overemphasized as their estimate of the effect of calorie on individual's health outcomes might be biased upward due to unobserved household fixed effects. These unobserved effects also raise concerns about the validity of the instruments used by PRH to reach to their conclusion. Moreover, as the nutrition literature suggests, while calorie intake is a direct function of calorie expenditure and thus of energy intensity of labour market activities, various nutrients analysed in this chapter need not.

In a bargaining framework, controlling for potential marriage market selection and unobserved household fixed effects, I demonstrate evidence of intrahousehold bargaining and positive effect of a wife's bargaining power as opposed to her husband's in the allocation of various nutrients for children and adolescents of both sexes, and for adult females. Thus, the policy implication of this chapter fundamentally differs from that based on a unitary framework. Based on PRH in a unitary framework, a key policy paradigm is to increase energy-intensive labour market opportunities for women, or to achieve economic development by transforming work activities to those in which linkages between food consumption and productivity are weak, which however, might increase within-group inequality for women due to wider variation in their economic activities. On the other hand, my findings imply that for any given level of economic development and household income, gender disparity (both between the sexes and within the adult women group) could be potentially reduced through increased women's bargaining power within the household achieved through various legal and policy changes that grant women more control over resources. This policy implication is consistent with a number of studies that provide evidence that more control of resources by women leads to an improvement in child health, nutrition, education, and on women's own well-being. Moreover, women's participation in the labour market, a key policy lever in the unitary framework itself is endogenous and is an outcome of intrahousehold bargaining.

However, the change in a woman's bargaining power may affect the marriages (and perhaps divorces). The measure of bargaining power used in this chapter (assets at marriage) is largely determined by parental wealth, and in this society the norm is that parents arrange the marriages for their offsprings. Thus, future work perhaps could focus on how the policy change leading to increased female controls of resources could potentially affect household formation and dissolution and not just intrahousehold allocation in a traditional poor rural society.

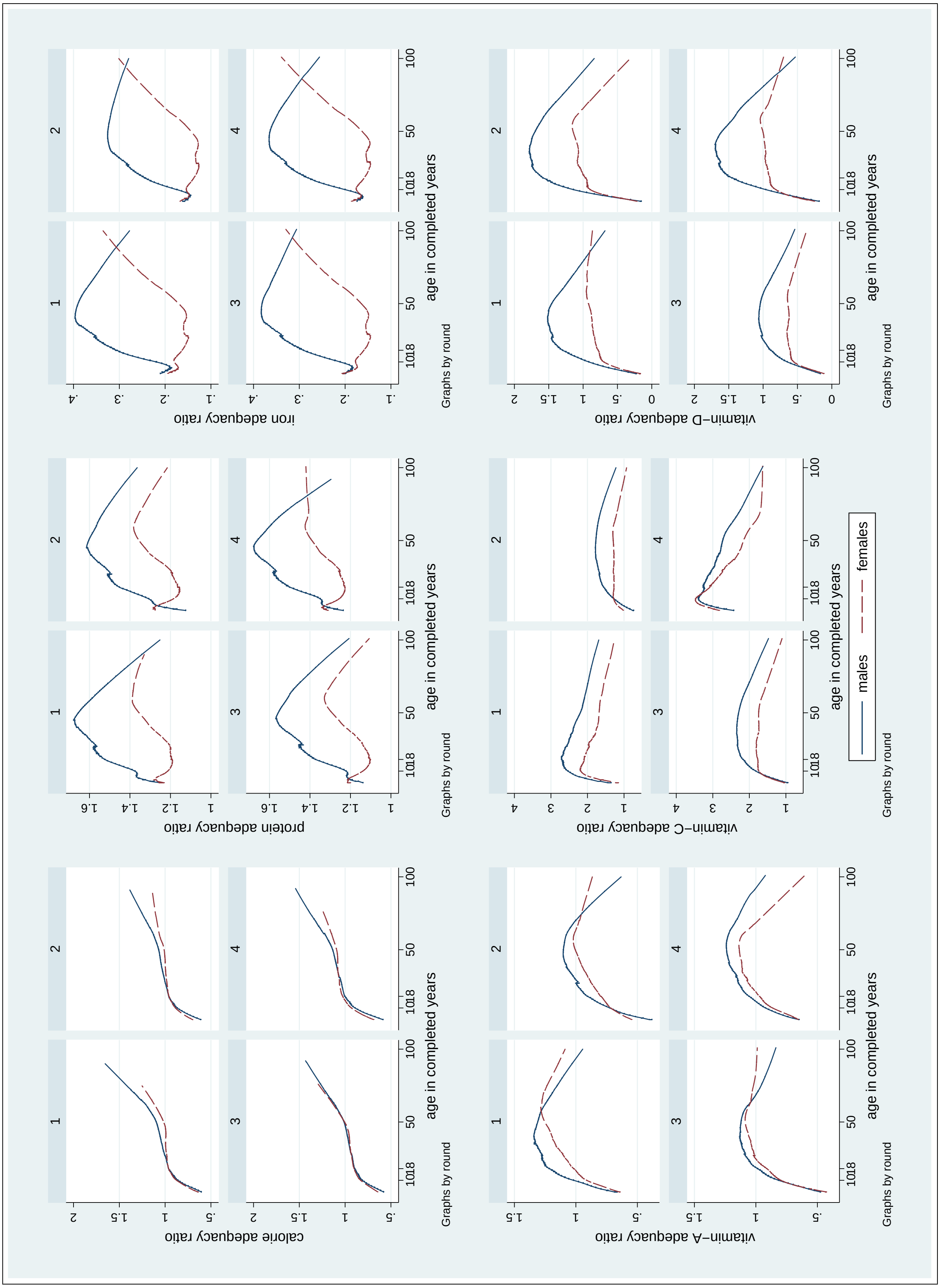

Figure 2.1: Adequacy Ratio, Lowess Fit, Bandwidth=0.8

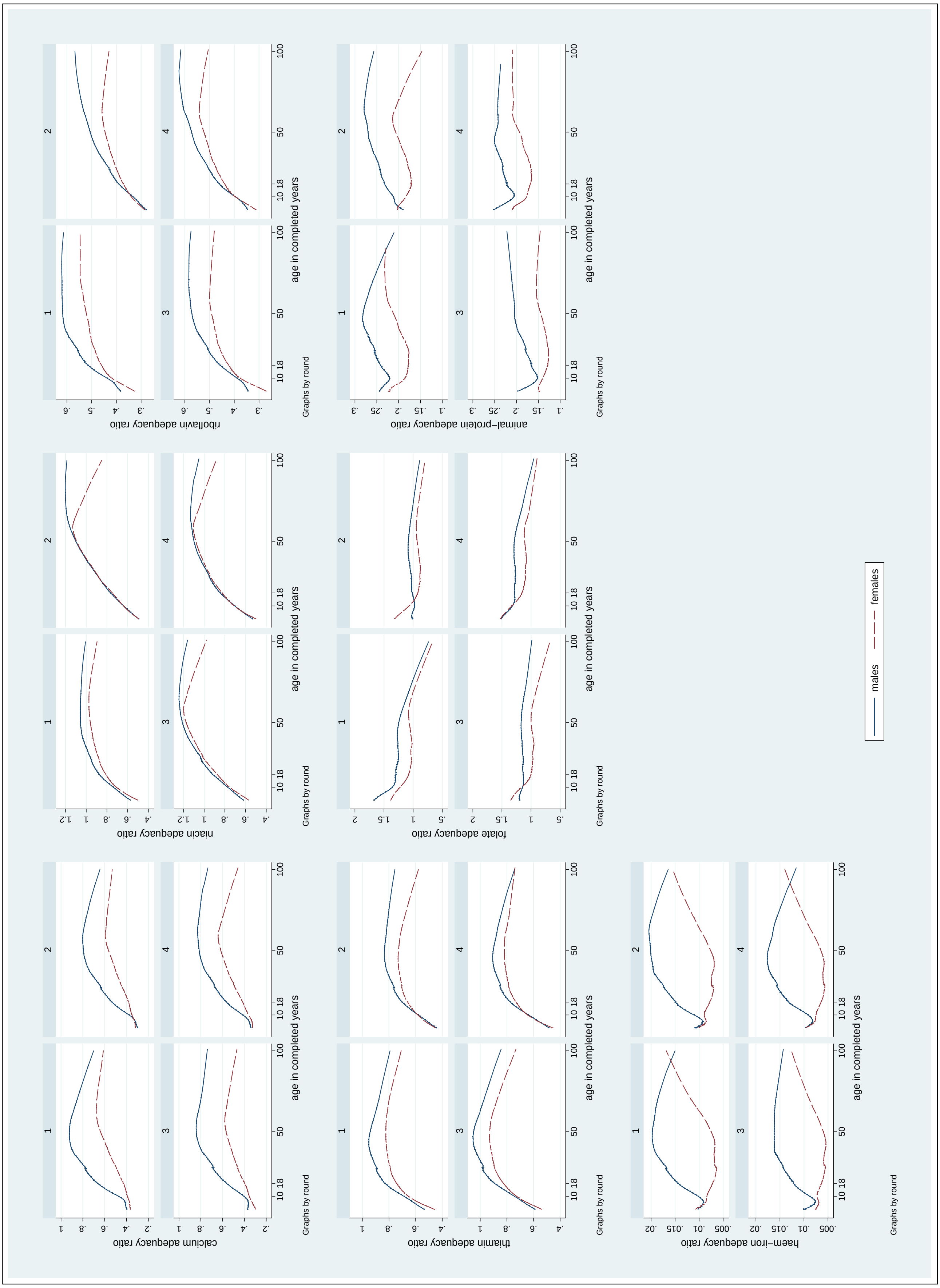

Figure 2.2: Adequacy Ratio, Lowess Fit, Bandwidth=0.8

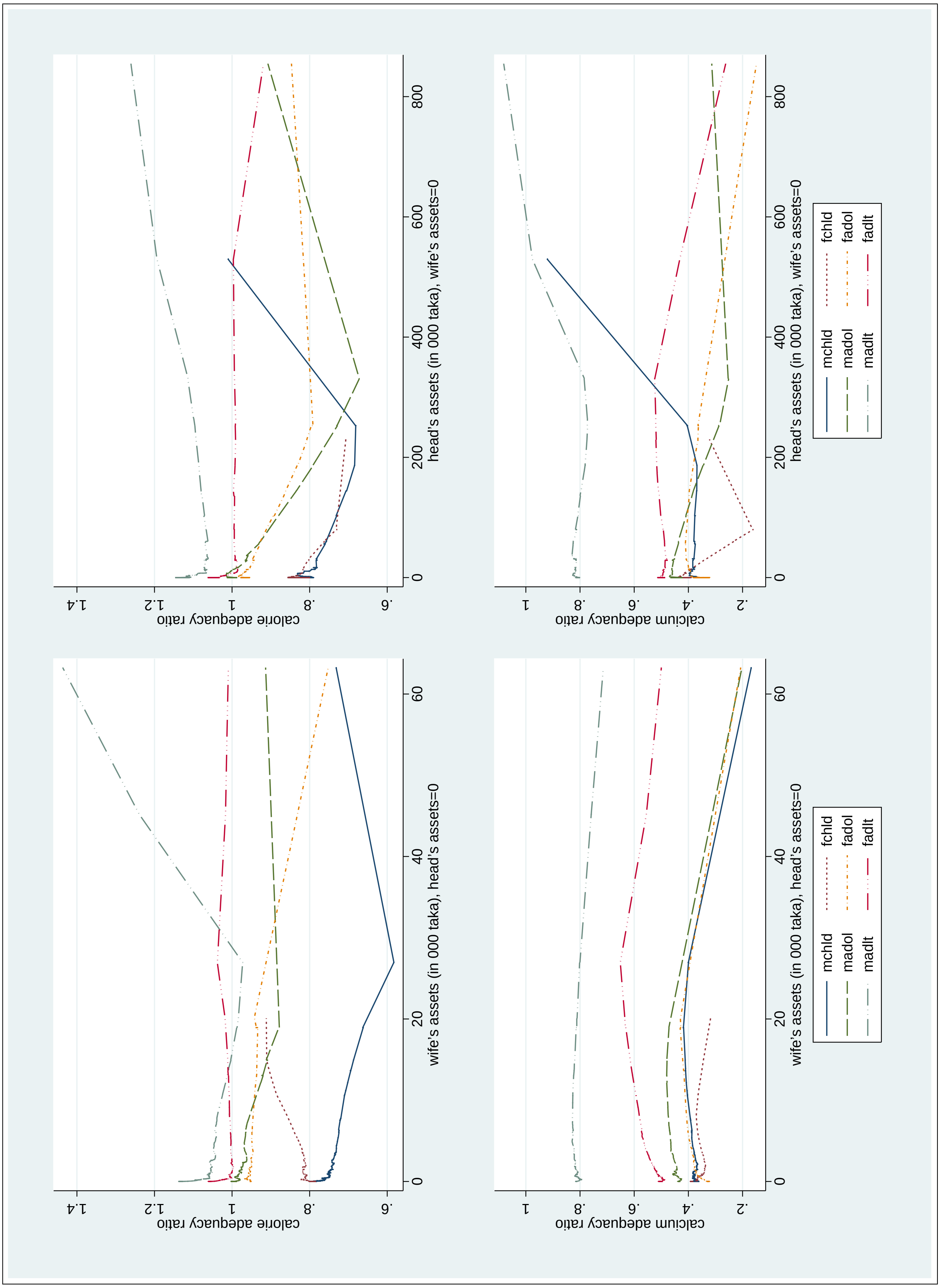

Figure 2.3: Adequacy Ratio & Spouses' Assets, Lowess Fit, Bandwidth=0.8

Note: mchld, male child, fchld, female child mdol, male adolescent, fadol, female adolescent, madlt, male adult, fadlt, female adult

Table 2.1: Descriptive Statistics of IFPRI and HES Samples

Variables	IFPRI								HES
	Round 1		Round 2		Round 3		Round 4		Rural
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean
HH size	6.57	2.98	6.54	2.94	6.46	2.79	6.40	2.79	5.25
Share of									
Boy	0.11	0.13	0.11	0.13	0.11	0.13	0.11	0.13	
Girl	0.10	0.13	0.10	0.13	0.10	0.13	0.10	0.13	
Madol	0.12	0.13	0.12	0.13	0.12	0.14	0.12	0.14	
Fadol	0.10	0.12	0.10	0.12	0.10	0.12	0.10	0.12	
Male adult	0.30	0.13	0.29	0.13	0.29	0.13	0.30	0.13	
Female adult	0.27	0.11	0.27	0.11	0.27	0.11	0.27	0.11	
Preg	71		64		55		67		
Lact	286		303		299		251		
W/H (kg/cm)									
Boy	0.139	0.026	0.141	0.025	0.141	0.026	0.142	0.045	
Girl	0.135	0.026	0.135	0.026	0.137	0.025	0.136	0.025	
Madol	0.221	0.044	0.225	0.046	0.228	0.045	0.227	0.044	
Fadol	0.231	0.048	0.233	0.047	0.233	0.045	0.233	0.047	
Male adult	0.299	0.036	0.298	0.036	0.298	0.035	0.300	0.053	
Female adult	0.280	0.038	0.277	0.038	0.279	0.038	0.282	0.040	
Mcapx	676.35	465.01	607.46	454.36	716.17	471.34	697.14	642.33	662.00
Lpc (acre)	0.22	0.25	0.23	0.26	0.23	0.26	0.23	0.27	
VUV of									
Rice	10.87	0.83	9.79	0.70	11.41	1.10	10.00	0.79	
Pulses	31.52	2.92	34.23	3.78	32.52	2.46	29.84	3.91	
Big fish	77.07	13.05	60.40	10.40	68.34	10.20	85.42	17.51	
Small fish	65.67	8.98	46.69	6.63	64.72	13.73	68.77	12.64	
Egg	64.95	7.29	78.03	10.31	65.32	8.22	69.24	9.48	
Pov rate	Share of Individual Below the Poverty Line								
Abs poor	67.57		66.48		71.81		59.48		47.1
Hcore poor	42.53		45.69		48.82		37.46		24.6
Pov rate (CBN)	Share of Individual below								
	UPL	LPL	UPL	LPL	UPL	LPL	UPL	LPL	UPL
Site 1	0.54	0.36	66.81	53.25	50.24	32.02	54.65	38.86	55.2
Site 2	0.43	0.37	59.52	51.01	38.68	32.39	46.18	39.34	LPL
Site 3	0.53	0.33	62.29	47.58	51.72	37.98	54.37	35.74	38.5
	Time Invariant Household Characteristics								
Landless	4.75								5.5
< 1 acre	48.75								61.3
1 - < 2.5 acres	25.27								19
2.5 - < 7.5 acres	19.13								12
≥ 7.5 acres	2.1								2.2
Spouse charc.		Mean	Std		Mean	Std			
Age	Head	46.48	12.16	Wife	37.63	11.04			
Education	Head	3.50	4.16	Wife	1.74	2.79			
Assets	Head	32,266	149,113	Wife	2,683	10,704			
of which,									
housing	Head	2,364	6,624	Wife	184.29	2,044.36			
cattle	Head	7,178	29,758	Wife	479.74	3,322.83			
durables	Head	2,874	8,956	Wife	1,205.12	4,388.96			
food	Head	0	0	Wife	382.29	930.86			
land	Head	20,284	139,639	Wife	604.35	7,972.25			

Note: HH, household; Madol, male adolescent; Fadol, female adolescent; preg, pregnant; lact, lactating; W/H, weight for height; Mcapx, monthly per capita expenditure; lpc, land, per capita; vuv, village unit values;
pov, poverty; abs, absolute; hcore, hardcore; charc, characteristics; STD, standard deviation

Table 2.2: Distribution of Calories and Energy Intensity of Occupation by Age and Sex, PRH Classification

	Age<6		t test	6≤Age<12		t test	Age≥12		t test
	male	female	(p value)	male	female	(p value)	male	female	(p value)
IFPRI									
Mean Household Calorie Consumption	1,078	1,127	-0.39	1,802	1,635	2.70	2,800	2,163	22.13
			0.70			0.01			0.00
Mean Household Coefficient of Variation	0.32	0.27	0.60	0.18	0.15	1.50	0.18	0.15	3.62
			0.55			0.14			0.00
PRH			χ^2 (d.f.)			χ^2 (d.f.)			χ^2 (d.f.)
Mean Household Calorie Consumption	891	751	2.35	1,549	1,536	0.25	2,672	2,063	609.1
			(217)			(220)			(465)
Mean Household Coefficient of Variation	0.44	0.41	0.26	0.11	0.11	0.23	0.12	0.07	4.48
			(38)			(29)			(143)
Energy Intensity of Occupation, IFPRI					Percent				
Low	100	100		98.31	97.97		46.49	26.27	
Medium	0	0		0.54	1.45		4.83	71.85	
High	0	0		1.15	0.58		48.68	1.88	
Energy Intensity of Occupation, PRH					Percent				
Insignificant	98.7	99.3		70.5	69.1		26.8	20.6	
Light	1.3	0.7		28.8	25.6		22.6	8.5	
Moderate	0	0		0	4.5		2.82	68.2	
Very High	0	0		0.7	0.8		31.9	1.2	
Exceptionally High	0	0		0	0		15.90	1.50	
IFPRI	Age<10		t test	10≤Age<18		t test	Age≥18		t test
	male	female	(p value)	male	female	(p value)	male	female	(p value)
Mean Household Calorie Consumption	1,434	1,315	2.18	2,363	2,019	6.29	2,913	2,186	19.05
			0.03			0.00			0.00
Mean Household Coefficient of Variation	0.28	0.27	0.56	0.16	0.13	2.01	0.16	0.17	-0.14
			0.58			0.05			0.89
Energy Intensity of Occupation					Percent				
Low	99.78	99.48		77.8	75.72		38.96	14.1	
Medium	0.16	0.35		4.39	23.41		4.61	83.72	
High	0.05	0.17		17.81	0.87		56.42	2.18	

Table 2.3: Estimation of Health Technology: OLS and IFE

Variables	Dependent Variable: L (Individual's weight for height)					
	(1)	(2)	(3)	(4)	(5)	(6)
	Male, HEIO		Male, not HEIO		Female	
	OLS	FE	OLS	FE	OLS	FE
L calorie	0.0513***	0.0067***	0.1097***	0.0054**	0.0760***	0.0054***
intake	(0.009)	(0.002)	(0.008)	(0.002)	(0.006)	(0.002)
preg					0.1197***	0.0333***
nant					(0.010)	(0.004)
lact					0.0653***	-0.0077**
ating					(0.008)	(0.004)
L mcapx	0.0827	0.0049	0.1384*	0.0078	0.0570	-0.0239
	(0.076)	(0.019)	(0.076)	(0.024)	(0.057)	(0.015)
$(\text{L mcapx})^2$	-0.0044	-0.0003	-0.0085	-0.0007	-0.0024	0.0017
	(0.006)	(0.001)	(0.006)	(0.002)	(0.004)	(0.001)
L land	0.0108	0.0229*	0.0142	-0.0140	-0.0141	-0.0050
per capita	(0.012)	(0.012)	(0.015)	(0.024)	(0.011)	(0.011)
L household	0.0453***	0.0295**	0.0319**	-0.0079	0.0098	-0.0040
size	(0.012)	(0.013)	(0.014)	(0.020)	(0.011)	(0.012)
share of	-0.0798*	-0.0142	-0.2174***	-0.0464	-0.1576***	-0.0589**
boys	(0.043)	(0.026)	(0.047)	(0.031)	(0.040)	(0.026)
share of	-0.0748*	-0.0565**	-0.0330	-0.0178	-0.2523***	-0.0673***
girls	(0.043)	(0.024)	(0.050)	(0.032)	(0.039)	(0.025)
share of	-0.0033	-0.0309	-0.0891*	0.0031	-0.1077***	-0.0700***
madol	(0.047)	(0.025)	(0.048)	(0.029)	(0.040)	(0.024)
share of	-0.0062	-0.0490**	-0.0750	-0.0011	-0.0870**	-0.0063
fadol	(0.041)	(0.021)	(0.047)	(0.028)	(0.035)	(0.020)
share of	0.0425	0.0084	0.1949***	0.0418	-0.0003	-0.0129
madlt	(0.046)	(0.023)	(0.052)	(0.031)	(0.044)	(0.024)
head's	0.0017		0.0033***		0.0012	
schooling	(0.001)		(0.001)		(0.001)	
wife's	0.0011		0.0025		0.0046***	
schooling	(0.002)		(0.002)		(0.002)	
head's	-0.0087***		0.0019		0.0028	
age	(0.003)		(0.004)		(0.003)	
head's	0.0001***		-0.0000		-0.0000	
age^2	(0.000)		(0.000)		(0.000)	
wife's	0.0059*		-0.0067		-0.0046	
age	(0.003)		(0.004)		(0.003)	
wife's	-0.0001**		0.0001		0.0000	
age^2	(0.000)		(0.000)		(0.000)	
L hvpwed	-0.0005		-0.0022		-0.0007	
	(0.002)		(0.002)		(0.002)	
L wvpwed	0.0073*		0.0003		0.0007	
	(0.004)		(0.005)		(0.004)	
Constant	-5.6971***	-8.3137***	-3.8445***	-2.2452***	-3.6609***	-2.5293***
	(0.344)	(0.919)	(0.278)	(0.115)	(0.198)	(0.112)
Adj.R^2	0.370	0.125	0.821	0.128	0.753	0.146
Observations	2,815	2,815	4,565	4,565	7,305	7,305
Individuals	858	858	1436	1,436	2152	2,152

Note: HEIO, high energy intensive occupation; L natural log, mcapx, monthly per capita expenditure; madol, male adolescent; fadol, female adolescent; madlt, male adult; hvpwed, 1+head's assets; wvpwed, 1+wife's assets (both in 000; taka); additional controls are log age and its square; survey rounds and site dummies; robust standard errors are in parentheses clustered at individual level; *** significant at 1%, ** at 5%, and * at 1% level.

Table 2.4: Intrahousehold Bargaining and Calorie, Protein, and Vitamin A Allocations

VARIABLES	(1) Lcal SUR_{LS}	(2) Lcal SUR_{HFE}	(3) Lprot SUR_{LS}	(4) Lprot SUR_{HFE}	(5) Lanimprot SUR_{LS}	(6) Lanimprot SUR_{HFE}	(7) Lvita SUR_{LS}	(8) Lvita SUR_{HFE}
boy	-0.305***	-0.292***	-0.167***	-0.164***	-0.193***	-0.211***	-0.550***	-0.460***
	(0.030)	(0.030)	(0.027)	(0.025)	(0.063)	(0.050)	(0.061)	(0.050)
girl	-0.256***	-0.259***	-0.205***	-0.225***	-0.221***	-0.266***	-0.643***	-0.585***
	(0.032)	(0.032)	(0.029)	(0.027)	(0.067)	(0.054)	(0.071)	(0.057)
madol	-0.046*	-0.050**	-0.268***	-0.268***	-0.333***	-0.355***	-0.361***	-0.322***
	(0.024)	(0.024)	(0.022)	(0.021)	(0.056)	(0.046)	(0.054)	(0.044)
fadol	-0.030	-0.044	-0.358***	-0.373***	-0.556***	-0.512***	-0.376***	-0.383***
	(0.027)	(0.028)	(0.023)	(0.022)	(0.061)	(0.049)	(0.057)	(0.045)
fadlt	0.005	0.000	-0.146***	-0.143***	-0.344***	-0.297***	-0.115***	-0.089**
	(0.021)	(0.022)	(0.019)	(0.019)	(0.049)	(0.041)	(0.042)	(0.036)
preg	-0.106***	-0.111**	-0.281***	-0.317***	-0.451***	-0.518***	-0.081	-0.014
	(0.041)	(0.046)	(0.039)	(0.044)	(0.171)	(0.132)	(0.138)	(0.124)
lact	-0.048*	-0.010	-0.333***	-0.338***	-0.250***	-0.412***	-0.451***	-0.386***
	(0.025)	(0.026)	(0.023)	(0.024)	(0.077)	(0.059)	(0.074)	(0.057)
L hast $\times$	0.006	0.001	-0.002	-0.001	-0.049***	-0.024*	0.006	-0.009
boy	(0.009)	(0.008)	(0.008)	(0.008)	(0.019)	(0.015)	(0.022)	(0.017)
L wast $\times$	-0.016	-0.009	-0.015	-0.003	0.012	0.047	-0.001	-0.000
boy	(0.025)	(0.024)	(0.020)	(0.020)	(0.042)	(0.036)	(0.037)	(0.035)
L hast $\times$	0.003	0.003	-0.000	-0.001	-0.034	-0.030*	-0.008	0.018
girl	(0.009)	(0.009)	(0.009)	(0.008)	(0.022)	(0.016)	(0.019)	(0.017)
L wast $\times$	0.027	0.040*	0.010	0.031*	0.034	0.057	0.059	0.051
girl	(0.021)	(0.021)	(0.018)	(0.017)	(0.049)	(0.041)	(0.049)	(0.045)
L hast $\times$	-0.014**	-0.013**	-0.001	-0.001	-0.012	-0.027**	-0.004	-0.001
madol	(0.006)	(0.006)	(0.006)	(0.006)	(0.016)	(0.012)	(0.016)	(0.012)
L wast $\times$	0.029*	0.029*	0.021	0.018	0.023	0.035	0.035	0.022
madol	(0.016)	(0.016)	(0.013)	(0.012)	(0.036)	(0.027)	(0.030)	(0.024)
L hast $\times$	-0.001	-0.001	0.005	0.000	-0.019	-0.028*	0.014	0.010
fadol	(0.008)	(0.008)	(0.007)	(0.006)	(0.017)	(0.015)	(0.017)	(0.012)
L wast $\times$	0.015	0.030*	0.002	0.029**	0.060*	0.060**	0.002	0.057*
fadol	(0.017)	(0.018)	(0.015)	(0.013)	(0.036)	(0.028)	(0.035)	(0.031)
L hast $\times$	-0.007	-0.007	0.006	0.004	0.005	-0.008	0.012	0.015
fadlt	(0.006)	(0.006)	(0.005)	(0.005)	(0.012)	(0.011)	(0.012)	(0.011)
L wast $\times$	0.013	0.020	0.021*	0.027**	0.040	0.033	0.034	0.039*
fadlt	(0.014)	(0.014)	(0.012)	(0.011)	(0.027)	(0.027)	(0.022)	(0.021)
L hast $\times$	0.027	0.022	0.016	0.017	0.069	0.084*	-0.032	-0.054
preg	(0.017)	(0.019)	(0.019)	(0.019)	(0.054)	(0.046)	(0.070)	(0.069)
L wast $\times$	0.016	0.022	-0.006	0.020	0.002	0.055	-0.024	-0.032
preg	(0.029)	(0.036)	(0.026)	(0.032)	(0.135)	(0.135)	(0.093)	(0.087)
L hast $\times$	0.006	-0.005	-0.009	-0.013*	-0.017	0.006	-0.019	-0.025
lact	(0.009)	(0.009)	(0.008)	(0.008)	(0.025)	(0.020)	(0.025)	(0.018)
L wast $\times$	-0.022	-0.049*	-0.003	-0.030	-0.005	0.010	-0.055	-0.064
lact	(0.022)	(0.030)	(0.021)	(0.029)	(0.055)	(0.051)	(0.057)	(0.047)
L hast	0.001		-0.001		0.023**		0.015	
	(0.005)		(0.004)		(0.012)		(0.010)	
L wast	-0.028**		-0.022**		-0.007		-0.014	
	(0.012)		(0.011)		(0.024)		(0.022)	
kappa	0.000	0.001	-0.019***	-0.017***	-0.005	-0.005	-0.004	-0.016***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.007)	(0.005)	(0.007)	(0.005)
L mcapx	0.435***	0.300*	0.478***	0.526***	2.074***	1.405*	0.509	0.019
	(0.152)	(0.168)	(0.168)	(0.181)	(0.575)	(0.748)	(0.444)	(0.608)
(L macapx)^2	-0.026**	-0.016	-0.030**	-0.032**	-0.126***	-0.089	-0.032	0.003
	(0.011)	(0.012)	(0.013)	(0.013)	(0.043)	(0.055)	(0.033)	(0.045)

Table 2.4: Intrahousehold Bargaining and Calorie, Protein, and Vitamin A Allocations

VARIABLES	(1) Lcal SUR_{LS}	(2) Lcal SUR_{HFE}	(3) Lprot SUR_{LS}	(4) Lprot SUR_{HFE}	(5) Lanimprot SUR_{LS}	(6) Lanimprot SUR_{HFE}	(7) Lvita SUR_{LS}	(8) Lvita SUR_{HFE}
L landpc	0.052***	-0.067	0.025	-0.142	0.021	-0.236	-0.072	0.457
	(0.018)	(0.107)	(0.017)	(0.113)	(0.057)	(0.436)	(0.055)	(0.407)
L hhsz	0.030*	0.048	0.041**	-0.032	0.074	-0.249	0.049	0.824*
	(0.018)	(0.108)	(0.020)	(0.121)	(0.064)	(0.496)	(0.057)	(0.452)
round1	-0.021	-0.020	0.027*	0.019	0.166***	0.123**	0.020	0.051
	(0.014)	(0.015)	(0.015)	(0.015)	(0.057)	(0.062)	(0.056)	(0.060)
round2	0.036	0.054**	0.057**	0.062**	0.177**	0.008	-0.206**	-0.239**
	(0.023)	(0.025)	(0.024)	(0.026)	(0.081)	(0.089)	(0.085)	(0.095)
round3	-0.080***	-0.083***	-0.045**	-0.064***	-0.146**	-0.215***	-0.137**	-0.098
	(0.018)	(0.020)	(0.020)	(0.021)	(0.067)	(0.079)	(0.065)	(0.075)
Constant	-2.413***	-2.309***	-1.303*	-2.192***	-5.716**	-4.652	-5.875***	-5.709*
	(0.611)	(0.766)	(0.673)	(0.832)	(2.481)	(3.571)	(2.030)	(3.148)
Observations	10,555	10515	10,555	10515	10,555	10515	10,555	10515
test of equation 2.13 for L hast=L wast, for :								
boy	0.429	0.701	0.557	0.956	0.193	0.065	0.867	0.820
girl	0.282	0.103	0.610	0.103	0.221	0.059	0.220	0.513
madol	0.012	0.015	0.123	0.152	0.402	0.045	0.235	0.416
fadol	0.412	0.108	0.886	0.046	0.057	0.009	0.761	0.150
fadlt	0.189	0.084	0.283	0.064	0.279	0.196	0.404	0.318
preg, fadol	0.902	0.484	0.490	0.419	0.933	0.684	0.975	0.554
preg, fadlt	0.806	0.513	0.821	0.491	0.824	0.936	0.800	0.681
lact, fadol	0.679	0.669	0.894	0.702	0.213	0.126	0.482	0.881
lact, fadlt	0.742	0.533	0.370	0.813	0.350	0.324	0.771	0.705

Robust standard errors clustered at the household level are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
cal, calorie adequacy ratio; prot, protein adequacy ratio; animprot, animal protein intake/total protein requirement; vita, vitamin A adequacy ratio; L, natural log; madol, male adolescent; fadol, female adolescent; fadlt, female adult; preg, pregnant; lact, lactating; hast, 1+husband's assets; wast, 1+wife's assets; mcapx, monthly per capita expenditure landpc, per capita land; hhsz, household size; additional controls (not shown) are discussed in section 2.4.

Table 2.5: Intrahousehold Bargaining and Vitamin C, D, and Iron Allocations

VARIABLES	(9) Lvitc SUR_{LS}	(10) Lvitc SUR_{HFE}	(11) Lvitd SUR_{LS}	(12) Lvitd SUR_{HFE}	(13) Liron SUR_{LS}	(14) Liron SUR_{HFE}	(15) Lanimiron SUR_{LS}	(16) Lanimiron SUR_{HFE}
boy	-0.350***	-0.293***	-1.026***	-0.942***	-0.673***	-0.624***	-0.630***	-0.636***
	(0.054)	(0.045)	(0.096)	(0.077)	(0.035)	(0.035)	(0.065)	(0.055)
girl	-0.471***	-0.401***	-1.087***	-1.055***	-0.740***	-0.713***	-0.690***	-0.722***
	(0.059)	(0.054)	(0.112)	(0.097)	(0.042)	(0.040)	(0.072)	(0.058)
madol	-0.103**	-0.103***	-0.135*	-0.132**	-0.516***	-0.506***	-0.512***	-0.559***
	(0.041)	(0.036)	(0.072)	(0.059)	(0.036)	(0.037)	(0.061)	(0.054)
fadol	-0.164***	-0.197***	-0.379***	-0.341***	-0.699***	-0.690***	-0.833***	-0.804***
	(0.045)	(0.037)	(0.082)	(0.062)	(0.041)	(0.041)	(0.065)	(0.058)
fadlt	-0.328***	-0.322***	-0.350***	-0.323***	-0.951***	-0.925***	-1.122***	-1.082***
	(0.035)	(0.030)	(0.064)	(0.051)	(0.029)	(0.029)	(0.051)	(0.044)
preg	-0.438***	-0.351***	-1.598***	-1.589***	-1.678***	-1.710***	-1.777***	-1.776***
	(0.114)	(0.119)	(0.209)	(0.168)	(0.076)	(0.072)	(0.164)	(0.135)
lact	-0.394***	-0.296***	-1.202***	-1.188***	-0.365***	-0.358***	-0.254***	-0.409***
	(0.057)	(0.047)	(0.108)	(0.086)	(0.038)	(0.036)	(0.079)	(0.058)
L hast ×	0.046**	0.018	0.008	-0.012	0.008	-0.005	-0.056***	-0.031**
boy	(0.020)	(0.015)	(0.030)	(0.025)	(0.010)	(0.010)	(0.021)	(0.016)
L wast ×	-0.024	-0.021	-0.013	0.007	-0.005	-0.010	0.039	0.037
boy	(0.036)	(0.034)	(0.078)	(0.070)	(0.021)	(0.022)	(0.042)	(0.036)
L hast ×	0.015	-0.001	-0.014	-0.025	0.006	0.006	-0.025	-0.023
girl	(0.020)	(0.018)	(0.035)	(0.028)	(0.011)	(0.010)	(0.022)	(0.016)
L wast ×	0.057	0.074*	-0.084	-0.021	-0.005	0.021	0.025	0.045
girl	(0.043)	(0.044)	(0.093)	(0.092)	(0.023)	(0.021)	(0.051)	(0.045)
L hast ×	-0.009	0.003	-0.006	-0.028*	-0.015	-0.013	-0.030*	-0.033**
madol	(0.014)	(0.011)	(0.020)	(0.015)	(0.010)	(0.010)	(0.017)	(0.014)
L wast ×	0.047*	0.033*	0.019	-0.004	0.041*	0.024	0.027	0.045
madol	(0.025)	(0.018)	(0.046)	(0.036)	(0.023)	(0.022)	(0.038)	(0.033)
L hast ×	0.010	0.018*	-0.002	-0.009	0.027**	0.018	-0.010	-0.015
fadol	(0.014)	(0.010)	(0.021)	(0.016)	(0.013)	(0.012)	(0.019)	(0.017)
L wast ×	-0.039	0.029	0.075	0.053	0.027	0.050*	0.111***	0.096***
fadol	(0.034)	(0.027)	(0.047)	(0.038)	(0.029)	(0.028)	(0.040)	(0.035)
L hast ×	0.018*	0.022**	0.010	0.008	0.002	0.001	-0.008	-0.015
fadlt	(0.009)	(0.009)	(0.015)	(0.013)	(0.006)	(0.006)	(0.012)	(0.011)
L wast ×	0.056**	0.058***	0.012	0.013	-0.006	-0.003	0.018	0.005
fadlt	(0.022)	(0.021)	(0.033)	(0.032)	(0.014)	(0.014)	(0.026)	(0.026)
L hast ×	-0.024	-0.025	0.106	0.186***	-0.001	0.007	0.073	0.077
preg	(0.059)	(0.056)	(0.085)	(0.065)	(0.039)	(0.034)	(0.054)	(0.047)
L wast ×	0.062	0.034	0.153	0.132	-0.009	0.041	-0.115	-0.048
preg	(0.077)	(0.079)	(0.138)	(0.117)	(0.039)	(0.040)	(0.162)	(0.172)
L hast ×	-0.007	-0.038**	0.060*	0.019	-0.006	-0.013	-0.017	0.004
lact	(0.020)	(0.016)	(0.035)	(0.031)	(0.012)	(0.011)	(0.025)	(0.019)
L wast ×	-0.101*	-0.089*	0.000	-0.015	-0.001	-0.021	-0.006	0.026
lact	(0.054)	(0.048)	(0.077)	(0.069)	(0.029)	(0.038)	(0.057)	(0.052)
L hast	0.010		-0.010		-0.006		0.021*	
	(0.009)		(0.018)		(0.006)		(0.012)	
L wast	-0.038*		-0.027		-0.009		0.006	
	(0.020)		(0.039)		(0.013)		(0.024)	
kappa	-0.003	-0.013***	-0.019*	-0.019***	-0.023***	-0.027***	-0.015**	-0.016**
	(0.005)	(0.004)	(0.010)	(0.007)	(0.004)	(0.004)	(0.008)	(0.006)
L mcapx	0.878**	0.620	2.797***	2.512**	0.492*	0.150	2.060***	0.917
	(0.397)	(0.485)	(0.939)	(1.169)	(0.254)	(0.262)	(0.586)	(0.721)
(L macapx)^2	-0.056*	-0.040	-0.186***	-0.178**	-0.029	-0.006	-0.122***	-0.052
	(0.030)	(0.036)	(0.071)	(0.088)	(0.019)	(0.019)	(0.044)	(0.054)

Table 2.5: Intrahousehold Bargaining and Vitamin C, D, and Iron Allocations

VARIABLES	(9) Lvitc SUR_{LS}	(10) Lvitc SUR_{HFE}	(11) Lvitd SUR_{LS}	(12) Lvitd SUR_{HFE}	(13) Liron SUR_{LS}	(14) Liron SUR_{HFE}	(15) Lanimiron SUR_{LS}	(16) Lanimiron SUR_{HFE}
L landpc	-0.028	0.605*	-0.022	0.204	0.022	0.005	-0.023	-0.172
	(0.046)	(0.337)	(0.083)	(0.584)	(0.026)	(0.173)	(0.060)	(0.421)
L hhsz	0.042	0.999***	0.054	0.406	0.068**	0.085	0.062	-0.308
	(0.049)	(0.369)	(0.099)	(0.651)	(0.028)	(0.181)	(0.067)	(0.476)
round1	-0.249***	-0.236***	-0.083	-0.160*	0.039*	0.022	0.146**	0.092
	(0.044)	(0.047)	(0.086)	(0.090)	(0.023)	(0.024)	(0.058)	(0.061)
round2	-0.423***	-0.375***	0.025	-0.123	-0.013	0.008	0.207**	0.061
	(0.066)	(0.071)	(0.124)	(0.139)	(0.035)	(0.037)	(0.084)	(0.092)
round3	-0.130**	-0.096*	-0.296***	-0.390***	0.014	-0.009	0.004	-0.094
	(0.051)	(0.058)	(0.110)	(0.121)	(0.030)	(0.031)	(0.066)	(0.076)
Constant	-7.229***	-6.942***	1.876	0.430	-3.344***	-3.220***	-9.033***	-7.312**
	(1.698)	(2.515)	(3.828)	(5.076)	(1.017)	(1.201)	(2.535)	(3.393)
Observations	10,555	10,515	10,555	10,515	10,555	10,515	10,555	10,515
P-value of the tests of equation 2.13 for L hast=L wast, for :								
boy	0.076	0.286	0.811	0.801	0.574	0.852	0.053	0.085
girl	0.404	0.130	0.494	0.968	0.679	0.530	0.385	0.170
madol	0.067	0.189	0.636	0.554	0.028	0.131	0.194	0.034
fadol	0.189	0.703	0.156	0.126	0.991	0.267	0.008	0.005
fadlt	0.121	0.117	0.961	0.880	0.596	0.775	0.407	0.495
pregnant, fadol	0.711	0.487	0.476	0.950	0.905	0.253	0.701	0.945
pregnant, fadlt	0.204	0.337	0.773	0.729	0.788	0.585	0.351	0.581
lactating, fadol	0.021	0.437	0.863	0.706	0.880	0.583	0.084	0.029
lactating, fadlt	0.221	0.704	0.399	0.656	0.930	0.725	0.476	0.367

Robust standard errors clustered at the household level are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
vitc, vitamin C adequacy ratio; vitd, vitamin D adequacy ratio; iron, iron adequacy ratio; animiron, animal iron intake/total iron requirement; L, natural log; madol, male adolescent; fadol, female adolescent; fadlt, female adult; preg, pregnant; lact, lactating; hast, 1+husband's assets; wast, 1+wife's assets; mcapx, monthly per capita expenditure landpc, per capita land; hhsz, household size; additional controls (not shown) are discussed in section 2.4.

Table 2.6: Intrahousehold Bargaining and Calcium, Niacin, Riboflavin, Thiamin, and Folate Allocations

Vars	(1) Lcalci SUR_{LS}	(2) Lcalci SUR_{HFE}	(3) Lniac SUR_{LS}	(4) Lniac SUR_{HFE}	(5) Lribo SUR_{LS}	(6) Lribo SUR_{HFE}	(7) Lthia SUR_{LS}	(8) Lthia SUR_{HFE}	(9) Lfola SUR_{LS}	(10) Lfola SUR_{HFE}
boy	-0.795***	-0.772***	-0.463***	-0.446***	-0.431***	-0.411***	-0.434***	-0.415***	0.046	0.096***
	(0.039)	(0.036)	(0.031)	(0.030)	(0.030)	(0.028)	(0.029)	(0.028)	(0.041)	(0.034)
girl	-0.945***	-0.922***	-0.520***	-0.508***	-0.525***	-0.503***	-0.490***	-0.473***	-0.040	-0.013
	(0.047)	(0.044)	(0.035)	(0.033)	(0.035)	(0.031)	(0.034)	(0.032)	(0.045)	(0.038)
madol	-0.690***	-0.679***	-0.312***	-0.311***	-0.316***	-0.311***	-0.251***	-0.241***	-0.159***	-0.135***
	(0.036)	(0.034)	(0.026)	(0.027)	(0.026)	(0.024)	(0.024)	(0.023)	(0.035)	(0.029)
fadol	-0.787***	-0.793***	-0.240***	-0.253***	-0.239***	-0.247***	-0.186***	-0.197***	-0.109***	-0.118***
	(0.038)	(0.035)	(0.028)	(0.027)	(0.027)	(0.025)	(0.026)	(0.023)	(0.038)	(0.030)
fadlt	-0.330***	-0.320***	-0.028	-0.010	-0.145***	-0.128***	-0.098***	-0.075***	-0.190***	-0.166***
	(0.029)	(0.027)	(0.023)	(0.022)	(0.022)	(0.021)	(0.020)	(0.019)	(0.029)	(0.025)
preg	-0.837***	-0.830***	-0.134**	-0.188***	-0.093	-0.103	-0.144***	-0.192***	-0.975***	-0.953***
	(0.098)	(0.091)	(0.053)	(0.055)	(0.064)	(0.064)	(0.050)	(0.053)	(0.096)	(0.090)
lact	-0.774***	-0.743***	-0.132***	-0.142***	-0.087***	-0.078***	-0.136***	-0.131***	-0.367***	-0.358***
	(0.047)	(0.036)	(0.032)	(0.030)	(0.030)	(0.027)	(0.028)	(0.026)	(0.047)	(0.038)
L hast ×	0.003	-0.004	0.004	0.001	0.006	0.002	0.011	0.005	0.007	-0.007
boy	(0.013)	(0.011)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.013)	(0.011)
L wast ×	0.013	0.024	-0.017	-0.018	-0.002	0.013	-0.016	-0.007	-0.025	-0.006
boy	(0.023)	(0.024)	(0.026)	(0.025)	(0.021)	(0.021)	(0.022)	(0.021)	(0.022)	(0.023)
L hast ×	0.000	0.008	0.006	0.004	0.006	0.010	0.004	0.004	0.007	0.013
girl	(0.014)	(0.012)	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)	(0.013)	(0.011)
L wast ×	0.068*	0.064*	0.005	0.023	0.053**	0.046**	0.004	0.028	0.017	0.037
girl	(0.035)	(0.034)	(0.021)	(0.022)	(0.022)	(0.022)	(0.020)	(0.020)	(0.033)	(0.030)
L hast ×	-0.003	-0.008	-0.012*	-0.008	-0.009	-0.008	-0.010	-0.008	-0.012	-0.009
madol	(0.011)	(0.009)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.006)	(0.011)	(0.008)
L wast ×	0.043**	0.042**	0.017	0.015	0.030**	0.029**	0.025*	0.015	0.032	0.013
madol	(0.021)	(0.018)	(0.015)	(0.015)	(0.014)	(0.013)	(0.014)	(0.012)	(0.022)	(0.015)
L hast ×	0.016	0.008	0.007	0.005	0.010	0.004	0.009	0.005	0.010	0.003
fadol	(0.012)	(0.010)	(0.008)	(0.007)	(0.009)	(0.007)	(0.008)	(0.006)	(0.011)	(0.008)
L wast ×	-0.007	0.054**	-0.014	0.010	-0.006	0.029	-0.013	0.015	-0.041	0.014
fadol	(0.028)	(0.025)	(0.019)	(0.018)	(0.020)	(0.018)	(0.018)	(0.014)	(0.027)	(0.020)
L hast ×	0.014*	0.010	0.015**	0.015**	0.009	0.006	0.008	0.006	0.014*	0.015**
fadlt	(0.008)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)
L wast ×	0.038**	0.043***	0.014	0.019	0.022*	0.026**	0.019	0.024**	0.027*	0.023
fadlt	(0.015)	(0.014)	(0.015)	(0.014)	(0.012)	(0.012)	(0.012)	(0.011)	(0.016)	(0.015)
L hast ×	0.004	0.000	0.016	0.023	0.001	-0.003	0.020	0.028	-0.012	-0.003
preg	(0.053)	(0.049)	(0.025)	(0.027)	(0.034)	(0.034)	(0.027)	(0.023)	(0.050)	(0.042)
L wast ×	-0.016	-0.013	0.047	0.095*	-0.025	-0.002	-0.012	0.033	0.053	0.077
preg	(0.058)	(0.055)	(0.053)	(0.052)	(0.043)	(0.040)	(0.044)	(0.037)	(0.057)	(0.057)
L hast ×	-0.021	-0.025**	-0.004	-0.012	-0.011	-0.012	-0.003	-0.011	-0.031*	-0.036***
lact	(0.016)	(0.012)	(0.012)	(0.011)	(0.011)	(0.010)	(0.010)	(0.008)	(0.017)	(0.013)
L wast ×	-0.039	-0.041	-0.001	-0.031	-0.018	-0.028	0.001	-0.020	-0.037	-0.019
lact	(0.038)	(0.034)	(0.027)	(0.037)	(0.026)	(0.031)	(0.023)	(0.030)	(0.037)	(0.035)
L hast	0.010		-0.005		0.004		-0.005		0.003	
	(0.007)		(0.006)		(0.005)		(0.005)		(0.007)	
L wast	-0.013		-0.024*		-0.020*		-0.017		0.000	
	(0.016)		(0.013)		(0.012)		(0.013)		(0.017)	
kappa	-0.012***	-0.016***	-0.017***	-0.018***	-0.010***	-0.013***	-0.011***	-0.014***	-0.004	-0.010***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.003)
L mcapx	0.638*	-0.090	0.911***	0.591***	0.720***	0.367	0.731***	0.464**	0.393	0.183
	(0.328)	(0.356)	(0.199)	(0.209)	(0.235)	(0.261)	(0.221)	(0.226)	(0.329)	(0.382)
(L mac	-0.035	0.016	-0.060***	-0.038**	-0.044**	-0.021	-0.046***	-0.029*	-0.018	-0.007
apx)^2	(0.025)	(0.026)	(0.015)	(0.015)	(0.018)	(0.019)	(0.017)	(0.017)	(0.025)	(0.028)

Table 2.6: Intrahousehold Bargaining and Calcium, Niacin, Riboflavin, Thiamin, and Folate Allocations

Vars	(1) Lcalci SUR_{LS}	(2) Lcalci SUR_{HFE}	(3) Lniac SUR_{LS}	(4) Lniac SUR_{HFE}	(5) Lribo SUR_{LS}	(6) Lribo SUR_{HFE}	(7) Lthia SUR_{LS}	(8) Lthia SUR_{HFE}	(9) Lfola SUR_{LS}	(10) Lfola SUR_{HFE}
L landpc	0.015	0.184	0.036*	-0.001	0.014	-0.017	0.017	0.003	0.016	0.157
	(0.035)	(0.219)	(0.020)	(0.127)	(0.022)	(0.166)	(0.020)	(0.140)	(0.036)	(0.255)
L hhsz	0.085**	0.374	0.083***	0.110	0.066***	0.125	0.064***	0.121	0.095**	0.254
	(0.035)	(0.244)	(0.024)	(0.133)	(0.025)	(0.192)	(0.024)	(0.148)	(0.040)	(0.280)
round1	0.046	0.064*	-0.018	-0.035*	0.018	0.015	0.013	-0.003	-0.069*	-0.049
	(0.034)	(0.035)	(0.018)	(0.019)	(0.022)	(0.024)	(0.019)	(0.020)	(0.036)	(0.037)
round2	0.049	0.008	0.053*	0.067**	-0.022	-0.017	0.029	0.043	-0.136***	-0.106*
	(0.050)	(0.053)	(0.030)	(0.031)	(0.035)	(0.038)	(0.031)	(0.032)	(0.051)	(0.056)
round3	-0.013	0.012	0.070***	0.042*	-0.058**	-0.065**	0.113***	0.089***	-0.165***	-0.127***
	(0.041)	(0.044)	(0.024)	(0.025)	(0.028)	(0.031)	(0.025)	(0.027)	(0.043)	(0.047)
Const.	-6.956***	-5.018***	-3.636***	-3.516***	-5.121***	-4.479***	-3.328***	-3.245***	-2.211*	-0.463
	(1.371)	(1.781)	(0.806)	(0.980)	(0.951)	(1.253)	(0.860)	(1.032)	(1.340)	(1.773)
Obs.	10,555	10,515	10,555	10,515	10,555	10,515	10,555	10,515	10,555	10,515
P-value of the tests of equation 2.13 for L hast=L wast, for :										
boy	0.717	0.320	0.458	0.486	0.731	0.653	0.260	0.616	0.189	0.984
girl	0.078	0.132	0.957	0.429	0.069	0.151	0.987	0.285	0.801	0.446
madol	0.065	0.016	0.095	0.188	0.017	0.012	0.031	0.089	0.081	0.226
fadol	0.456	0.089	0.330	0.823	0.481	0.195	0.283	0.520	0.092	0.606
fadlt	0.176	0.044	0.946	0.769	0.368	0.148	0.384	0.146	0.465	0.627
preg, fadol	0.606	0.687	0.880	0.247	0.475	0.654	0.370	0.762	0.863	0.218
preg, fadlt	0.961	0.800	0.640	0.219	0.801	0.721	0.712	0.622	0.326	0.219
lact, fadol	0.402	0.468	0.633	0.727	0.505	0.807	0.542	1.000	0.230	0.496
lact, fadlt	0.878	0.608	0.927	0.689	0.829	0.931	0.495	0.766	0.862	0.466

Robust standard errors clustered at the household level are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
calci, calcium adequacy ratio; niac, niacin adequacy ratio; ribo, riboflavin adequacy ratio; thiamin adequacy ratio; fola, folate adequacy ratio; L, natural log; madol, male adolescent; fadol, female adolescent; fadlt, female adult; preg, pregnant; lact, lactating; hast, 1+husband's assets; wast, 1+wife's assets; mcapx, monthly per capita expenditure landpc, per capita land; hhsz, household size; obs, observations; additional controls (not shown) are discussed in section 2.4.

Appendix

Construction of Adequacy Ratio for different Age-Gender Group for Calorie and Other Nutrients

Calorie Requirement, RDA_i^{cal}: As is well-known in nutrition literature, among the nutrients analyzed here, only an individual's calorie requirement depends on his/her energy expenditure. At a given age, the main component of the energy requirement is the BMR. The relationship of the energy expenditure of a given level of physical activity to BMR is affected by the metabolic constant, mc (described above) of that activity, body weight, and age. For ages 18 years and above, the energy requirement calculation proceeds as follows. First, I calculate the BMR from body weight of individuals based on the methodology described in World Health Organization (1985) (henceforth, WHO methodology)[23]. Utilising 24-hour time allocation data of individuals (for a subset of individuals, this data is available in the survey), energy requirement for different activities are then calculated as : $t_a \times mc_a \times BMR$, where t_a is time (in minutes) spent in an activity, a. Total energy requirement for individuals of age 18 years and older is the sum of his/her energy requirement in different activities in 24 hours (including sleep). Based on WHO methodology, an allowance of 285 kcal is given for pregnancy and 500 kcal for lactating status.

Energy requirement for children is estimated directly from the observed intakes of healthy children growing normally. These requirements for each age are given in World Health Organization (1985) and are based on the United States National Center for Health Statistics, NCHS, referenced children sample[24]. Finally, as time allocation data is scarce for adolescent group in IFPRI sample, the calorie requirement data of the reference NCHS adolescent group as reported in World Health Organization (1985) is used as proxy for calorie requirement of adolescent group in IFPRI data[25].

Protein and Micronutrient Requirements: While the main determinants of energy requirement are body weight, age, and physical activity, for protein requirement, the determinants are only body weight and age, and not physical activity. Moreover, measuring protein quantity is not enough, as protein quality is also important. Good quality proteins are those that provide adequate amounts of essential amino acids and have a high degree of digestibility. These conditions are satisfied by the proteins in egg, milk, meat, and fish[26]. A correction is required both for digestibility and amino acid score for protein from all other sources when analysing the protein requirement[27].

[23]BMR (in kilocalories per day) of different age-sex groups are predicted based on the following equations: (i) males (18-30 years): $15.3W + 679$, (ii) males (30-60 years): $11.6W + 879$, (iii) males (> 60 years): $13.5W + 487$; (iv) females (18-30 years): $14.7W + 496$, (v) females (30-60 years): $8.7W + 829$, and (vi) females (> 60 years): $10.5W + 596$, where W is the body weight in kilograms.

[24]The rationale for using NCHS referenced sample of children are many. First, for young infants and children, requirement for growth is a substantial component of the total requirement for energy and there are large variations within the normal range of the rate of growth among children. Second, for both infants and children, it is not possible to specify with any confidence the allowance that should be made for a desirable level of physical activity. Third, while time spent in all types of physical activities need to be known in order to calculate total energy expenditure, that information is generally not available. Finally, while children in many developing countries are smaller at birth than those in industrialized countries and grow at a slower rate during infancy and early childhood, the evidence suggests that in young children these differences are mainly due to environmental factors including inadequate nutrition, and that genetic and ethnic factors are of lesser significance. Therefore, young children of different ethnic groups should be considered as having the same or similar growth potentials. Thus, it is desirable that the growth potential of children be fully expressed and provided for in energy and protein requirements (World Health Organization, 1985).

[25]if adolescents are engaged in more energy-intensive work in rural Bangladesh, then these requirement figures will be underestimation of actual requirements for this group.

[26]For example, while the protein from egg, milk, meat, or fish has 100% digestibility relative to reference proteins the digestibility of an Indian rice and beans diet is only 82%

[27]These corrections can be applied either to the requirement or the dietary protein intake. The total protein content of the diet = total N(nitrogen)$\times$ 6.25. The biological value of the diet = total protein $\times$ digestibility factor $\times$ amino acid score. The digestibility factor is the digestibility relative to that of the reference protein (e.g., egg, milk, meat, or fish), expressed as a percentage. The amino acid score expresses the amino acid pattern as a percentage of the

I use the protein requirement figures for different age-sex groups (corrected for requirements) with necessary allowance for pregnancy and lactation from Food and Agriculture Organization (2009)[28].

Although required in small amounts, micronutrients are essential for life, and needed for a wide range of body functions and processes. Age-sex specific RDA figures (with pregnancy and lactating allowance) for different micronutrients are obtained from World Food Programme (2000). Analogous to quality of protein, sources of iron are important. Iron in meat (haem iron) is more easily absorbed than iron contained in plant foods (non-haem iron). Trace minerals from the meat sources have higher bio-availability and contribute to higher bio-availability of iron from plant sources. Similarly, nutrition literature indicates that minerals and vitamins from meat sources are more highly bio-available than from plant sources. Moreover, meat consumption can increase the bio-availability of minerals and vitamins contained in plant products when meats and plants are consumed concurrently. I use the iron requirement figures that assumes very low iron bioavailability as observed in South Asian Diet.

appropriate reference pattern for each age group. These corrected intakes are then compared with the requirement. The corrected requirement in terms of the diet consumed is: standard requirement $\times \frac{1}{digestibility} \times \frac{1}{aminoacidscore}$. The corrected requirements are then compared with observed intakes. See World Health Organization (1985) for further discussions.

[28]The requirement is based on a diet containing a great deal of cereals, starchy roots and pulses (high fibre) and little complete (animal) protein as in the case of Bangladeshi diet.

CHAPTER III

Intrahousehold Bargaining and Food Distribution in Rural Bangladesh

Abstract: Using spouses' assets at marriage as proxy for bargaining power and proposing alternative measures of food distribution that shift the focus from calorie intake to the cost and composition of individuals' diet, I find evidence of intrahousehold bargaining in food allocation from expensive and nutritionally rich sources in rural Bangladesh. The bargaining effects remain significant after eliminating potential marriage market selection effects and various unobserved household fixed effects. While adult women fare worse than adult males in the intakes from the most expensive food group, they tend to be better-off when a wife as opposed to a head has more bargaining power. The nature of preference and bargaining tend to vary across income levels. At the low income level, a wife prefers male preschoolers to female preschoolers, which reverses at the middle income level. In contrast to previous literature, I also find that nonparametric Engle curves for food expenditure, calorie, and calorie from animal food-group tend to be not linear but quadratic in nature.

3.1 Introduction

Some ethnographic studies document gender discrimination in food distribution in Bangladesh. Women appear to be a "residual category", eating after men and children, and making to do with what is left (Kabeer, 1998). This practice is believed to ensure the longevity and good fortune of male guardians, and girls are taught to get used to such deprivation (Naved, 2000).

In contrast, as discussed in Chapter 2, an influential study of Pitt et al. (1990) (henceforth PRH), focusing on individuals' calorie intakes, find that households in rural Bangladesh are inequality averse, and that gender disparity in calorie intake reflects the gender differences in the energy intensities of occupations. Moreover, if there is any discrimination, that tends to be against males who bear the cost of equalisation of calorie intake more than women, considering that men participate in high energy intensive occupations. Similarly, Behrman and Deolalikar (1990) find no evidence of gender discrimination in intrahousehold calorie allocation in rural south India[1].

This chapter attempts to reconcile these contrasting evidences. In Chapter 2, I demonstrated that calorie intake - the focus of many past studies including PRH, is not a sufficient statistic for various critical nutrients. In this chapter, I attempt to demonstrate that calorie might not be a good metric for analysing a household's food distribution behaviour. Consider an extreme case where two identical individuals in a household receive exactly the same amount of calories. Focusing on calorie would imply no intrahousehold inequality. However, the cost and content of calorie of the two individuals could be quite different. Given the wide variety of food sources, one individual could consume a disproportionately larger share of food items, which are more expensive, better tasting, of better quality, and/or are more prestigious, than the other member to obtain the same amount of calorie. This type of discrimination, as reflected in ethnographic studies, is not revealed if the focus is only on calorie intake.

Analysing individuals' food intakes from different sources, and proposing a number of measures of food distribution that focus on the cost and composition of one's diet, I demonstrate evidence of significant intrahousehold bargaining (particularly between adult males and females) on calorie and expenditure allocations for fish, animal and dairy products (henceforth, animal products/group), which are the most expensive sources of calories. A wife's assets[2] positively affect these allocations for adult females but negatively for adult males. Intrahousehold bargaining is also evident to some extent for the food allocation for elderly and pregnant women within the household. These effects are significant both with and without the proxy for health and energy-intensive occupations to account for the potential nutrition and labour market linkages as illustrated by PRH.

As discussed in Chapter 2, with the exception of a few natural experiments, bargaining measures used in past studies, are endogenous to decisions made within marriage. My measures—husband's and wife's assets at marriage—-while could be exogenous to the decisions made within marriage, it can still be endogenous to marriage due to marriage market selection, failure to control which could lead to an erroneous rejection of the unitary model. Moreover, some standard controls (in the empirical literature of unitary or collective framework), such as, household size and composition could be potentially correlated with unobserved household characteristics, such as fertility preference. All these motivate the use of household fixed effect (henceforth, HFE) estimates to test the evidence of bargaining in nutrient allocation without contamination from marriage market selection and unobserved household characteristics.

How does gender disparity in food distribution varies with household income? A few studies attempted to explore the relationship between intrahousehold inequality and aggregate household wellbeing (Haddad and Kanbur, 1992; Kanbur and Haddad, 1994; Haddad et al., 1995), and the findings are ambiguous. A key deficiency of those studies are that as they use some aggregate

[1]For a comprehensive survey on intrahousehold inequality in food distribution, see Behrman and Deolalikar (1988) and Behrman (1990).

[2]Spouses' assets imply assets at marriage throughout the thesis unless otherwise specifically mentioned.

measure of inequality (such as Gini coefficient), they could not examine which specific age-sex groups fare worse within the household, and if their wellbeing improve with the improvement of aggregate household wellbeing, which I attempt to analyse in this chapter. Dividing households into low, middle, and high income groups based on their monthly per capita expenditure, I find that at the low income level, a wife prefers expenditure and calorie allocation from the most expensive food group for male preschoolers to female preschoolers while this pattern reverses at the middle income level. Similarly, a wife's bargaining power positively affects the allocation from expensive food group for adult females and negatively for adult males at low income level, but such bargaining is not evident as household income increases.

In analysing intrahousehold food distribution, in contrast to previous literature, I also find that nonparametric Engle curves for food expenditure, calorie, and calorie from animal food-group tend to be not linear but quadratic in nature implying that (i) the food budget share tends to decline at a slower rate with the increase in income at low levels of income but at a higher rate at high levels of income, (ii) even in this poor country, per capita calorie consumption increases at a decreasing rate with the increase in income and the calorie demand tends to be saturated at the higher income level, (iii) even at a very low level of income, the demand for the most expensive food group tends to increase at an increasing rate with the increase in income, before it start to increase at a decreasing rate and eventually flattens out at an income level, which is higher than at which calorie demand starts to saturate.

The rest of the chapter is organised as follows. Section 3.2 briefly describes the conceptual and empirical frameworks, which are similar to chapter 2. Section 3.3 provides a descriptive analysis of intrahousehold food distribution. Section 3.4 provides the empirical analysis, and Section 3.5 concludes.

3.2 Conceptual and Empirical Frameworks

I use the conceptual framework used in Chapter 2 with the change that instead of a vector of nutrients ($\mathbf{C_i}$), a vector of foods consumed by individuals ($\mathbf{F_i}$) is in the utility functions, implying that individuals derive satisfaction from the consumption of different foods in addition to the indirect effects of foods on their health outcomes. All the other notations and interpretations of the following equations are same as Chapter 2 (see Section 3). In a collective framework, husband (h) and wife (w) care about his/her own and other $N-1$ ($i \in N$) household members' consumption of foods ($\mathbf{F}$), health outcomes ($\mathbf{H}$), and effort level (e). For all Pareto-efficient outcomes, there exists some weight λ (where, $\lambda = \lambda(a_h, a_w)$), for which the household maximises its objective function:

$$(3.1) \qquad Max \qquad \lambda U_h(\mathbf{F}_i, \mathbf{H}_i, e_i; \mathbf{Z}) + (1-\lambda)U_w(\mathbf{F}_i, \mathbf{H}_i, e_i; \mathbf{Z})$$

subject to the following health production function, wage function, and household budget constraints:

$$\mathbf{H}_i = H(\mathbf{F}_i, e_i, \mu_i) \tag{3.2}$$

$$w_i = w(\mathbf{H}_i, e_i) \tag{3.3}$$

$$v + \sum_i w_i = Y = \sum_i \mathbf{PF} \tag{3.4}$$

Maximising household's objective function, subject to these constraints yields a set of reduced form food demand functions:

$$\mathbf{F}_i = f(\mathbf{P}, Y, \lambda; \mathbf{I}, \mathbf{Z}) = f(\mathbf{P}, Y, \lambda(a_h, a_w); \mathbf{I}, \mathbf{Z}) \tag{3.5}$$

where, $\mathbf{I}$ is a vector of individual characteristics, $\mathbf{Z}$ is a vector of household characteristics, and a_h and a_w are measures of bargaining power of head's and his spouse. The test for unitary model is:

$$\frac{\partial \mathbf{F}_i}{\partial a_i} = 0; i = h, w \tag{3.6}$$

In the case of income pooling, $\frac{\partial \mathbf{F}_i}{\partial a_i} = 0$, whereas in the presence of intrahousehold bargaining, $\frac{\partial \mathbf{F}_i}{\partial a_h} \neq \frac{\partial \mathbf{F}_i}{\partial a_w}$.

Empirically, using a variety of measures of individual food allocation (see Section 3.3), I estimate the following empirical specification of equation 3.5:

$$\begin{aligned} lny_{ijst} = {} & \beta_0 + \beta_{\mathbf{1}}\mathbf{A}_{ijst} + \beta_{\mathbf{2}}\mathbf{I}_{ijst} + \beta_{\mathbf{3}}\mathbf{X}_{hjst} + \beta_{\mathbf{4}} ln\mathbf{P}_{st} + \beta_{\mathbf{5}}\mathbf{R}_t + \beta_{\mathbf{6}}\mathbf{S}_s \\ & + \beta_{\mathbf{7}}\mathbf{X}_{mjs} + \beta_{\mathbf{8}}\mathbf{X}_{wjs} + \beta_{\mathbf{9}}(\mathbf{A}_{ijst} \times \mathbf{X}_{mjs}) + \beta_{\mathbf{10}}(\mathbf{A}_{ijst} \times \mathbf{X}_{wjs}) + \epsilon_{ijst} \end{aligned} \tag{3.7}$$

where, lny is log of some measure of food allocation of an individual i of household j in site s at time t, $\mathbf{A}_{ijst}$, is a vector of individual characteristics dummies including an individual's age-sex group, pregnancy, and lactating status, $\mathbf{I}_{ijst}$ contains individuals' health outcomes (log of weight for height) and the dummies for high energy intensity of the primary and secondary occupations of the individual, $\mathbf{X}_{hjst}$ is a vector of both time-variant and time-invariant household characteristics including log of per capita adult equivalent monthly expenditure and its square, log of household landholding, and log of adult equivalent household size, $ln\mathbf{P}_{st}$ is a vector of log of site prices of rice, pulses, big fish, small fish, and egg, proxied by mean unit values of households in a given site in a given round for these food groups[3], and $\mathbf{R}_t$ and $\mathbf{S}_s$ are the dummies for survey rounds and sites. Using the same cut-off points of metabolic constant (mc) of different activities as in Chapter 2, individuals' primary and secondary occupations are categorized into high, medium, and low energy-intensive activities.

As discussed in Chapter 2, OLS estimates of equation 3.7 might be biased as embodied in the error term (ϵ_{ijst}), could be household's or spouses' unobserved fertility (and son) preference that could influence household size, composition and could be correlated with sex-specific food allocations. Similarly, spouses' assets and education at marriage could be correlated with their unobserved characteristics, such as their preference for children's (of particular sex) nutrition and health, which in turn could be correlated with household formation through marriage market selection. To the extent these unobserved effects are time invariant, these could be eliminated through HFE estimate. Occupational choices can be influenced by unobserved health endowment and ability. Food allocation can also determine occupational energy intensity, rather than the opposite. However, I follow the exogeneity assumption of PRH that occupational choices are given by social norms whereby males tend to engage in energy-intensive labour market activities, while women activities are essentially circumscribed to low-energy intensive household activities. Health outcomes and food allocations are potentially determined by their health endowments that are known to households but not to the researcher. But, if a household's food allocation rule based on individuals' health endowment and ability (which in turn also affect their occupational choices and labour market productivity) is time invariant, then it is absorbed in HFE estimates[4]. Thus, I also estimate the above empirical model using HFE estimate. However, time-invariant household characteristics are also absorbed in household fixed effects, which include spouses' bargaining measures. The effects of the variables with limited variation, such as household size, demographic composition, and per capita landholding, are likely to be imprecisely estimated. The HFE estimates will also be based on a restricted sample of households that have at least one member of each of the age-sex group under consideration, and the noise to signal ratio is likely to increase due to differencing.

Household income (proxied by expenditure) is also potentially endogenous as both nutrient consumption and health endowment of individuals may affect household income. While household expenditure is often instrumented by household landholding, following Behrman and Deolalikar (1990), I use both current and permanent income (proxied by household landholding) measures as explanatory variables to measure current and permanent income elasticities. Controlling for household income, a general test of the unitary framework (i.e., equation 3.6) is that the effect of a head's assets (and/or education) will be same as the effect of a wife's assets (and/or education) for the allocation of food for a particular group or individual.

[3]A comprehensive set of site prices were initially included in the regression functions, and then I have kept the food prices which appear to be significant most of the times for the outcomes analysed here.

[4]In future analysis, I attempt to replace individuals' weight for height with the measure for endowments and adult equivalent household size with household size and composition to examine (dis)economies of scale in food consumption as is done in Chapter 2.

Based on OLS estimates, I test whether a head's and his wife's assets and education have the same effects on food allocation for the non-pregnant and non-lactating adult women within the household (the omitted category in age-sex group dummies), i.e., $\beta_{\mathbf{7_q}} = \beta_{\mathbf{8_q}}$, (where q = assets, education) and test for the total effect of a husband's and a wife's assets for each of the other age-sex-pregnancy-lactating categories, i.e., $\beta_{\mathbf{7_q}} + \beta_{\mathbf{9_q}} = \beta_{\mathbf{8_q}} + \beta_{\mathbf{10_q}}$. As in HFE estimate, spouses' bargaining measures are eliminated with household fixed effects, I can only test if relative to the omitted category, the bargaining measures of a head have differential effects than the bargaining measures of his wife for the food allocation for each of the other age-sex-pregnancy-lactating groups, i.e., $\beta_{\mathbf{9_q}} = \beta_{\mathbf{10_q}}$, which is also done based on OLS estimates for comparison with HFE results. As discussed in Chapter 2, spouses' education may not necessarily imply bargaining (but efficiency), but I use these proxies to control for any potential correlation between their education and assets at marriage and thus focus on bargaining effects that are based on spouses' assets. Thus in the empirical analysis of Section 3.4, I only focus on the bargaining effects (relative to the adult women) based on assets measure only (given the caveats associated with education as bargaining measure): $\beta_{\mathbf{9_q}} = \beta_{\mathbf{10_q}}$, as this set of restrictions can be tested in HFE and can be compared with similar tests based on OLS estimate.

Further, to analyse how the pattern of intrahousehold bargaining and food distribution varies across different income groups, I augment equation 3.7 by interacting individual characteristics and bargaining measures with income tercile dummies ($t2 = 1$ if the household income falls in second tercile and $t3 = 1$ if the household income falls in third tercile) with the omitted category being low income households ($t1 = 1$). Analogous tests for intrahousehold bargaining are performed for each of the income groups.

3.3 Data and Descriptives

I use the same IFPRI data set used and described in Chapter 2 (see Section 5), which also contains description of most of the explanatory variables used in the empirical analysis below. Table 3.1 presents the descriptive statistics of the key household characteristics utilized in the empirical analysis. Based on the monthly per capita expenditure (averaged over four rounds), used as proxy for per capita income[5], I divide the sample into three groups as proxy for different income groups: tercile 1 (low income), tercile 2 (middle income), and tercile 3 (high income), to investigate how gender difference in food distribution for a given age group varies across income groups.

The mean per capita expenditure not only varies significantly across terciles, but also within a given tercile across rounds (with the exception for tercile 3's mean expenditure between round 3

[5]As poverty rate (based on Costs of Basic Needs) in Bangladesh is calculated based on per capita not per adult equivalent household expenditure, I use the same measure for categorising the households into terciles. In empirical analysis in the following section, I use per adult equivalent household expenditure and adult equivalent household size.

and 4)[6]. For each tercile, the lowest mean expenditure is observed in round 2, which as mentioned in Chapter 2, contains the major agricultural lean season. Based on costs of basic needs approach, the rural national upper and lower poverty lines are taka 591 and 499 (per person per month). While the mean per capita expenditure for tercile 1 households fall below the lower poverty line, that for tercile 3 is above the upper poverty line in every round. The mean expenditure of tercile 2, however, falls below the upper poverty line in rounds 2 and 4.

Household landholding (recorded in the first round and is time invariant in the survey) is positively associated with income level of the household. The mean landholding of tercile 3 households are about 3 times higher than that of tercile 1 households and the mean differs significantly across terciles.

As described in Chapter 2, wives' bargaining power seem much less than that of their husbands based on assets (aggregate value at 1996 prices of housing, landholding, cattle, durable, and food owned individually by the spouses) and education at the time of marriage. Head's assets at tercile 2 and 3 are significantly higher than that at tercile 1, while the difference of mean assets between tercile 2 and 3 are not significant. The value of head's housing and cattle that he owned at the time of marriage seems to be positively associated with current household income level as mean values of these increases at higher terciles, and the difference between any pair of terciles are significant. On the other hand, an inverse U-shape pattern appears in terms of head's landholding at marriage and household income, with highest mean value observed at tercile 2. The mean value of each of these asset components of the head differ significantly across terciles. While the mean value of wives' assets differ significantly across terciles, the value of their landholding does not. The value of wives' cattle do not differ significantly between terciles 2 and 3 and housing between terciles 1 and 3. Across all terciles, 98-99% of the wives compared to 88-89% of the heads did not own any land or housing on their own at the time of marriage, while 7-10% of the wives compared to 12-16% of the heads owned some cattle. As opposed to 45-53% of the husbands, 16-22% of the wives did not have any asset at marriage as most of the wives owned some food items (which were not owned by any husband). However, the mean value of total assets is much lower for wives than husbands due to sex-difference in ownership pattern of different asset components (i.e., only a few wives compared with the husbands owned any land, housing, or cattle at the time of their marriage). The relative gap between spouses' bargaining power tends to marginally decline at higher income level. While at tercile 1, the mean value of a wife's assets is only 8% of that of the husband, at tercile 3, it increases to 9%. While the average years of wives' schooling are 41% of that of the husbands at tercile 1, this increases to 53% at tercile 3.

I use a further disaggregated age-gender group than presented in Chapter 2: pre-school male and female children (≤ 5 years), male and female children of $5- \leq 10$ years, male and female adolescents ($10- \leq 19$ years), male and female adults ($19- \leq 55$ years) and male and female elderly (> 55 years). The omitted group in the empirical analysis is the non-pregnant and non-lactating adult

[6]P-values of the group mean tests are not reported to conserve space but available upon request.

women. The demographic composition of the sample (see Table 3.3) indicates a higher proportion of male and female pre-schoolers and lower proportion of adult and elderly men and women among low income group (tercile 1), compared to the middle and high income groups. As should be expected, for a given tercile, there is very limited variation of demographic composition across rounds within a year. Using adult equivalent scales of Ahmed and Shams (1994) (presented in Table 3.2), I construct the adult equivalent household size (hhadeq), log of which is used in the empirical analysis. As expected from demographic composition, hhadeq is highest in tercile 3, followed by tercile 2 and 1. Apart from the household size between tercile 2 and 3 in round 4, in each of the other rounds the mean hhadeq differs significantly across terciles. The hhadeq across rounds for a given tercile, however, does not vary significantly except for tercile 3 between rounds 2 and 3 and 2 and 4.

Consistent with Engle's law, the per capita monthly food expenditure as a share of per capita monthly total expenditure declines as income increases. For instance in round 1, the low income group spends about three-fourth of its total budget on food, while the corresponding food budget share is 50% for tercile 3 households. For any given round, the food budget share varies significantly across terciles. For the high income group, the food budget share remains the same in all rounds except in round 3 when it declines by 7 percentage points from other rounds. For terciles 1 and 2, consistent with the phenomenon that monthly per capita expenditure declines in round 2, the food budget share increases in this round, declines in round 3 in which per capita expenditure increases (for all terciles) and then in round 4 comes back to the level closer to that observed in round 1, possibly implying that the household tends to protect their food budget as much as possible from short-term income fluctuations. With the exception for tercile 1 between rounds 1 and 4, for tercile 2 between rounds 2 and 4, for tercile 3 among rounds 1, 2, and 4, the budget share differ significantly across all the other rounds for a given tercile.

Figure 3.1 depicts nonparametric (using locally weighted regression method, lowess at bandwidth 0.8) food budget share Engle curves for different rounds, which are concave and quadratic implying that the budget share tends to decline at a slower rate with the increase in income at low levels of income but at a higher rate at high levels of income. In round 3, when income increases from its downfall in round 2 that contains the major lean season, for very poor households, the food budget share tends to increase before it starts to decline with the increase in income. While previous studies found linear food Engle curves in richer countries, Bhalotra and Attfield (1998) demonstrate that in poor societies, such as in rural Pakistan, it tends to be quadratic. As they mentioned, a quadratic Engle curve implies a demand system of rank three. Hence rank two Piglog demand systems, such as the Almost Ideal Demand System, the Log-Translog model, and the Linear Expenditure System are inappropriate for demand analysis in rural societies where the Engle curve appears to be quadratic.

As mentioned in Chapter 2, a useful feature of IFPRI survey is the information of individuals' intakes of more than 200 food items categorised into 17 food groups. For my analysis, I aggregate these food groups into three broad food groups: cereal, plant, and animal. Plants and animal

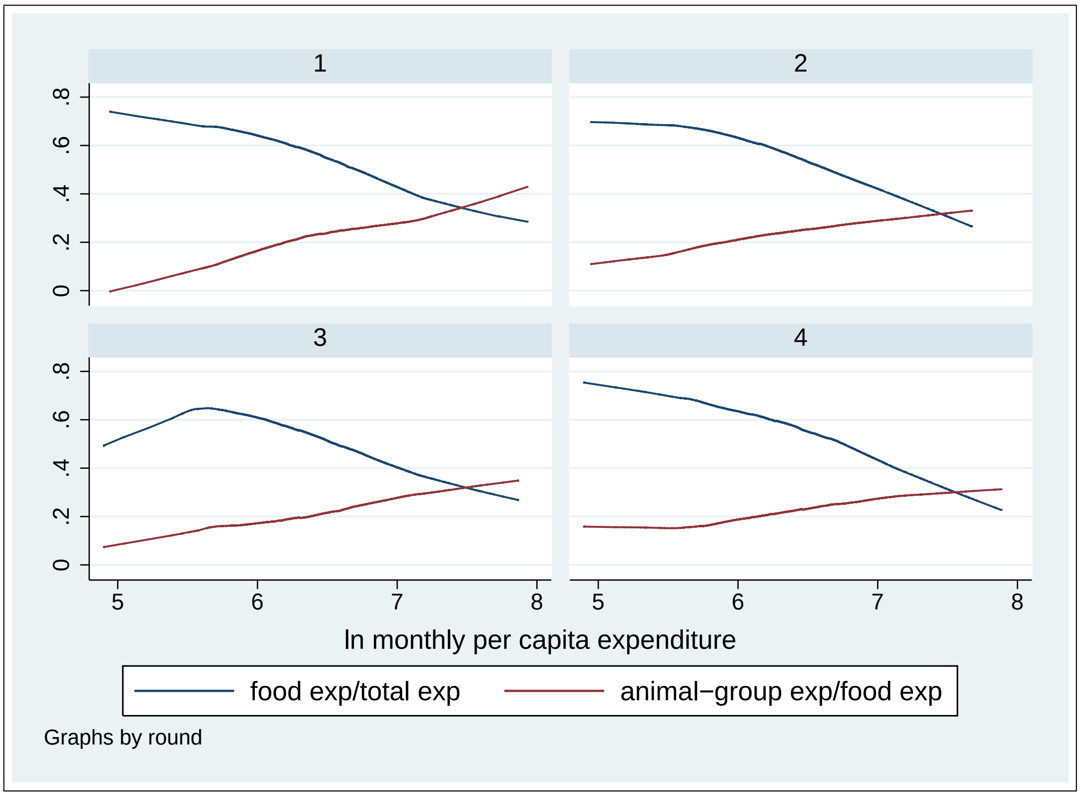

Figure 3.1: Food expenditure and animal-group expenditure shares, Lowess Fit, Bandwidth=0.8

Note: exp, per capita expenditure

products are much richer sources of micronutrients than cereals. The bioavailability of micronutrients in animal products is much higher than that in plant products. The former also promote the bioavailability of micronutrients in plant foods and cereals. In terms of price, the animal food group, followed by the plant group, are expensive sources of energy while cereals being the cheapest source. On average, the amount of money required to purchase 100 calories from plant and animal groups are almost 5 and 21 times higher than that required to purchase the same amount of calories from cereal sources. Within-tercile standard deviation for all terciles in any given round appears to be highest for animal group and lowest for cereal group indicating more varieties of animal products from which the consumption is made, while cereal consumption is primarily dominated by rice consumption (of more homogeneous nature). A comparison of price of animal calorie across terciles show that the households at higher income group tend to pay less than those at lower income group. This could be due to the possibility that higher income group purchase more quantity and get some sort of bulk discounts, and also the possibility that higher income households tend to live in places that have better infrastructure and market conditions, which might lower the supply cost and thus prices. For any given round, the animal group price is significantly different across terciles (with the exception for terciles 1 and 2 in rounds 1 and 2, terciles 1 and 3 in round 2, and terciles 2 and 3 in round 3). For all terciles, the price appears to be lowest in round 2 and highest in round 3. The price also differs significantly across rounds for any given tercile (with the exception for tercile 1 between round 3 and 4, for tercile 2 between rounds 1 and 4, for tercile 3 between rounds 1, 2, and 4.

The plant group price is not significantly different in round 1 and 2 between terciles 1 and 2, and in round 3 between terciles 1 and 3. For each of the other rounds, it varies significantly among the terciles. Higher income households tend to pay marginally higher than lower income households for the same amount of plant calories. For tercile 1, the price differs significantly across rounds. Apart from the price in round 1 and 4, the price differs significantly across rounds for tercile 2. For tercile 3, the price difference is significant between rounds 1 and 3, 2 and 3, and 3 and 4.

Among the food groups, the cereal group price varies the least across terciles for a given round. Nonetheless, this relative small difference is significant with the exception in round 1 across three terciles. The variation of cereal price seems to be higher between consecutive rounds for a given tercile than across terciles in a given round. For each of the terciles, the price is lower in rounds 2 and 4 than in rounds 1 and 3 and varies significantly across rounds.

The per capita expenditure on animal group as a share of total per capita food expenditure tends to increase sharply with the increase in income as Figure 3.1 demonstrates. Despite being the very costly source of calorie, on average households at tercile 1 spend about 20% of their food budget on animal group, which increase to 26% for households at tercile 3. For each round, this share varies significantly across terciles. For tercile 1, the share varies significantly across rounds with the exception between rounds 1 and 4. For tercile 2, with the exception between rounds 3 and 4, the share varies significantly across all the other rounds. For tercile 3, the expenditure share differs significantly between rounds 1 and 3, 2 and 3, and between 3 and 4.

As expected, bulk of a household's food expenditure is on cereal, which is nearly half of the total food expenditure for the households at tercile 1 and reduces to about 38% at tercile 3. For each round, the cereal expenditure share varies significantly among terciles. The variation in cereal expenditure share is much higher between any pair of terciles for a given round than across rounds for a given tercile, implying the higher stability of cereal consumption (compared to consumption from two other food groups) across rounds[7]. For tercile 1, the cereal share in a given round is significantly different from that in any other round with the exception of the share difference between rounds 1 and 2 and 3 and 4. On the other hand, for tercile 2, the cereal share in round 2 is only significantly different from that in round 4. For tercile 3, the share differs significantly across rounds other than that between rounds 2 and 3 and 1 and 3.

The absolute and hard core poverty lines based on direct calorie intake (DCI) method are 2122 kcal and 1805 kcal per person per day. The mean household per capita calorie consumption at tercile 1 is below the hard core poverty line in the first three rounds. While the per capita calorie consumption at tercile 2 and 3 are above the hard core poverty lines, the mean consumption does not exceed the absolute poverty line in any round even for tercile 3 households. For each round, the mean calorie consumption varies significantly across terciles. For all terciles, the lowest mean calorie consumption is observed in round 3 and highest in round 4. For tercile 1, the mean consumption varies significantly between rounds apart from that between rounds 1 and 2, and 2 and 3. For tercile 2, it varies significantly across all rounds. For tercile 3, other than the difference between rounds 1 and 2, mean calorie consumption varies significantly across all other rounds.

Tercile 1 households meet 86-88% of their calories from cereal sources and only a meager 2% from the most expensive animal group. While the animal calorie share doubles between tercile 1 and tercile 3, animal group still contribute to only 4% of total calorie at tercile 3. Nonparametric total calorie and animal calorie Engle curves are presented in Figure 3.2, which imply that at the lowest level of income (roughly up to log per capita expenditure of 5), while total calorie tends to increase at a constant rate, the animal calorie at an increasing rate, before both tend to increase at a decreasing rate with further increase in income. The calorie Engle curve tends to flatten at an income level that is lower than the income level at which the similar flattening of the animal calorie Engle curve occurs, implying that at an income level when the demand for calorie started to saturate, the demand for animal calorie still increases resulting in an increasing share of calories from the most expensive animal group at the higher levels of income. In contrast to the previous literature (Deaton and Subramanian, 1996), the nonparametric calorie Engle curve appears to be quadratic implying that even for this poor rural society, the demand for calorie tends to diminish with the increase in income.

[7] Subtracting the sum of cereal and animal group expenditure and calorie shares from 100 provides the expenditure and calorie share of plant group.

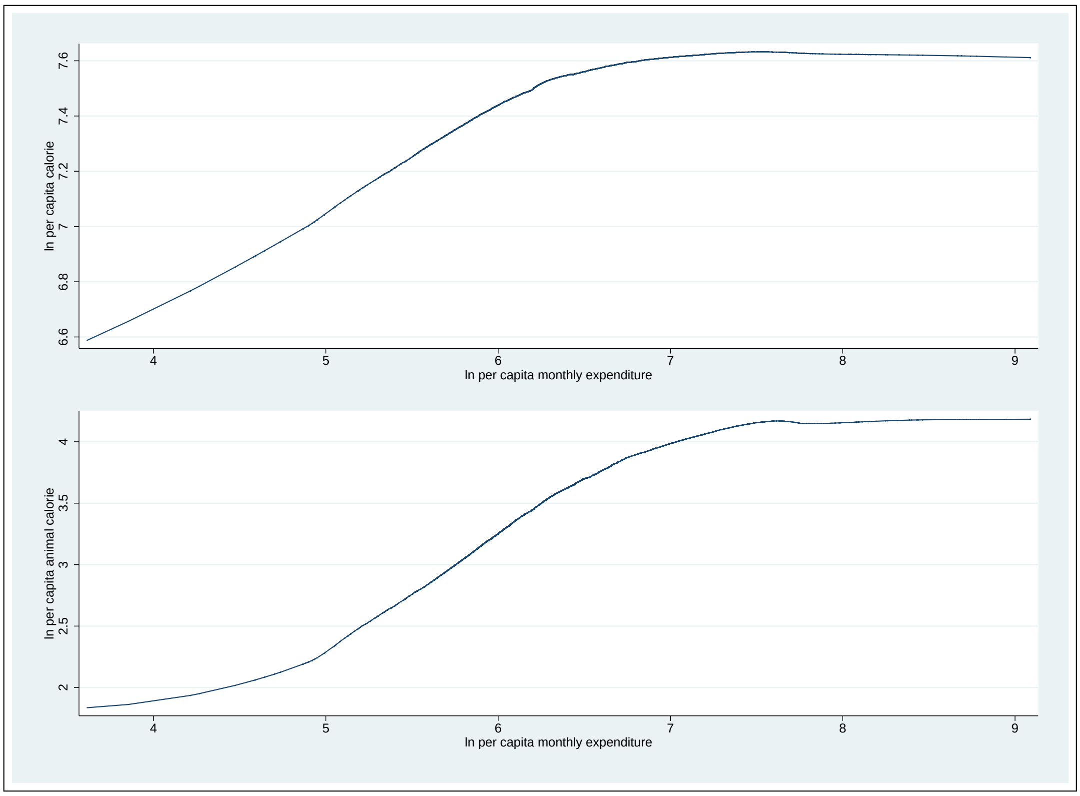

Figure 3.2: Nonparametric Calorie and Animal Calorie Engle Curves, Lowess Fit, Bandwidth=0.8

3.3.1 Measures of Intrahousehold Food Distribution

Motivated by the above descriptive analysis, I use a variety of measures to analyse intrahousehold food distribution. The first set of measures are an individual's calorie and expenditure share from animal, cereal, and plant groups, which reflect the content and cost composition of an individual's total calorie intake. I also measure expensiveness of an individual's diet by using the unit cost of calorie, i.e., the ratio of total food expenditure (s_i) to total calorie intake (c_i) of an individual. While the unit cost of calorie indicates the costliness of one's diet in absolute sense, to assess the relative costliness of an individual's diet within the household, I construct the following index of an individual's spending share over calorie share within the household:

$$r_i = \frac{\frac{s_i}{\sum_i s_i}}{\frac{c_i}{\sum_i c_i}}$$

Nutrition literature views that under normal circumstances (i.e., without famine) given the wide range of food sources, an individual is highly likely to meet his/her calorie need, which in turn motivates the construction of the calorie adequacy ratio (World Health Organization, 1985). PRH also make the case of equitable distribution of calorie within the household. Based on the assumption that calorie is distributed equally within the household as per individuals' requirements, this index portrays how expensive is the calorie bundle of that individual relative to the other individuals within the household. Thus, $r_i > 1$ would indicate a favorable position of individual i within the household in terms of getting allocation from relatively expensive food items (and vice versa) while $r_i = 1$ would imply the fair position of the individual. Obviously, this argument breaks down if the assumption of equitable calorie distribution within the household does not hold.

Table 3.3 summarises the mean value of these measures (averaged over four rounds) of food distribution for different age-sex groups at different levels of income. The calorie share of animal group is the highest for preschoolers, but that hardly exceeds 5% of the total calorie. Within age-group gender disparity in animal calorie intake is the highest for preschoolers followed by elderly and adult groups. While female preschoolers on average have slightly more total calories than their male counterparts, male preschoolers have about 28% more calories from animal sources than female preschoolers. An almost similar magnitude of gender disparity is observed for the elderly group, while within the adult group, male calorie intake from animal sources is about 24% higher than that of females. The calorie share from plant sources, which are much cheaper than animal sources, but more expensive than cereals are higher for adult and elderly males compared with adult and elderly females. On the other hand, for younger age groups, the female's plant calorie share is higher than that of the male.

The pattern of within-age group gender disparity for animal calorie share also varies across income groups. The gender disparity is highest for preschoolers followed by adults in tercile 1, at which boys, on average, have 34% more calories from animal sources than girls while adult males have 25% more calories than adult females. For preschoolers, while animal calorie share increases from low to middle and to high income households, the gender inequality worsens at tercile 2 (at which boys get 56% more calories from animal sources than girls) and lessens at tercile 3 (at which a boy's share is only 11% more than a girl's). The animal calorie share of adult males is 25% higher than that of adult females at terciles 1 and 2, while this disparity reduces to 20% at tercile 3. While the disparity within the elderly group is nonexistent at tercile 1, it increases sharply at tercile 2 and 3. Within children and adolescents, the gender disparity is relatively modest.

Figure 3.3 nonparametrically shows how animal calorie share vis-a-vis the calorie adequacy ratio[8] varies with per capita expenditure for preschoolers and adults. While for the most of the per capita expenditure range, a girl's calorie adequacy ratio appears to be higher than that of a boy, the opposite appears for animal calorie share. For the adult group, while the gender disparity tends to reduce with the increase in income (over the mid range of per capita expenditure), over the same income range, the disparity tends to persist for animal calorie share with a male's share higher than a female's.

An inverse-U relationship between income levels and gender disparity also appears for expenditure share for animal group for preschoolers. At tercile 1, the animal expenditure share of boys is 14.5% higher than that of girls. The difference further increases to 22% at tercile 2, but declines

[8]Defined as an individual's calorie intake as a share of his/her calorie requirement, see Section 5 and Appendix of Chapter 2 for a detailed description of the construction of adequacy ratios.

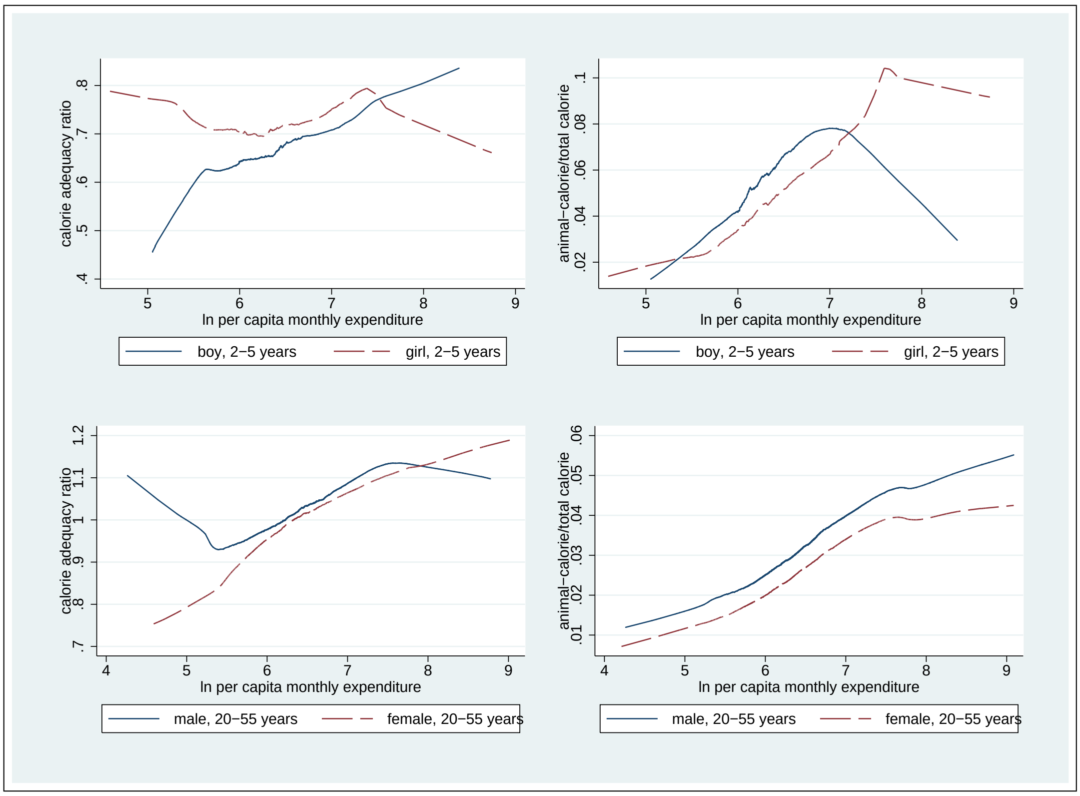

Figure 3.3: Nonparametric Calorie Adequacy Ratio and Animal Calorie Share Curves, Lowess Fit, Bandwidth=0.8

to only 6% at tercile 3. The gender difference within the adult group decreases monotonically with the increase in income level.

The gender disparity in terms of the unit cost of calorie is highest for the adult group followed by the elderly. On the basis of one's expenditure share over calorie share, the gender disparity is highest among the elderly, followed by the adult and preschooler groups. The pattern of gender disparity across the age-groups is broadly similar across three terciles. However, the disparity within the elderly category tends to increase with the income level of the household.

3.4 Estimation

To analyse intrahousehold bargaining and food distribution, I estimate equation 3.7 using OLS and household FE estimates for log of the intrahousehold food distribution measures discussed in the preceding section[9]. Table 3.4 presents the results of the key parameters of interest for log calorie share from animal, plant, and cereal groups.

[9] I have also analysed variations of this empirical model for each of the dependent variables controlling for only bargaining measures based on assets and with and without the control for health and occupational measures using both OLS and FE estimates. To conserve space, I do not report those results as the pattern of intrahousehold bargaining and food distribution revealed from those results are similar to the models presented here.

Consistent with the descriptive analysis above, pro-male bias in intrahousehold allocation of animal calories are evident within the preschoolers, adults, and elderly age-groups. For each of these groups, a male's animal calorie share is significantly higher than a female's both in OLS and FE estimates.

Conversely, the calorie share from the cheapest source (i.e., cereal) is slightly lower for males than females in these age-groups; this gender-difference is significant within the adult and elderly groups. Adult and elderly males compared with adult and elderly females tend to have more calories from the plant sources as well, which are less expensive than animal sources but more expensive than cereal sources. The gender disparity for these age groups are significant in both OLS and FE estimates.

What role does intrahousehold bargaining play in food distribution? As the estimates and the tests of the unitary model demonstrate, based on assets as the proxy for bargaining power, there is evidence of significant intrahousehold bargaining for food distribution between adult males and females. A wife's assets positively affect the calorie allocation from animal and plant sources (with the magnitude of the effect much larger for animal sources) for adult women (who are the most disadvantaged in getting the allocation from animal sources) in OLS estimates. A wife's assets negatively affect the allocation for adult men both in OLS and FE estimates (being absorbed in household fixed effects, the effect of a wife's bargaining power on adult women is unidentified in HFE estimate). Quantitatively, doubling a wife's assets will reduce adult males' calorie share from animal sources by 15% and that from plant sources by 8% in OLS estimate, while the reduction in corresponding shares based on HFE estimates are 12.5% and 7.5%, respectively. On the other hand, doubling a wife's assets will increase adult females' calorie share from animal and plant sources by 11.5% and 8%, respectively in OLS estimate. The magnitude of age-sex group coefficients and their interactions with assets measures are smaller in HFE than OLS estimates, possibly indicating that OLS estimates might be biased upwards as far as these coefficients are concerned due to the unobserved household and marriage market selection effects (see Section 3.2). As the tests for the unitary model show, these effects are significantly different from the corresponding effects of a husband's assets. A wife's assets also negatively affect the calorie share from plant sources for elderly males and positively affect their cereal calories, and differs significantly from the corresponding effect of a husband's assets. Finally, I also find intrahousehold bargaining over the allocation of plant calories for pregnant women both in OLS and FE estimates, where a wife's assets positively, but a husband's assets negatively, affect a pregnant woman's plant calories. Doubling a wife's assets will increase plant calorie share for pregnant women by 18% in OLS estimate and 25.5% in FE estimates. The effect of a wife's assets for the calorie allocation for lactating women, however, appears to be negative (doubling her assets will reduce the plant calorie share by 9%), but only significantly different from the corresponding effect of a husband's assets in FE estimates.

Among other covariates, the health and energy intensity of primary occupation (caveats of which are discussed in Section 3.2) are negatively associated with animal calorie share but positively with cereal calorie share implying that increased calorie required for higher energy expenditure are primarily met from calorie-dense and comparatively cheaper cereal sources. At low levels of income, animal and plant calorie shares increases with income, while the effect of income on cereal share appears to be not significant. Animal calorie share seems to be marginally higher in rounds 1 and 2 and lower in round 3 compared with round 4, while opposite pattern appears for plant and cereal calorie shares. Household landholding has a small but significant effect only on an individual's animal calorie share. Doubling the landholding will increase the calorie share from animal group by about 1%, while doubling household expenditure at the initial level of expenditure will increase the share by more than 3% (results not shown).

Using log expenditure share for these three food groups as dependent variables (Table 3.5), I find that adult males have significantly higher expenditure share for animal products and significantly lower expenditure share for cereals compared to adult females. Similar gender difference is also significant within elderly group particularly for expenditure share for animal products. As the tests for the unitary model show, intrahousehold bargaining on the allocation of animal and cereal expenditure shares for the adult and elderly males are significant. Doubling a wife's assets will lead to a decrease in expenditure share for adult males by 17% in OLS and 10% in FE estimates, and an increase in cereal expenditure share for cereals by about 11% in OLS and 8% in FE estimates. Doubling a wife's assets will also lead to a reduction in elderly males' expenditure share for animal products by 20% in OLS and 15% in FE estimates, and an increase in the expenditure share for cereals by 8% in FE estimates. The difference between OLS and HFE estimate of these bargaining coefficients might imply that OLS estimates are upward biased.

In terms of the costliness of diet, based on log of unit cost of calorie, significant intrahousehold bargaining is again observed for the adult group and for boys of age group 6-10 years. The unit cost of calorie is significantly higher for adult males than adult females (as the first two columns of Table 3.6 shows). While the unit cost for preschoolers and elderly groups is higher than that for adult females (implying the disadvantaged position of adult females within the household), within age-group gender disparity is not significant for any other age-group. Doubling a head's assets will increase the unit cost of calorie for adult males by 2% while doubling a wife's assets will reduce this by 9% in OLS and 7% in HFE estimates. Conversely, doubling a head's assets do not have any significant impact on the unit cost of adult females while doubling a wife's assets will increase it by 8% in OLS estimate.

Assessing the relative cost of one's diet using the index r_i (the last two columns of Table 3.6), I find that adult males have a higher index (by 0.07 points) than adult females. Preschoolers and elderly age-groups also have significantly higher index than adult females while adolescent groups have lower value of the index than adult females. Within age-group gender difference is significant for the adult group. An increase in a wife's assets increases adult women's index and decreases adult males' index. The opposite effect of a husband's and a wife's assets is also seen for the index of elderly males. On the other hand, while both husband's and wife's assets are negatively associated with elderly females' index, the effect of the later is almost twice as much as the effect of the former. Intrahousehold bargaining is also significant for boys of age group 6-10 years. An increase in women's bargaining power tends to have a more equitable distribution of food expenditure within the households as the index of the groups that are negatively affected by the increase in wife's assets is higher than the index of adult women. Finally, intrahousehold bargaining based on r_i index is also evident for pregnant women, which is negatively affected by the increase in a head's assets.

3.4.1 Intrahousehold Bargaining and Food Distribution across Terciles

Analysing how intrahousehold bargaining and food distribution vary across different income groups, I find that within age-group gender difference with males having higher animal calorie share than females is significant at tercile 1 for the adult group, at tercile 2 for preschoolers and adolescent groups, and at tercile 3 for the elderly group (Table 3.7).

Significant intrahousehold bargaining appears for the adult category at tercile 1, in which a wife's assets are significantly and positively associated with adult women's animal calorie share (in OLS) and negatively associated with adult males' share (both in OLS and FE estimates).

Furthermore, at tercile 1 a wife's assets affect the allocation of animal calories positively for male preschoolers, but negatively for female preschoolers. This reverses at tercile 2, and no evidence of bargaining is found for the preschooler group at tercile 3. In addition, at tercile 1, a wife's assets significantly and negatively affect the allocation for male children and female adolescents, indicating a reallocation of animal calories in favor of preschooler males and adult females at the expense of preschooler females, adolescent females, male children, and adult males. These effects of a wife's assets also reverse or disappear at higher income levels.

Women preferences for male children for schooling, is postulated in the literature as a motivation for old-age support as women marry at younger age than their husbands and thus should live longer than their husbands, ceteris paribus (Quisumbing and Maluccio, 2003). The above pattern of intrahousehold bargaining over food allocation adds a more nuanced view to this literature as the male preference is not prominent across all of the age-groups or income groups.

In terms of food expenditure share of different food groups, I find that adult males' food expenditure share for animal sources are significantly higher than adult females', while the former's expenditure share of cereals are significantly lower than the latter's at tercile 1 (Table 3.8). These differences are however no longer significant at higher income levels. As far as other age-groups are concerned, preschooler boys have a significantly higher animal expenditure share than preschooler girls at tercile 2, while adolescent males have a higher share than adolescent females at terciles 2 and 3.

Bargaining effect is significant for the preschooler group. A wife prefers male to female preschoolers at tercile 1, but female to male preschoolers at higher income levels. Both at terciles 1 and 2, the effect of a wife's assets is significantly different from the effect of a head's assets for this age group.

At tercile 1, doubling a wife's assets will increase the animal expenditure share for preschooler males by 46%, but will not affect the expenditure share for preschooler females. Conversely at tercile 2 (relative to the corresponding age groups at tercile 1), doubling a wife's assets will reduce the expenditure share for preschooler males by 76%, and increase that for preschooler females by 104% in HFE estimates. At tercile 1, intrahousehold bargaining is also significant for the adult group. A wife's assets positively affect the animal expenditure share of adult females, but negatively that of adult males. Doubling a wife's assets will increase the share for adult females by 26% in OLS estimate while will reduce that for adult males by 36% in OLS and 27% in FE estimates[10].

3.5 Conclusion

Past literature on intrahousehold inequality in food distribution focusing on total calorie intake has claimed that the households are inequality averse, and apparent gender-disparity in calorie allocation is due to the gender-disparity in energy-intensity of occupational activities. I empirically demonstrate in this chapter that focusing on total calorie intake does not reveal the underlying household behaviour for food distribution. Using a variety of measures for food distribution that shift the focus from an individual's total calorie intake to the cost and composition of that intake, I show that gender inequality of food distribution may persist resulting from intrahousehold bargaining. In contrast to the previous literature in richer societies, I also find that nonparametric food expenditure Engle curve appears to be quadratic, a similar shape that is found in semiparametric analysis in a poor country, Pakistan by Bhalotra and Attfield (1998). Moreover, in contrast with the finding of previous literature in poor society that nonparametric calorie Engle curve is linear, I find that calorie Engle curve tends to be quadratic, implying that even in this poor society, per capita calorie consumption increases at a decreasing rate with the increase in income and the calorie demand tends to be saturated at the higher income level. On the other hand, for the most expensive calorie sources, i.e, animal-group, at the very low level of income, the demand for animal calorie tends to increase at an increasing rate with the increase in income, before it start to increase at a decreasing rate and eventually flattens out at an income level, which is higher than at which calorie demand starts to saturate. These findings based on simple nonparametric analysis, obviously are not conclusive, but might provide motivation for further work on food demand in poor societies.

While adult women are one the most disadvantaged groups within the household in terms of allocation from the most expensive food groups, their position improves relative to their male counterparts when a wife has more bargaining power within the household. The nature of preference and bargaining, however, vary across income levels. At the low income level, a wife prefers male preschoolers to female preschoolers in terms of allocation from animal sources while she prefers

[10] A wife's preference for male to female preschooler and adult female to adult males at the low income level also appears when I use log of unit cost of calorie and r_i index as dependent variables (results not reported). However, the bargaining effects are not significant.

female preschoolers to male preschoolers at the middle income level. As the general bargaining framework used in this chapter does not explain why the effect of bargaining should vary across income levels, this might lay out the ground for further work to test the robustness of this empirical finding and its underlying theoretical explanations.

At their face value, the findings, however, imply that from the policy point of view, it is not only enough to understand to whom within the household the policy should be targeted to improve the allocation for a particular age-gender group, but that one also needs to know the level of average wellbeing of the household as the pattern of intrahousehold bargaining might vary at different levels of income.

This phenomenon of intrahousehold bargaining on food distribution also has important nutritional implications as animal, fish, dairy, and plant products are much richer sources of micronutrients than cereals. The bioavailability of micronutrients in animal products is much higher than that in plant products. Animal, fish and dairy products also promote the bioavailability of micronutrients in non-staple plant foods and cereals. The findings of this chapter are consistent with the findings of Chapter 2, which demonstrates evidence of intrahousehold bargaining on the allocation of a range of critical nutrients.

Table 3.1: Household Characteristics

	Round	Tercile 1 Mean	Tercile 1 Std	Tercile 2 Mean	Tercile 2 Std	Tercile 3 Mean	Tercile 3 Std
Mcapx	1	409	122	609	174	1001	644
	2	342	102	522	150	959	620
	3	422	121	628	172	1102	618
	4	398	129	586	172	1118	964
Hhadeq	1	4.70	1.80	5.07	2.15	5.51	2.93
	2	4.71	1.77	5.04	2.13	5.39	2.88
	3	4.67	1.74	5.07	2.17	5.20	2.60
	4	4.68	1.76	5.04	2.20	5.11	2.54
Food expenditure share	1	0.75	0.31	0.64	0.25	0.51	0.25
	2	0.79	0.38	0.67	0.27	0.51	0.26
	3	0.68	0.30	0.57	0.25	0.44	0.23
	4	0.76	0.37	0.66	0.29	0.51	0.27
Taka to purchase 100 calorie from Animal group	1	6.13	3.56	6.17	3.17	5.67	2.79
	2	5.58	2.69	5.50	2.61	5.66	2.68
	3	7.16	3.56	6.41	2.81	6.24	3.12
	4	6.97	4.34	6.06	3.67	5.82	2.85
from Plant group	1	1.60	0.83	1.59	0.86	1.81	1.18
	2	1.72	0.92	1.74	0.83	1.84	1.23
	3	1.33	0.90	1.27	0.58	1.33	0.56
	4	1.42	1.01	1.60	1.10	1.77	1.50
from Cereal group	1	0.30	0.05	0.30	0.04	0.30	0.05
	2	0.27	0.04	0.27	0.04	0.28	0.04
	3	0.31	0.05	0.31	0.05	0.32	0.06
	4	0.27	0.05	0.28	0.05	0.28	0.05
Animal exp/ total food exp	1	0.19	0.15	0.24	0.16	0.27	0.16
	2	0.21	0.14	0.25	0.14	0.26	0.14
	3	0.18	0.13	0.21	0.14	0.25	0.15
	4	0.19	0.14	0.21	0.15	0.27	0.16
Cereal exp/ total food exp	1	0.50	0.15	0.43	0.13	0.39	0.14
	2	0.49	0.12	0.43	0.13	0.38	0.13
	3	0.48	0.14	0.42	0.12	0.38	0.12
	4	0.47	0.14	0.42	0.13	0.36	0.13
Calorie per capita	1	1748	474	2019	588	2064	607
	2	1735	580	1941	665	2086	767
	3	1705	623	1854	548	1996	599
	4	1913	617	2117	634	2195	707
Animal calorie/ total calorie	1	0.02	0.03	0.03	0.03	0.04	0.03
	2	0.02	0.02	0.03	0.03	0.04	0.03
	3	0.02	0.02	0.03	0.02	0.03	0.03
	4	0.02	0.02	0.03	0.02	0.04	0.03
Cereal calorie/ total calorie	1	0.86	0.07	0.82	0.08	0.81	0.09
	2	0.88	0.05	0.85	0.07	0.82	0.08
	3	0.82	0.09	0.79	0.08	0.77	0.09
	4	0.85	0.06	0.83	0.06	0.81	0.08
Head's assets		20994	70261	36965	216099	38815	117843
Wife's assets		1662	4769	2206	8697	3675	12554
Head's house		2024	5906	2603	7023	3281	8445
Wife's house		114	1209	271	2856	149	1802
Head's cattle		6148	28193	7391	30318	9974	32307
Wife's cattle		324	1603	678	5239	728	4275
Head's durable		1718	5482	2266	7371	6274	15231
Wife's durable		888	3864	880	2757	2188	6669
Head's food		0	0	0	0	0	0
Wife's food		296	446	320	489	634	1638
Head's land		11696	56443	25355	214103	19458	97077
Wife's land		303	2635	290	3842	287	5665
Head's education		1.99	3.08	3.26	3.94	5.28	4.64
Wife's education		0.82	1.87	1.74	2.71	2.66	3.31
Head's age		45	12	46	12	48	12
Wife's age		36	11	37	11	40	11
Hhland		0.78	1.02	1.52	1.77	2.51	2.68

Note: Mcapx, monthly per capita expenditure, exp, expenditure, Hhadeq, adult equivalent household size, Hhland, household landholding (in acre)
Std, standard deviation.

Table 3.2: Adult Equivalence Weights by Age and Sex

Ages (years)			
From	To	Females	Males
0	1	0.25	0.25
1	2	0.36	0.37
2	3	0.4	0.42
3	4	0.43	0.46
4	5	0.46	0.49
5	6	0.48	0.53
6	7	0.49	0.56
7	8	0.49	0.58
8	9	0.49	0.58
9	10	0.49	0.58
10	11	0.64	0.70
11	12	0.64	0.71
12	13	0.66	0.73
13	14	0.68	0.77
14	15	0.7	0.81
15	16	0.7	0.85
16	17	0.72	0.89
17	18	0.75	0.92
18	30	0.82	1.03
30	60	0.83	1.03
60	–	0.61	0.68

Table 3.3: Food Distribution Measures by Age and Sex

	N	Calorie/Day	Calorie Share		Food Exp	Food Exp. Sh		Unit Cost	r_i
All			Animal	Plant	Tk/day	Animal	Plant		
m2-5	164	1026	5.48	16.71	6.91	25.97	32.84	0.12	1.15
f2-5	177	1033	4.26	17.87	6.78	22.99	35.36	0.11	1.11
m6-10	329	1627	3.00	14.80	9.85	21.97	32.9	0.15	1.03
f6-10	278	1534	2.99	15.23	9.28	21.3	34.1	0.15	1.05
m11-19	695	2483	2.76	14.10	14.27	22.45	31.79	0.2	0.98
f11-19	658	2061	2.59	14.52	11.80	21.51	32.83	0.18	0.97
m20-55	1176	3032	3.12	15.22	18.81	23.69	34.09	0.29	1.03
f20-55	1090	2259	2.52	14.65	13.18	20.55	34.8	0.22	0.98
m>55	244	2590	3.90	16.32	17.16	24.51	36.26	0.25	1.09
f>55	243	1919	3.07	15.05	12.04	21.85	36.51	0.21	1.04
Tercile 1									
m2-5	68	942	3.78	15.48	5.49	22.57	30.97	0.11	1.14
f2-5	81	984	2.81	15.80	5.46	19.71	34.05	0.10	1.10
m6-10	141	1578	2.14	13.25	8.13	18.32	31.46	0.15	1.02
f6-10	125	1479	2.37	13.71	7.80	17.81	33.29	0.15	1.06
m11-19	204	2355	1.92	13.00	11.65	17.92	30.92	0.20	0.98
f11-19	236	1945	1.85	13.17	9.77	17.67	31.45	0.18	0.97
m20-55	342	2941	2.15	13.72	15.83	19.21	32.82	0.29	1.02
f20-55	349	2137	1.72	13.25	10.84	16.19	33.49	0.22	0.99
m>55	71	2488	2.20	15.28	13.53	17.32	36.4	0.23	1.08
f>55	72	1734	2.21	13.09	9.54	17.79	34.29	0.22	1.07
Tercile 2									
m2-5	47	1049	6.01	16.36	7.19	26.96	32.70	0.12	1.15
f2-5	53	1051	3.86	17.09	7.17	22.06	35.68	0.10	1.1
m6-10	111	1630	3.05	14.95	10.26	22.83	33.14	0.15	1.02
f6-10	91	1536	2.84	14.7	9.11	21.76	33.28	0.14	1.02
m11-19	228	2469	2.76	13.77	14.3	23.24	31.47	0.20	0.99
f11-19	196	2089	2.55	14.89	11.95	21.79	33.05	0.17	0.97
m20-55	407	3055	3.06	14.87	18.85	23.79	34.21	0.29	1.03
f20-55	374	2282	2.45	14.37	13.18	20.69	34.87	0.22	0.98
m>55	84	2703	3.11	15.76	16.53	23.03	36.35	0.24	1.08
f>55	81	1953	2.72	14.7	11.65	20.95	36.80	0.19	1.04
Tercile 3									
m2-5	38	1113	7.16	19.02	8.55	29.45	35.76	0.13	1.15
f2-5	40	1075	6.44	21.19	7.98	27.92	36.63	0.13	1.12
m6-10	75	1709	4.43	17.26	12.23	27.02	35.05	0.16	1.05
f6-10	67	1615	4.08	18.10	11.69	25.97	36.24	0.16	1.07
m11-19	259	2634	3.67	15.65	17.04	26.44	33.08	0.21	0.97
f11-19	234	2169	3.51	15.73	14.01	25.71	34.21	0.18	0.97
m20-55	467	3102	4.17	17.13	21.84	28.20	35.25	0.30	1.03
f20-55	373	2364	3.45	16.41	15.64	25.01	36.11	0.24	0.99
m>55	106	2555	5.63	17.46	19.95	30.25	36.09	0.28	1.10
f>55	99	2029	4.06	16.85	14.31	25.76	37.95	0.22	1.02

Note: Exp, expenditure, Tk, taka, the numbers with m and f represent age, m, male, f, female, m2-5, male of 2-5 years, f2-5, female of 2-5 years, and so on.

Table 3.4: Intrahousehold Bargaining and Individual's Calorie Share from Food Groups

	Log of Calorie Share From					
	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
male, 2-5 years	0.345***	0.180***	-0.067***	-0.042*	0.058	0.061
	[0.082]	[0.065]	[0.026]	[0.025]	[0.065]	[0.049]
female, 2-5 years	0.130	0.025	-0.051	-0.013	0.174***	0.064
	[0.083]	[0.065]	[0.037]	[0.030]	[0.062]	[0.050]
male, 6-10 years	0.110**	0.040	-0.009	0.015	0.081**	0.033
	[0.048]	[0.031]	[0.012]	[0.010]	[0.039]	[0.027]
female, 6-10 years	0.092*	0.039	-0.013	0.006	0.050	-0.002
	[0.054]	[0.036]	[0.018]	[0.015]	[0.037]	[0.025]
male, 11-19 years	0.089***	0.049**	-0.005	0.009	0.023	-0.002
	[0.032]	[0.023]	[0.007]	[0.007]	[0.023]	[0.018]
female, 11-19 years	0.050	0.024	-0.005	0.015*	0.062***	0.010
	[0.031]	[0.022]	[0.007]	[0.009]	[0.023]	[0.018]
male, 20-55 years	0.223***	0.157***	-0.034***	-0.015**	0.112***	0.068***
	[0.033]	[0.024]	[0.007]	[0.006]	[0.025]	[0.018]
male, > 55 years	0.246***	0.208***	-0.058***	-0.030***	0.202***	0.147***
	[0.053]	[0.045]	[0.012]	[0.010]	[0.036]	[0.030]
female, > 55 years	0.112**	0.076*	-0.013	0.000	0.023	0.027
	[0.049]	[0.041]	[0.011]	[0.008]	[0.037]	[0.030]
log head's asset	0.014	0.021	0.001	-0.002	-0.008	-0.002
× male 20-55 years	[0.014]	[0.014]	[0.003]	[0.002]	[0.011]	[0.008]
log head's asset	0.013	0.020	0.007	-0.004	-0.020	0.010
× male > 55 years	[0.030]	[0.028]	[0.006]	[0.005]	[0.020]	[0.016]
log head's asset	-0.053	-0.022	0.009	-0.001	-0.017	-0.006
× female > 55 years	[0.033]	[0.030]	[0.007]	[0.006]	[0.025]	[0.022]
log wife's asset	-0.150***	-0.125***	0.026***	0.022***	-0.078**	-0.075**
× male 20-55 years	[0.047]	[0.047]	[0.009]	[0.007]	[0.038]	[0.029]
log wife's asset	-0.135	-0.125	0.045***	0.029**	-0.132***	-0.151***
× male > 55 years	[0.096]	[0.087]	[0.016]	[0.012]	[0.047]	[0.040]
log wife's asset	-0.079	-0.051	0.036	0.028	0.017	-0.059
× female > 55 years	[0.148]	[0.115]	[0.031]	[0.020]	[0.089]	[0.057]
log head's asset	0.021		-0.006*		0.031***	
	[0.015]		[0.003]		[0.012]	
log wife's asset	0.115**		-0.023**		0.077*	
	[0.052]		[0.010]		[0.042]	
log head's asset	-0.039	-0.040	0.002	0.006	-0.009	-0.001
× pregnant	[0.058]	[0.043]	[0.011]	[0.011]	[0.040]	[0.037]
log wife's asset	0.080	-0.079	-0.030	-0.011	0.184*	0.255**
× pregnant	[0.183]	[0.129]	[0.024]	[0.026]	[0.096]	[0.121]
log head's asset	-0.001	0.033*	-0.001	-0.007	0.004	0.007
× lactating	[0.025]	[0.020]	[0.005]	[0.005]	[0.022]	[0.018]
log wife's asset	-0.073	-0.011	0.017	0.012	-0.041	-0.089**
× lactating	[0.083]	[0.070]	[0.011]	[0.013]	[0.058]	[0.044]
pregnant	0.025	0.042	-0.001	0.000	0.022	0.005
	[0.087]	[0.069]	[0.014]	[0.014]	[0.060]	[0.053]
lactating	0.033	-0.045	0.002	0.012	-0.032	-0.017
	[0.039]	[0.029]	[0.007]	[0.008]	[0.029]	[0.023]
log weight	-0.024	-0.111***	0.018	0.054***	0.060	-0.047*
for height	[0.057]	[0.034]	[0.012]	[0.011]	[0.037]	[0.025]
primary occupation,	-0.089***	-0.060***	0.026***	0.010**	-0.092***	-0.033**
energy intensive	[0.025]	[0.017]	[0.005]	[0.004]	[0.018]	[0.013]
secondary occupation,	-0.024	0.033**	0.005	-0.007**	0.012	0.030***
energy intensive	[0.022]	[0.014]	[0.004]	[0.003]	[0.017]	[0.011]
constant	-33.280**	0.910***	8.629***	4.497***	-4.498	2.519***
	[13.860]	[0.098]	[1.712]	[0.023]	[4.917]	[0.081]
adj R^2	0.153	0.021	0.108	0.024	0.180	0.004
observations	13906	14581	13906	14581	13906	14581
households	783	837	783	837	783	837
Effect of (relative to adult females) head's=wife's assets						
male 20-55 years	0.00	0.00	0.01	0.00	0.08	0.02
female 20-55 years	0.08		0.11		0.28	
male > 55 years	0.14	0.12	0.02	0.01	0.03	0.00
female > 55 years	0.86	0.81	0.34	0.17	0.70	0.39
pregnant	0.52	0.77	0.20	0.53	0.05	0.04
lactating	0.40	0.55	0.14	0.15	0.45	0.04

Robust standard errors clustered at the household level are in brackets. *** p<0.01, ** p<0.05, * p<0.1. Additional controls and tests (not shown) are discussed in section 3.2.

Table 3.5: Intrahousehold Bargaining and Individual's Expenditure Share on Different Food Groups

	Log of Food Expenditure Share on					
	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
male, 2-5 years	0.298**	0.119	-0.148***	-0.082**	-0.144***	-0.092**
	[0.116]	[0.083]	[0.052]	[0.041]	[0.051]	[0.040]
female, 2-5 years	0.055	-0.041	-0.147**	-0.045	0.006	-0.035
	[0.114]	[0.087]	[0.062]	[0.048]	[0.055]	[0.044]
male, 6-10 years	0.175**	0.080*	-0.057*	0.011	-0.028	-0.038*
	[0.073]	[0.046]	[0.032]	[0.021]	[0.032]	[0.022]
female, 6-10 years	0.104	0.085	-0.032	0.017	-0.030	-0.060***
	[0.083]	[0.054]	[0.033]	[0.022]	[0.031]	[0.021]
male, 11-19 years	0.206***	0.173***	-0.006	0.025*	-0.082***	-0.086***
	[0.051]	[0.036]	[0.018]	[0.014]	[0.020]	[0.016]
female, 11-19 years	0.109**	0.084**	-0.009	0.039**	-0.034*	-0.061***
	[0.052]	[0.034]	[0.019]	[0.016]	[0.019]	[0.015]
male, 20-55 years	0.304***	0.241***	-0.121***	-0.069***	-0.006	0.004
	[0.050]	[0.034]	[0.019]	[0.015]	[0.020]	[0.016]
male, > 55 years	0.249***	0.231***	-0.166***	-0.116***	0.088***	0.080***
	[0.075]	[0.056]	[0.031]	[0.025]	[0.028]	[0.025]
female, > 55 years	0.075	0.060	-0.082***	-0.082***	0.080**	0.112***
	[0.083]	[0.066]	[0.028]	[0.022]	[0.032]	[0.029]
log head's asset	0.022	0.034	0.000	-0.000	-0.022**	-0.025***
× male 20-55 years	[0.023]	[0.022]	[0.009]	[0.008]	[0.010]	[0.008]
log head's asset	0.018	0.025	0.000	-0.012	-0.023	-0.016
× male > 55 years	[0.039]	[0.034]	[0.018]	[0.013]	[0.017]	[0.014]
log head's asset	-0.046	-0.025	0.021	0.019	-0.019	-0.012
× female > 55 years	[0.051]	[0.047]	[0.020]	[0.015]	[0.017]	[0.016]
log wife's asset	-0.171***	-0.104**	0.106***	0.082***	-0.026	-0.022
× male 20-55 years	[0.061]	[0.046]	[0.030]	[0.023]	[0.032]	[0.028]
log wife's asset	-0.197**	-0.151*	0.089	0.082*	-0.065*	-0.085**
× male > 55 years	[0.083]	[0.083]	[0.058]	[0.046]	[0.036]	[0.040]
log wife's asset	-0.083	0.148	0.054	0.097*	-0.043	-0.152**
× female > 55 years	[0.229]	[0.187]	[0.076]	[0.053]	[0.097]	[0.061]
log head's asset	0.018		-0.023**		0.036***	
	[0.024]		[0.010]		[0.009]	
log wife's asset	0.120**		-0.089***		0.045	
	[0.060]		[0.035]		[0.045]	
log head's asset	-0.056	0.005	0.048*	0.057**	-0.017	-0.039
× pregnant	[0.094]	[0.072]	[0.026]	[0.029]	[0.028]	[0.024]
log wife's asset	-0.318	-0.126	-0.086	-0.037	0.300***	0.251***
× pregnant	[0.341]	[0.173]	[0.084]	[0.085]	[0.082]	[0.082]
log head's asset	0.031	0.050	-0.006	-0.014	0.003	-0.015
× lactating	[0.039]	[0.032]	[0.016]	[0.012]	[0.016]	[0.015]
log wife's asset	-0.090	0.021	0.057	0.021	-0.030	-0.058
× lactating	[0.093]	[0.076]	[0.046]	[0.036]	[0.070]	[0.054]
pregnant	0.168	0.034	-0.029	-0.037	-0.032	0.003
	[0.144]	[0.116]	[0.047]	[0.044]	[0.050]	[0.047]
lactating	0.024	-0.058	0.005	0.043**	-0.068***	-0.005
	[0.067]	[0.050]	[0.020]	[0.017]	[0.026]	[0.021]
log weight	0.041	-0.049	-0.004	0.088***	0.066**	-0.016
for height	[0.084]	[0.050]	[0.034]	[0.021]	[0.032]	[0.022]
primary occupation,	-0.056	-0.056**	0.077***	0.039***	-0.029*	-0.005
energy intensive	[0.038]	[0.024]	[0.014]	[0.011]	[0.015]	[0.011]
secondary occupation,	-0.044	0.021	0.017	-0.026***	0.015	0.012
energy intensive	[0.033]	[0.021]	[0.013]	[0.009]	[0.013]	[0.009]
constant	39.539***	2.550***	-32.204***	3.826***	4.615	3.497***
	[13.256]	[0.163]	[4.612]	[0.059]	[7.582]	[0.065]
adj. R^2	0.108	0.004	0.133	0.022	0.066	0.011
observations	13906	14581	13906	14581	13906	14581
households	783	837	783	837	783	837
Effect of (relative to adult females) head's=wife's assets						
male 20-55 years	0.00	0.01	0.00	0.00	0.92	0.92
female 20-55 years	0.12		0.07		0.84	
male > 55 years	0.02	0.05	0.14	0.05	0.30	0.10
female > 55 years	0.87	0.37	0.67	0.15	0.81	0.02
pregnant	0.45	0.47	0.11	0.28	0.00	0.00

Robust standard errors clustered at the household level are in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Additional controls (not shown) are discussed in section 3.2.

Table 3.6: Intrahousehold Bargaining and Costliness of Individual's Diet

Vars	Log Unit Cost of Calorie OLS	FE	Log r_i OLS	FE
male, 2-5 years	0.124***	0.076***	0.061*	0.060*
	[0.039]	[0.028]	[0.031]	[0.032]
female, 2-5 years	0.127***	0.066**	0.078**	0.062*
	[0.043]	[0.030]	[0.038]	[0.036]
male, 6-10 years	0.044	0.011	0.004	-0.004
	[0.027]	[0.016]	[0.016]	[0.018]
female, 6-10 years	0.038	0.013	0.012	0.010
	[0.026]	[0.017]	[0.031]	[0.029]
male, 11-19 years	0.012	-0.011	-0.017*	-0.023**
	[0.016]	[0.012]	[0.010]	[0.012]
female, 11-19 years	0.014	-0.024**	-0.028***	-0.036***
	[0.015]	[0.012]	[0.009]	[0.012]
male, 20-55 years	0.110***	0.065***	0.061***	0.067***
	[0.016]	[0.012]	[0.010]	[0.012]
male, > 55 years	0.142***	0.106***	0.099***	0.102***
	[0.026]	[0.020]	[0.019]	[0.023]
female, > 55 years	0.096***	0.101***	0.080***	0.102***
	[0.023]	[0.020]	[0.023]	[0.026]
log head's asset	-0.030*	-0.006	-0.009	-0.006
× male 6-10 years	[0.016]	[0.011]	[0.010]	[0.011]
log head's asset	-0.000	-0.000	-0.004	-0.006
× male 20-55 years	[0.007]	[0.006]	[0.005]	[0.006]
log head's asset	-0.006	0.005	0.009	0.013
× male > 55 years	[0.014]	[0.011]	[0.011]	[0.013]
log head's asset	-0.027	-0.028**	-0.026**	-0.033**
× female > 55 years	[0.018]	[0.013]	[0.013]	[0.014]
log wife's asset	-0.103**	-0.086***	-0.071***	-0.063**
× male 6-10 years	[0.049]	[0.033]	[0.027]	[0.029]
log wife's asset	-0.089***	-0.068***	-0.060***	-0.065***
× male 20-55 years	[0.027]	[0.021]	[0.014]	[0.016]
log wife's asset	-0.065	-0.054	-0.068**	-0.066*
× male > 55 years	[0.043]	[0.037]	[0.028]	[0.034]
log wife's asset	-0.067	-0.092**	-0.132***	-0.146***
× female > 55 years	[0.060]	[0.042]	[0.041]	[0.046]
log head's asset	0.021***		0.005	
	[0.008]		[0.003]	
log wife's asset	0.079***		0.035***	
	[0.030]		[0.010]	
log head's asset	-0.053**	-0.068***	-0.044***	-0.050***
× pregnant	[0.022]	[0.023]	[0.014]	[0.018]
log wife's asset	0.061	0.030	0.073	0.028
× pregnant	[0.090]	[0.088]	[0.046]	[0.039]
pregnant	0.029	0.054	0.023	0.020
	[0.040]	[0.038]	[0.025]	[0.025]
lactating	-0.002	-0.043***	-0.030***	-0.030**
	[0.019]	[0.014]	[0.010]	[0.013]
log weight	0.001	-0.048***	-0.073***	-0.092***
for height	[0.028]	[0.016]	[0.014]	[0.019]
primary occupation,	-0.061***	-0.030***	-0.025***	-0.028***
energy intensive	[0.012]	[0.008]	[0.006]	[0.009]
secondary occupation,	-0.014	0.020**	0.006	0.012
energy intensive	[0.011]	[0.008]	[0.005]	[0.008]
constant	21.492***	-5.206***	7.410	0.852***
	[4.304]	[0.050]	[4.760]	[0.033]
adj R^2	0.140	0.020	0.041	0.044
observations	13906	14581	13906	14581
households	783	837	783	837
Effect of (relative to adult females) head's=wife's assets				
male 6-10 years	0.16	0.02	0.03	0.07
male 20-55 years	0.00	0.00	0.00	0.00
female 20-55 years	0.06		0.01	
male > 55 years	0.19	0.12	0.01	0.03
female > 55 years	0.52	0.14	0.01	0.01
pregnant	0.20	0.27	0.01	0.06

Robust standard errors clustered at the household level are in brackets. *** p<0.01, ** p<0.05, * p<0.1. Additional controls (not shown) are discussed in section 3.2.

Table 3.7: Intrahousehold Bargaining and Individual's Calorie Share from Three Food Groups across Terciles

	Log of Calorie Share From					
	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
male, 2-5 years	0.319***	0.130	-0.072	-0.076	-0.006	0.144**
	[0.116]	[0.087]	[0.059]	[0.060]	[0.095]	[0.073]
female, 2-5 years	0.228**	0.080	-0.101**	-0.068*	0.229**	0.152*
	[0.102]	[0.082]	[0.042]	[0.035]	[0.096]	[0.084]
male, 6-10 years	0.091	0.007	0.010	0.013	0.018	0.051
	[0.061]	[0.051]	[0.016]	[0.011]	[0.056]	[0.039]
female, 11-19 years	0.092*	0.021	0.009	0.016	0.016	0.015
	[0.052]	[0.037]	[0.013]	[0.013]	[0.038]	[0.033]
male, 20-55 years	0.231***	0.102***	-0.026**	-0.014*	0.107***	0.081***
	[0.040]	[0.036]	[0.011]	[0.008]	[0.035]	[0.029]
t2 male, 2-5 years	-0.060	0.037	0.035	0.067	0.031	-0.161
	[0.155]	[0.133]	[0.067]	[0.069]	[0.131]	[0.119]
t2 female, 2-5 years	-0.327**	-0.282**	0.002	0.022	-0.090	-0.109
	[0.137]	[0.126]	[0.074]	[0.062]	[0.127]	[0.114]
t2 male, 6-10 years	-0.012	0.006	-0.018	0.004	0.054	-0.041
	[0.076]	[0.073]	[0.016]	[0.012]	[0.067]	[0.058]
t2 female, 11-19 years	-0.115	-0.010	-0.014	0.001	0.051	0.001
	[0.070]	[0.059]	[0.014]	[0.012]	[0.049]	[0.050]
t2 male, 20-55 years	-0.016	0.073	-0.009	0.005	-0.001	-0.030
	[0.049]	[0.047]	[0.013]	[0.009]	[0.042]	[0.041]
t3 male, 2-5 years	0.087	0.170	-0.012	0.021	0.107	-0.112
	[0.175]	[0.147]	[0.070]	[0.070]	[0.153]	[0.146]
t3 female, 2-5 years	-0.075	0.148	0.108*	0.092*	-0.076	-0.084
	[0.189]	[0.167]	[0.058]	[0.048]	[0.123]	[0.116]
t3 male, 6-10 years	0.017	0.130	-0.037*	-0.011	0.117	-0.002
	[0.096]	[0.085]	[0.023]	[0.021]	[0.075]	[0.069]
t3 female, 11-19 years	-0.083	-0.003	-0.018	-0.004	0.070	-0.024
	[0.078]	[0.072]	[0.016]	[0.013]	[0.052]	[0.050]
t3 male, 20-55 years	-0.041	0.111**	-0.010	-0.006	0.014	-0.012
	[0.055]	[0.055]	[0.014]	[0.010]	[0.043]	[0.045]
log head's asset	-0.123**	-0.046	0.019	0.022	0.061	0.000
× male 2-5 years	[0.056]	[0.052]	[0.021]	[0.021]	[0.058]	[0.050]
log head's asset	-0.059	-0.046	0.035**	0.025*	-0.048	-0.027
× female 2-5 years	[0.063]	[0.047]	[0.015]	[0.014]	[0.050]	[0.048]
log head's asset	-0.031	0.010	0.002	0.010	0.007	-0.040
× male 6-10 years	[0.037]	[0.035]	[0.008]	[0.007]	[0.040]	[0.033]
log head's asset	0.003	0.017	0.001	0.001	-0.008	-0.007
× female 11-19 years	[0.027]	[0.023]	[0.004]	[0.004]	[0.020]	[0.021]
log head's asset	0.005	0.040*	0.002	-0.000	-0.009	0.001
× male 20-55 years	[0.022]	[0.021]	[0.005]	[0.004]	[0.020]	[0.016]
log wife's asset	0.315*	0.359**	-0.001	0.044	0.061	-0.253
× male 2-5 years	[0.172]	[0.153]	[0.048]	[0.054]	[0.139]	[0.177]
log wife's asset	-0.415**	-0.341**	0.048	0.062	-0.071	-0.281*
× female 2-5 years	[0.183]	[0.168]	[0.056]	[0.053]	[0.153]	[0.156]
log wife's asset	-0.343***	-0.221**	0.015	0.006	-0.077	-0.074
× male 6-10 years	[0.094]	[0.090]	[0.021]	[0.019]	[0.107]	[0.104]
log wife's asset	-0.193**	-0.171**	0.004	0.012	-0.059	-0.014
× female 11-19 years	[0.097]	[0.081]	[0.015]	[0.019]	[0.098]	[0.091]
log wife's asset	-0.231***	-0.168**	0.012	0.013	-0.057	-0.068
× male 20-55 years	[0.084]	[0.081]	[0.013]	[0.016]	[0.062]	[0.077]
log head's asset	-0.001		0.001		0.008	
	[0.022]		[0.004]		[0.018]	
log wife's asset	0.213**		-0.005		-0.004	
	[0.087]		[0.015]		[0.078]	
t2: log head's asset	0.187	0.117	-0.037	-0.046	-0.024	0.041
× male 2-5 years	[0.122]	[0.114]	[0.027]	[0.029]	[0.074]	[0.069]
t2: log wife's asset	-0.530**	-0.481**	0.005	-0.052	0.000	0.335
× male 2-5 years	[0.239]	[0.229]	[0.069]	[0.068]	[0.252]	[0.237]
t2: log head's asset	0.073	0.037	-0.043*	-0.044**	0.093	0.086
× female 2-5 years	[0.115]	[0.107]	[0.023]	[0.021]	[0.090]	[0.096]
t2: log wife's asset	0.918***	0.799***	-0.008	-0.015	-0.063	-0.043
× female 2-5 years	[0.312]	[0.299]	[0.075]	[0.071]	[0.178]	[0.213]
t2: log head's asset	0.081	0.081	-0.008	-0.021**	0.008	0.051
× male 6-10 years	[0.054]	[0.055]	[0.011]	[0.010]	[0.049]	[0.043]

Table 3.7: Intrahousehold Bargaining and Individual's Calorie Share from Three Food Groups across Terciles

	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
t2: log wife's asset	0.370**	0.263*	-0.033	-0.003	-0.011	-0.054
× male 6-10 years	[0.178]	[0.159]	[0.040]	[0.038]	[0.139]	[0.130]
t2: log head's asset	0.057	0.043	-0.002	-0.006	-0.011	-0.007
× female 11-19 years	[0.041]	[0.040]	[0.007]	[0.006]	[0.030]	[0.032]
t2: log wife's asset	0.220	0.179	0.003	-0.017	0.016	0.018
× female 11-19 years	[0.144]	[0.128]	[0.021]	[0.025]	[0.108]	[0.118]
t2: log head's asset	0.013	-0.015	-0.002	-0.005	0.009	0.011
× male 20-55 years	[0.031]	[0.032]	[0.006]	[0.006]	[0.027]	[0.025]
t2: log wife's asset	0.162	0.096	0.008	-0.001	-0.052	-0.011
× male 20-55 years	[0.112]	[0.100]	[0.016]	[0.019]	[0.081]	[0.101]
t2: log head's asset	0.008	0.043	-0.006	-0.004	0.024	0.032
	[0.028]	[0.033]	[0.006]	[0.006]	[0.026]	[0.033]
t2: log wife's asset	-0.127	0.011	-0.019	-0.014	0.136*	0.069
	[0.114]	[0.104]	[0.018]	[0.023]	[0.078]	[0.093]
t3: log head's asset	0.057	0.004	-0.001	-0.025	-0.130	-0.035
× male 2-5 years	[0.095]	[0.088]	[0.036]	[0.037]	[0.081]	[0.070]
t3: log wife's asset	0.090	0.170	-0.000	-0.027	-0.144	0.044
× male 2-5 years	[0.387]	[0.382]	[0.080]	[0.084]	[0.239]	[0.197]
t3: log head's asset	-0.001	0.060	-0.083	-0.083*	0.068	0.100
× female 2-5 years	[0.158]	[0.143]	[0.054]	[0.048]	[0.070]	[0.069]
t3: log wife's asset	0.523*	0.309	-0.124*	-0.126*	0.209	0.372*
× female 2-5 years	[0.293]	[0.280]	[0.073]	[0.075]	[0.183]	[0.198]
t3: log head's asset	-0.051	-0.083	0.007	-0.019	-0.020	0.060
× male 6-10 years	[0.061]	[0.058]	[0.017]	[0.014]	[0.058]	[0.049]
t3: log wife's asset	0.387	0.304	0.006	0.026	-0.027	-0.119
× male 6-10 years	[0.261]	[0.247]	[0.059]	[0.063]	[0.231]	[0.256]
t3: log head's asset	-0.031	-0.065*	0.000	-0.003	-0.003	0.004
× female 11-19 years	[0.040]	[0.037]	[0.008]	[0.007]	[0.030]	[0.029]
t3: log wife's asset	0.123	0.157	0.020	0.011	-0.112	-0.114
× female 11-19 years	[0.154]	[0.127]	[0.029]	[0.029]	[0.170]	[0.166]
t3: log head's asset	0.020	-0.037	-0.002	0.001	-0.001	-0.013
× male 20-55 years	[0.029]	[0.030]	[0.007]	[0.006]	[0.024]	[0.022]
t3: log wife's asset	0.077	0.001	0.023	0.022	-0.030	-0.015
× male 20-55 years	[0.133]	[0.134]	[0.019]	[0.021]	[0.073]	[0.094]
t3: log head's asset	0.049	0.139***	-0.014*	-0.006	0.037	0.024
	[0.033]	[0.038]	[0.008]	[0.008]	[0.029]	[0.037]
t3: log wife's asset	-0.172	-0.078	-0.020	-0.024	0.085	0.079
	[0.123]	[0.122]	[0.023]	[0.027]	[0.094]	[0.126]
tercile2	0.058		0.013		-0.022	
	[0.054]		[0.013]		[0.043]	
tercile3	0.119*		0.007		0.002	
	[0.071]		[0.017]		[0.050]	
adj. R2	0.161	0.032	0.117	0.031	0.185	0.009
Effect of (relative to adult females)	head's=wife's assets					
male 2-5 years	0.01	0.01	0.61	0.63	1.00	0.17
t2: male 2-5 years	0.01	0.02	0.53	0.93	0.93	0.23
t3: male 2-5 years	0.94	0.68	0.99	0.99	0.96	0.72
female 2-5 years	0.07	0.09	0.80	0.47	0.89	0.11
t2: female 2-5 years	0.01	0.01	0.64	0.68	0.42	0.57
t3: female 2-5 years	0.11	0.42	0.62	0.61	0.45	0.17
male 6-10 years	0.00	0.02	0.57	0.84	0.45	0.75
t2: male 6-10 years	0.11	0.27	0.56	0.65	0.89	0.43
t3: male 6-10 years	0.11	0.14	0.99	0.47	0.98	0.47
female 11-19 years	0.05	0.02	0.87	0.57	0.61	0.94
t2: female 11-19 years	0.26	0.29	0.82	0.65	0.80	0.83
t3: female 11-19 years	0.33	0.09	0.51	0.64	0.52	0.48
male 20-55 years	0.01	0.01	0.43	0.42	0.46	0.40
t2: male 20-55 years	0.20	0.29	0.51	0.84	0.49	0.83
t3: male 20-55 years	0.67	0.79	0.22	0.35	0.71	0.98
female 20-55 years	0.01		0.71		0.88	
t2: female 20-55 years	0.25	0.78	0.46	0.69	0.18	0.72
t3: female 20-55 years	0.08	0.11	0.82	0.53	0.62	0.68

Robust standard errors clustered at the household level in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Tests for equality of coefficients for a bargaining measure on a given age-group of terciles 2 and 3 are relative to the bargaining effect on the corresponding age-group at tercile 1; t2=tercile2 and t3=tercile 3. Additional controls (not shown) are described in section 3.2. Observations and households are same as Table 3.6. Constant term is not reported.

Table 3.8: Intrahousehold Bargaining and Individual's Food Expenditure Share on Three Food Groups across Terciles

	Log of Food Expenditure Share on					
	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
male, 2-5 years	0.348*	0.099	-0.150*	-0.110	-0.152**	-0.007
	[0.180]	[0.118]	[0.083]	[0.069]	[0.074]	[0.059]
female, 2-5 years	0.097	-0.105	-0.211***	-0.107*	0.005	-0.013
	[0.184]	[0.146]	[0.075]	[0.060]	[0.080]	[0.067]
male, 6-10 years	0.177*	0.006	0.011	0.047*	-0.072*	-0.033
	[0.104]	[0.079]	[0.036]	[0.027]	[0.043]	[0.032]
male, 11-19 years	0.169**	0.073	0.010	0.050**	-0.084**	-0.076**
	[0.082]	[0.068]	[0.026]	[0.022]	[0.034]	[0.031]
female, 11-19 years	0.228**	0.113*	-0.009	0.051**	-0.065*	-0.079***
	[0.097]	[0.068]	[0.030]	[0.024]	[0.034]	[0.026]
male, 20-55 years	0.344***	0.168***	-0.120***	-0.037*	-0.011	0.009
	[0.071]	[0.059]	[0.024]	[0.021]	[0.028]	[0.025]
t2 male, 2-5 years	-0.174	0.001	0.092	0.070	-0.062	-0.199**
	[0.231]	[0.190]	[0.103]	[0.091]	[0.108]	[0.097]
t2 female, 2-5 years	-0.363	-0.252	0.045	0.064	0.038	0.026
	[0.254]	[0.227]	[0.109]	[0.091]	[0.119]	[0.108]
t2 male, 6-10 years	-0.072	0.048	-0.055	-0.056	0.042	-0.021
	[0.127]	[0.122]	[0.046]	[0.040]	[0.057]	[0.050]
t2 male, 11-19 years	0.030	0.161	-0.006	-0.050*	-0.001	-0.012
	[0.099]	[0.101]	[0.034]	[0.029]	[0.042]	[0.042]
t2 female, 11-19 years	-0.242*	-0.033	0.046	-0.003	0.036	0.019
	[0.127]	[0.110]	[0.037]	[0.032]	[0.045]	[0.041]
t2 male, 20-55 years	-0.070	0.130	0.013	-0.047*	0.002	-0.015
	[0.084]	[0.083]	[0.028]	[0.026]	[0.033]	[0.034]
t3 male, 2-5 years	-0.126	0.000	-0.014	-0.002	0.110	-0.039
	[0.249]	[0.185]	[0.114]	[0.096]	[0.133]	[0.121]
t3 female, 2-5 years	0.048	0.414*	0.176	0.083	-0.050	-0.091
	[0.264]	[0.231]	[0.111]	[0.090]	[0.115]	[0.108]
t3 male, 6-10 years	0.016	0.219*	-0.133*	-0.085	0.112*	0.012
	[0.138]	[0.127]	[0.071]	[0.058]	[0.061]	[0.054]
t3 male, 11-19 years	0.071	0.117	-0.016	-0.011	0.009	-0.018
	[0.117]	[0.118]	[0.041]	[0.036]	[0.048]	[0.047]
t3 female, 11-19 years	-0.195	-0.098	0.004	-0.032	0.066	0.055
	[0.128]	[0.110]	[0.046]	[0.040]	[0.046]	[0.039]
t3 male, 20-55 years	-0.089	0.120	0.006	-0.053*	0.024	-0.004
	[0.093]	[0.091]	[0.034]	[0.031]	[0.036]	[0.036]
log head's asset	-0.201*	-0.052	0.056	0.046	0.034	-0.018
× male 2-5 years	[0.108]	[0.091]	[0.036]	[0.032]	[0.058]	[0.052]
log head's asset	0.098	0.032	0.063*	0.046	0.006	0.019
× female 2-5 years	[0.103]	[0.083]	[0.035]	[0.029]	[0.048]	[0.040]
log head's asset	-0.028	0.041	0.006	0.011	0.035	-0.025
× male 6-10 years	[0.064]	[0.059]	[0.025]	[0.023]	[0.033]	[0.031]
log head's asset	-0.039	-0.014	0.004	0.005	0.014	0.001
× female 11-19 years	[0.050]	[0.040]	[0.016]	[0.012]	[0.019]	[0.016]
log head's asset	-0.009	0.043	0.008	-0.008	0.002	-0.006
× male 20-55 years	[0.037]	[0.034]	[0.017]	[0.015]	[0.018]	[0.015]
log wife's asset	0.366	0.456**	-0.034	0.016	-0.044	-0.174*
× male 2-5 years	[0.264]	[0.202]	[0.091]	[0.100]	[0.135]	[0.104]
log wife's asset	-0.803**	-0.513	0.195**	0.209***	-0.015	-0.136
× female 2-5 years	[0.348]	[0.339]	[0.090]	[0.074]	[0.118]	[0.100]
log wife's asset	-0.423***	-0.207	0.106*	0.047	-0.076	-0.046
× male 6-10 years	[0.152]	[0.131]	[0.054]	[0.052]	[0.076]	[0.072]
log wife's asset	-0.198	-0.201*	0.053	0.042	-0.098	-0.068
× female 11-19 years	[0.161]	[0.112]	[0.047]	[0.050]	[0.070]	[0.055]
log wife's asset	-0.358**	-0.269***	0.113***	0.060	-0.060	-0.025
× male 20-55 years	[0.150]	[0.102]	[0.041]	[0.044]	[0.052]	[0.050]
log head's asset	0.017		-0.001		0.010	
	[0.044]		[0.013]		[0.017]	
log wife's asset	0.258*		-0.044		0.043	
	[0.139]		[0.043]		[0.048]	
t2: log head's asset	0.201	0.025	-0.115**	-0.079	-0.044	-0.000
× male 2-5 years	[0.161]	[0.151]	[0.056]	[0.051]	[0.084]	[0.076]
t2: log wife's asset	-0.808**	-0.728***	0.076	0.010	0.123	0.231
× male 2-5 years	[0.347]	[0.278]	[0.149]	[0.144]	[0.205]	[0.144]
t2: log head's asset	-0.080	-0.162	-0.087	-0.089*	-0.014	0.006
× female 2-5 years	[0.180]	[0.174]	[0.055]	[0.049]	[0.084]	[0.082]

Table 3.8: Intrahousehold Bargaining and Individual's Food Expenditure Share on Three Food Groups across Terciles

	Animal Group		Cereal Group		Plant Group	
Vars	OLS	FE	OLS	FE	OLS	FE
t2: log wife's asset	1.338***	1.049**	-0.187	-0.160	-0.082	-0.138
× female 2-5 years	[0.420]	[0.422]	[0.128]	[0.112]	[0.138]	[0.143]
t2: log head's asset	0.114	0.032	-0.014	-0.031	-0.068	-0.012
× male 6-10 years	[0.087]	[0.084]	[0.038]	[0.031]	[0.044]	[0.042]
t2: log wife's asset	0.476*	0.259	-0.071	0.034	-0.038	-0.084
× male 6-10 years	[0.287]	[0.243]	[0.104]	[0.090]	[0.107]	[0.085]
t2: log head's asset	0.138*	0.094	-0.024	-0.021	-0.067**	-0.058**
× female 11-19 years	[0.072]	[0.063]	[0.024]	[0.021]	[0.027]	[0.027]
t2: log wife's asset	0.145	0.169	-0.078	-0.041	0.107	0.063
× female 11-19 years	[0.234]	[0.199]	[0.079]	[0.081]	[0.093]	[0.075]
t2: log head's asset	0.028	-0.035	-0.014	0.005	-0.025	-0.013
× male 20-55 years	[0.058]	[0.057]	[0.020]	[0.018]	[0.023]	[0.021]
t2: log wife's asset	0.286	0.256	-0.021	0.030	0.010	-0.015
× male 20-55 years	[0.220]	[0.167]	[0.059]	[0.061]	[0.062]	[0.062]
t2: log head's asset	-0.013	0.093	-0.021	-0.028*	0.031	0.012
	[0.060]	[0.064]	[0.017]	[0.016]	[0.020]	[0.024]
t2: log wife's asset	-0.192	0.063	-0.064	-0.135**	0.060	0.058
	[0.206]	[0.164]	[0.062]	[0.063]	[0.063]	[0.052]
t3: log head's asset	0.229*	0.034	-0.014	-0.028	-0.088	-0.018
× male 2-5 years	[0.126]	[0.110]	[0.061]	[0.057]	[0.065]	[0.057]
t3: log wife's asset	0.030	0.239	0.061	0.045	-0.257	-0.348
× male 2-5 years	[0.379]	[0.311]	[0.166]	[0.153]	[0.250]	[0.217]
t3: log head's asset	-0.343*	-0.225	-0.087	-0.095	-0.039	-0.022
× female 2-5 years	[0.180]	[0.176]	[0.091]	[0.080]	[0.081]	[0.072]
t3: log wife's asset	0.603	0.165	-0.291*	-0.290*	0.163	0.258**
× female 2-5 years	[0.400]	[0.388]	[0.159]	[0.171]	[0.142]	[0.125]
t3: log head's asset	-0.083	-0.181**	0.080*	0.022	-0.047	0.022
× male 6-10 years	[0.082]	[0.082]	[0.047]	[0.039]	[0.047]	[0.043]
t3: log wife's asset	0.651**	0.443	0.026	0.043	-0.105	-0.172
× male 6-10 years	[0.312]	[0.310]	[0.151]	[0.122]	[0.169]	[0.153]
t3: log head's asset	0.005	-0.029	0.011	0.013	-0.036	-0.017
× female 11-19 years	[0.065]	[0.057]	[0.025]	[0.019]	[0.029]	[0.026]
t3: log wife's asset	0.418**	0.433**	0.009	0.046	-0.054	-0.098
× female 11-19 years	[0.207]	[0.185]	[0.092]	[0.072]	[0.119]	[0.101]
t3: log head's asset	0.065	0.011	-0.010	0.017	-0.043*	-0.041*
× male 20-55 years	[0.048]	[0.050]	[0.021]	[0.020]	[0.023]	[0.021]
t3: log wife's asset	0.231	0.147	0.006	0.049	0.047	0.016
× male 20-55 years	[0.169]	[0.147]	[0.063]	[0.059]	[0.074]	[0.082]
t3: log head's asset	0.012	0.186***	-0.040**	-0.056***	0.043*	-0.003
	[0.054]	[0.069]	[0.020]	[0.019]	[0.023]	[0.027]
t3: log wife's asset	-0.207	0.080	-0.033	-0.089	-0.022	0.006
	[0.152]	[0.176]	[0.077]	[0.067]	[0.075]	[0.073]
tercile2	0.160		-0.027		-0.005	
	[0.097]		[0.029]		[0.033]	
tercile3	0.176		-0.058		0.013	
	[0.115]		[0.040]		[0.039]	
adj. R^2	0.110	0.012	0.146	0.032	0.069	0.013
Effect of (relative to adult females)	head's=wife's assets					
male 2-5 years	0.04	0.02	0.30	0.76	0.62	0.20
t2: male 2-5 years	0.01	0.02	0.22	0.56	0.47	0.17
t3: male 2-5 years	0.62	0.55	0.68	0.67	0.52	0.15
female 2-5 years	0.01	0.12	0.14	0.03	0.87	0.13
t2: female 2-5 years	0.00	0.01	0.49	0.56	0.68	0.40
t3: female 2-5 years	0.03	0.35	0.25	0.30	0.20	0.04
male 6-10 years	0.01	0.09	0.09	0.51	0.17	0.79
t2: male 6-10 years	0.23	0.38	0.61	0.49	0.79	0.43
t3: male 6-10 years	0.02	0.06	0.74	0.87	0.74	0.22
female 11-19 years	0.33	0.10	0.30	0.46	0.12	0.23
t2: female 11-19 years	0.97	0.71	0.51	0.81	0.07	0.12
t3: female 11-19 years	0.05	0.02	0.98	0.65	0.88	0.43
male 20-55 years	0.03	0.00	0.02	0.15	0.26	0.72
t2: male 20-55 years	0.26	0.10	0.91	0.71	0.60	0.98
t3: male 20-55 years	0.35	0.38	0.81	0.62	0.25	0.51
female 20-55 years	0.10		0.32		0.52	
t2: female 20-55 years	0.41	0.87	0.50	0.12	0.67	0.44
t3: female 20-55 years	0.18	0.60	0.93	0.65	0.40	0.91

Same end of table note as Table 3.7.

CHAPTER IV

Cultural Norms and Son-Preference in Intrahousehold Food Distribution - A Case Study of Two Asian Agrarian Economies

Abstract: Based on cost and content of individual calorie intake, I find evidence of son-preference in food distribution in rural Bangladesh and not in the rural Philippines, which is consistent with the contrasting cultural norms about females in these two agrarian economies. In Bangladesh, consistent with purdah culture, few female participate in the labour market and gender difference in wage rate is prominent, while transfer at marriage from a bride's family exceeds that from a groom's family. There, village wage rate of adult female positively and that of adult male negatively affect a girl's allocation from animal food group, while village average value of transfers from grooms' families in recent marriages positively affect a girl's allocation. Gender disparity seems not due to scarcity. Higher birth ordered children fare worse than lower birth ordered in both countries, but a higher birth ordered girl does worse than a higher birth ordered boy in Bangladesh but not in the Philippines. A village access to television in Bangladesh positively affects girls' allocation from animal group.

4.1 Introduction

Understanding how cultural norms can influence intrahousehold food distribution has critical policy implications in light of the severity of micronutrient malnutrition around the world. However, despite considerable advancement in intrahousehold resource allocation literature, still there is limited progress in understanding intrahousehold food distribution issues let alone the role of culture in food distribution. In general, existing empirical work in economics does not adequately capture the specific cultural contexts in which individuals within the households make decisions (Quisumbing, 2003; Fernandez, 2008), while the lack of individual dietary intake data in typical household surveys constrain the analysis of intrahousehold food distribution.

To the best of my knowledge, there have been only a few studies, such as Quisumbing and Maluccio (2003), that attempt to replicate a common intrahousehold allocation framework across different cultural contexts, and find pro-male bias in education spending in Bangladesh - a patriarchal society in which husbands control most of the household resources, but not in West Sumatra, Indonesia, which is a matrilineal and matrilocal society[1]. The contrast between these two Asian Islamic societies illustrates the difficulty in predicting the direction of sex preference without considering the underlying culture and customs.

[1]See also Quisumbing (2003) and the references therein.

Intrahousehold allocations can be influenced by norms dictating differential roles, acceptable behaviors, rights, privileges, and life options for women and men (Agarwal, 1997; Kabeer, 1999). The bargaining power and threat points of women vis-a-vis men could be influenced by cultural factors, such as the purdah (veil) culture, which limits womens ability to obtain and possess control over resources and their mobility. In such context, even if women have education, it may not serve them in the labor market as women have few opportunities to work outside home (Hallman, 2003).

While the test of unitary model is at the center of empirical intrahousehold literature, the absence of different cultural contexts in this analysis limits our understanding on how the effects of bargaining power of a husband vis-a-vis his wife vary in different cultural contexts. In societies, where cultural norms dictate male-preference, targeting policy toward women may not necessarily reduce gender inequality.

Women's son-preference may have a sound economic basis but that basis could be influenced by cultural norms. If a cultural context, such as purdah system, limits women's participation in outside economic activities and thus makes males the main bread-earners, then in the absence of public provision for old age support, women may invest in the human capital of sons even more than their husbands as women are younger at marriage and expect to live longer than their husbands, ceteris paribus[2]. The gender discrimination in South Asia (SA), in contrast to Sub-Saharan Africa (SSA) where daughters are slightly more nutritionally favored than sons, is arguably due to the dowry culture in SA that requires families to pay bridegrooms to marry their daughters vis-a-vis the custom of bridegrooms to pay a bride price in SSA (Quisumbing, 2003).

The cultural norms of a patriarchal society combined with economic necessity of manual labour in an agrarian economy may imply that sons are prized (Chung and Das Gupta, 2007), while the tradition of dowry payments could put families with daughters in a disadvantaged position. Some religions and customs also put a premium on sons as in Hindu tradition a son light a man's funeral pyre. Lineage is primarily traced through the male in many societies, and families may depend on males for physical protection (Oldenburg, 1992).

In this context, this chapter attempts to make a number of contributions to the literature. First, focusing on food distribution among children in two poor agrarian societies, I demonstrate the evidence of son-preference in Bangladesh but not in the Philippines, which is consistent with the contrasting cultural norms about gender in these societies. Bangladesh is a patrilineal and patriarchal society with strong male dominance while the Philippines is a bilineal society with non gender-discriminatory social norms. The son-preference, arguably, is not likely to be driven by — the current nutrition-health-labour market linkage — a key economic explanation in the literature for observed sex-disparity in food distribution in an agrarian economy. As data shows, in Bangladesh, where son-preference is prominent, children do not participate in the labour market. In the Philippines, where they do, there is no such son-preference. If the disparity is driven by

[2]The age at marriage of women can also be influenced by the cultural norms related to womens labor market participation vis-a-vis household activities. Smith et al. (2003) find women marry at younger ages in South Asia and at older ages in Latin America.

labour market participation, one would expect disparity among older than younger children. Son-preference, however, is persistent at all ages in Bangladesh, but at no age in the Philippines[3].

While sex-disparity among children could be influenced by future sex-disparity in labour market participation rates, Behrman (1988b) does not find any such link in rural India[4]. Consistent with the purdah culture in Bangladesh, I find that few women participate at the labour market. Although both societies are agrarian, adult males' labour market participation is 7 times that of adult females in Bangladesh, while it is only double of that of adult females in the Philippines. Mean village wage rate of adult male is twice as much as that of adult female in Bangladesh, while consistent with egalitarian norms in the Filipino society, no such sex-disparity in wage rate is observed there.

Using village mean wage rate of adult males and females as proxy for future earning potential of boy and girl in a society - an approach similar to Rosenzweig and Schultz (1982)[5], I find that village female wage rate positively and male wage rate negatively affect a girl's allocation from animal food group (which is the most expensive and also nutritionally rich) in Bangladesh, but not in the Philippines[6]. Thus my second contribution is the demonstration of the link between intrahousehold food allocation and expected labour market returns in Bangladesh, while the previous literature found no such link in South Asia. The lack of such link in the Philippines could be due to no sex-disparity in adult wage to begin with and no bar on labour market participation of females due to the country's egalitarian social norms.

Third, based on the same Rosenzweig-Schultz type assumption, I also explore if and how children's food allocation in Bangladesh[7] is affected by the practice of dowry versus bride-price in a village and find that the higher are the transfers from grooms' families at the recent marriages in a village, the higher is a girl's allocation of animal foods, while the higher are the transfers from brides' families, the lower (although not statistically significant) is a girl's allocation. While some previous studies (cited below) analyse the link between dowry and intrahousehold allocation, I add

[3]The influential work of Pitt et al. (1990) (henceforth PRH) in rural Bangladesh illustrates that gender disparity in food distribution is prominent among adults but absent among children (less than 12 years), which they argue, is due to adult males' engagement in more energy-intensive labour market activities in which health influences productivity, while adult females (for whom there is no market returns for health due to social norm driven sex-segregated occupational pattern) are confined to low energy-intensive household activities. Hence, PRH argue that the nutrition-health-labour market linkage is not relevant for children, and thus no sex-disparity in food distribution is observed among them.

[4]Using the same data, PRH find gender inequality in calorie consumption for the age group ≥ 13, and argue that this further strengthens their claim as a large proportion of children ≤ 13 years do not participate in the labour market.

[5]They view that in a stable slowly developing society parents reasonably expect that conditions which they face as adults will also condition in a similar way the behaviour of their offspring. Thus they assume expectations of future sex-specific earning opportunities of children are formed on the basis of contemporaneous sex-specific patterns of adult earnings.

[6]As Folbre (1984) commented on Rosenzweig and Schultz (1982), it is however difficult to determine whether this link depicts the relationship between intrahousehold allocation and sex-disparity in expected labour market returns or evidence of intrahousehold bargaining on current allocation in which women who have greater incomes have greater influence in intrahousehold allocations that leads to greater investments in daughters.

[7]Similar data is unavailable in the Philippines survey.

to this literature by exploring households' responses to their future transfers at marriages of their daughters and current food allocation to these girls. These second and third findings, potentially indicate that son-preference in Bangladesh (and its absence in the Philippines) is a household's economic response to pre-existing cultural norms in this society, i.e., purdah culture and customs of dowry vis-a-vis bride price.

As opposed to the findings of many previous studies, my fourth contribution is that not only I show the evidence of gender-inequality in food distribution, but also demonstrate that inequality is not necessarily due to scarcity[8]. Son-preference is more prominent in non-poor or higher income households than poor or lower income households in Bangladesh, while not in either category of households in the Filipino sample (which appears to be poorer than Bangladeshi one). As the empirical analysis suggests below, dowry payment might rise with household wealth. This might be a potential explanation of son-preference in non-poor households in Bangladesh.

Fifth, while I do not have any direct way to measure the effect of cultural norms in intrahousehold food distribution in these two societies, for Bangladesh, using community information of the survey, I use whether a village has access to television (tv) as a proxy for more liberal cultural norms towards gender. Jensen and Oster (2009) find that introduction of cable tv is associated with significant decreases in domestic violence toward women and son-preference in India and cites a number of studies that found television can influence a wide range of attitudes and behaviour. Television can expose remote rural villages to modern lifestyles. Many popular tv dramas and soap operas in Bangladesh feature urban (and even international settings) in which women have education, work outside home, live independently and marry later; all of which differ in salient ways from those practiced in the rural areas. I find a village access to tv significantly improves girls' food allocation in Bangladesh. While the previous literature is mixed on the effect of birth order (Das Gupta, 1987; Bhalotra and Attfield, 1998), I find that higher birth ordered children fare worse than lower birth ordered in both countries, but a higher birth ordered girl does worse than a higher birth ordered boy in Bangladesh but not in the Philippines.

Sixth, I attempt to contribute to the measurement of intrahousehold food distribution. While PRH and many previous studies (for a survey, see Behrman (1990), among others) focus on individual calorie intake as the metric for intrahousehold food distribution, I focus not just on the total calorie intake but on its cost and composition, which have important nutritional implications.

Finally, I also attempt to improve upon the empirical strategy. Barcellos et al. (2010) argue that findings of the previous work are biased due to their assumption that boys and girls live in

[8] Using adult-good method, (Deaton, 1989) finds no evidence of boy-girl discrimination. Using household food expenditure data from rural Pakistan, Bhalotra and Attfield (1998) find no evidence of sex-disparity in children's food allocation. While some studies argue that boys receive more nutrition (Chen et al., 1981; Das Gupta, 1987), more healthcare (Basu, 1993; Ganatra and Hirve, 1994) and are more likely to be vaccinated (Borooah, 2004) than girls, others find no difference in anthropometric measures (Marcoux, 2002). While some studies find that households discriminate between boys and girls in bad times (Behrman, 1988a; Rose, 2000), Duflo (2005) concludes that even in the countries where the preference for boys is strongest, it is hard to find evidence that girls receive less care than boys under normal circumstances.

families with similar characteristics (observables and unobservables), which is incorrect if families have a preference for sons and follow a male-biased stopping rule of childbearing. To overcome this problem, they restrict the sample to families (with the age of children 0-12 months or a bit older) identical in observables and find son-preference in terms of time allocation, breastfeeding, vaccinations, and vitamin supplementation. While novel, this strategy suffers from the bias resulting from unobservable household characteristics, and also does not enable them to analyze discrimination within older children. I thus employ household fixed effect (henceforth, FE) methods to control for unobserved household fixed effects in analysing intrahousehold food distribution.

The chapter, nonetheless, has several limitations. First, available survey information does not enable me to directly measure the effect of cultural norm on sex-disparity in food distribution. Apart from cultural norms, the underlying differences in food distribution in two societies could be governed by economic factors unobserved in the data. Second, I use individual food intake data based on 24-hour recall methodology. Such data, arguably, provides a better measure for calorie demand as opposed to household food expenditure surveys (Behrman and Deolalikar, 1987; Bouis and Haddad, 1992; Bouis et al., 1992). Nonetheless, the recall data could be prone to reporting bias in favor of respondents appropriate norms rather than actual allocations. While theoretically the bias could go either way, if people tend not to publicly admit their obvious discriminations (Levitt and Dubner, 2005), then in a discriminatory environment against girls, the recall data is likely to understate actual boy-girl discrimination of food-intake. Third, it is also not obvious whether the observed sex-difference in food allocation in the sample households is over or under representation of true inequality. On the one hand, there could be sample selection bias resulting from past discrimination against girls through sex-selective abortion and higher female infant mortality resulting from household's neglect of critical care or food allocation to the female infants (Das Gupta, 1987). In that case, the observed boy-girl difference in the data is likely to be the lower bound of true inequality as the girls appeared in the sample are the preferred ones. On the other hand, as mortality rate tends to drop after age 5 and also reflected in household's reported mortality incidence in Bangladesh data (see Table 4.1), the girls observed in the sample could be the ones who have better health endowments (as they have survived)[9]. So it is unclear if the observed allocations are over or under-estimation of true sex-disparity as it will depend on whether the households compensate or reinforce endowments of the surviving children within and between gender.

The rest of the chapter is organized as follows. Section 4.2 highlights cultural norms of the two countries. Section 4.3 provides descriptive analysis of the survey data. Section 4.4 provides the empirical analysis, and Section 4.5 concludes.

4.2 Cultural Norms

This section contrasts the cultural norms of Bangladesh and the Philippines.

[9]Similar sex-disaggregated mortality data is unavailable in the Philippines survey.

4.2.1 Bangladesh

Bangladesh is a patriarchal society with high level of gender discrimination. More than 2.7 million Bangladeshi women are missing, indicating son-preference led sex-selective abortions, and neglect and abandonment of girls in early childhood (OECD, 2009). Based on the son-preference sub-index of the OECD Social Institutions and Gender Index (SIGI), Bangladesh holds 101th position (with the index value of 0.5) out of 122 countries while China holds the last position[10].

Morris (1997) views that the combination of religion, history and culture in Bangladesh poses too formidable a barrier to overcome for women, who are dependent on men throughout their lives, from their fathers through to husbands, brothers or sons. They do not have their own identities, and rarely viewed as individuals outside of the world of men. From the time of birth, as Morris notes, a Muslim woman's place in Bangladeshi society is largely pre-determined. While a son is welcomed into the world with the cry of "Allah Akbar" (God is Great), a female child receives only the whisper of the Qurannic prayer. Soon after the birth of a girl, her relatives begin the negotiations for her marriage. A key feature of this marriage is the dowry payment, that occurs over the course of several years and is a significant financial burden for most families. An inability to pay dowry severely affects a young bride's treatment in her husband's family home, which is consistent with Rao (1997), who finds that lower dowries increase wife-beating.

Amin and Cain (1997) documents dowry inflation in Bangladesh over the past decades. As Ambrus et al. (2010) illustrate, dowry system first emerged in the 1950s and has now almost fully replaced the traditional system of bride prices, making Bangladesh the only Muslim country in which bride price is rarely observed and dowry is almost universally practiced. While muslim marriages involve negotiation of a mehr (traditional Islamic brideprice, ideally to be paid at the time of marriage) as a part of the marriage contract, the key characteristic of mehr in Bangladesh is that, unlike in other Islamic countries, it is almost universally and automatically specified to be paid only in the case of husband-initiated divorce, much like a standard prenuptial agreement.

Womens access to education and employment in rural Bangladesh are also constrained by the purdah (veil) custom, which impedes womens freedom and mobility (Begum, 1998; Rozario, 1998; Gruenbaum, 1991; Hoodfar, 1991; Papanek, 1982) and enable men to dominate their women by exercising control over property, income and their labor (Rahman, 1994; Zaman, 1995). Bakr (1994) finds that the practice of purdah, which is socially and culturally determined, has been used deliberately as an instrument to enable men to dominate the family structure and divide labor by gender, leaving women extremely dependent upon their husbands. Hashemi et al. (1996) argue that as a result of purdah, Bangladeshi women are traditionally isolated at home with little social contact outside of their own kin groups. Amin (1997) finds that the practice of female seclusion, influences and conditions womens decisions regarding roles they assume, and remains a dominant

[10] This indicator is inspired by Sen (1990). The SIGI countries are coded by Klasen based on Klasen and Wink (2003) on the scale of 0, 0.25, 0.5, 0.75 and 1, with 0 indicating that missing women is not a problem and 1 indicating a severe incidence of excess female mortality. See Economist (2010) for a recent survey of the missing women issue in developing countries.

influence in womens lives, showing little evidence of responsiveness to poverty.

In this socio-cultural context, it is unsurprising that women appear to be a "residual category" in intrahousehold food distribution, eating after men and children, and making to do with what is left (Kabeer, 1998). This practice is believed to ensure the longevity and good fortune of male guardians, and thus girls are taught by their mothers to get used to such deprivation (Naved, 2000).

4.2.2 The Philippines

Mendez and Jocano (1974), Medina (1995), and Miralao (1997), among others, provide detailed accounts of the traditional regime of the Filipino family. The pre-colonial social structure of the Philippines gave equal importance to maternal and paternal lineage, which gave Filipino women enormous power within a clan. Women were entitled to property, engaged in trade, could exercise their divorce right, and could become village chiefs in the absence of a male heir. Although the male-centered colonization processes affected some significant changes in the traditional gender regime, Filipino women, in comparison with their Euro-American and Southeast Asian counterparts, have always enjoyed a greater share of legal equality with men, and have held a relatively high social status that can be traced to the pre-colonial era. The laws in the Philippines reflect egalitarian rather than patriarchal politics. It is illegal to publicly denigrate women. Women have the same legal rights to parental authority, and can inherit, sell, and own property as men (Agbayani-Siewerat, 2004; OECD, 2009).

The tradition of marriage and courtship depicts the importance of bride and her family in the society. A man is expected to court a woman to win her heart. Parents prefer their daughter to be courted in their home, so they have a chance to know the man. Sometimes, the courtship lasts for several years during which the man is measured on his ability to respect the womans family and servitude. Often, the woman is courted by several men, and will choose the best from among her suitors.

Traditionally, dowry was a part of the Filipino marriage, but in contrast to Bangladesh, it is the payment from groom to bride and her family (similar to bride-price in Sub-Saharan Africa). Before marriage, the groom gave a dowry (*bigay-kaya*) to the bride's family, consisted of gold, land, money, slaves, or anything of value[11].

In Filipino folklore, both the husband and wife come from a single piece of bamboo, which contributes to the egalitarian concept to the role of husband and wife in the society. Conversely in Bangladesh, grounded in Islamic tradition, the belief is that the woman is made out of a chest bone

[11]Some other forms of dowry included: (i)*Panghimuyat* - a sum of money given to the bride's mother as the compensation for the sleepless nights she endured while rearing the girl; (ii) *Bigay-susu* - another sum given to the mother or wet nurse who gave milk to the bride during her infancy; (iii) *Himaraw* - a sum of money given to the parents of the bride to reimburse them for the cost of bringing her up. The giving of the ring, although influenced by the western culture, is actually a scaled-down version of the tradition of groom's offering of dowry to his wife and her family. Aside from the dowry, the groom had to serve the bride's parents for free for chopping wood, fetching water, and other manual work. See http://philippinealmanac.com/philippine-history/marriage-customs-of-the-ancient-filipinos/.

of the man, and so she is inherently weaker and dependent on the man. A father in the Filipino tradition is a bread-winner while the mother is the Reyna ng Tahanan (Queen of the Home). She controls the finances, acts as religious mentor, disciplines the children, and may also arrange the marriages of sons and daughters to improve the familys dynastic connections. Overall, she holds the key to household development (Flavier, 1970). Since she controls the household finance, her parental family rather than her husbands family has a better chance of receiving financial help.

In this cultural setting, society values offspring regardless of sex. Female children are as valuable as male ones as it is recognized that women are as important as men. Parents provide equal opportunities to their children regardless of sex. In contrast to Bangladesh, linguistic analysis of Filipino kin terminology has a striking lack of gender differentiation (Stoodley, 1957). For example, the Tagalog language has a general term for child (anak), but no specific word for either daughter or son. Similarly, the ethnographic studies document no evidence of son preference in food distribution (Palabrica-Costello, 1994). Fertility studies show that Filipinos are just as likely to desire (if not slightly more) a daughter as a son (Wong and Ng, 1985). Almond et al. (2009) find that while for all other Asian immigrants to Canada, sex ratios are normal at first parity and rise with parity if there were no previous sons, for the Filipino immigrants, the sex-ratio is at biological norm for all parities including for the third child preceded by two girls indicating no son preference at all. According to SIGI index of OECD, the Philippines is one of the top-ranked countries (ranked 7th out of 102 non-OECD countries while Bangladesh ranked 90), reflecting a high degree of gender equality. In terms of son-preference index, the Philippines value is 0 indicating no problem of missing women (OECD, 2009).

4.3 Data and Descriptives

4.3.1 Bangladesh

For Bangladesh, I use the same IFPRI survey data described in Chapters 2 and 3. As Chapter 2 describes (see Table 1 of Chapter 2), there is limited variation of household size and composition across rounds (as should be expected as the survey was conducted in four rounds within a period of one year with roughly a four-month gap between the rounds), but per capita expenditure varies significantly between the rounds. Similarly, Chapter 3 shows that food budget share and budget share for different food groups significantly vary between the rounds, particularly for low and middle income households (see Table 1 of Chapter 3).

Table 4.1 presents some descriptives averaging over four rounds. I divide the households into poor and non-poor category based on the absolute poverty line (i.e., per capita calorie consumption of 2122 kcal per day). As this case study involves data from two different countries at different time periods, use of APL is convenient as it does not require conversion of nominal income to real income using purchasing power parity to analyze the behavior of poor and non-poor groups in these two different samples. Based on APL, majority of the households in any given round are poor. At the same time, majority of the households tend to move in and out of poverty in different rounds as about 35% households remain poor in all four rounds. About 7% of the households are landless based on the landholding data collected in round 1.

As already discussed in Chapter 2, PRH's claim of children's non-participation at the labour market tends to hold in IFPRI survey (see Table 2 of Chapter 2). Detailed work activities of children are absent in the survey. Based on recorded occupation of 1203 children (of which 630 are boys), 2 boys are involved in farming, 1 in service, 2 as labour and another 2 as servants, while 1 girl in household work, 3 as servants, and 1 as labour. The rest are recorded as children or students under occupational category. Survey data on wage rate of different individuals and activities also do not indicate any wage labour of children, and even for adult category, there is few female participation in wage labour (see Table 4.2, which averaged wage rate of all activities in four rounds by sex and age). Adult males' participations in wage labour are more than 7 times higher than that of adult females, while the mean wage rate of adult males is almost double of that of adult females. The mean village wage rate[12] of adult males are also twice as much as that of adult females (see Table 4.1).

The marriage module of the survey records transfers (at 1996 prices) at marriage from a wife's family to her husband's family, husband, or to her and her husband (henceforth, loosely termed as dowry) and the transfer from her husband's family to her family, her, or to her and her husband (loosely termed as mehr, i.e., bride-price). For the empirical analysis in the following section, I construct village-level average of total transfer from a wife's and a husband's family based on the marriages that occurred between 1990 and 1995, which, consistent with the phenomenon of dowry price inflation, shows that on average transfer from a wife's family (dowry) is about 3.5 times higher than the transfer from a husband's family (mehr)[13].

Table 4.3 presents a simple regression analysis of the association between a husband's and wife's own and family characteristics and transfer at marriage from their families (first 2 columns report OLS results and last two seemingly unrelated regression (SUR) results). A wife's parents' landholding increases both the dowry and mehr, although the magnitude of the effect of the former is larger than the latter implying a net outflow (the overall mean value of dowry of all marriages in the survey is 9,544 taka while the corresponding mean value of mehr is 6,496 taka, both in 1996 prices) from a wife's family, which increases with the landholding of her parents. For a 10% increase in wife's parents' landholding would increase the transfer from her family by 16% while from her groom's family by 15% in SUR estimate. Education of a wife's father is also positively associated with both dowry and mehr. A wife's education increases mehr, while a husband's education increases dowry, and the magnitude of these opposite effects are almost similar for an additional year of schooling of a wife vis-a-vis her husband. Finally, the coefficient of length of marriage is consistent with the

[12]Mean wage rate is the averaged over all activities of adult males and females in four rounds in a given village, and nominal wage rate is deflated by village rice price averaged over four rounds to obtain a proxy for real wage rate.

[13]Data enables me to construct the village-level average for 33 out of 47 villages based on the marriages occurred in the specified period.

findings in the literature about dowry price inflation and replacement of bride price with dowry in recent periods. The higher the length of a marriage (i.e., the earlier is the year of marriage), the lower (higher) is the value of transfer from a wife's (groom's) family. An additional year of length of marriage decreases dowry by 3% and increase mehr by 5% in SUR estimate.

The literature suggests that girls tend to live in bigger families with higher number of siblings than boys (Morduch and Stern, 1997). Based on the number of co-residing living siblings for a boy vis-a-vis a girl, both the mean and 75th percentile of female siblings of a boy and a girl appear to be higher in poor households than non-poor households. The mean of total number of siblings are higher in poor than non-poor households. The mean and 25th percentile of male siblings of a girl is also higher in poor than non-poor households, indicating that girls tend to live in bigger families in poor households. However, this pattern could be due to use of per capita calorie based poverty line. By construction, per capita calorie intake would be lower in households with higher number of children as a child would consume less calories than an adult. Moreover, if a girl's required calorie amount is less than a boy as the WHO requirement figures suggest, and accordingly if a girl consumes less calorie than a boy, then APL based poor households could end up having more children than adults and more girls than boys.

Regarding a village's access to television, it appears that 4 out of 47 villages do not have any access to television, which contain about 13% and 7% of total survey observations for female and male, respectively.

Both monthly per capita expenditure and per capita calorie consumption are higher in non-poor than poor households, while the composition of food expenditure and calorie consumption from the three broadly defined food-groups: animal, fish, and dairy (henceforth, animal), cereals, and plant and others, are roughly similar between the two groups. Moreover, food expenditure share is also substantially higher for non-poor households than poor households, primarily due to higher amounts of calorie consumption of the latter, indicating high income elasticity for food consumption, particularly at relatively low levels of income. As reflected in the price to purchase same amount of calories from different food groups, the animal group is the most expensive.

Children ($\leq$ 10 years) on average have about 500 calories more in non-poor households than in poor households (see Table 4.4). The total calorie intake of boys is about 8% higher than girls in non-poor households, while the corresponding difference is 4% in poor households. However, the boy-girl difference in total calorie intake does not necessarily imply discrimination as the mean requirement of total calorie intake of girls for this age group is about 214 calories less than that of the boys, while the requirements for all other critical macro and micronutrients are almost same for boys and girls[14].

[14]See World Food Programme (2000) for requirements for micronutrients for males and females of different age groups of developing countries. As described in Chapter 2, the calorie requirement figures for children are from World Health Organization (1985), which are based on the United States National Center for Health Statistics (NCHS) referenced children sample. Some studies argue that the calorie requirement figures are themselves gender-biased as the standards based on energy use for various activity levels systematically may understate the actual energy use of

PRH view that calorie is the sufficient statistic for all other nutrients, while evidence suggests critical micronutrient malnutrition among individuals who are at or above their calorie adequacy ratio (Bouis et al., 1992) as predominant sources of calories, although cheap, are not always good sources of a variety of critical micronutrients (IFRPI-BIDS-INFS, 1998). Moreover, for critical nutrients like protein and iron, not only the quantity matters, the sources matter too. Protein from animal and dairy sources as opposed to cheaper cereal sources are of high quality and digestibility, while iron from the former sources, known as haem-iron, have high bioavailability (World Health Organization, 1985). Furthermore, as Chapter 3 demonstrates, focusing on calorie intake may understate intrahousehold inequality as two individuals might consume the same amount of calories but one's intake, as opposed to the other's, may be composed of a larger share of food items, which are more expensive and/or more nutritious. This type of discrimination, as reflected in the ethnographic studies, is not revealed if the focus is only on total calorie intake.

Given that the animal group is the most expensive food group and at the same time rich in various nutrients, such as protein and iron, and also promotes bioavailability of micronutrients in non-staple plant foods and cereals, I focus on individuals' calorie and food expenditure share of animal group in analyzing intrahousehold food distribution. The boy-girl disparity based on animal-group shares in calorie and food expenditure is prominent in non-poor than in poor households. The calorie share from animal group is virtually same between boys and girls in poor households while boys' share is 22% higher than girls' share in non-poor households. The same pattern applies regarding boys' vs girls' intakes of animal calories as a share of total household calories from animal sources, and boys' and girls' food expenditure shares on animal products in poor and non-poor households[15]. None of these differences are likely to be driven by the age-composition of the children as the mean age of children is around 6 years for both types of households.

Upper panel of Figure 4.1 presents nonparametric (using locally weighted regression method, lowess at bandwidth 0.8) Engel curve for boys and girls for total calorie, calorie from animal group, and calorie from cereal group, while the lower panel portrays their calorie adequacy ratio[16], and calorie share from animal and cereal groups. As opposed to the linear calorie Engel curve in the literature (Deaton and Subramanian, 1996), these Engel curves are broadly quadratic implying the increase in total calorie and animal and cereal calorie before their declines with the increase income. In line with the analysis in Chapter 3, intake of cereal calorie tends to flatten at a relatively low level of income compared to the income level at which animal calorie intake tends to decline. While boys' total calorie intakes surpass girls' intakes with the increase in income, girls' calorie adequacy ratio appear to be higher than that of the boys at all income level. Conversely, as income level increases, boys' total animal calorie intakes and animal calorie as a share of total calorie intake both tend to surpass those of girls roughly at around monthly per capita expenditure of 350 taka (which

women (Chen et al., 1981; Sen, 1984)

[15]Total household animal calorie and expenditure on animal food group are the sum of animal calorie intake and expenditure on animal food group of all individuals within the household and not just those of the children.

[16]Calorie adequacy ratio is described in details in Chapter 2 (see Section 5.1 and Appendix of Chapter 2). It is an individual's calorie intake as a share of his/her calorie requirement.

is about 150 taka less than the national rural lower poverty line in 1995-96). This is consistent with the above descriptive analysis that boy-girl difference in animal calorie share is higher in non-poor households than in poor households. Finally, as expected, cereal share in total calorie tends to decline with the increase in income. Nonparametric Engel curves of total expenditure and animal and cereal expenditure as a share of total expenditure broadly mirror the findings based on total calorie and calorie share Engel curves (not shown).

4.3.2 The Philippines

The Philippines data comes from the IFPRI study, the Philippines Cash Cropping Project. The objective of the study was to understand the effects of cash cropping on human nutrition. Four survey rounds were administered to 448 households in 29 villages over a sixteen-month period in 1984-85 in the predominantly rural southern providence of Bukidnon. The households, comprising 2,880 individuals, were surveyed to assess the effects of agricultural commercialization on land tenure, household resource allocation and nutrition. Similar to the Bangladesh survey[17], the survey in the Philippines also collected a wide array of individual and household level information including demography, schooling, farm and non-farm labour, food and non-food expenditure, and most importantly for my analysis, the individual food intake information based on 24-hour recall methodology.

Table 4.5 presents some descriptives averaging over four rounds. Based on APL, the Filipino sample seems to have a larger proportion of poor households than the Bangladeshi sample, perhaps because the survey area was a relatively poorer province and the sampling criteria was that only households with at least one child less than five years old and farming less than 15 hectares of land were eligible for the survey. More than half of the sample households are landless compared to 7% of household in Bangladesh sample. About 5% households owned a television set, the effect of which on food allocation as a proxy for modern and liberal norms about gender is explored in empirical analysis. Even in this disproportionately large share of poor households, similar to the Bangladesh case, a significant share of the households tended to move in and out of poverty in different survey rounds. While more than 97% of the households seemed to be poor at least in one round, 71% of the households were poor in all four survey rounds. Consistent with the poverty level, more than 70% of the household expenditure were spent on food.

Average household size is about 1 person lower in non-poor households than in poor households, while share of boys compared to that of girls are higher in non-poor than poor households. While on average male siblings tend to be roughly similar between poor and non-poor households, female siblings are less in non-poor than poor households, resulting in total siblings of a child higher in poor than non-poor households. This pattern is similar to Bangladesh sample, although the magnitude is much higher in the Filipino sample. However, as mentioned before, this pattern could be due to the per capita calorie based poverty line used in both samples.

[17]The survey in the rural Philippines was used as a valuable input in designing the subsequent Bangladesh Survey.

While the magnitude differs, there are also some broad similarities between Filipino and Bangladeshi samples in terms of calorie consumption and composition of food expenditure. In the Philippines data, on average the per capita calorie consumption of the non-poor household is about 1000 calorie higher than that of the poor households. However, the calorie and expenditure composition for the broadly defined three food groups, i.e., animal, plants and others, and cereals, are roughly similar between the poor and non-poor households. Similar to Bangladesh, animal products are the most expensive sources of calories in the Philippines, and the households spend about 30% of their food budget to obtain about 6% of their calories from this expensive food group. A key difference with Bangladesh, however, is that the plant and other sources contribute larger than cereal sources in calorie and expenditure compositions. This is due to Filipino households' reliance on roots and tubers, cassava, and corn as some cheaper sources of calories.

However, noticeable difference is observed between Bangladesh and the Philippines in terms of gender disparity in wage labour and wage rate. Adult males' labour market participation is not 7 times higher (as in Bangladesh) but about twice as much as the participation of adult females in the Philippines. Unlike Bangladesh, adult males' wage rate is almost the same as that of adult females. Similar pattern also emerge for village-level mean wage rates of adult males and females, which are not significantly different from each other (see Table 4.5).

Regarding children's food distribution (Table 4.4), boys' calorie intakes are about 3-4% higher than that of the girls, which could be due to the differences in the calorie requirements for boys vis-a-vis girls. What is different from Bangladesh is the phenomenon of no significant gender disparity in either poor or non-poor Filipino households in either the calorie share or the expenditure share of animal products. Girls' calorie share from animal sources are about 9% higher than boys' share in the non-poor households, while the expenditure share from the animal products are roughly the same between boys and girls in the non-poor households.

Figure 4.2 presents the calorie Engel curves for the Philippines. Similar to Bangladesh, with the increase in income, calorie from animal group increases while that from cereal group declines. Total calorie intake tends to increase with income and at log per capita expenditure value of 3, girls' calorie adequacy ratio surpasses that of the boys. Unlike Bangladesh, there is much less sex-disparity in animal calorie consumption. If anything, girls' animal calorie (and animal calorie share) Engel curve tends to be on or slightly over the boys' curve. As the APL measure suggests that the Filipino sample is relatively poorer than the Bangladeshi sample, unlike Bangladesh, the decline in calorie intake for children with the increase in income is not prominent in the Filipino Calorie Engel curve. Engel curves based on expenditure measures portray the similar story from the expenditure side (not presented).

4.4 Empirical Analysis

I first estimate the following basic empirical model, separately for Bangladesh and the Philippines:

$$y_{ijst} = \beta_0 + \beta_1 age_{ijst} + \beta_2 age^2_{ijst} + \beta_3 girl_{ijst} + \mathbf{X}_{hjst} \times \beta_{\mathbf{4}} + \sum_t \beta_{5t} R_t + \sum_l \beta_{6l} S_l + \epsilon_{ijst} \tag{4.1}$$

where, y is a measure of intrahousehold food distribution of an individual i of household j in site s at time t, and the set of household characteristics ($\mathbf{X}_{hjst}$)) include per capita expenditure and its square, per capita landholding, and household size, all in logs, share of boys, girls, adolescents males and females, and adult males, survey rounds (R_t), and sites (S_l) (for Bangladesh) dummies. The sign and size of coefficient β_3 of girl dummy variable (=1 if the child is a girl) is of key interest.

OLS estimate of equation 4.1 has econometric concerns as households with boys vis-a-vis girls could differ in terms of observables and unobservable characteristics. A household's unobserved fertility preference can affect both the household size and sex-composition of the children and sex-preference in food allocation. Marriage market selection effect (Foster, 1998) can also be at play, whereby, each spouse's sex-preference for a child could be correlated with the other spouse's characteristics (such as education and assets) through marriage, which in turn could be correlated with sex-composition of children and their food allocation. Also, if girls are born in bigger families, then they may have (lower) higher food allocation if bigger families have greater (dis)economies of scale (Deaton and Paxson, 1998). If the scale (dis)economies are not sufficiently captured by the household size and composition, then OLS estimates may carry a bias. To the extent, these unobserved household and spouses' characteristics and unmeasured scale effect are time invariant, they could be controlled in household fixed effect (FE) estimate. As the survey was conducted in four rounds in both countries, exploiting within household variation in food distribution measures between boys and girls in different rounds and variation in time-varying household characteristics across rounds (such as their poverty status and monthly per capita expenditure), I also estimate equation 4.1 using household FE. However, as already indicated in the previous chapters, there is limited variation in household size and composition, and per capita landholding in Bangladesh as landholding information is collected in the first round only, which could potentially lead to imprecise estimation of the effects of these variables. The HFE estimates will also be based on a restricted sample of households that have at least a boy and girl under consideration. The noise to signal ratio is also likely to increase due to differencing.

Using both OLS and FE, I also estimate a number of variants of equation 4.1 to explore different hypotheses. First, to explore whether a village's access to tv is conducive for less sex-disparity in food allocation in Bangladesh, I augment the basic specification by controlling for a dummy = 1, if the village has access to tv (and 0 otherwise) and its interaction with the girl dummy. Similar village level data on tv access is not available in the Philippines survey, but whether household has a tv or not is. So, for the Philippines, I use a dummy (=1) if the household has a tv and interact that with the girl dummy. However, having a tv within the household may not sufficiently capture the effect of social norm of the community and its effect at the household level as a household within a community can be largely influenced by communal norms. In Bangladesh, it is quite common that villagers (men) watch tv (even if they do not own it) in small tea-stalls or at the market places, while female neighbours gather in a neighbour's house who has a tv to watch popular tv dramas and serials. Thus, a tv may affect the norms of a community, even if not many individuals in that community necessarily own a tv but are able to watch it. A village's access to tv, as the results in the following sub-section summarises, seem to positively affect a girl's food allocation from animal group in Bangladesh, but a household's tv in the Philippines does not have any significant effect on girl's allocation. So, in other variants of equation 4.1, I control for the tv effect in Bangladesh but not in the Philippines.

Related to the discussion on child mortality at different ages (see Section 4.1) and it's drop after age 5, it is useful to investigate at which age sex-disparity in food distribution becomes apparent. Instead of just the intercept effect of sex-difference in basic specification, in a variant, I also interact age with girl dummy.

To explore the link between future labour market returns and current food distribution among children, in the spirit of Rosenzweig and Schultz (1982), in one specification, I control for mean real village wage rate of adult males and females and interact these wage rates with girl dummy. For Bangladesh, related to dowry vs mehr practices, to explore if a household's allocation for a girl (vis-a-vis a boy) could be influenced by the expected payments that the household vis-a-vis the groom's family is likely to make at that girl's wedding, in another specification, I use village mean payments from grooms' families and brides' families at the marriages (and their interaction with girl dummy) that occurred between 1990-95 and formed some of the survey households.

To explore if households prefer first born to those of higher birth orders, in another specification, I control for a child's birth order and interact this with girl dummy to see whether the allocation is worse for higher birth order children, particularly if they are girls. Further to the indication of more disparity in non-poor households than poor households in Bangladesh in descriptive analysis, in another specification, I use an APL dummy (=1 if the household is poor), and its interaction with girl dummy. APL is a time-varying household characteristic as households tend to move in and out of poverty in different rounds. To explore if son-preference varies with land ownership, in another variant, instead of controlling for per capita landholding, I use a dummy equals 1 if the household is landless and interact the landless dummy with girl dummy. Households may discriminate against girls in bad times but not in good times, as suggested by previous studies. To explore the effect of seasonality on gender discrimination, in another specification I interact round dummies with girl dummy to see if a girl's allocation is particularly worse in any particular round. Finally, in one variant, I also interact girl dummy with log household size and log per capita expenditure to explore how a girl vis-a-vis a boy fares in bigger vs smaller households and as household income increases, ceteris paribus. The estimates of these models for Bangladesh and the Philippines are summarised below.

4.4.1 Bangladesh

Table 4.6 presents OLS and FE estimates of the equation 4.1 for calorie and animal calorie shares. In line with the summary statistics and nonparametric figures, a girl's total calorie intake appears to be lower than a that of a boy (about 5% in OLS and 4% in FE estimate), while a girl's calorie adequacy ratio appears to be higher than that of a boy because of lower requirement figures for girls compared to boys for a given age.

Son-preference becomes evident in the allocation of animal calories. A girl's animal calorie share is about 11% lower than that of a boy (column 6), while her animal calorie as a share of total animal calorie of the household is 12% lower than the corresponding share of a boy in FE estimate (column 8). FE estimates are both higher in magnitudes and significance level, potentially indicating downward bias of OLS results resulting from unobserved household fixed effects discussed above. Household size, holding composition fixed, is a proxy for scale economies. No consistent pattern of scale economies appears from changing sign and significance of the coefficient of household size for total calorie and animal calorie measures. Limited variation in household size across rounds also makes it difficult to obtain precision of scale effect in FE estimate. In terms of seasonality, calorie intake seems to be lower in round 1 and 3, while animal calorie share in total calorie seems to be higher in round 1 and 2 compared to round 4, indicating seasonality can vary differently for different food items. At low level of income, while a child's calorie adequacy ratio increases with the household income, her animal calorie as a share of total household animal calorie declines substantially perhaps due to disproportionately larger increase in animal calorie consumption of adolescents and adults. This is consistent with the per capita animal calorie Engel curve depicted in Chapter 3 (see Figure 2 of Chapter 3).

Table 4.7 summarises key parameters of interests from different variants of equation 4.1 for total calorie and animal calorie based food distribution measures. In model 1, I augment the basic specification by adding a village access to tv dummy and its interaction with girl. While a girl's animal calorie share in her total calorie and in households total animal calorie appear to be 36% and 27% lower than the corresponding shares of a boy (column 6 and 8), if a village has access to tv, then these shares of a girl increases by 28% and 16%, respectively compared to a girl in a village which does not have an access to tv. Both girl and girl × tv coefficients are jointly significant for all the dependent variables in model 1[18].

In model 2, instead of age square in equation 4.1, I interact girl dummy with age to see at which age sex-disparity becomes prominent. The intercept effect remains substantial for animal calorie shares (column 5-8). For each incremental age, the female's allocation vis-a-vis a male's increases only marginally, resulting sex-difference to be persistent at each age of the child. For following variants, I thus return to age and its square specification.

Model 3 explores the link between children's food distribution and expected labour market

[18]p-values of the joint significance of the parameters of interest in all these variants are not reported but available upon request

returns and finds a strong positive (negative) link between a girl's animal calorie allocation and mean village wage rate of adult women (men) in addition to a strong positive effect of tv on a girl's allocation. Doubling female wage rate would increase a girl's animal calorie share in her total calorie by 40%, while doubling male wage would reduce it by 30%. The coefficients of girl and girl $\times$ log female wage (Lfwage) and girl and girl $\times$ log male wage (Lmwage) are jointly significant in FE estimates for animal calorie share in total calorie and in household's total animal calories and so are the girl and girl $\times$ tv coefficients. Model 4 further includes mean village transfer from a bride's family (dowry) and groom's family (mehr) and their interaction with girl dummy. A girl's animal calorie allocation seems to be negatively associated with dowry and positively with mehr, and the coefficient of mehr is significant at 10%, providing at least weak indication for the link between these practices and intrahousehold allocation. Model 5 demonstrates that children of higher birth order, particularly if they are girls seem to be in a disadvantaged position compared to the ones who were born ahead of them in the allocation of animal calories (both as a share of individual total calorie and as a share of total household animal calorie). The coefficient of girl and girl $\times$ birth order are jointly significant in FE estimate for these calorie shares (column 6 and 8).

In contrast to the previous literature, the gender disparity seems not to be driven by scarcity as poverty does not appear to be a key determinant of disparity in model 6. While a girl's animal calorie share in her total calorie intake is about 41% lower than a boy (column 6) and a girl's animal calorie share in households total animal calorie is 31% lower than a boy (column 8) in non-poor households, no such disparity appears in poor households. In terms of these animal calorie shares, a girl's position is worse than a boy's in households with landholdings. While compared to a girl in households with landholding, a girl in landless households is worse-off (model 7), it is not possible to identify in FE estimate whether boy-girl discrimination is worse in landless than in households with land. Consistent with the findings related to absolute poverty level, model 8 demonstrates that a girl's animal calorie shares are worse in higher income households than lower income households and in bigger households than in smaller ones. Girls doing worse in higher income or non-poor households than in poor households are consistent with some previous literature. Almond et al. (2009) note that sex-ratio is higher in the richer states of India, such as Punjab, while Sen and Sengupta (1983) find higher gender disparity in anthropometry measures in richer households than in poorer ones. As the results in Table 4.3 tends to indicate, dowry payment may rise (more than mehr) with daughter's parents wealth, which in turn may lead to stronger son-preference in non-poor households[19].

Finally, to explore whether households discriminate against girls in bad times but not in good times, as the previous literature suggests, I interact girl dummy with survey round dummies. As

[19]Son-preference in non-poor households is also consistent with the long-standing hypothesis of evolutionary biology, namely the Trivers-Willard (TW) hypothesis (Trivers and Willard, 1973), which predicts that high-status individuals favor boys and low-status individuals favor girls. Almond and Edlund (2007) provide evidence of TW hypothesis in terms of childrens sex-ratio from US natality data, while Hopcroft (2007) provides evidence in terms of childs education in the US.

mentioned in Chapter 2, round 2 contains the major agricultural lean season, while round 3 contains the minor one. But I do not find any significant evidence of seasonality either on a girl's or on a boy's animal calorie shares. Neither a girl's (boy's) animal calorie as a share of her (his) total calorie nor as a share of total household's animal calorie differ significantly across survey rounds (results unreported).

Sex disparity based on expenditure measures (summarised in Table 4.8) broadly resemble to those based on calorie measures. Model 1 reports the result of girl dummy from the estimation of basic specification (equation 4.1). Consistent with total calorie intake, a girl's total food expenditure is 5% lower than a boy in OLS and 3.5% in FE estimate. A girl's animal food expenditure share in total food expenditure is 6% lower than that of a boy in FE, while her animal food expenditure as a share of total household animal food expenditure is 7% lower than a boy.

Effect of a village access to tv (model 2) have substantial positive impact on these expenditure shares of a girl. A girl's animal food expenditure share in her total food expenditure is 27% higher and her animal food expenditure share in total household animal food expenditure is 18% higher in a village which has access to tv compared to the one which does not (column 6 and 8). The girl dummy and its interaction with tv dummy are jointly significant in FE estimate for all the dependent variables. Instead of age square, when girl dummy is interacted with age (model 3), I find substantial intercept effect of girl dummy for animal expenditure shares (col 6 and 8) and only marginal increment of these shares for a girl with the increase of her age, implying persistence of sex-disparity at all ages of children for animal group expenditure shares. For the remaining variants, I revert to age and age square specification.

Doubling village female wage rate would increase a girl's animal expenditure share in her total food expenditure by 24% (model 4 column 6) and her animal food expenditure share in total household animal food expenditure share by 22%, while doubling village male wage would reduce the later share by 22%. The effect of mean village dowry on a girl's animal expenditure shares has expected negative signs but is not statistically significant, while mean village mehr positively affect these shares and significant at 10% level for a girl's animal expenditure share in her total food expenditure (model 5 column 6 and 8). Girls of higher birth order also have less expenditure allocation for animal group and both girl and birth order interaction are jointly significant for these expenditure shares in FE estimate (model 6 column 6 and 8).

Gender disparity in animal expenditure shares are also prominent in non-poor than poor households (model 7 column 6 and 8). A girl's animal expenditure share in her total food expenditure is 30% lower and her animal expenditure as a share of total household animal food expenditure is 23% lower than the corresponding shares of a boy in households with landholding, while these share do not vary significantly between a girl in landholding household and a girl in landless household (model 8 column 6 and 8). Model 9 suggests that a girl is worse-off in bigger households than smaller households in terms of expenditures shares on animal food. Doubling the household size would reduce her animal expenditure share in total food expenditure by 20% (column 6) while her share in total household animal expenditure by 27% (column 8). Finally, no significant effect of seasonality is observed on a girl's animal food expenditure shares (results not reported).

4.4.2 The Philippines

Table 4.9 presents the results of the estimates of basic specification (equation 4.1) for calorie based measures for the Philippines. Similar to Bangladesh, a girl's total calorie intake is about 3% lower than that of a boy, while her calorie adequacy ratio is about 7% higher than a boy in FE estimate. OLS estimates are also similar in magnitudes. In contrast to Bangladesh, however, there does not appear any significant boy-girl difference in animal calorie shares (column 6 and 8). Household size and boys' share do not vary across rounds and thus are dropped in FE estimate.

Table 4.10 summarises variants of equation 4.1 for calorie and animal calorie shares. A household's tv ownership does not significantly affect a girl's animal calorie allocation (model 1), so in subsequent variants I do not control for tv. Interacting girl dummy with age (model 2) does not indicate that gender inequality in animal calorie allocation, which is absent to begin with, appears to be significant at higher or lower ages. Model 3 onwards I revert to age and age square specification. There does not appear any significant effect of village male or female wage rate on a girl's animal calorie allocation (model 3, column 6 and 8). Girl dummy and its interaction with either male or female wage are not jointly significant. While a child of higher birth order seems to be worse-off than those of lower birth order for the child's share in household's total animal calorie, the effect does not vary significantly between a higher birth ordered girl vs a boy (model 4, column 8). In terms of animal calorie shares, gender disparity is not significant either in poor or non-poor households (model 5), or in landless or not landless households (model 6). Neither does it appear that a girl is worse-off in bigger vs smaller household or in higher income vs lower income households in terms of her animal calorie shares (model 7). In terms of seasonality (model 8), compared to round 4, a boy's animal calorie share in his total calorie is only significantly different in round 1 (16% less), while a girl's corresponding share does not vary significantly in rounds 1 to 3 from that in round 4. A boy's animal calorie as a share of total household animal calorie is significantly different in round 1 (13.5% lower) and 2 (8% lower) from that in round 4, while the corresponding share of a girl is 9% higher than that of a boy in round 1, 15% in round 2, and 10% in round 3, all statistically significant. In round 4, however, a girl share is 20% less than that of a boy (boys' coefficients are unreported).

Table 4.11 summarises the results of different variants of the basic specification for total food expenditure and animal food expenditure shares which broadly resemble to the above results based on total calorie and animal calorie share measures. The first model reports girl dummy coefficient of the estimate of equation 4.1, which shows no significant sex disparity in FE estimates for any of the outcome variables. A household's tv ownership does not affect a girl's food expenditure based measures in FE estimate (model 2) and thus is not controlled for in remaining models. When instead of age square, I interact girl dummy with age, neither of them individually or jointly significant for animal expenditure shares (model 3), and thus I revert to age and age square specification for the remaining models. There does not appear any significant relationship between either adult male or female village real wage rate and a girl's animal expenditure shares (model 4). While a higher birth ordered child appears to get less in terms of total food expenditure, share of household's total food expenditure and share of total household expenditure on animal food compared to a lower birth ordered child, this birth order effect does not vary between gender (model 5). Gender inequality in animal expenditure shares is not prominent either in poor or in non-poor household (model 6), or in landless or non-landless households (model 7). It does not appear either that a girl is better or worse-off in larger vs smaller households or in higher income vs lower income households in terms of animal expenditure shares (model 8).

Finally, in terms of seasonality (a boy's coefficients are not shown to conserve space), compared to round 4, a boy's animal expenditure share in total food expenditure is 23.5% lower in round 1 and 19% lower in round 2, while a girl's share is 5% higher than a boy's share in round 1 and 13% higher in round 2. The corresponding shares in round 3 are not significantly different from round 4. A boy's animal food expenditure as a share of total household animal food expenditure is 15% lower in round 1 and 8% lower in round 2 compared to that in round 4, while his share in round 3 is not significantly different from round 4. Conversely, the corresponding girl's share is 12% lower than a boy's share in round 4, but 11% higher in round 1, 14% higher in round 2, and 13% higher in round 3.

4.5 Conclusion

Despite substantial progress in intrahousehold resource allocation literature, the effect of socio-cultural context on such allocation has remained less explored in empirical work. While existing literature focuses on a wide range of individual outcomes, the analysis of intrahousehold food distribution based on actual food intake data is also limited. Focusing on total calorie intake, previous literature has suggested that in an agrarian economy food intake affects the productivity of manual labor, and the gender disparity in food distribution is due to the gender disparity in energy-intensity of occupations, whereby men as opposed to women are engaged in more energy-intensive labour market activities and such sex-segregation of occupational activities are driven by cultural norms. Hence, the inequality is observed among adults but not among children and there is no evidence between the intrahousehold allocation among children and expected labour market participation. Some literature further suggests that the boy-girl discrimination could be driven by scarcity of households resources as such inequality is observed in bad times but not under normal circumstances.

In this context, I attempt to contribute to the literature by demonstrating that intrahousehold inequality in food distribution tends to exist among children in Bangladesh but not necessarily apparent if the focus is on total calorie intake but not on the cost and composition of calories. The latter also have critical nutritional implications as the most expensive sources of calories, i.e., the animal food group, are also nutritionally rich. Total calorie, a key focus of past literature, might not be a good metric for analysing intrahousehold food distribution as calorie adequacy can coexist with micronutrient deficiency. Given the wide range of food sources to meet one's calorie need, two people can consume the same amount of calories but the cost and content of that intake can vary substantially. Thus, focusing on calorie intake may understate intrahousehold inequality in food distribution as well.

To further explore the role of cultural norms in son-preference in food distribution, I analyse the case of two agrarian economies — Bangladesh and the Philippines — in which manual labor is a key feature. The traditional role of gender in economic activities is similar in these two societies - men the bread winners and primarily engaged in manual labor intensive agricultural activities, and women the home makers engaged primarily in household activities. However, the two societies differ strikingly regarding their attitude towards women, which in turn has been influenced by deep-rooted and long-standing cultural values. In the patriarchal society in Bangladesh, women appear to be a "residual' category whose position is influenced by "purdah", and who are a potential source of drainage of household resources in their paternal family through "dowry payments". On the other hand, women are the "queen of the home" for whom the men have to engage in "courtship" and traditionally have had to pay bride-price and provide manual labor to serve brides' parental family in the egalitarian society of the Philippines. Consistent with the contrasting cultural norms in these two societies, using a variety of measures focusing on allocation from animal food group, I find strong evidence of son-preference in Bangladesh, but not in the Philippines.

Consistent with the previous literature, this inequality does not appear to be due to gender inequality in labour market activities, as children in Bangladesh do not appear to participate in the labour market although sex-disparity in food distribution is prominent there. Moreover, if inequality is due to labour market activities, then it should be more prominent among older than younger children, while it appears to be persistent across all ages in Bangladesh, but at no age in the Philippines. The inequality does not appear to be driven by scarcity either as it is more prominent in non-poor or higher income households than poor or lower income households in Bangladesh, and not evident in either category of households in the Philippines.

While both Philippines and Bangladesh are agrarian economies, consistent with the literature on purdah culture in Bangladesh, I find limited participation of adult women in the labour market. While adult males' labour market participation is double of that of adult females in the Philippines, it is seven-folds of that of adult females in Bangladesh. Adult males' wage rate is double of that of adult females in Bangladesh, while consistent with the egalitarian values no such wage difference is apparent in the Philippines. Adult female wage rate tends to positively while adult male wage rate negatively affect a girl's allocation from animal food group in Bangladesh. Such effects, however, are not observed in the Philippines.

Dowry system is argued to contribute to gender disparity in South Asia. As the literature suggests, Bangladesh is the only Muslim country in which bride price is rarely observed and dowry is almost universally practiced. Consistent with that, I find that on average transfers from a bride's family exceeds the transfer from a groom's family at marriage and the former seems to be higher while the later lower the more recent the marriage is. Exploring how households response to their future transfers at marriages of their daughters and current food allocation to these girls, I find that the higher are the transfers from grooms' families at the recent marriages (either to bride, groom and bride, or bride's family) in a village, the higher is a girl's allocation of animal foods, while the higher are the transfers from brides' families (either to bride, groom and bride, or groom's family), the lower (although not statistically significant) is a girl's allocation. These findings possibly indicate while son-preference in Bangladesh (and its absence in the Philippines) might have a sound economic basis, but this basis is shaped by pre-existing cultural norms in these societies (e.g., purdah culture and customs of dowry vis-a-vis bride price). Son-preference in non-poor households in Bangladesh but not in the Philippines might also be related with phenomenon that transfers from a bride's family tends to increase with bride's parents wealth (proxied by bride's parents landholding). While transfers from a groom's family also tend to increase with bride's families wealth, consistent with dowry price inflation and replacement of bride price with dowry, as the descriptive analysis shows, the effect of bride's parents wealth on the transfer from bride's family is higher than that on the transfer from groom's family. Finally, consistent with the literature that tv can play an important role in promoting modern norms related to gender in villages, I find that a village's access to tv in Bangladesh positively affect a girl's allocation from animal food group.

A serious limitation of my analysis, however, is the inability to directly measure the strength of cultural norms across households and its impact on intrahousehold food distribution. Apart from cultural norms, the underlying differences in food distribution in two societies could also be governed by economic factors unobserved in the data.

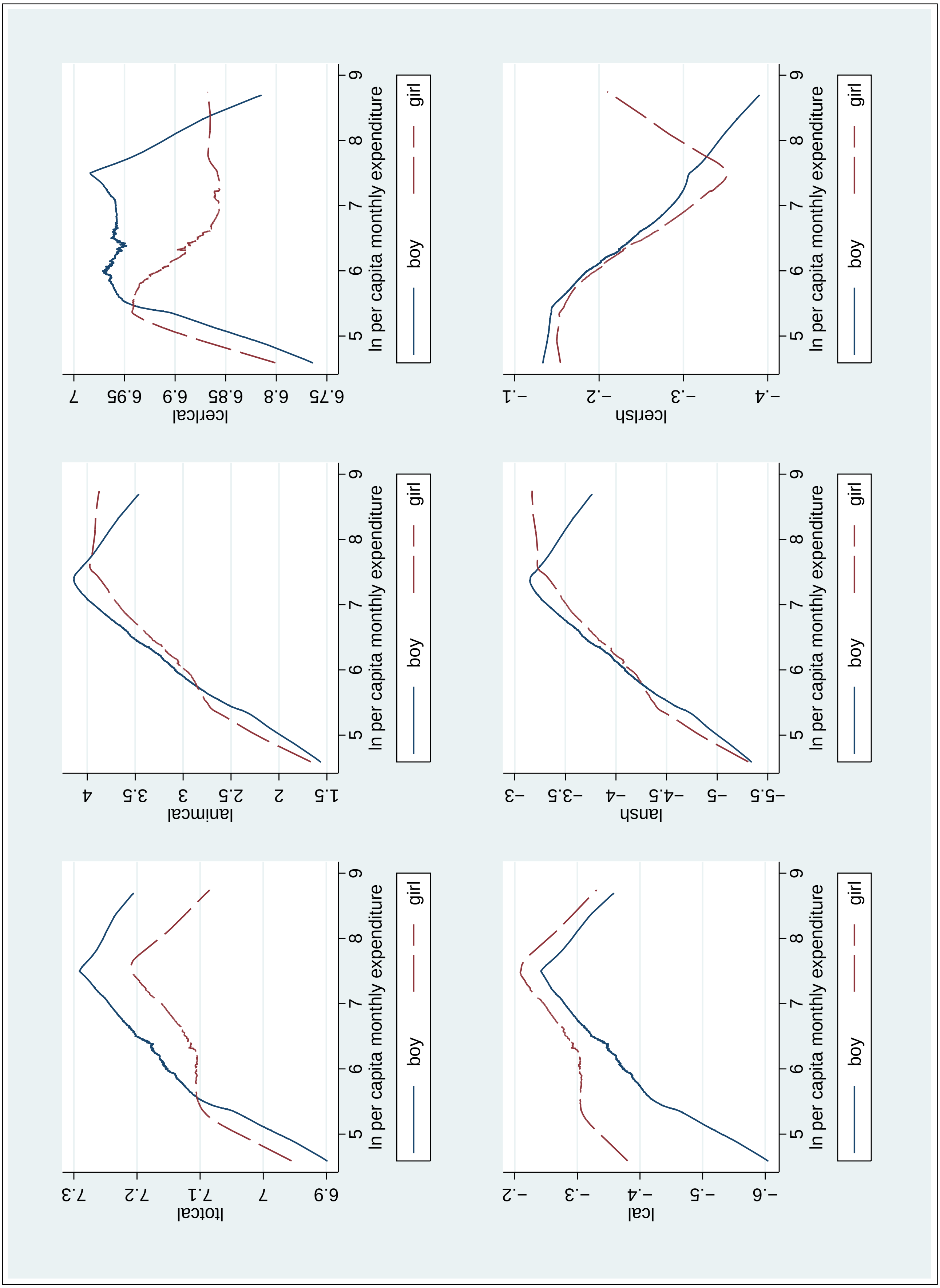

Figure 4.1: Bangladesh: Calorie Share Engel Curves, Lowess Fit, Bandwidth=0.8

Note: ltotcal, ln calorie intake; lanimcal, ln animal-calorie intake; lcerlcal, ln cereal calorie intake; lcal, calorie adequacy ratio; lansh, ln (animal-calorie/total calorie); lcerlsh, ln(cereal calorie/total calorie)

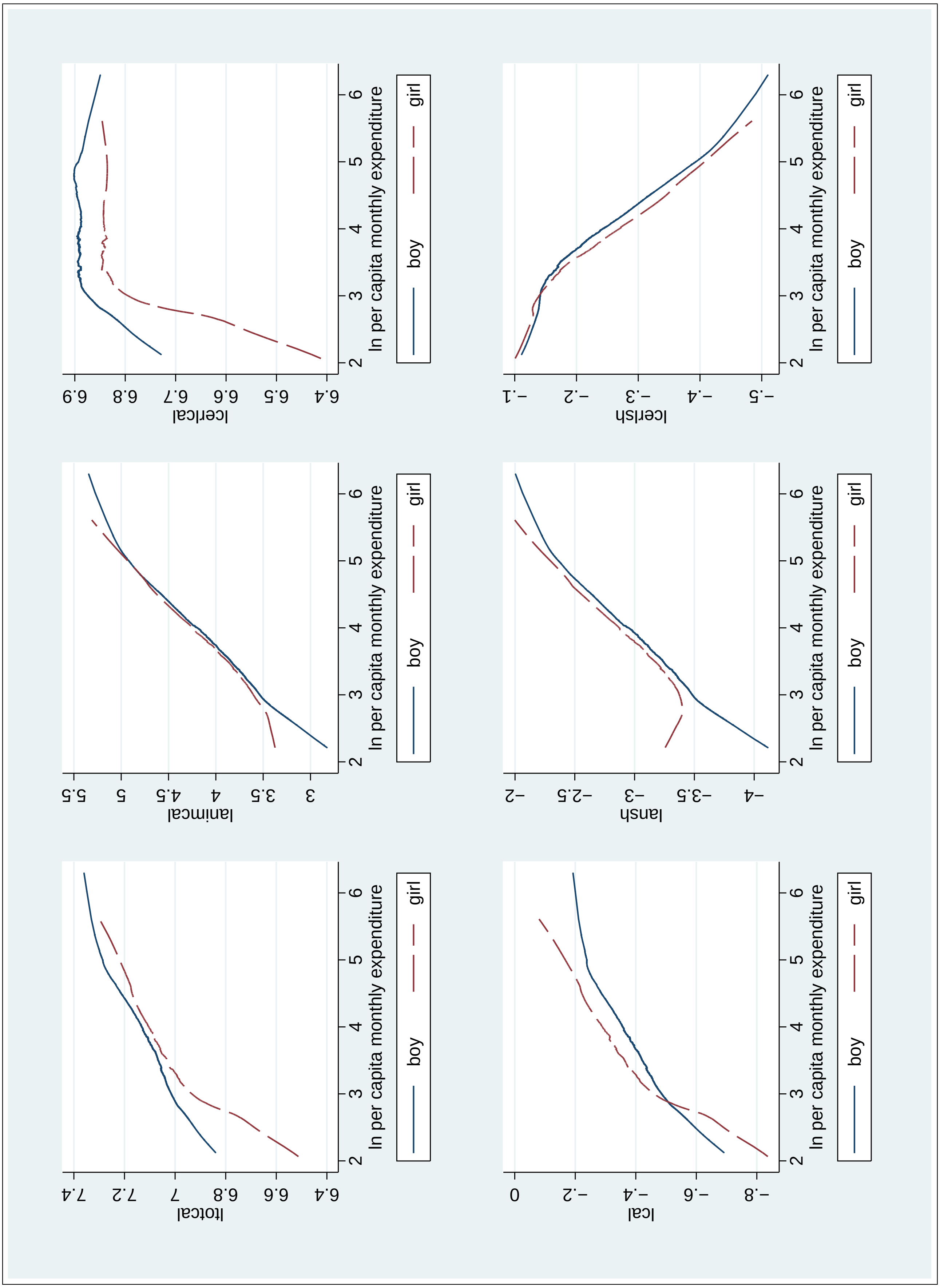

Figure 4.2: Philippines: Calorie Share Engel Curves, Lowess Fit, Bandwidth=0.8

Note: ltotcal, ln calorie intake; lanimcal, ln animal-calorie intake; lcerlcal, ln cereal calorie intake; lcal, calorie adequacy ratio; lansh, ln (animal-calorie/total calorie); lcerlsh, ln(cereal calorie/total calorie)

Table 4.1: Household Characteristics of Bangladeshi Sample

		All	Poor	Non-Poor								
Monthly per capita expenditure		680	603	737								
Share of food expenditure		73.73	66.81	78.84								
Share of per capita food expenditure on:												
Animal products		22.59	22.91	22.36								
Plants and others		34.35	34.96	33.90								
Cereals		43.06	42.13	43.74								
Price (in Taka) to purchase 100 calories from:												
Animal products		6.11	6.20	6.06								
Plants and others		1.58	1.69	1.50								
Cereals		0.29	0.29	0.29								
Per capita calorie consumption/day		2288	1771	2665								
Share of food groups in per capita calorie consumption/day												
Animal products		2.86	3.00	2.77								
Plants and others		14.77	14.64	14.87								
Cereals		82.36	82.36	82.36								
Mean Age		26.82	25.41	27.85								
Poverty rate (APL)	Round 1	Round 2	Round 3	Round 4								
% of household poor	71.15	70.33	76.53	63.13								
All rounds		34.83										
% of households landless		6.82										
	Nominal		Real									
Village wage rate	Mean	Std	Mean	Std								
Female	3.44	1.50	0.33	0.16								
Male	6.62	1.16	0.63	0.11								
Village Average, 1990-95			Mean	Std								
Transfer from wife's family (dowry)			7089	7201								
Transfer from husband's family (mehr)			2037	1999								
Child's Mortality Age (in years)		0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	
Total		582	108	81	35	43	12	24	7	5	8	
Boy (%)		58	48	53	37	39	75	42	71	60	25	
	Male Siblings				Female Siblings				Total Siblings			
All	Mean	Std	25^{th} %tile	75^{th} %tile	Mean	Std	25^{th} %tile	75^{th} %tile	Mean	Std	25^{th} %tile	75^{th} %tile
Boy	1.21	1.20	0	2	1.06	1.05	0	2	2.54	1.62	1	3
Girl	1.17	1.10	0	2	1.06	1.01	0	2	2.56	1.63	1	3
Non-poor												
Boy	1.26	1.24	0	2	0.82	0.95	0	1	2.07	1.58	1	3
Girl	1.08	1.06	0	2	0.91	0.92	0	1	1.99	1.47	1	3
Poor												
Boy	1.24	1.21	0	2	1.19	1.07	0	2	2.43	1.57	1	3
Girl	1.28	1.12	1	2	1.18	1.02	0	2	2.41	1.56	1	3

Table 4.2: Wage Rates of Males and Females in Bangladeshi and Filipino Sample

	N	Age		P-value	Real Wage Rate		
		Mean	Std		Mean	Std	P-value
				Bangladesh			
Children ($\leq$ 10 years)							
Boy	0						
Girl	0						
Adolescent (¡10¡18)							
Male	75	15.12	1.92	0.70	0.51	0.21	0.27
Female	7	14.79	2.07		0.41	0.20	
Adult ($\geq$ 18)							
Male	458	36.59	12.85	1.00	0.66	0.23	0.00
Female	65	36.59	11.85		0.38	0.21	
				The Philippines			
Children ($\leq$ 10 years)							
Boy	11	8.95	0.68	0.24	1.93	0.77	0.15
Girl	9	8.47	1.01		2.42	0.65	
Adolescent (¡10¡18)							
Male	119	14.56	2.12	0.03	2.94	1.33	0.03
Female	84	13.92	2.00		2.56	1.12	
Adult ($\geq$ 18)							
Male	358	33.36	8.78	0.00	3.76	1.41	0.27
Female	168	31.16	7.42		3.54	2.20	

Real wage rate is nominal wage rate (Taka/hour in Bangladesh and Pesos/day in the Philippines) deflated by mean village rice price

Table 4.3: Transfers at Marriage from Wife's and Husband's Family in Bangladesh

	(1)	(2)	(3)	(4)
Variables	Ldwry	Lmehr	Ldwry	Lmehr
	OLS	OLS	SUR	SUR
Lwpland	0.147***	0.124***	0.163***	0.151***
	(0.053)	(0.042)	(0.053)	(0.044)
Lhpland	0.051	0.120***	0.040	0.099**
	(0.048)	(0.039)	(0.047)	(0.039)
lenmarr	-0.028***	0.049***	-0.029***	0.048***
	(0.007)	(0.005)	(0.007)	(0.006)
huseduc	0.075***	-0.026	0.078***	-0.029
	(0.023)	(0.020)	(0.022)	(0.021)
wifeduc	0.006	0.077***	-0.002	0.075***
	(0.026)	(0.029)	(0.025)	(0.028)
feducfw	0.036*	0.039*	0.038*	0.043*
	(0.021)	(0.023)	(0.021)	(0.023)
feducmw	-0.047	0.041	-0.050	0.043
	(0.032)	(0.036)	(0.031)	(0.036)
feducfh	0.043*	0.014	0.035	0.018
	(0.023)	(0.019)	(0.022)	(0.019)
feducmh	-0.005	0.005	0.002	0.001
	(0.049)	(0.064)	(0.048)	(0.064)
Constant	7.608***	5.471***	7.614***	5.449***
	(0.251)	(0.215)	(0.252)	(0.229)
Observations	348	363	342	342
adj R^2	0.194	0.350		

Heteroscedasticity consistent robust standard errors clustered at household level are in brackets; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; dwry, wife's family transfer, mehr, husband's family transfer; wpland, wife's parents land; hpland, husband's parents land; lenmarr, length of marriage, huseduc, husband's education, wifeduc, wife's education; huseduc, husband's education; feducfw, wife's father education; feducmw, wife's mother's education; feducfh, husband's father education, feducmh, husband's mother education; L, natural log.

Table 4.4: Food Distribution between Boys and Girls ($\leq$ 10 years) in Bangladesh and the Philippines

	All		Poor		Non-Poor	
Bangladesh	Boy	Girl	Boy	Girl	Boy	Girl
Total calorie intake	1451	1361	1185	1137	1757	1627
Calorie share from animal group	3.73	3.43	3.74	3.75	3.71	3.05
Calorie share from plant and other (excluding cereals)	15.36	16.14	15.37	15.61	15.34	16.78
Individual's animal calorie/Household's animal calorie (%)	0.16	0.14	0.16	0.15	0.16	0.13
Individual's plant calorie/Household's plant calorie (%)	0.15	0.14	0.15	0.15	0.14	0.13
Individual's cereal calorie/Household's cereal calorie (%)	0.14	0.13	0.14	0.14	0.13	0.12
Total food expenditure (Taka/day)	8.99	8.41	7.55	7.17	10.63	9.90
Expenditure Share on:						
Animal group	23.14	21.88	22.87	22.63	23.45	20.99
Plant group	32.88	34.53	33.59	34.05	32.08	35.11
Individual food expenditure/Household Food Expenditure (%)	0.14	0.14	0.15	0.14	0.14	0.13
Mean Age	6.44	6.27	6.31	6.19	6.59	6.36
Philippines						
Total calorie intake	1288	1236	1121	1081	1843	1763
Calorie share from animal group	7.28	7.37	7.27	7.16	7.32	8.11
Calorie share from plant and other (excluding cereals)	66.13	69.42	64.81	68.99	70.53	70.89
Individual's animal calorie/Household's animal calorie (%)	0.14	0.14	0.14	0.14	0.15	0.15
Individual's plant calorie/Household's plant calorie (%)	0.13	0.12	0.13	0.12	0.14	0.13
Individual's cereal calorie/Household's cereal calorie (%)	0.13	0.13	0.13	0.12	0.15	0.16
Total food expenditure (Taka/day)	4.01	4.05	3.33	3.30	6.26	6.62
Expenditure Share on:						
Animal group	32.93	31.93	33.42	32.14	31.29	31.19
Plant group	51.61	54.07	50.42	53.57	55.58	55.76
Individual food expenditure/Household Food Expenditure (%)	0.13	0.13	0.13	0.13	0.14	0.13
Mean Age	4.94	4.99	5.01	5.05	4.71	4.83

Table 4.5: Household Characteristics of Filipino Sample

	All	Poor	Non-Poor
Monthly per capita expenditure	197	179	247
Share of food expenditure	72.60	73.03	71.39
Share of per capita food expenditure on:			
Animal products	29.87	30.19	28.96
Plants and others	54.91	53.83	57.98
Cereals	15.22	15.98	13.05
Price (in Pesos) to purchase 100 calories from:			
Animal products	1.77	1.75	1.84
Plants and others	0.42	0.41	0.43
Cereals	0.24	0.23	0.27
Per capita calorie consumption/day	1832	1576	2557
Share of food groups in per capita calorie consumption/day			
Animal products	6.09	5.91	6.61
Plants and others	68.02	67.02	70.90
Cereals	25.89	27.07	22.50
Household size	7.14	7.22	6.29
Boy share	0.22	0.22	0.23
Girl share	0.20	0.20	0.17
Adolescent male share	0.08	0.08	0.10
Adolescent female share	0.09	0.09	0.07
Adult male share	0.20	0.19	0.23
Adult female share	0.18	0.18	0.20
Mean Age	17.65	17.53	17.98

Poverty rate (APL)	Round 1	Round 2	Round 3	Round 4
% of household poor	84.15	91.74	93.97	92.86
All rounds		70.98		
% of households landless	58.26	57.81	56.92	56.25

	Nominal		Real	
Village wage rate	Mean	Std	Mean	Std
Female	20.44	6.41	3.65	1.45
Male	21.85	3.70	3.78	0.72

	Male Siblings				Female Siblings				Total Siblings			
All	Mean	Std	25^{th} %tile	75^{th} %tile	Mean	Std	25^{th} %tile	75^{th} %tile	Mean	Std	25^{th} %tile	75^{th} %tile
Boy	2.27	1.64	1	3	2.03	1.49	1	3	4.30	2.32	2	6
Girl	2.16	1.58	1	3	2.09	1.65	1	3	4.25	2.35	2	6
Non-poor												
Boy	2.04	1.74	1	3	1.31	1.30	0	2	3.35	2.16	1	5
Girl	1.88	1.44	1	3	1.69	1.57	1	2	3.58	2.22	1	5
Poor												
Boy	2.29	1.63	1	3	2.10	1.49	1	3	4.39	2.31	3	6
Girl	2.18	1.58	1	3	2.12	1.66	1	3	4.30	2.36	2	6

Table 4.6: Intrahousehold Food Distribution in Bangladesh: OLS and FE Estimates

Variables	log total calorie		$\log\frac{calorieintake}{calorierequirement}$		$\log\frac{animalcalorie}{totalcalorie}$		$\log\frac{animalcalorie}{householdanimalcalorie}$	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
age	0.264***	0.283***	0.153***	0.172***	-0.290***	-0.251***	0.073*	0.085
	(0.021)	(0.023)	(0.021)	(0.023)	(0.060)	(0.061)	(0.044)	(0.053)
age^2	-0.013***	-0.014***	-0.008***	-0.010***	0.018***	0.015***	-0.001	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)	(0.003)	(0.004)
female	-0.053***	-0.040**	0.054***	0.066***	-0.034	-0.107**	-0.079**	-0.123***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.054)	(0.050)	(0.038)	(0.044)
Lmcapx	0.416	0.467	0.431	0.494*	2.291**	0.542	-0.884	-2.106***
	(0.286)	(0.295)	(0.285)	(0.293)	(0.908)	(1.203)	(0.545)	(0.658)
$Lmcapx^2$	-0.025	-0.030	-0.027	-0.033	-0.133*	-0.028	0.062	0.147***
	(0.022)	(0.022)	(0.022)	(0.022)	(0.069)	(0.089)	(0.042)	(0.049)
Llandpc	0.026	-0.839***	0.026	-0.869***	0.277***	0.803	0.046	-0.139
	(0.034)	(0.324)	(0.034)	(0.320)	(0.106)	(1.378)	(0.059)	(0.821)
Lhhsz	0.084**	-0.376	0.083**	-0.392*	0.123	1.032	-0.862***	-0.370
	(0.033)	(0.230)	(0.032)	(0.227)	(0.094)	(1.077)	(0.053)	(0.643)
shm0-10	0.220	0.013	0.216	-0.002	-0.437	0.974	0.070	2.052
	(0.146)	(0.438)	(0.146)	(0.433)	(0.470)	(1.619)	(0.280)	(1.347)
shf0-10	0.281**	0.508	0.276**	0.528	-0.715	-0.556	-0.071	1.404
	(0.134)	(0.402)	(0.133)	(0.398)	(0.463)	(2.339)	(0.269)	(1.166)
shm11-17	0.308**	0.238	0.298**	0.229	-0.421	-1.165	-0.029	0.755
	(0.126)	(0.418)	(0.126)	(0.414)	(0.481)	(1.853)	(0.278)	(1.265)
shf11-17	0.069	0.021	0.063	0.005	-0.300	-0.371	0.014	0.009
	(0.131)	(0.381)	(0.130)	(0.378)	(0.450)	(1.656)	(0.262)	(1.061)
shm18+	-0.208	-0.455	-0.215	-0.457	0.643	2.149	-0.042	0.327
	(0.169)	(0.511)	(0.168)	(0.504)	(0.525)	(2.040)	(0.326)	(1.495)
round1	-0.036*	-0.041*	-0.042**	-0.047**	0.128	0.164*	0.017	0.042
	(0.021)	(0.022)	(0.021)	(0.022)	(0.087)	(0.092)	(0.048)	(0.052)
round2	0.002	-0.004	-0.000	-0.007	0.256***	0.209**	0.031	0.024
	(0.021)	(0.022)	(0.021)	(0.022)	(0.081)	(0.085)	(0.044)	(0.046)
round3	-0.102***	-0.113***	-0.104***	-0.115***	-0.118	-0.078	-0.019	0.005
	(0.022)	(0.023)	(0.022)	(0.023)	(0.088)	(0.091)	(0.047)	(0.048)
site1	-0.028		-0.028		-0.355***		0.036	
	(0.025)		(0.025)		(0.084)		(0.047)	
site2	-0.034		-0.035		0.101		0.099**	
	(0.025)		(0.025)		(0.082)		(0.043)	
Constant	4.290***	5.543***	-2.782***	-1.521	-12.273***	-8.162*	2.105	4.909*
	(0.933)	(1.196)	(0.931)	(1.189)	(3.032)	(4.877)	(1.765)	(2.597)
Observations	3,349	3,349	3,349	3,349	3,005	3,005	3,005	3,005
Adj. R^2	0.331	0.272	0.143	0.111	0.114	0.026	0.163	0.030
Households	627	627	627	627	618	618	618	618

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets; *** p<0.01, ** p<0.05, * p<0.1; Mcapx, monthly per capita expenditure, landpc, land per capita, sh, share, m, male, f, female and associated numbers indicate age group, i.e., shm0-10, share of males of age0-10 in the household; hhsz, household size; L, natural log.

Table 4.7: Intrahousehold Food Distribution in Bangladesh-Alternative Models

Model	Variables	log total calorie		$\log\frac{calorieintake}{calorierequirement}$		$\log\frac{animalcalorie}{totalcalorie}$		$\log\frac{animalcalorie}{householdanimalcalorie}$	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	girl	-0.107*	-0.087	0.002	0.015	0.215	-0.364*	-0.034	-0.271**
		(0.057)	(0.066)	(0.057)	(0.067)	(0.181)	(0.189)	(0.097)	(0.124)
	tv	0.003		0.002		0.269		0.049	
		(0.052)		(0.052)		(0.170)		(0.096)	
	tv ×	0.060	0.052	0.058	0.056	-0.271	0.282	-0.050	0.163
	girl	(0.057)	(0.069)	(0.057)	(0.069)	(0.187)	(0.196)	(0.102)	(0.135)
2	girl	-0.031	-0.062	0.025	-0.015	-0.224	-0.457*	-0.233	-0.267
		(0.083)	(0.098)	(0.081)	(0.094)	(0.242)	(0.235)	(0.142)	(0.166)
	tv	0.014		0.008		0.247		0.049	
		(0.053)		(0.053)		(0.174)		(0.096)	
	tv ×	0.039	0.004	0.046	0.022	-0.220	0.340*	-0.041	0.149
	girl	(0.059)	(0.076)	(0.058)	(0.074)	(0.188)	(0.195)	(0.101)	(0.133)
	age	0.113***	0.106***	0.058***	0.050***	-0.102***	-0.066***	0.041***	0.049***
		(0.005)	(0.006)	(0.005)	(0.006)	(0.016)	(0.014)	(0.010)	(0.013)
	age ×	-0.010	0.001	-0.003	0.008	0.062***	0.009	0.029**	0.001
	girl	(0.008)	(0.010)	(0.008)	(0.009)	(0.022)	(0.021)	(0.014)	(0.016)
3	girl	-0.173**	-0.104	-0.062	0.003	0.312	-0.149	-0.024	-0.237
		(0.076)	(0.078)	(0.077)	(0.079)	(0.246)	(0.223)	(0.136)	(0.196)
	tv	0.005		0.004		0.273		0.023	
		(0.053)		(0.053)		(0.176)		(0.098)	
	tv ×	0.048	0.047	0.047	0.052	-0.237	0.436**	-0.010	0.244*
	girl	(0.059)	(0.073)	(0.060)	(0.074)	(0.198)	(0.204)	(0.106)	(0.139)
	Lfwage	-0.004		-0.002		-0.040		-0.148**	
		(0.042)		(0.042)		(0.135)		(0.075)	
	Lfwage	-0.029	-0.015	-0.026	-0.012	0.098	0.399***	0.133	0.231
	× girl	(0.043)	(0.048)	(0.043)	(0.048)	(0.135)	(0.154)	(0.088)	(0.165)
	Lmwage	0.091		0.089		-0.374		0.024	
		(0.088)		(0.087)		(0.283)		(0.167)	
	Lmwage	-0.089	-0.008	-0.090	-0.003	0.020	-0.297	-0.250	-0.376**
	× girl	(0.085)	(0.076)	(0.085)	(0.076)	(0.292)	(0.207)	(0.155)	(0.169)
4	girl	-0.229	-0.184	-0.120	-0.082	0.447	-0.461	-0.277	-0.738
		(0.228)	(0.233)	(0.226)	(0.231)	(0.646)	(0.574)	(0.386)	(0.482)
	tv	0.015		0.013		0.334*		0.039	
		(0.054)		(0.054)		(0.181)		(0.099)	
	tv ×	0.028	0.041	0.027	0.044	-0.319	0.433**	-0.040	0.256*
	girl	(0.061)	(0.075)	(0.061)	(0.076)	(0.205)	(0.205)	(0.109)	(0.142)
	Lfwage	0.009		0.010		0.014		-0.160*	
		(0.048)		(0.048)		(0.151)		(0.086)	
	Lfwage	-0.062	0.003	-0.059	0.002	0.069	0.398**	0.135	0.298
	× girl	(0.053)	(0.064)	(0.052)	(0.063)	(0.154)	(0.179)	(0.110)	(0.202)
	Lmwage	0.080		0.077		-0.346		-0.069	
		(0.080)		(0.079)		(0.318)		(0.188)	
	Lmwage	-0.016	-0.042	-0.015	-0.030	0.056	0.007	-0.105	-0.247
	× girl	(0.091)	(0.085)	(0.091)	(0.084)	(0.356)	(0.263)	(0.189)	(0.207)
	Lvdowry	0.003		0.004		0.125**		-0.004	
		(0.018)		(0.018)		(0.056)		(0.032)	
	Lvdowry	-0.011	0.006	-0.011	0.005	-0.054	-0.087	-0.032	-0.029
	× girl	(0.019)	(0.024)	(0.019)	(0.023)	(0.059)	(0.063)	(0.035)	(0.059)
	Lvmehr	0.011		0.010		-0.127*		-0.079**	
		(0.021)		(0.021)		(0.077)		(0.039)	
	Lvmehr	0.020	0.004	0.020	0.006	0.050	0.161*	0.082	0.118
	× girl	(0.026)	(0.028)	(0.026)	(0.028)	(0.086)	(0.085)	(0.052)	(0.088)

Table 4.7: Intrahousehold Food Distribution in Bangladesh-Alternative Models

Model	Variables	log total calorie		$\log \frac{calorieintake}{calorierequirement}$		$\log \frac{animalcalorie}{totalcalorie}$		$\log \frac{animalcalorie}{householdanimalcalorie}$	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
5	girl	-0.141**	-0.091	-0.030	0.021	0.318	-0.309	-0.155	-0.308**
		(0.067)	(0.082)	(0.067)	(0.082)	(0.231)	(0.224)	(0.110)	(0.145)
	tv	-0.003		-0.005		0.339*		0.051	
		(0.055)		(0.055)		(0.179)		(0.089)	
	tv ×	0.029	0.059	0.028	0.065	-0.318	0.376*	-0.053	0.274*
	girl	(0.060)	(0.079)	(0.060)	(0.079)	(0.203)	(0.221)	(0.105)	(0.143)
	border	0.001	-0.022	0.000	-0.019	-0.036	-0.102	-0.050***	-0.123*
		(0.012)	(0.039)	(0.012)	(0.039)	(0.037)	(0.085)	(0.018)	(0.067)
	border	0.017	-0.003	0.016	-0.007	-0.018	-0.042	0.040**	-0.013
	× girl	(0.011)	(0.011)	(0.011)	(0.011)	(0.041)	(0.029)	(0.020)	(0.024)
6	girl	-0.182***	-0.090	-0.071	0.012	0.211	-0.408*	-0.065	-0.311**
		(0.058)	(0.069)	(0.058)	(0.070)	(0.202)	(0.211)	(0.106)	(0.137)
	tv	-0.014		-0.016		0.281*		0.055	
		(0.050)		(0.050)		(0.167)		(0.094)	
	tv ×	0.093*	0.060	0.091*	0.063	-0.295	0.276	-0.063	0.161
	girl	(0.055)	(0.070)	(0.055)	(0.071)	(0.187)	(0.195)	(0.101)	(0.135)
	APL	-0.345***	-0.317***	-0.344***	-0.316***	0.223**	0.124	0.117**	0.051
		(0.022)	(0.024)	(0.022)	(0.024)	(0.089)	(0.111)	(0.051)	(0.070)
	APL	0.055*	-0.005	0.053*	-0.005	0.041	0.068	0.063	0.056
	×girl	(0.030)	(0.031)	(0.030)	(0.031)	(0.112)	(0.121)	(0.064)	(0.081)
7	girl	-0.102*	-0.092	0.007	0.011	0.223	-0.337*	-0.025	-0.247*
		(0.058)	(0.067)	(0.058)	(0.067)	(0.181)	(0.196)	(0.097)	(0.128)
	tv	0.006		0.004		0.277*		0.053	
		(0.052)		(0.052)		(0.167)		(0.095)	
	tv ×	0.056	0.053	0.054	0.057	-0.288	0.271	-0.056	0.152
	girl	(0.058)	(0.069)	(0.058)	(0.070)	(0.186)	(0.201)	(0.101)	(0.138)
	landless	-0.005		-0.005		-0.201		0.037	
		(0.046)		(0.046)		(0.166)		(0.098)	
	landless	-0.044	0.060	-0.046	0.059	0.097	-0.278	-0.065	-0.223
	×girl	(0.061)	(0.087)	(0.060)	(0.086)	(0.192)	(0.201)	(0.133)	(0.192)
8	girl	-0.084	-0.226	0.035	-0.115	1.119*	0.969	0.270	0.450
		(0.235)	(0.250)	(0.235)	(0.251)	(0.636)	(0.698)	(0.447)	(0.522)
	tv	0.008		0.006		0.264		0.053	
		(0.052)		(0.052)		(0.170)		(0.096)	
	tv ×	0.051	0.050	0.049	0.054	-0.264	0.336*	-0.057	0.209
	girl	(0.057)	(0.069)	(0.057)	(0.069)	(0.186)	(0.193)	(0.103)	(0.135)
	Lmcapx	-0.031	0.020	-0.033	0.018	-0.160*	-0.129	-0.078	-0.031
	×girl	(0.033)	(0.035)	(0.033)	(0.035)	(0.094)	(0.104)	(0.062)	(0.068)
	Lhhsz	0.095**	0.010	0.096**	0.011	0.047	-0.303**	0.101	-0.298*
	×girl	(0.046)	(0.049)	(0.047)	(0.050)	(0.146)	(0.149)	(0.108)	(0.159)
	Lmcapx	0.436	0.455	0.453	0.483*	2.419***	0.605	-0.833	-2.117***
		(0.287)	(0.287)	(0.286)	(0.286)	(0.918)	(1.218)	(0.544)	(0.657)
	Lmcapx^2	-0.026	-0.030	-0.027	-0.032	-0.137**	-0.028	0.060	0.149***
		(0.022)	(0.022)	(0.022)	(0.022)	(0.069)	(0.090)	(0.042)	(0.050)
	Lhhsz	0.041	-0.379	0.040	-0.395*	0.092	1.076	-0.908***	-0.313
		(0.038)	(0.231)	(0.038)	(0.229)	(0.109)	(1.073)	(0.070)	(0.634)

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets; *** p<0.01, ** p<0.05, * p<0.1; Mcapx, monthly per capita expenditure, fwage, mean female village wage mwage, mean male village wage, vdowry, mean (1990-95) village transfer at marriage from wife's family, vmehr, mean(1990-95) village transfer at marriage from husband's family, border, child's birth order, APL, absolute poverty line; hhsz, household size; L, natural log. Additional covariates are from the basic specification, see Table 4.6.

Table 4.8: Intrahousehold Food Expenditure Distribution in Bangladesh-Basic and Alternative Models

Model	Variables	log (totexp)		$\log(\frac{totexp}{hhtotexp})$		$\log(\frac{animexp}{totexp})$		$\log(\frac{animexp}{hhanimexp})$	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	girl	-0.051**	-0.035*	-0.051***	-0.032	0.001	-0.064*	-0.055*	-0.074*
		(0.021)	(0.019)	(0.019)	(0.020)	(0.041)	(0.036)	(0.032)	(0.038)
2	girl	-0.037	-0.108**	-0.095**	-0.078*	0.165	-0.313*	-0.031	-0.240**
		(0.058)	(0.047)	(0.048)	(0.046)	(0.154)	(0.162)	(0.095)	(0.122)
	tv	0.084		-0.023		0.156		0.053	
		(0.053)		(0.045)		(0.142)		(0.092)	
	tv ×	-0.015	0.081	0.049	0.051	-0.179	0.273	-0.026	0.182
	girl	(0.060)	(0.051)	(0.049)	(0.051)	(0.158)	(0.166)	(0.100)	(0.130)
3	girl	0.002	-0.025	-0.046	0.000	-0.105	-0.455**	-0.181	-0.273*
		(0.085)	(0.081)	(0.074)	(0.080)	(0.194)	(0.192)	(0.127)	(0.155)
	tv	0.093*		-0.015		0.143		0.056	
		(0.053)		(0.046)		(0.144)		(0.092)	
	tv ×	-0.032	0.040	0.032	0.007	-0.148	0.306*	-0.023	0.154
	girl	(0.061)	(0.056)	(0.051)	(0.056)	(0.159)	(0.162)	(0.099)	(0.129)
	age	0.094***	0.097***	0.090***	0.093***	-0.047***	-0.033***	0.060***	0.060***
		(0.006)	(0.007)	(0.005)	(0.007)	(0.011)	(0.010)	(0.009)	(0.012)
	age ×	-0.005	-0.009	-0.006	-0.008	0.038**	0.019	0.022*	0.008
	girl	(0.009)	(0.010)	(0.008)	(0.010)	(0.016)	(0.016)	(0.012)	(0.015)
4	girl	-0.096	-0.029	-0.097	-0.025	0.163	-0.115	-0.017	-0.149
		(0.084)	(0.069)	(0.070)	(0.073)	(0.192)	(0.171)	(0.124)	(0.172)
	tv	0.092*		-0.026		0.155		0.028	
		(0.054)		(0.046)		(0.144)		(0.093)	
	tv ×	-0.031	0.118**	0.046	0.072	-0.187	0.372**	0.009	0.263*
	girl	(0.062)	(0.057)	(0.051)	(0.055)	(0.166)	(0.173)	(0.103)	(0.135)
	Lfwage	-0.010		-0.017		-0.003		-0.132**	
		(0.047)		(0.038)		(0.102)		(0.065)	
	Lfwage	-0.049	0.103**	-0.009	0.058	-0.029	0.242**	0.114	0.217
	× girl	(0.051)	(0.052)	(0.044)	(0.059)	(0.102)	(0.099)	(0.079)	(0.147)
	Lmwage	-0.042		0.016		0.024		0.042	
		(0.098)		(0.073)		(0.262)		(0.131)	
	Lmwage	-0.031	-0.030	0.015	0.002	0.055	-0.027	-0.202	-0.221*
	× girl	(0.098)	(0.074)	(0.082)	(0.070)	(0.225)	(0.149)	(0.125)	(0.124)
5	girl	-0.043	-0.233	-0.088	-0.128	0.133	-0.270	-0.257	-0.482
		(0.273)	(0.242)	(0.222)	(0.230)	(0.465)	(0.391)	(0.340)	(0.385)
	tv	0.098*		-0.015		0.179		0.041	
		(0.055)		(0.047)		(0.145)		(0.092)	
	tv ×	-0.030	0.112*	0.043	0.077	-0.269	0.354**	-0.019	0.266*
	girl	(0.064)	(0.060)	(0.053)	(0.059)	(0.170)	(0.176)	(0.104)	(0.136)
	Lfwage	-0.005		-0.042		0.018		-0.154**	
		(0.053)		(0.041)		(0.109)		(0.072)	
	Lfwage	-0.044	0.148**	0.020	0.107	-0.080	0.221*	0.121	0.297*
	× girl	(0.060)	(0.065)	(0.054)	(0.074)	(0.110)	(0.116)	(0.099)	(0.180)
	Lmwage	-0.090		-0.112		0.224		-0.071	
		(0.101)		(0.083)		(0.276)		(0.152)	
	Lmwage	-0.017	-0.055	0.064	-0.015	0.099	0.230	-0.071	-0.107
	× girl	(0.110)	(0.084)	(0.095)	(0.085)	(0.267)	(0.208)	(0.158)	(0.171)
	Lvdowry	0.006		0.016		0.086*		-0.005	
		(0.021)		(0.016)		(0.045)		(0.028)	
	Lvdowry	-0.015	0.017	-0.018	0.007	-0.027	-0.058	-0.031	-0.030
	× girl	(0.022)	(0.025)	(0.019)	(0.025)	(0.044)	(0.046)	(0.032)	(0.051)

Table 4.8: Intrahousehold Food Expenditure Distribution in Bangladesh-Basic and Alternative Models

Model	Variables	log (totexp)		$\log(\frac{totexp}{hhtotexp})$		$\log(\frac{animexp}{totexp})$		$\log(\frac{animexp}{hhanimexp})$	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Lvmehr	-0.004		-0.039*		-0.061		-0.075**	
		(0.028)		(0.021)		(0.057)		(0.034)	
	Lvmehr	0.010	0.013	0.026	0.011	0.038	0.101*	0.077*	0.098
	× girl	(0.032)	(0.027)	(0.027)	(0.031)	(0.063)	(0.060)	(0.047)	(0.078)
6	girl	-0.062	-0.125**	-0.142**	-0.114**	0.233	-0.185	-0.137	-0.233
		(0.066)	(0.059)	(0.056)	(0.055)	(0.196)	(0.199)	(0.109)	(0.143)
	tv	0.080		-0.033		0.220		0.061	
		(0.055)		(0.047)		(0.150)		(0.093)	
	tv ×	-0.049	0.101*	0.038	0.081	-0.215	0.327*	-0.024	0.282**
	girl	(0.062)	(0.055)	(0.049)	(0.050)	(0.173)	(0.192)	(0.105)	(0.143)
	border	-0.029**	-0.028	-0.024**	-0.028	-0.022	-0.018	-0.041**	-0.078
		(0.013)	(0.044)	(0.012)	(0.041)	(0.023)	(0.074)	(0.016)	(0.059)
	border	0.019	0.001	0.019*	0.004	-0.015	-0.057**	0.034**	-0.025
	× girl	(0.012)	(0.013)	(0.011)	(0.012)	(0.034)	(0.024)	(0.017)	(0.020)
7	girl	-0.115*	-0.130**	-0.122**	-0.083	0.155	-0.370**	-0.064	-0.283**
		(0.061)	(0.055)	(0.051)	(0.050)	(0.176)	(0.182)	(0.103)	(0.130)
	tv	0.070		-0.019		0.165		0.059	
		(0.051)		(0.044)		(0.139)		(0.089)	
	tv ×	0.010	0.087*	0.038	0.049	-0.196	0.269	-0.040	0.179
	girl	(0.058)	(0.052)	(0.048)	(0.051)	(0.157)	(0.165)	(0.098)	(0.130)
	APL	-0.271***	-0.255***	0.087***	0.064***	0.166**	0.103	0.121***	0.062
		(0.031)	(0.035)	(0.022)	(0.024)	(0.068)	(0.092)	(0.043)	(0.057)
	APL	0.071*	0.022	0.051*	0.008	0.041	0.083	0.067	0.062
	×girl	(0.039)	(0.038)	(0.030)	(0.030)	(0.089)	(0.101)	(0.058)	(0.069)
8	girl	-0.025	-0.105**	-0.091*	-0.080*	0.160	-0.298*	-0.032	-0.226*
		(0.059)	(0.048)	(0.049)	(0.046)	(0.154)	(0.165)	(0.095)	(0.126)
	tv	0.088*		-0.022		0.156		0.052	
		(0.053)		(0.045)		(0.140)		(0.091)	
	tv ×	-0.024	0.080	0.048	0.051	-0.181	0.265	-0.025	0.175
	girl	(0.060)	(0.052)	(0.049)	(0.050)	(0.159)	(0.168)	(0.099)	(0.132)
	landless	-0.004		0.017		-0.117		0.028	
		(0.048)		(0.047)		(0.149)		(0.088)	
	landless	-0.088	-0.024	-0.051	0.026	0.112	-0.123	0.012	-0.112
	×girl	(0.071)	(0.088)	(0.065)	(0.083)	(0.160)	(0.172)	(0.112)	(0.158)
9	girl	0.263	0.187	0.100	0.153	0.494	0.033	-0.083	-0.123
		(0.288)	(0.275)	(0.219)	(0.231)	(0.479)	(0.543)	(0.406)	(0.471)
	tv	0.082		-0.024		0.155		0.059	
		(0.052)		(0.045)		(0.142)		(0.092)	
	tv ×	-0.013	0.091*	0.049	0.061	-0.178	0.302*	-0.035	0.216*
	girl	(0.060)	(0.051)	(0.049)	(0.051)	(0.159)	(0.164)	(0.101)	(0.129)
	Lmcapx	-0.055	-0.028	-0.042	-0.015	-0.062	0.002	-0.013	0.059
	×girl	(0.043)	(0.042)	(0.031)	(0.033)	(0.073)	(0.085)	(0.057)	(0.061)
	Lhhsz	0.022	-0.069	0.036	-0.077	0.032	-0.202**	0.075	-0.268*
	×girl	(0.052)	(0.053)	(0.048)	(0.061)	(0.113)	(0.094)	(0.093)	(0.142)
	Lmcapx	1.147***	0.785*	-0.749***	-0.980***	2.049***	1.232	-0.547	-1.530***
		(0.407)	(0.424)	(0.253)	(0.286)	(0.775)	(1.015)	(0.498)	(0.576)
	Lmcapx^2	-0.064**	-0.049	0.055***	0.066***	-0.129**	-0.082	0.037	0.102**
		(0.031)	(0.032)	(0.020)	(0.022)	(0.058)	(0.074)	(0.039)	(0.044)
	Lhhsz	0.018	-0.376	-0.927***	-1.203***	-0.009	0.014	-0.941***	-0.669
		(0.045)	(0.392)	(0.036)	(0.318)	(0.078)	(0.873)	(0.059)	(0.615)

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets;*** p<0.01, ** p<0.05, * p<0.1; totexp, individual's total food expenditure; hhtotexp, household's total food expenditure, animexp, individual's animal food expenditure; hhanimexp, total household animal food expenditure. For covariates' descriptions, see Table 4.7 notes.

Table 4.9: Intrahousehold Food Distribution in the Philippines: OLS and FE Estimates

Variables	log total calorie		$\log \frac{calorieintake}{calorierequirement}$		$\log \frac{animalcalorie}{totalcalorie}$		$\log \frac{animalcalorie}{householdanimalcalorie}$	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
age	0.174***	0.184***	0.001	0.017	-0.189***	-0.131***	0.026	0.037
	(0.019)	(0.016)	(0.019)	(0.016)	(0.041)	(0.033)	(0.025)	(0.029)
age^2	-0.009***	-0.009***	0.001	0.000	0.013***	0.008***	0.000	0.000
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.003)	(0.002)	(0.002)
female	-0.037**	-0.034**	0.067***	0.069***	0.053	0.010	-0.005	-0.014
	(0.015)	(0.013)	(0.015)	(0.013)	(0.038)	(0.021)	(0.022)	(0.020)
Lmcapx	0.216	0.372	0.280	0.354	0.492	-0.487	-0.484**	-0.418
	(0.218)	(0.245)	(0.221)	(0.246)	(0.561)	(0.669)	(0.223)	(0.267)
$Lmcapx^2$	-0.009	-0.034	-0.019	-0.033	0.008	0.088	0.059**	0.050
	(0.028)	(0.031)	(0.028)	(0.032)	(0.072)	(0.086)	(0.029)	(0.034)
Llandpc	0.027	0.161	0.032	0.186	0.107	-0.487	0.059	0.604**
	(0.058)	(0.184)	(0.058)	(0.192)	(0.142)	(1.000)	(0.061)	(0.254)
Lhhsz	0.052		0.055		0.051		-0.773***	
	(0.051)		(0.052)		(0.129)		(0.064)	
shm0-10	0.114		0.094		-0.404		-0.638**	
	(0.220)		(0.221)		(0.590)		(0.264)	
shf0-10	0.042	-0.429	0.009	-0.864	-0.249	2.242	-0.469*	0.298
	(0.213)	(0.891)	(0.214)	(0.949)	(0.603)	(2.515)	(0.271)	(0.877)
shm11-17	-0.250	-0.120	-0.271	0.002	-0.562	-1.543	-1.147***	0.056
	(0.240)	(0.484)	(0.241)	(0.502)	(0.635)	(1.411)	(0.283)	(0.406)
shf11-17	-0.377*	-0.856	-0.429*	-1.176	-0.677	2.227	-0.772***	0.664
	(0.218)	(0.766)	(0.223)	(0.822)	(0.598)	(2.126)	(0.284)	(0.557)
shm18+	0.370	-0.817	0.350	-0.601	-0.737	-4.602**	-0.382	-1.403*
	(0.268)	(1.007)	(0.271)	(1.002)	(0.733)	(1.896)	(0.313)	(0.850)
round1	0.016	0.024	0.028	0.042	-0.122	-0.138	-0.107***	-0.095***
	(0.027)	(0.030)	(0.027)	(0.030)	(0.084)	(0.085)	(0.032)	(0.036)
round2	-0.026	-0.022	-0.029	-0.020	-0.040	-0.087	-0.022	-0.009
	(0.024)	(0.026)	(0.025)	(0.026)	(0.077)	(0.081)	(0.028)	(0.031)
round3	-0.097***	-0.095***	-0.099***	-0.095***	0.064	0.075	0.020	0.021
	(0.026)	(0.027)	(0.026)	(0.027)	(0.078)	(0.079)	(0.025)	(0.025)
Constant	5.606***	5.795***	-1.332***	-0.960	-4.135***	-1.659	0.807*	-1.423**
	(0.467)	(0.612)	(0.475)	(0.621)	(1.271)	(1.654)	(0.475)	(0.630)
Observations	3,826	3,826	3,715	3,715	3,548	3,548	3,548	3,548
adj R^2	0.180	0.171	0.062	0.037	0.089	0.016	0.258	0.044
Households	426	426	424	424	423	423	423	423

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets; *** p<0.01, ** p<0.05, * p<0.1; Mcapx, monthly per capita expenditure, landpc, land per capita, sh, share, m, male, f, female and associated numbers indicate age group, i.e., shm0-10, share of males of age0-10 in the household; hhsz, household size; L, natural log.

Table 4.10: Intrahousehold Food Distribution in the Philippines: Alternative Models

Model	Variables	log total calorie		$\log \frac{calorieintake}{calorierequirement}$		$\log \frac{animalcalorie}{totalcalorie}$		$\log \frac{animalcalorie}{householdanimalcalorie}$	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	girl	-0.039**	-0.037***	0.065***	0.068***	0.003	0.001	-0.007	-0.011
		(0.016)	(0.014)	(0.016)	(0.013)	(0.002)	(0.002)	(0.023)	(0.021)
	tv	0.186***		0.187***		0.018		0.148	
		(0.067)		(0.067)		(0.025)		(0.091)	
	tv ×	0.009	0.046	-0.000	0.018	-0.006	-0.007	0.009	-0.060
	girl	(0.068)	(0.034)	(0.071)	(0.035)	(0.018)	(0.008)	(0.095)	(0.043)
2	girl	-0.067	-0.038	-0.045	-0.034	0.054	0.071	-0.033	0.047
		(0.050)	(0.046)	(0.049)	(0.041)	(0.109)	(0.075)	(0.059)	(0.066)
	age	0.072***	0.079***	0.002	0.010**	-0.039***	-0.029***	0.029***	0.045***
		(0.005)	(0.005)	(0.005)	(0.004)	(0.011)	(0.009)	(0.006)	(0.007)
	age ×	0.006	0.001	0.019**	0.017***	-0.001	-0.011	0.005	-0.010
	girl	(0.008)	(0.007)	(0.008)	(0.006)	(0.018)	(0.012)	(0.009)	(0.010)
3	girl	0.096	0.105	0.225	0.183*	0.178	0.141	0.089	0.118
		(0.150)	(0.104)	(0.152)	(0.101)	(0.340)	(0.184)	(0.190)	(0.175)
	Lfwage	-0.013		-0.024		-0.092		-0.067	
		(0.048)		(0.048)		(0.117)		(0.055)	
	Lfwage	0.052	0.019	0.058	0.050	-0.296**	-0.053	0.072	-0.036
	× girl	(0.051)	(0.038)	(0.050)	(0.037)	(0.129)	(0.067)	(0.069)	(0.068)
	Lmwage	-0.060		-0.039		0.106		0.089	
		(0.100)		(0.100)		(0.237)		(0.116)	
	Lmwage	-0.152	-0.123	-0.178	-0.133*	0.185	-0.047	-0.133	-0.064
	× girl	(0.117)	(0.082)	(0.119)	(0.078)	(0.259)	(0.146)	(0.147)	(0.136)
4	girl	-0.044	-0.007	0.082**	0.116***	-0.027	-0.004	0.022	0.011
		(0.037)	(0.029)	(0.038)	(0.027)	(0.085)	(0.048)	(0.043)	(0.048)
	border	-0.024**	-0.046**	-0.024**	-0.046**	-0.040	-0.015	-0.071***	-0.065**
		(0.011)	(0.020)	(0.011)	(0.019)	(0.030)	(0.031)	(0.012)	(0.032)
	border	0.002	-0.007	-0.003	-0.011*	0.020	0.002	-0.006	-0.006
	× girl	(0.009)	(0.007)	(0.009)	(0.007)	(0.020)	(0.011)	(0.010)	(0.011)
5	girl	0.006	-0.033	0.103*	0.058	0.004	-0.002	0.056	0.042
		(0.052)	(0.049)	(0.053)	(0.051)	(0.009)	(0.007)	(0.059)	(0.059)
	APL	-0.479***	-0.458***	-0.479***	-0.464***	0.014**	0.010	0.143***	0.013
		(0.037)	(0.041)	(0.037)	(0.042)	(0.007)	(0.007)	(0.049)	(0.049)
	APL	-0.047	-0.002	-0.042	0.011	-0.002	0.003	-0.066	-0.061
	×girl	(0.053)	(0.051)	(0.054)	(0.053)	(0.009)	(0.008)	(0.061)	(0.060)
6	girl	-0.021	-0.014	0.083***	0.091***	0.003	-0.001	0.018	-0.014
		(0.025)	(0.019)	(0.025)	(0.018)	(0.004)	(0.002)	(0.032)	(0.029)
	landless	-0.003	-0.071	-0.012	-0.070	-0.004	0.015	0.003	0.027
		(0.034)	(0.081)	(0.034)	(0.082)	(0.005)	(0.021)	(0.037)	(0.103)
	landless	-0.031	-0.038	-0.031	-0.040	-0.002	0.003	-0.045	-0.001
	×girl	(0.036)	(0.027)	(0.036)	(0.025)	(0.005)	(0.003)	(0.043)	(0.040)
7	girl	-0.257	-0.179	-0.068	-0.021	0.006	0.379	0.008	0.131
		(0.176)	(0.138)	(0.183)	(0.132)	(0.432)	(0.262)	(0.213)	(0.180)
	Lmcapx	0.048*	0.033	0.037	0.015	-0.047	-0.044	0.004	0.017
	×girl	(0.029)	(0.024)	(0.030)	(0.024)	(0.075)	(0.055)	(0.040)	(0.034)
	Lhhsz	0.022	0.014	0.000	0.018	0.104	-0.102	-0.013	-0.099
	×girl	(0.061)	(0.049)	(0.063)	(0.048)	(0.136)	(0.073)	(0.070)	(0.068)
	Lmcapx	0.189	0.357	0.255	0.347	0.523	-0.470	-0.487**	-0.425
		(0.219)	(0.244)	(0.223)	(0.245)	(0.565)	(0.669)	(0.222)	(0.269)
	Lmcapx^2	-0.009	-0.034	-0.018	-0.033	0.007	0.088	0.059**	0.050
		(0.028)	(0.031)	(0.028)	(0.031)	(0.072)	(0.086)	(0.029)	(0.034)
	Lhhsz	0.042		0.054		0.004		-0.767***	
		(0.060)		(0.060)		(0.139)		(0.068)	
8	girl	-0.063**	-0.061**	0.044	0.048*	-0.022	-0.050	-0.087***	-0.100***
		(0.028)	(0.028)	(0.029)	(0.028)	(0.067)	(0.066)	(0.030)	(0.029)
	round 1	0.008	0.002	0.010	0.000	0.064	0.055	0.080*	0.087**
	× girl	(0.041)	(0.041)	(0.041)	(0.041)	(0.102)	(0.099)	(0.044)	(0.043)
	round 2	0.033	0.038	0.027	0.032	0.162	0.136	0.155***	0.151***
	× girl	(0.035)	(0.035)	(0.036)	(0.036)	(0.099)	(0.098)	(0.043)	(0.042)
	round 3	0.064	0.068	0.054	0.056	0.073	0.051	0.095**	0.102***
	× girl	(0.041)	(0.041)	(0.041)	(0.041)	(0.103)	(0.103)	(0.038)	(0.037)

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets;*** p<0.01, ** p<0.05, * p<0.1; For covariates' abbreviations see Table 4.7 notes. Covariates from basic specification (Table 4.9) are controlled for.

Table 4.11: Intrahousehold Food Expenditure Distribution in the Philippines: Basic and Alternative Models

Model	Variables	log (totexp)		log($\frac{totexp}{hhtotexp}$)		log ($\frac{animexp}{totexp}$)		log ($\frac{animexp}{hhanimexp}$)	
		OLS	FE	OLS	FE	OLS	FE	OLS	FE
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	girl	-0.019	-0.024	-0.032*	-0.027	0.011	-0.014	-0.011	-0.023
		(0.021)	(0.016)	(0.018)	(0.017)	(0.032)	(0.016)	(0.022)	(0.019)
2	girl	-0.028	-0.024	-0.039**	-0.027	-0.002	-0.003	-0.018	-0.022
		(0.021)	(0.017)	(0.018)	(0.017)	(0.006)	(0.003)	(0.023)	(0.020)
	tv	0.063		0.096		0.017		0.063	
		(0.131)		(0.078)		(0.032)		(0.134)	
	tv ×	0.223**	0.006	0.150	0.006	0.023	-0.001	0.153	-0.027
	girl	(0.106)	(0.045)	(0.103)	(0.045)	(0.028)	(0.011)	(0.157)	(0.056)
3	girl	-0.037	0.010	-0.101*	0.018	0.041	-0.004	-0.029	0.025
		(0.064)	(0.057)	(0.054)	(0.057)	(0.088)	(0.049)	(0.059)	(0.061)
	age	0.055***	0.069***	0.051***	0.069***	-0.015	-0.018***	0.031***	0.046***
		(0.006)	(0.006)	(0.006)	(0.006)	(0.009)	(0.006)	(0.006)	(0.007)
	age ×	0.004	-0.005	0.013	-0.007	-0.006	-0.002	0.003	-0.008
	girl	(0.010)	(0.008)	(0.008)	(0.008)	(0.014)	(0.008)	(0.009)	(0.009)
4	girl	0.171	0.261*	-0.005	0.150	0.255	0.023	0.162	0.102
		(0.234)	(0.145)	(0.149)	(0.137)	(0.279)	(0.134)	(0.194)	(0.171)
	Lfwage	-0.064		-0.039		-0.012		-0.059	
		(0.063)		(0.046)		(0.096)		(0.057)	
	Lfwage	-0.010	-0.011	0.056	-0.008	-0.310***	-0.019	0.059	-0.043
	× girl	(0.073)	(0.052)	(0.056)	(0.052)	(0.112)	(0.051)	(0.069)	(0.068)
	Lmwage	0.128		0.093		0.242		0.168	
		(0.128)		(0.095)		(0.197)		(0.136)	
	Lmwage	-0.134	-0.203*	-0.072	-0.124	0.105	-0.010	-0.181	-0.051
	× girl	(0.162)	(0.108)	(0.118)	(0.109)	(0.222)	(0.105)	(0.156)	(0.133)
5	girl	-0.063	-0.026	-0.016	-0.023	-0.089	-0.008	0.008	0.000
		(0.045)	(0.037)	(0.032)	(0.037)	(0.078)	(0.033)	(0.043)	(0.045)
	border	-0.054***	-0.063***	-0.082***	-0.057**	-0.018	0.006	-0.070***	-0.064**
		(0.014)	(0.024)	(0.009)	(0.022)	(0.025)	(0.026)	(0.013)	(0.031)
	border	0.012	0.001	-0.004	-0.001	0.026	-0.002	-0.004	-0.005
	× girl	(0.011)	(0.009)	(0.007)	(0.009)	(0.018)	(0.007)	(0.010)	(0.010)
6	girl	0.071	0.023	-0.037	-0.026	0.003	-0.006	0.007	0.007
		(0.090)	(0.079)	(0.054)	(0.051)	(0.020)	(0.017)	(0.007)	(0.007)
	APL	-0.431***	-0.432***	0.109**	0.006	0.042**	0.029	0.022***	0.006
		(0.057)	(0.060)	(0.047)	(0.051)	(0.018)	(0.019)	(0.005)	(0.005)
	APL	-0.098	-0.050	0.006	-0.001	-0.004	0.004	-0.012	-0.012
	×girl	(0.093)	(0.084)	(0.055)	(0.053)	(0.020)	(0.019)	(0.007)	(0.008)
7	girl	0.023	-0.009	-0.016	-0.017	0.006	-0.004	0.005	-0.020
		(0.034)	(0.025)	(0.027)	(0.026)	(0.009)	(0.004)	(0.033)	(0.029)
	landless	-0.060	0.064	-0.009	0.048	0.001	0.083***	-0.020	-0.019
		(0.038)	(0.145)	(0.033)	(0.090)	(0.012)	(0.027)	(0.041)	(0.114)
	landless	-0.082*	-0.027	-0.031	-0.018	-0.014	0.004	-0.033	-0.006
	×girl	(0.045)	(0.034)	(0.036)	(0.034)	(0.012)	(0.006)	(0.044)	(0.039)
8	girl	-0.498**	-0.300*	-0.231	-0.235	-0.022	0.216	-0.042	-0.027
		(0.245)	(0.180)	(0.184)	(0.171)	(0.355)	(0.200)	(0.209)	(0.171)
	Lmcapx	0.077*	0.056*	0.022	0.046*	-0.052	-0.031	0.005	0.030
	×girl	(0.040)	(0.031)	(0.031)	(0.027)	(0.058)	(0.044)	(0.039)	(0.032)
	Lhhsz	0.098	0.037	0.058	0.021	0.107	-0.057	0.005	-0.051
	×girl	(0.082)	(0.056)	(0.061)	(0.055)	(0.120)	(0.050)	(0.070)	(0.062)
	Lmcapx	0.686**	0.619*	-0.354	-0.294	0.838*	0.060	-0.484**	-0.519*
		(0.300)	(0.342)	(0.225)	(0.218)	(0.443)	(0.548)	(0.211)	(0.269)
	$Lmcapx^2$	-0.027	-0.054	0.047	0.032	-0.063	0.014	0.059**	0.062*
		(0.039)	(0.045)	(0.029)	(0.027)	(0.055)	(0.069)	(0.027)	(0.034)
	Lhhsz	0.035		-0.680***		0.026		-0.781***	
		(0.075)		(0.062)		(0.113)		(0.078)	
9	girl	-0.072*	-0.072*	-0.078***	-0.073***	-0.057	-0.073	-0.105***	-0.120***
		(0.037)	(0.037)	(0.025)	(0.025)	(0.053)	(0.054)	(0.030)	(0.030)
	round 1	0.061	0.049	0.066*	0.062*	0.051	0.051	0.103**	0.111***
	× girl	(0.058)	(0.060)	(0.035)	(0.035)	(0.090)	(0.086)	(0.043)	(0.042)
	round 2	0.055	0.053	0.053	0.058*	0.147*	0.126*	0.145***	0.142***
	× girl	(0.048)	(0.048)	(0.033)	(0.032)	(0.077)	(0.075)	(0.042)	(0.041)
	round 3	0.095*	0.091*	0.058**	0.061**	0.075	0.058	0.123***	0.131***
	× girl	(0.052)	(0.051)	(0.028)	(0.028)	(0.086)	(0.086)	(0.039)	(0.039)

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets;*** p<0.01, ** p<0.05, * p<0.1; See Table 4.8 notes for covariates' abbreviations. Covariates from basic specification (Table 4.9) are controlled for.

CHAPTER V

How Responsive are Nutrient Intakes to Implicit Nutrient Prices? A Hedonic Demand Analysis

Abstract: Using a characteristic demand framework and exploiting spatial and time variation in household unit values of food items as proxy for village food prices, I estimate implicit nutrient prices and analyse responsiveness of individual nutrient intakes to implicit nutrient prices in rural Bangladesh controlling for unobserved individual fixed effects. I find individual intakes of calories, macronutrients, and a set of micronutrients are inelastic to implicit calorie prices while the own and cross implicit price elasticities for a range of critical micronutrients are highly elastic to implicit micronutrient prices. Comparing the nutrient intake behaviour of poor and non-poor, I find that calorie intake is highly inelastic for both groups while micronutrient intakes are not, and that both macro and micronutrient intakes of poor compared with non-poor are more responsive to implicit macro and micronutrient prices. These findings suggest that the conventional way of addressing people's hunger and nutrition needs by subsidising one or two key staples should be revisited.

5.1 Introduction

Understanding how responsive is nutrient intakes to nutrient prices is critical for at least four reasons. First, a proper understanding is critical to design and implement effective government policies to prevent hunger and malnutrition. In many poor countries like Bangladesh, poverty often rears its ugliest face in terms of hunger and malnutrition. Consequently, a substantial amount of resources are devoted to food subsidy and nutritional intervention programmes, which are a major part of the government's anti-poverty programmes. To assess the need, efficiency, and effectiveness of these programmes, it is important to understand the demand for various nutrients.

Second, understanding how nutrient intakes vary with changes in nutrient prices is critical to fight against micronutrient malnutrition. Micronutrient malnutrition is one of the most serious public health problems in developing countries. More than two billion people in the developing world currently suffer from micronutrient malnutrition in one form or another(ACC/SCN, 2003).

Third, knowing how people value different attributes of foods is essential to determine agricultural marketing potential of foods produced through new technologies. A number of agricultural technologies, such as high-yielding varieties (HYV) and bio-fortification of foods, are being applied in developing countries. If these technologies, such as bio-fortification of a particular food, say, wheat, results more nutrients, but somehow distorts its colour or taste, and if people value the color and taste of a food more than its nutritional value, then these technologies would not be able to reach the goal of reducing malnutrition.

Finally, understanding nutrient intake behaviours is important from the perspective of economic development. There is now widespread evidence that better nutrition improves cognitive skills, reduces monetary and opportunity costs associated with illness, and improves labour productivity (for a survey of this literature, see Behrman et al., 2004).

The prevailing policy conclusion from existing food demand literature in poor countries is that the nutritional status of the poor may be quite vulnerable to upward fluctuations of food prices, and that a strategy of low food prices should benefit the poor. Employing the standard demand analysis framework, these studies in poor countries found higher price-responsiveness of low income households[1].

However, a problem with these studies and their policy conclusions is that they shed no light on (i) preference for nutritive contents vis-*à*-vis non-nutritive attributes of foods, and (ii) the extent to which food prices reflect the nutritive characteristics of foods vis-*à*-vis their non-nutritive attributes. Therefore, it is not obvious from these studies why an individual's nutritional status might deteriorate due to an increase in certain food prices as, theoretically, the effect could go either way.

A food item has various characteristics - nutritive (i.e., protein, fat, carbohydrate, vitamins, and minerals) and non-nutritive (i.e., aroma, taste, texture, and class appeal. These characteristics influence people's demand for food. An individual may consume a particular food item for its nutrient contents and/or for its non-nutritive features. There is indirect evidence that non-nutritive attributes of foods can dominate nutritional consideration even for the poor and malnourished people (Behrman and Deolalikar, 1989, 1990; Pitt, 1983).

Thus, inferring nutrient intake behaviour based on the conventional demand framework, as applied in past food demand studies, could be misleading. People can be benefitted nutritionally by an increase in the price of certain foods if they substitute higher-priced foods with those that are cheaper but more nutritious despite being inferior in various non-nutritive features. Conversely, if people substitute higher-priced foods with cheaper foods of less nutritive values, then their nutritional status will deteriorate[2].

Hence, for the policy to fight malnutrition, it is critical to understand to what extent individuals (of different characteristics) value nutrients vis-*à*-vis nonnutritive features of different foods. Otherwise, it would be difficult to determine what types of foods to subsidise, and whether or not a price subsidy would be more effective than direct nutritional interventions.

In this paper, I attempt to bridge the gap between two broad streams of literature on food demand. Based on the conventional demand framework, one stream analyses the nutrient responsiveness of different income groups to the changes in food prices. On the other hand, based on the characteristics demand framework, the other stream attempts to estimate the implicit prices of

[1](For a summary of this literature, see Behrman and Deolalikar, 1988; Behrman, 1995; Bouis, 1996).

[2]For a detailed discussion on the possible effects of food price changes on nutrition (see Behrman et al., 1988; Bouis, 1996).

characteristics of a given food or food-group.

Using a characteristics demand framework (Gorman, 1980; Lancaster, 1966, 1971; Ladd and Suvannunt, 1976)) and utilising the spatial (Deaton, 1988) and time variation of food prices in rural Bangladesh, I estimate the implicit prices of key nutrients in different locations in rural Bangladesh for different time periods. Using these implicit nutrient prices (as opposed to a few food prices typically used in the literature) in the nutrient demand function, I estimate the nutrient price responsiveness of nutrient intakes of individuals. This procedure enables me to measure peoples' demand for the nutrients embodied in the foods by eliminating their demand for the non-nutritive attributes of foods. I find that calorie intake is highly inelastic to implicit calorie price, while micronutrient intakes are highly elastic to implicit micronutrient prices. Moreover, for a range of nutrients, poor's intakes are more responsive than non-poor's.

This chapter thus has obvious policy implications. If food demand is guided by nutrient contents of foods, then subsidising nutritious foods will be an effective way to improve the nutritional status of people (especially of the poor). Similarly, if people tend to consume more nutritious foods with an increase in income, then policies to promote economic growth and income earning opportunities for the poor will have a beneficial effect in improving their nutritional status. On the other hand, if to a large extent food demand is guided by various nonnutritive attributes, then by subsidising nutritious foods with unattractive non-nutritive features, a food policy or a growth promoting policy is unlikely to achieve desired results. More direct nutritional interventions would be required in this circumstance. Finally, if the nutrient intakes of individuals of certain characteristics (such as women or female children) within the households are more responsive to implicit nutrient prices, the price subsidy of nutritious foods can also be an effective way to tackle the malnutrition problems of specific population groups.

Furthermore, analysing nutrient intakes based on individual food intake, not on household food expenditure, I also attempt to contribute to the broader literature on food demand analysis. While the nutritional intakes of individuals and their determinants are the ultimate interest of government policy, most of the earlier demand studies use household food expenditure data in the absence of individual food intake data. However, inferences based on food expenditure data may not necessarily be a good proxy for the predictions based on actual food intake within the household. A number of studies (for a discussion of this literature, see Bouis and Haddad, 1992) demonstrate that the income elasticity of calorie consumption tends to be overestimated using the household food expenditure data as opposed to food intake data. This may lead to erroneous policy conclusion that growth-promoting policies will automatically address malnutrition in developing countries[3].

The rest of the chapter is organized as follows. Section 5.2 provides a brief review of related literature. Section 5.3 lay out the theoretical framework for the empirical analysis. Section 6.2 describes the data and provides descriptive analysis. Section 6.2.2 provides empirical analysis of the demand for nutrients in rural Bangladesh. Section 5.6 concludes the paper.

[3]For a debate on this topic, see Behrman and Deolalikar (1987); Deaton and Subramanian (1996)

5.2 Related Literature

This section briefly summarizes two streams of the literature on food demand analysis. Based on the conventional demand framework, one stream analyses the price responsiveness of nutrient intakes of different income groups in developing countries. Based on the characteristics demand framework, the other stream estimates the implicit prices of different nutritive and nonnutritive characteristics of a given food item or food group.

Theoretically, it can be argued that different income groups (i.e., poor and non-poor) can have different price and income elasticities. As is well-known, the price elasticities can be decomposed by the Slutsky equation:

$$e_{ij} = s_{ij} - E_i a_j \tag{5.1}$$

where e_{ij}, often referred to as the Cournot elasticity, is the overall demand elasticity for good i when price of good j changes; s_{ij}, the Slutsky elasticity, is the pure substitution elasticity for good i when the price of good j changes; E_i, the Engel elasticity, is the income elasticity for good i; a_j is the amount spent on good j as a percentage of total expenditure. When $i = j$, the own price components are given and when $i \neq j$, the cross-price components are given. So, e_{ij} can vary with income, if s_{ij}, E_i, and/or a_j vary with income.

Based on the conventional demand framework, Pinstrup-Andersen et al. (1976) is one of the first studies that provided empirical evidence that low income groups are more price-responsive than high income groups[4]. Their objective was to analyze the nutritional distribution of different income groups due to an increase in various commodity supplies. They argued that nutritional distribution should be considered when establishing commodity priorities in agricultural research and policy because increasing the supply of some foods may actually exacerbate malnourishment as people substitute luxury goods for more nutritious commodities.

Pinstrup-Andersen et al. (1976) used data from a household survey of 230 families in Cali, Colombia. The survey contained information on the quantities consumed and prices paid for 22 different foods, household size, and income. Althought the families were reinterviewed eighteen months later, the attrition rate was 30%. In the absence of an extensive and accurate time series data, they adopted Frisch's technique (Frisch, 1959) for estimating a complete set of own and cross-price elasticities when income elasticities, budget proportions, and money flexibility are known. The fist two can be calculated from cross-sectional data, and the money flexibility can be indirectly determined when the own-price elasticities of a few goods are known. However, their entire methodology, rests on the critical assumption of want independence among goods under consideration[5].

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[4] For a detailed discussion of this study and a number of other studies spawned by this study, see Waterfield (1985)

[5] Good i is want independent of all other goods, if the marginal utility of good i depends only on the quantity of good i and not on any other quantity. This assumption implies direct additivity of the utility function: $U(q_1, q_2, ..., q_n) = u_1(q_1) + u_2(q_2) + ... + u_n(q_n)$.

Brandt and Goodwin (1980) criticised Pinstrup-Andersen et al. (1976) arguing that the use of the Frisch methodology was inappropriate. They showed that if the goods are actually 'want dependent', then the own-price elasticities will be in error by the sum of the non-zero cross-commodity 'want elasticities.' Calculating price elasticities by both the Frisch method and a time-series method using an extensive Canadian database, they found that the Frisch value to be consistently over-estimated, typically by a factor of two[6].

Using a comprehensive household survey, the 1976 Indonesian Socio-Economic Survey, Timmer and Alderman (1979) found that the poor are more sensitive to price changes than the rich. The survey covered 54,000 households - 18,000 surveyed in each trimester of 1976. Data were collected for over 100 food commodities, but the authors were concentrated only on rice, fresh cassava, and corn - the three major foodstuffs accounting for more than two-thirds of average energy intake[7]. Data were reported for 12 income classes and 24 provinces, separately for urban and rural consumers, and for three different time periods.

Timmer and Alderman (1979) found that both the budget proportion and income elasticity, that is a_j and E_i in equation 5.1, declined with increased income. Elasticities estimated by Timmer and Alderman (1979) were significantly higher in absolute magnitude than typically reported in the literature. One explanation is that these elasticities, being estimated from cross-sectional data, represent long-term responses to changes in incomes and prices. Long-term parameters are always larger than short-term parameters because consumers' tastes and preferences take time to adjust to changing incomes and prices. Due to these high elasticities, they claimed that directing income to the poor will be an efficient way to improve their calorie intake.

Timmer (1981) showed that the pure substitution elasticity (i.e., s_{ij} in equation 5.1) also varies by income class. This implies the need to understand how price changes affect nutritional level of the poor. As Timmer argued, the price effects may be much more important to the nutritional status of the poor than the income effects. If the poor are already at the nutritional margin of survival, then even modestly higher food prices may have a profound welfare effect.

Pitt (1983) also found that the poor respond differently than the rich to changes in prices and income. He used a large panel data of 5750 rural households in Bangladesh interviewed in four successive quarters. As the data were available at the household level rather than at the regional level, he was able to perform his estimations at the household level.

Pitt's study differs from the previous studies as he estimated both the commodity price elasticity matrix and a nutrient-food price elasticity matrix. He observes that the largest substitution cross-price elasticity is for wheat demand with respect to rice price; if rice price goes up, consumers heavily substitute wheat for rice. Moreover, wheat has a uniformly negative row of nutrient elas-

[6]Pinstrup-Andersen (1980) replied to the critique stating that their primary purpose of the study was not to estimate price elasticities but to develop nutritional impact of the supply expansions. Due to the urgency of the problem, they settled for directions and orders of magnitude, even though greater precision could not be obtained.

[7]Energy and calorie, or more preciously, kilo calorie (a measure of energy) are used interchangeably throughout the thesis.

ticities for low-income households, implying that subsidizing wheat will increase the intake of all nutrients. Pulses – an important and inexpensive source of protein that has been considered for price subsidies by the government – on the other hand, have a mostly positive row of nutrient elasticities. This implies that subsidising pulses will actually reduce the nutrient intake of the low-income households. In contrast to Timmer and Alderman (1979), Pitt argues that income transfers may not be as effective as the programmes that encourage consumption of more nutritious foods to increase nutrition, because even poorly nourished households can improve their nutrition simply by altering their diet. Taste appears plays an important role in a household's dietary intake.

The phenomenon that the poor are more price-responsive than rich is also evident in Alderman (1986); Behrman and Deolalikar (1989, 1990), among others. Alderman reviews the empirical estimates of food price and income elasticities disaggregated by income groups. He finds that with a few exceptions, these elasticities decline in absolute value with the increase in income. This is consistent across a wide range of countries, for cross-section data sets collected at various frequencies and time intervals, and employing several estimation techniques.

Similarly, using national-level information on food expenditures and prices for a number of countries over time, Behrman and Deolalikar (1989) finds that food indifference curve becomes more sharply curved as food expenditure increases. This in turn implies that the price response is higher at lower incomes.

Behrman and Deolalikar (1990) estimate the nutrient responses of individuals of different age and sex within the household to changes in four basic food prices (gram, sorghum, milk, and rice) in rural South Indian villages. This study improves upon the previous studies as it is based on individual food intake data as opposed to household food expenditure data. It also controls for unobserved fixed effects that may contaminate the estimation.

One of the key findings of this study is that individual nutrient intakes respond strongly to these four food prices. While the price of sorghum (the basic staple food in these villages), generally has negative effects in nutrient intakes, other food prices, particularly of milk and rice, often have strong positive impacts on nutrient consumption. They also find that the nutritional burden due to increased food prices that typically occur in the lean agricultural season (or in a drought year) falls disproportionately on female members within the household. However, by the same token, they enjoy the nutritional bonus from falling food prices (in the post-harvest seasons or in a year of favorable monsoons).

The positive nutrient elasticity to a set of food prices are also evident in a number of other studies, such as in Pitt and Rosenzweig (1985), which conjecture the influence of taste, aroma, status, etc. in food demand for the poor. They also argue that other than the basic staple, subsidising foods that tend to have positive price response to nutrients will adversely affect the nutrition status of the poor.

However, none of these studies provide any useful insights in the fundamental policy question of how people value different characteristics——nutritive and non-nutritive—— embodied in foods.

Moreover, there is a possibility that the results of these studies may be contaminated without controlling for a number of other correlated food prices. Thus, the policy conclusions emerging from these studies that only focus on a few food prices may be erroneous.

Prato and Bagali (1976) criticise the conventional food demand studies because of the absence of a behavioral framework and empirical analysis of the nature and importance of nutritional and nonnutritional factors that affect food demand. Using the US food consumption survey data from a number of regions and of different income classes for 42 food items of the meat, poultry, and fish category, they found the existence of nutritional inefficiencies in consumer food choices. Nutritional inefficiency was defined as the situation when nutrients were not obtained from the minimum-cost foods. They also find that this nutritional inefficiency tends to increase with residual food expenditure (defined as total food expenditure minus the minimum-cost food expenditure).

Nutritional inefficiency can arise because of demand for non-nutrient attributes of foods, such as, taste, aroma, texture, etc. People may spend more to obtain the same or perhaps lower amount of nutrients from foods that are otherwise rich in terms of non-nutritive attributes. As already discussed above, a number of studies (using traditional demand framework) indirectly infer the importance of non-nutritive attributes in the demand for food by the poor.

The absence of a characteristics demand framework in food demand studies in developing countries is somewhat ironic as this framework has its roots in agriculture. Waugh (1928) empirically analyses the relationship between the physical characteristics (i.e., size, shape, color, maturity, uniformity, etc.) of vegetables and their market prices to determine consumer valuations of these characteristics. He observes that such information would be useful for asparagus producers. As Waugh notes, the prices of agricultural products, like any other commodity, vary in two distinct ways - time variation (day-to-day or seasonal) and the variation at any particular time due to differences in characteristics. He studied the relationship between the physical characteristics of vegetables and their prices at any particular time. Waugh (1929) further argues that there is a distinct tendency for market prices of many commodities to vary with certain physical characteristics, and this relationship can be fairly accurately determined through statistical analysis.

As is well-known, the commodity characteristics based demand framework was subsequently laid out by Gorman (1980); Lancaster (1966, 1971). While in the traditional demand framework the goods are the objects of the utility function, in the characteristic demand framework, it is the characteristics of goods from which the utility is derived. A good can possess more than one characteristic, and many characteristics can be shared by more than one good. Goods in combination may possess characteristics different from those pertaining to the goods separately. Consumption is viewed as an activity in which goods, singly or in combination, are inputs and in which the output is a collection of characteristics. Utility or preference orderings are assumed to rank collections of characteristics and only to rank collections of goods indirectly through the characteristics that they possess[8]. Maximisation of this utility function subject to usual budget

[8]Various ingredients of characteristics demand framework are also evident in Strotz (1957, 1959); Gorman (1959); Stigler (1945); Thrall et al. (1954); Morishima (1959); Quandt (1956); Becker (1965).

constraint thus yields the implicit prices of characteristics, which in turn is the basis of the hedonic price function[9].

Lancaster's characteristics demand framework, has been criticised for the assumption of linear consumption technology by Lucas (1975) and for the assumption of nonnegative marginal utilities of all characteristics (by (Hendler, 1975)). Both Lucas and Hendler also criticise the assumption that utility depends only upon total quantities of characteristics and not upon their distribution among commodities.

Ladd and Suvannunt (1976) further develop a consumer goods characteristics model, which is not prone to these criticisms[10]. They test two hypotheses: (i) the retail price of a product is a weighted linear combination of product's characteristics, each weight being a marginal implicit price of a characteristic; and (ii) consumer demand for a product is a function of income, product prices, and product's characteristics. They found that the statistical results were consistent with both of their hypotheses.

Using a hedonic price approach (based in the characteristics demand framework), a number of studies estimate implicit values of nutrient and non-nutrient characteristics of a particular food item, such as, milk, breakfast cereals, cowpea, wine, etc. For instance, Langyintuo et al. (2004) estimated the implicit price for various nonnutritive characteristics of cowpeas, which is an important food legume throughout West and Central Africa. Five samples were purchased once per month from seven markets in Ghana and Cameroon between 1997 and 2000. In the market, price and vendor characteristics were noted. In the laboratory, size of grains, color, texture, and damage levels were recorded. Using a hedonic price regression model, they find that quality characteristics are very important in West African food markets. Even low income consumers are willing to pay a premium for products that match their preferences.

Household survey data on prices and quantities consumed are often weighted averages of a number of market goods. Information may be available on how much a household spends on cereals, but not necessarily on specific brands and types of cereals. Lenz et al. (1994) developed an aggregate commodity framework to address this issue of aggregate commodity groups in analyzing valuation of different characteristics embodied in milk. In this two-stage framework, the household in the first stage chooses the "average" price, the "average" nutrient content, and the quantity of the aggregate commodity which will maximize their utility subject to the budget constraint. In the second stage, the household decides which market goods, and the quantity of each good that

[9]Hedonic price regressions have been extensively used to measure consumers' valuations for various characteristics of durable goods, such as automobiles (Giliches, 1961), computers (see, among others Berndt and Griliches, 1990), as well as air quality and environmental amenities, (for a survey, see Cropper and Oates, 1992). The underlying objective of all these studies to regress commodity prices of a given commodity on various commodity characteristics to estimate the buyer's marginal willingness to pay for each attribute are much in the same spirit of Waugh's interpretation of his asparagus regressions. As the topic of my analysis is food demand, I focus here only on the hedonic price studies of nondurable agricultural goods.

[10]This model is essentially a consumer goods counterpart to the model developed by Ladd and Martin (1976) to study prices and demand for input characteristics.

will meet the requirements of the first stage. Researchers focus on the first stage when estimating the hedonic price function, since the "average" information on price, nutrient, and nonnutrient food characteristics is adequate to estimate implicit values of characteristics. In this framework, consumer choices for average price and nutrient content should be restricted to a convex feasible set defined by the prices and nutrient contents of the individual market goods.

Lenz et al. (1991) use this framework to estimate the implicit values of protein, fat, and calcium from dairy product retail prices. In their model, the marginal implicit values of these nutrients are a function of household characteristics, i.e., households of different characteristics value different nutrients differently. Empirically, they find that these implicit values differ depending on household characteristics such as age, occupation of the household head, education of the meal planner, nutritional status of the household, and region and zone of domicile.

Shi and Price (1998) extend the framework of Lenz et al. (1994) by explicitly modeling the nonnutrient food characteristics as a function of household characteristics. They estimate the implicit values of nutrient and nonnutrient characteristics of breakfast cereals and the effects of sociodemographic variables on these values. They used the 1987-88 household portion of the US Department of Agriculture's nationwide food consumption survey data[11].

Using the same notion that different households value the nutrient contents of food items differently, Cook and Eastwood (1992) incorporate the issue of "subsistence" into the characteristics demand framework. The interpretation of subsistence, as given originally by Samuelson (7 48), is that a consumer needs minimum amount of goods, so utility is derived from the consumption of goods over and above these subsistence levels. Similarly, in the Cook-Eastwood framework, consumers need minimum amount of nutrients to survive, let alone to have healthier lives. These subsistence levels are primarily attained through regular consumption of food. Utility arises from the consumption of nutrients in excess of subsistence levels. Thus, Cook and Eastwood (1992) write the utility function in terms of nutrients consumed above the subsistence level. This approach yields hedonic price equations that can be consistent with declining marginal utilities of nutrients. Using this framework, they estimate the hedonic price function and nutrient demands for three groups of households: below the subsistence levels of all nutrients, below the subsistence level of at least one nutrient but not all nutrients, and above the subsistence levels of all nutrients.

As the hedonic price theory does not provide any guidance on the functional form of the hedonic price function, Stanley and Tschirhart (1991) estimate the hedonic model using the Box-Cox transformation technique. However, Cassel and Mendelsohn (1985) list several reasons why it may be inappropriate to use the Box-Cox technique: (i) this functional form does not necessarily yield more accurate estimates of implicit prices of product characteristics, (ii) the nonlinear transformation leads to complex estimates of slopes and elasticities and makes it difficult to interpret results, and (iii) the Box-Cox form usually leads to an increase in the number of parameters in the model, and hence the efficiency of the parameter estimates is reduced.

[11] Implicit values of characteristics of breakfast cereals was also estimated by Morgan (1987); Stanley and Tschirhart (1991), among others.

As Nerlove (1995) points out, while the hedonic price function provides implicit prices for product characteristics, almost all these hedonic price analyses purport to view these implicit prices of characteristics as consumers' valuation of these characteristics (i.e., the characteristics price ratio is viewed to reflect consumers' marginal rates of substitution among attributes). However, as Rosen (1974) points out, it is problematic to regard implicit prices of characteristics as an indicator only of consumers' valuation without considering the supply side. To the extent product characteristics affect marginal utility as well as marginal costs, implicit prices derived from hedonic models characterise equilibrium between supply and demand in the market for a product characteristics. This is similar to the identification problem related to demand and supply functions as illustrated by Working (1927). Price-quantity observations represent equilibria of demand and supply and only under special circumstances can regressions of price on quantity or of quantity on price be used to infer anything about the underlying supply and/or demand functions. Rosen argues that essentially the same identification problem exists for hedonic price functions, where in general, the coefficients in the estimated hedonic regression reflect both supply and demand considerations, both producers' costs and consumers' preferences.

To overcome this identification problem, Rosen (1974) outlines a two-step procedure. In the first step, one needs to estimate the implicit prices of product characteristics by the usual hedonic method, i.e., regressing observed differentiated product prices on all their characteristics using the best fitting functional form, without regard to demand-side shifters (such as income, taste variables) and supply-side shifters (such as, producers' characteristics, technological differences between producers etc.). In the second step, one needs to use the computed implicit marginal prices of product characteristics (from the first step) in the simultaneous estimation of market demand and supply functions to trace out the supply and demand functions (involving usual demand-supply function identification strategies).

Subsequently, Brown and Rosen (1982) argue that Rosen's original procedure is flawed. The implicit prices estimated in Rosen's first-step cannot play the same role in estimation that direct observations on the implicit prices would play if available. As the implicit prices in Rosen's first-step are created only from observed sample quantities, any new information that they may provide can only come from *a priori* restrictions placed on the functional form of the price function. In the absence of such restrictions, as Brown and Rosen demonstrate (with the example of a quadratic hedonic price function), the second-stage structural estimation of the demand and supply functions as suggested by Rosen may only reproduce the information already provided by the first-stage estimation of the price function.

As Brown and Rosen argue, a way-out from this problem, is to first estimate the hedonic price function separately for spatially distinct markets, and then to estimate the common structural demand and supply functions for all the markets. By doing so, the price function would not only depend on the common demand and supply vectors associated with the observations, but also upon other market-specific factors. If one is then to impose the condition that the structural demand

and supply parameters be identical across markets, even though the hedonic price loci are not, the identification can be achieved[12]. One added advantage of this strategy, as Palmquist (1984) noted, is that the hedonic regressions need not be arbitrarily restricted to be non-linear for demand estimation.

Nerlove (1995) argues that, similar to Working's analysis, in hedonic analysis it may be possible to identify the hedonic price function exclusively with factors reflecting consumers preferences or solely reflecting costs of productions and supply conditions. As is well-known, if the quantity supplied shifts exogenously independently of the shifts in the demand function, a regression of price on quantity will estimate the price elasticity of demand (Schultz, 1938). Conversely, if prices are exogenously determined such as in the world markets, for a small group of consumers purchasing in a local market with supplies perfectly elastic at world prices, the regression of quantity on price may arguably be used to estimate the demand elasticity (Stone, 1954).

Thus, as Nerlove (1995) discusses, there are two polar cases in which consumers' valuation of attributes can be inferred from the hedonic price function. Polar case 1 is the situation in which supplies of product varieties are exogenously determined. This is typically applied in the hedonic price functions for environmental amenities, automobile options, or computer characteristics, in which it is often argued that supplies are exogenously determined. Polar case 2 is the situation in which product prices and their attributes may be taken as exogenous. Nerlove uses the polar case 2 set-up in estimating Swedish wine consumers' preferences for various wine attributes. His underlying assumption is that the prices of different wine varieties are exogenous to Swedish consumers, and are determined in the world market. He thus estimates consumers' valuation for different wine attributes not from a hedonic price function[13], but from a wine demand function for Swedish consumers (i.e., regressing quantity sold/purchased on exogenously determined prices of wine variety and different wine attributes), whose tastes, arguably differ from those of the world market at large, and who exert no appreciable influence on prices. Nerlove further showes that estimates of implicit prices of attributes obtained from wine demand function vary substantially from those obtained from the hedonic price function.

5.3 Theoretical Framework

The underlying theoretical framework for my analysis is a food characteristics demand framework grounded in the work of Lancaster (1966, 1971); Gorman (1980); Ladd and Suvannunt (1976), among others. Unlike traditional consumer theory in which utility is derived from the commodity,

[12]Although they did not note it, Witte et al. (1979) applied this strategy by estimating hedonic price function separately for four different cities. On the other hand, as an identification strategy, Harrison and Rubinfeld (1978) imposed restrictions on the functional form of the price function. Epple (1987) provided a critical analysis of these various identification strategies

[13]Notice that, the usual hedonic price regression in which unit variety prices are regressed on unit quality characteristics can be carried out using the Swedish data, but the coefficients in such regressions reflect a mixture of world consumers preferences and the world supply considerations.

in this framework a consumer derives utility not from the commodity itself, but from the characteristics that a commodity or a commodity bundle possesses.

So, suppose there are k different nutritional characteristics (such as energy, protein, minerals, vitamins, etc.) and t different non-nutrient characteristics, such as taste, texture, aroma, smell, etc. available in some or all food items from which a household derives utility. Generally, a food item posseses more than one characteristics and many characteristics are shared by more than one commodity. Let n be the total number of food items consumed by a household with both $k \leq n$ and $t \leq n$.

Let $q_1, q_2, ...q_n$ are the quantities of n different food items consumed by the household and there corresponding market prices (per unit) are $p_1, p_2, ...p_n$. I further assume that households are price taker and do not have influence on market prices of these commodities. Different nutritional characteristics are available in fixed amount in per unit of a food item. Let a_{jk} be the amount of nutrient k available in per unit of commodity j. Therefore, the total nutrient intake of a household can be represented by the following equation:

$$\mathbf{z} = \mathbf{A}\mathbf{q}$$

where, $\mathbf{z}$ is a vector of k different nutrient intakes by the household, q is a vector of quantities of n different commodities consumed by the household, and $\mathbf{A}$ is a matrix of nutrient contents common to all consumers in which the entry a_{jk} implies the amount of nutrient k available in one unit of commodity j.

If food is weakly separable from nonfood, the household food consumption decision becomes:

$$Max \qquad u_f(\mathbf{z}, \mathbf{t}; \mathbf{c}) \tag{5.2}$$

subject to the household budget constraint:

$$\mathbf{p}'\mathbf{q} \leq y_f;$$

$$\mathbf{z} = \mathbf{A}\mathbf{q};$$

$$\mathbf{t} = t(\mathbf{q});$$

where, $u_f(.)$ is the household subutility function for food in which $\mathbf{c}$ represents a vector of household characteristics that accounts for differences in utility functions across households, $\mathbf{q}$ is a vector of quantities of different food items consumed by the household, $\mathbf{t}$ is a vector of non-nutrient commodity specific characteristics such as taste, aroma, associated with some or all of the food items[14], $\mathbf{p}$ is a market price vector of different food items, and y_f is the household food expenditure.

[14]The objective function with commodity specific characteristics is based on, among others, the work of Prato and Bagali (1976); Pudney (1981). As already discussed in the previous section, a number of studies involving traditional consumer demand analysis framework also found evidence for people's preferences for non-nutrient characteristics of food even at a low income level.

Thus the Lagrangian for the household utility maximization becomes:

$$L = u_f(\mathbf{z}, \mathbf{t}; \mathbf{c}) - \lambda(\mathbf{p}'\mathbf{q} - y_f) \tag{5.3}$$

The first-order necessary conditions for the maximization of (5.3) yields the hedonic price function which decomposes the price of a commodity into its implicit values of the characteristics:

$$p_j = [(\frac{\partial u_f}{\partial \mathbf{z_k}})\lambda^{-1}]\mathbf{a_{jk}} + [(\frac{\partial u_f}{\partial \mathbf{t_j}})\lambda^{-1}]\mathbf{b_j} \tag{5.4}$$

where, λ is the marginal utility of food expenditures, $(\frac{\partial u_f}{\partial \mathbf{z_k}})$ is a vector of marginal utility of k nutrients, $\mathbf{a_{jk}} = \frac{\partial \mathbf{z_k}}{\partial q_j}$ is vector of nutrient contents per unit of food item j.

The term, $[(\frac{\partial u_f}{\partial \mathbf{z_k}})\lambda^{-1}]$ is a vector of marginal implicit prices of k nutrients. This is a vector of monetized values of the marginal utilities with respect to the k nutrients as represented by the ratio of the marginal utilities of the nutrients to the marginal utility of money (i.e., food expenditure). Similarly, the term, $[(\frac{\partial u_f}{\partial \mathbf{t_j}})\lambda^{-1}]$ is a vector of marginal implicit prices of nonnutrient or commodity-specific characteristics, and $\mathbf{b_j} = \frac{\partial \mathbf{t_j}}{\partial \mathbf{q_j}}$ is a vector of nonnutrient contents per unit of commodity j. Thus the term $[(\frac{\partial u_f}{\partial \mathbf{t_j}})\lambda^{-1}]\mathbf{b_j}$ represents value attributed to the characteristics specific to commodity j, or in other words, represents the "food" effect. Equation 5.4 thus decomposes the market price per unit of a food item into implicit market prices for characteristics.

Let Θ be the vector of implicit market prices of characteristics. Substituting these market prices of characteristics into the market prices of commodities in the consumer budget constraint (using equation 5.4), the first order necessary conditions of the consumer utility maximization problem also yield the household's demand equations for k nutrients:

$$z_k = f(y_f, \Theta; \mathbf{c}) \tag{5.5}$$

Observations on market prices per unit of n different food items, on k different nutrients in per unit of n different food items, and the usual information of household characteristics enable one to empirically estimate both equations 5.4 and 5.5.

5.4 Data

I use the household survey data of the International Food Policy Research Institute (IFPRI) as used and discussed in the previous chapters. The data was collected from 47 villages located in four different districts in rural Bangladesh[15]. Four rounds of surveys were conducted in every four months between June 1996 and September 1997. The questionnaire was administered to about 5,541 individuals in 955 rural households in each round, and collected detailed information on household

[15]Bangladesh is divided into 6 divisions. A division is then divided into districts. A district is composed of several thanas. Thanas are divided into unions. A union is composed of several villages.

and individual characteristics including demography, agricultural production and other income-earning activities, food and non-food expenditure, individual food intakes, health, education, and morbidity status. As illustrated in Chapter 2, the basic summary statistics of the sample indicate that the sample broadly represents the characteristics of the rural Bangladeshi households.

Two features of the survey are particularly useful for my analysis: household expenditure on a wide range of food items, and individual intakes of these food items. As Deaton (1997) notes, in developed countries almost all the identifying price variations in demand analysis come from price changes over time, while in developing countries, in addition to intertemporal variation in prices there is often spatial variations in prices that is not typically available in developed economies. This is due to the absence of the highly developed infrastructure, transport and distribution system in many developing countries. Moreover, lack of competition and fragmented agricultural input markets for seeds, irrigation equipments, fertiliser, etc. also contribute to variation in agricultural production costs in different geographical locations in many poor countries like Bangladesh. Thus, the household surveys, such as the one used here, that collect information on the expenditure and quantity purchased of different food items often provide a useful source of food price data in terms of unit values.

Altogether, the IFPRI survey has information on household expenditure and quantity purchased of more than 300 finely disaggregated food items in 47 villages. However, a great number of these items are not consumed in all 47 villages and in all rounds, and also not by all households in the same village in a given round. Eliminating those items that consumed by only a small number of households in a few villages in a particular round, I am left with more than 100 different food items. Based on the dietary pattern of the rural Bangladeshi households, these food items are then broadly categorised into 17 different food groups: rice, wheat and wheat sources, other cereals, potatoes, lentils, leafy green vegetables, other vegetables, fruits, meat, milk, egg, big fish, small fish, oil, spices, sugar and sweets, and miscellaneous (which contains items like tea, betel leafs, etc.).

To analyse the spatial variation of food prices across villages, I first calculate unit value of each of the food items purchased by different households by dividing expenditure by the quantity purchased. Then, following Deaton and Grimard (1992); Deaton et al. (1994), I run a regression of the logarithm of unit value on dummies for each village for each of the 17 broadly defined food groups. The F-tests and R^2 statistics of these regressions are presented in the left panel of table 5.1. Obviously, a village drops out from this regression for a given food group or food item, if no household in that village purchased that item at the time of the survey. The focus of investigation here is whether or not there is the evidence that unit values are informative about prices. Since prices should not vary much within villages in the short-run, there should be significant F-statistics for the village effects. As can be seen from table 5.1, the F-statistics are highly significant for each of the food groups. With the exception of potatoes, for all other relatively more homogeneous food groups, such as rice, cereals, lentils, etc., the village effect explains 10-20% of the total variance in the logarithms of unit values. One should also keep in mind that there is typically strong political pressure on the government to always equalise the prices of key food items, such as rice, potatoes[16], etc. in the country. Despite this, it appears that there is a significant variation of prices of these items across villages.

While for some of the more heterogenous food groups, such as vegetables, fruits, fish, meat, etc., the R^2 statistic is very low, I find relatively high R^2 when I focus on specific food items within each of these food groups commonly consumed in most of the villages. To illustrate this further, the right panel of table 5.1 presents the F and R^2 statistics for a few specific food items. While the village effects explain about 18% of total variance of the logarithm of the unit values for the leafy green vegetable group, for more common food items within this group, such as for cabbage or *palang-shak* (a local variety of spinach), the village effects explain about 39% and 42% of the total variance, respectively. Similarly, for the "other vegetable" group the R^2 is very low while for more specific food items within this group, such as bitter gourd, the village effects explain nearly 60% of the total variance of the logarithm of unit values. Similar phenomenon is evident for other food groups as well. Thus, the results in this table provides indication that there is spatial price variation for finely defined food items and that the variation in unit values provides a proxy to the spatial variation in village prices[17].

However, there are two problems associated with treating these unit values as village prices: the choice of quality and measurement errors (Deaton, 1997). As unit values are computed by dividing expenditures by physical quantity, high quality items or mixtures that have a relatively large share of high quality items will have higher unit prices. Unlike market prices, over which the household has no control, quality is chosen by the household. Consequently, a unit value is chosen to some extent. Hence, there is a risk of a simultaneity bias if the unit values are used in a straightforward way to explain the patterns of demand.

The severity of this bias depends on the size of the quality effects, which in turn can be assessed by running regressions of the logarithm of unit value on the logarithm of total expenditure, household size and demographic composition. Since better-off households tend to buy higher-quality goods, unit values will be positively related to incomes or total expenditure. Prais and Houthakker (1955) first estimated this type of regression to measure the expenditure elasticity of quality for different food items consumed by the British households.

Ideally, such a regression function should also include market prices and in the absence of that control for village effects. The analysis of Deaton and Grimard (1992) for Pakistan and Deaton et al. (1994) for Maharashtra, India show modest quality elasticities for important cereal categories (4-10%), but relatively high quality elasticity for heterogeneous meat category (15-18%) in rural India and Pakistan. Based on these and the previous work of Deaton (1988, 1990), Deaton (1997)

[16]Different political regimes have made concerted efforts to encourage people to use potatoes as a key substitute for rice

[17]I run the village effect regression for each food item and find that for most of the common and widely consumed food items across villages, the village effects explain a substantial share of total variance of the logarithm of unit values.

summarizes that the quality effects are real but modest and provides a method to control for quality effect and measurement errors in estimating price elasticity of demand using unit values.

To assess the quality effect in IFPRI data, I run a similar regression of the following form (equation 5.6), first, for each of the food groups, and then for each of the finely disaggregated food item as Deaton (1997) argues that ultimately the quality effect will be absent for a finely disaggregated homogeneous food item:

$$lnρ = \alpha_1 + \beta_1 lnx + \beta_2 lnn + \mathbf{c} \times \beta_3 + \sum_v \gamma_v d_v + \sum_r \delta_r t_r + u_1 \tag{5.6}$$

where ρ is the unit value, x is the monthly per adult equivalent real household expenditure (nominal expenditure deflated by village rice price of a given round), n is the adult equivalent household size, **c** is a vector of household characteristics, such as age, education, and occupation of the household head and his/her spouse, d is the village dummy, t is the dummy for survey round, and u_1 is the error term. The coefficient β_1, which measures the expenditure elasticity of quality for different food groups and specific food items are summarized in table 5.2.

I find that the quality effect is not significant for the important food groups that provide bulk of the energy requirements for the rural households, such as, rice, wheat and wheat products, potatoes, and lentils. For more heterogeneous food groups, such as fish and meat, the quality effect is significant but modest, while the effect is somewhat high for the milk group.

However, investigation of the quality effect for each of the finely disaggregated food item reveals that these quality effects for milk, fish, meat, sugar (that includes also sweets), and other food groups are primarily because of the bunching of a variety of heterogenous commodities under each group. At a more disaggregated level, for most of the commonly consumed food items within each of this food group, the quality effect is nonexistent. This is further illustrated in the right panel of table 5.2. Among the broadly defined food groups, the expenditure elasticity of quality seems to be highest for milk and milk products (17%). Disaggregating this category into the specific food items, it appears that the quality elasticity is modest (only 2%) for unpasteurised cow milk and significant only at 10% level, while for the ice-cream, it is not significant. Similarly, for the heterogenous meat group, the quality elasticity is 3.5%, which is modest. But disaggregating this group into specific meat types, i.e., beef, chicken, and mutton, it appears that the quality effect is nonexistent for any of these food items. For the fruit group as well, for majority of the commonly consumed fruits, such as, mango, papaya, guava, pineapple, etc. the quality effect is absent, while for a few fruits, such as jackfruit, banana, and coconut, it is substantial. A similar phenomenon is seen in the fish group (and also for most of the other groups, the results for which are not shown).

The absence of (or modest) quality effect for most of the widely consumed food items is consistent with the phenomenon of lack of product differentiation in rural markets due to lack of technological advancement and the relatively underdeveloped agro-processing industry in the country. Typically, most of the food items are purchased in raw, unrefined, or unprocessed form from the local bazaar (markets) for household cooking and food preparation purposes. Hence, while the beef and chicken are two different types of meat, it is the same raw beef or chicken that the households of different income levels and in different villages purchased for consumption.

To proxy for village price for each of the finely disaggregated food items, I average the unit values of a given food item consumed by all the households in a given village in a given round. This averaging procedure is expected to minimise the measurement error in the data and eliminate any potential quality effect (although as discussed above for most of the food items such an effect is absent). The mean unit values at different villages in different rounds for a few key food items are presented in figures 5.1 - 5.6.

These figures illustrate at least three points. First, even for primary staple rice, there is both spatial variation in price across villages and seasonal variation within a particular village. For instance, the minimum mean unit value of rice is Tk 8.5 in village 46 in round 1 while it is Tk 12.5 in village 6 in the same round. In terms of seasonality, for instance in village 3, the price per kilogram drops by almost 42% between rounds 3 and 4. Second, compared with rice, the spatial and seasonal variation is relatively higher for some other food items like fish, meat, and milk. In round 1, the mean price of rice per kilogram across all the villages are about 10 taka with a standard deviation of 0.88, while for instance that of chicken in the same round is Tk 76 with a standard deviation of 12.5. Third, as the graphs show, the seasonal fluctuation varies among villages, in some villages it is more prominent than in others. Exploiting these features of the mean unit values (proxy for village prices), I estimate the hedonic price function in the next section.

The other feature of the survey, which is used in previous chapters, is the individual food intake data. As discussed in the previous chapters, the survey provides information on individuals' food intakes. Using the Berkeley Food Composition Table, individual intakes of various foods are converted into intakes of calories and its decomposition into macronutrients, i.e., protein, fat, and carbohydrate, and into intakes of a set of micronutrients, vitamin a, vitamin c, vitamin d, niacin, riboflavin, thiamine, folate, iron, zinc, and calcium. While there are more nutrients in different foods that are not brought into the analysis, the intakes of these nutrients are critical (as discussed in chapter 1) and was also analysed in the previous literature, such as in Behrman and Deolalikar (1990).

As many of the nutrients are present, albeit in different quantities in different foods, and as an individual consumes different foods, the individual intake of different nutrients are correlated. Table 5.3 provides the correlation matrix of individuals' nutrient intakes, in which the intake of each individual nutrient is expressed as per unit of calorie. As is well-known, calorie is a linear combination of three macronutrients: protein, fat, and carbohydrate[18]. A key finding from the correlation matrix is that higher share of carbohydrate in one's total calorie intake appears to be negatively correlated with two other macronutrients and the set of micronutrients. Among the micronutrients, intakes of zinc, iron, and thiamine per unit of calorie also seem to be relatively

[18]Per gram of carbohydrate, fat, and protein roughly yield 4 kilocalorie (kcal), 9 kcal, and 4 kcal, respectively. In this chapter, as in other literature, the calorie is loosely used as kilocalorie, i.e., 1 calorie=1kcal.

highly correlated[19].

In the next section, I further explore how responsive are individual intakes of various nutrients with respect to the implicit price of nutrients after distilling out the so called food or product effect in terms of taste, texture, aroma, etc.

5.5 Empirical Analysis

5.5.1 Hedonic Food Price Regression

Based on the above discussion related to various nutritive and non-nutritive characteristics of a food item that may influence people's demand for food, the first step is to estimate the implicit prices of nutrients by separating out the "food" effects, i.e., non-nutritive characteristics of a given food item. This is done by estimating a hedonic price regression by regressing the logarithm of mean village unit values of different food items on their nutritive characteristics, controlling for the unobserved product effects through food dummies and unobserved village effect through village dummies.

I follow an estimation strategy similar to Brown and Rosen (1982) as discussed in section 5.2. Each village in a specific survey round is viewed as a spatially distinct market. Exploiting the features of spatial variation in prices, combined that with the limited or no evidence of quality effect, and averaging out the quality effect (if there is any) and the measurement error in the unit values at the household level, I use the mean village-level unit value of a given food item as the proxy for village price for that item. Using these proxy village prices for different food items in different rounds, I identify the implicit nutrient prices in different villages at different time periods.

More specifically, let $\mathbf{V}$ be a set of villages, $\mathbf{J}$ be a set of different food items and $\mathbf{C}_j$ be the vector of all the nutrients embodied in per unit of food j where $j \in \mathbf{J}$. Let p_j be the price of the food item $j \in \mathbf{J}$ is p_j. We assume that $\forall j \in \mathbf{J}$, p_j is the same within a village $v \in \mathbf{V}$ but it differs across villages, i.e., $\forall j \in \mathbf{J}$, $p_{jv_m} \neq p_{jv_n} \forall m \neq n$, and $p_{jv_m} = p_{jv_n} \forall m = n$.

Thus the hedonic price regression that I estimate is:

$$ln\mathbf{p_{jvt}} = \alpha + \mathbf{C_j}\beta_{\mathbf{t}} + \sum_{v=2}^{47} \gamma_{vt} D_v C_j + \sum_{v=2}^{47} \eta_{vt} D_v + \sum_{j=2}^{109} \delta_{jt} F_j + u_{jt} \tag{5.7}$$

where, t is the survey round, D_v is the village dummy, F_j is the food dummy controlling for the food effect (the omitted food item is rice), and u_{jt} is the random error term. The coefficient vector $\beta_{\mathbf{t}}$ provides the log of implicit price of nutrients in the omitted village at time t while the implicit

[19] As discussed in chapter 1, for some of the nutrients, such as protein and iron the sources matter a lot. For instance protein from meat, egg, and milk are considered as high quality and highly digestible compared to the protein from the plant sources such as from rice. Similarly, iron from animal sources, i.e., haem iron, get easily absorbed in the body compared to iron (known as nonhaem iron) from plant sources. Such minute distinction for these two nutrients, however, are not further pursued here. For the purpose of empirical analysis I also drop oil, spices, and miscellaneous food categories as actual individual intakes of these items are hard to determine. These are used as condiments to prepare the whole meal, which is then eaten by different members.

prices of the nutrient vector in a village v at time t is : $\beta_t + \gamma_{vt}$. Logarithm of the village level mean unit values of different food items at different survey rounds, as calculated and discussed in the preceding section, are used as the dependent variable in this regression function.

I first estimate equation 5.7 to obtain the implicit price of calorie in different villages at different rounds. The nutrient vector $\mathbf{C_j}$ becomes a scalar in this case representing total calorie per unit of food j and β_t is the log price of per unit of calorie in village 1 at time t. Adding it to γ_{vt}, I obtain the calorie price in village v at time t.

The implicit price of calorie is important in its own right, particularly in a number of circumstances. First, assume a situation where people's demand for food is primarily driven by the need to satiate hunger. Suppose, people demand food to satisfy their energy need and also to obtain pleasure from its non-nutritive attributes, such as taste or aroma. Second, coupled with this demand, assume a situation where given the low literacy level within the household limits the knowledge about the requirements of different nutrients, their availability in different food items, and their usefulness for healthiness and wellbeing[20]. In these circumstance, the households do not primarily consume food to fulfil various nutritional requirements, but to satisfy the energy needs of its members. However, in this process, the requirements for some of the nutrients, are (partially) fulfilled by the consumption of the food items chosen to satiate hunger as typically a food item is embodied with different nutrients *albeit* in different proportions. Third, there could be a situation in which people are aware of the importance of various nutrients, but there are short-term and long-term issues associated with satisfying different nutritional requirements. Hunger is of more immediate concern, while satisfying the calcium requirement, for example, is a relatively longer term issue. This is because the implication of going hungry is immediate, while it takes time for the bones to weaken due to sustained deficiency of calcium over a relatively longer period of time, among other things. In all of these circumstances, the most important nutritive aspect of a food item is its energy content. Hence, understanding the response of individuals' intakes of calorie and other nutrients to the implicit price of calorie is important from the policy point of view.

After estimating the implicit calorie price, I then estimate the hedonic price regression for the whole set of macro (by decomposing calorie intake into protein, carbohydrate, and fat) and micro nutrients (i.e., vitamins and minerals) under consideration. Detailed estimates of these series of hedonic price regressions are not presented to conserve space, but the correlation matrix of the implicit price of different nutrients in the sample are presented in table 5.4.

[20]In other words, if a rural Bangladeshi were asked about the amount of riboflavin or niacin contained in per unit of rice or in beef, it would not be surprising if that person did not know what riboflavin or niacin was, let alone the amounts of these nutrients that could be found in rice or in meat. Although that could make the same mistake if the same question was asked about the amount of calories in these food items, he or she would be well aware of how full a stomach could be from a given quantity of rice, meat or vegetable. This is the attribute of the food item, which is linked with its calorie content.

5.5.2 Demand for Nutrients

In this subsection, I estimate the individual nutrient intake responses to implicit nutrient prices in rural Bangladesh. The standard reduced form demand function in the literature is:

$$ln\mathbf{q^k_{ihvt}} = a + bln\mathbf{P_{vt}} + cln\mathbf{Y_{hvt}} + dln\mathbf{Z_{hv}} + u^k_{ihvt} \tag{5.8}$$

where, $\mathbf{q^k_{ihvt}}$ is the intake of nutrient k of individual i living in household h in village v at time t, $\mathbf{P_{vt}}$ is a vector of village food prices at time t, $\mathbf{Y_{hvt}}$ is the current or real per capita or per adult equivalent household income, $\mathbf{Z_{hv}}$ is a vector of observed time invariant household characteristics and u^k_{ihvt} is the error term. Equation 5.8 could be further augmented by including time dummies to explore the effect of agricultural seasonality and/or village, household, and/or individual fixed effects to control for unobserved location, household, or individual specific effects, which could be correlated with the village food prices, income and other household characteristics.

I differ from this conventional reduced form demand equation by replacing the food price vector, $\mathbf{P_{vt}}$ with the implicit nutrient price vector, $\mathbf{\Gamma_{vt}}$, estimated in the previous subsection. This attempt sheds light on to what extent individuals' demand for food are driven by the nutrient contents of the food vis-a-vis the non-nutritive attributes. Thus the reduced form demand equation that I estimate is:

$$ln\mathbf{q^k_{ihvt}} = \pi + \varpi ln\mathbf{\Gamma_{vt}} + \zeta ln\mathbf{Y_{hvt}} + \vartheta ln\mathbf{Z_{hv}} + \xi^k_{ihvt} \tag{5.9}$$

As I have four rounds of data, in order to control for agricultural seasonality, I also include round and site dummies in equation 5.9 and perform both the OLS and individual fixed effect (FE) estimates to control for unobserved individual specific characteristics that may otherwise contaminate the income and price elasticities. Controlling for individual fixed effects also controls for any unobserved village and household fixed effects. In terms of household characteristics, I use (log of) per capita adult equivalent household expenditure deflated by the village rice price (measured by the mean unit value of rice in a given village) as a measure of real income, its square, log of household landholding and site dummies and log of adult equivalent household size. Individual characteristics include age and its square and a dummy equals 1 if the individual is female and zero otherwise. However, households' landholdings, site dummies, and gender dummy drop out in the FE estimate.

Nutrient Intakes and Implicit Calorie Price

I first estimate individual nutrient intake response to implicit calorie price only for reasons already discussed above. The village level implicit calorie price is deflated by the village rice price to obtain a measure of real price for calorie. Table 5.5 reports the elasticity estimates for calorie and its disaggregation into the macronutrients, while table 5.6 reports the estimates for micronutrients.

Overall, individual calorie and macronutrient intakes are statistically significant but inelastic to implicit calorie price. The calorie intake to calorie price elasticity is only -0.06 in FE estimate. However, decomposing calories into specific macronutrients reveal that intakes of protein and fat compared to carbohydrate although inelastic are relatively more responsive to calorie price than the carbohydrate intakes. The responsiveness of fat intake is almost twice of that of protein intake in FE estimate. Finally, as the column (9)-(14) show, an individual's calorie composition changes with the increase in calorie price. As price increases, the share of protein and fat in one's calorie intake declines (with fat more than protein) while the share of carbohydrate increases implying carbohydrate as a cheaper source of calorie than the two other macronutrients.

As far as the other variables are concerned, individuals' consumption of calories and each of the macronutrients increases with household income at the lower level of income, and then at a higher income level these consumptions tend to decline with the increase in income. In terms of calorie composition, intakes of protein and fat increase while carbohydrate decline with the increase in income at the low income level. Also, females (controlling for age) tend to have less calories and the macronutrients than males.

None of the calorie price elasticities are greater than one for individuals' micronutrient consumption either although some of the micronutrient intakes, such as, vitamin A, vitamin C, and calcium, appear to be relatively more responsive to calorie price than the others. I estimate both OLS and FE models using log of micronutrient intake as a share of calorie as the dependent variable but to conserve space I only report the FE estimates (table 5.6). For most of the micronutrients, the magnitude of both price and income elasticities are considerably lower in FE estimate compared to the corresponding OLS estimates after eliminating unobserved location, household, and individual specific effects. Nonetheless, compared with the calorie price responsiveness of calorie and macronutrient intakes as a share of calorie, the magnitude of the price responsiveness of these three micronutrient intakes are still higher. This is consistent with the different situations discussed above in which calorie, and thus macronutrient consumption, becomes more important to satiate hunger than meeting the micronutrient requirements either due to people's limited knowledge about micronutrients and/or the relatively longer term nature of the impact of lack of micronutrient consumption compared with the more immediate pain of hunger. On the other hand, a reduction in calorie price (and micronutrient prices as discussed below) can influence higher intakes of some of these critical micronutrients implying price mechanism as a key policy lever to address malnutrition issues.

In terms of income elasticity, vitamin D appears to be highly (positively) elastic at the lower level of income. Although inelastic, vitamin A and C also appear to be sizeably responsive to income at the lower level.

Nutrient Intakes and Implicit Macro and Micro Nutrient Prices

After exploring the aggregate calorie price elasticity, I analyse the responsiveness of total calorie and macronutrient intakes to implicit macronutrient prices, and the responsiveness of micronutrient intakes to micronutrient prices[21]. As presented in table 5.7, focusing on FE estimate, I find that total calorie intake is negatively associated with the increase in protein price (an elasticity of -0.28) and fat price (an elasticity of -0.81), while the calorie intake has high positive elasticity with respect to carbohydrate price. This implies that protein and fat (particularly, protein) are substituted for carbohydrate when the price of carbohydrate increases while when the price of protein and fat increases consumption of carbohydrate tends to decline with decreased protein and fat consumption. Altogether, this implies people's preference for protein over carbohydrate consumption.

This is further evident from the responsiveness of the absolute intakes of these three nutrients to nutrient prices. As the table shows, individual protein intake is negative and inelastic to the increase in protein price, closer to unitary elasticity with respect to fat price, and highly elastic (positively) to carbohydrate price. Fat intake is elastic (negative) both to own fat price and to protein price, while the effect with respect to carbohydrate price although substantial not statistically significant. Conversely, the own price elasticity of carbohydrate intake is not statistically significant, while the intake of carbohydrate is negatively associated with the increase in protein and fat prices. As a share of total calorie, the own price elasticity for any of these three nutrients are not significant. However, protein intake as a share of total calorie is highly elastic (positive) with respect to carbohydrate price, while carbohydrate intake as a share of total calorie is highly inelastic *albeit* positive with respect to protein price. Fat intake as a share of total calorie is negatively associated with both protein (the elasticity is close to unity) and carbohydrate price (highly elastic).

While I estimate both OLS and FE models to investigate micronutrient intake responses to micronutrient prices, to conserve space I summarise the FE results as the unobserved location, household, and individual effects may contaminate the OLS estimates anyway (table 5.8). The intakes are expressed as a share of calorie intake. The own price elasticity of vitamin A and calcium intake seem highly elastic (negative). While the own price elasticity of vitamin A is substantial, it is not significant. For a number of micronutrients, the cross price effects are highly elastic and significant. For instance, the intakes of vitamin C and calcium are highly (negatively) elastic with respect to vitamin A price, while the intakes of niacin, thiamin, and zinc are highly (positively) elastic with vitamin A price. Intakes of a series of critical nutrients, such as vitamin A, niacin, riboflavin, thiamin, and calcium are also highly (negatively) elastic to vitamin C price. In addition to highly elastic and negative own price effect of folate and calcium, the prices of these nutrients negatively affect the intakes of a number of other nutrients, and these effects are highly elastic. Finally, even though inelastic, both the own and cross-price elasticities are sizeable for a number of

[21] Unlike the case of calorie price, I do not deflate the nutrient prices by the village rice price, but control for the village rice price in the regressions. This is because deflating the nutrient prices by rice price creates a very high degree of collinearity among a large number of nutrient prices, which in turn could create the problem of multicollinearity by controlling for the set of highly collinear prices in the same regressions

other nutrients as can be seen from table 5.8.

Nutrient Intake Behaviour of Poor and Non-Poor Households

A key topic of investigation in past food demand literature, as discussed in section 5.2, was whether or not the poor are more responsive than the non-poor to food price changes. In the estimates presented in the previous subsection, it appears that nutrient consumption is more responsive at a relatively lower level of income. In this subsection, I analyse the nutrient intake behaviour of individuals of poor and non-poor households by estimating equation 5.9 separately for each of these groups by OLS and FE methods. Based on the direct calorie intake method of poverty line, households are classified as poor in any given round if their per capita calorie consumption in that round is below 2122 kcal. As I now split the sample between poor and non-poor group, I no longer control for the square of the household per capita expenditure in the regression. For any given nutrient intake, the pattern of the difference between poor's and non-poor's response to price, income, and other control variables is broadly similar between OLS and FE estimates. To conserve space, I only report the FE estimates.

Although inelastic with respect to calorie price, the poor's intakes of protein and fat (with fat more than protein) are more responsive to price than the non-poor's intakes of these macronutrients (table 5.9). With the increase in calorie price, the poor's share of protein and fat as a share of total calorie decline more than the corresponding share of these nutrients in total calorie intake of the non-poor people. For instance, a 100% increase in calorie price will lead to a 12% decline in protein share in the total calorie for the poor, while the corresponding decline will be only 5% for the non-poor. The magnitude of difference is even higher for the fat consumption where the poor's price elasticity is more than three times higher than that of the non-poor. Thus the pattern of price responsiveness suggest that both poor and non-poor households will consume less protein and fat and slightly more carbohydrate due to increase in calorie price while these magnitudes of decline in protein and fat and the increase in carbohydrate (as share of total calorie) are higher for poor people compared to non-poor. Conversely, the non-poor's income elasticity of these intakes (both in absolute quantities and as shares of total calorie) are higher compared to that of the poor implying that particularly to impact the macronutrient consumption of the poor people, the price-subsidy will be a more effective instrument than the overall income enhancing policies.

For all the micronutrients (expressed as share of calorie intake), the poor's intakes are more responsive to calorie price than that of the non-poor (table 5.11). With the exception of vitamin D that has a positive elasticity, for all other micronutrients, the calorie price elasticity is negative and sizeable although inelastic. For instance, the poor's calorie price elasticity for vitamin C intake (-0.49) is 2.5 times as much as that of the non-poor's, while the poor's price elasticity for riboflavin is almost four times as much as the corresponding elasticity of the non-poor people. Moreover, all the calorie price elasticities are statistically significant for the poor, while some of these are not significant for the non-poor group.

Using implicit macronutrient prices instead of calorie price (table 5.12), I find that compared with the non-poor, the poor's total calorie intake is more responsive and negatively affected by the increase in protein and fat prices. Conversely, the non-poor's total calorie increases with the increase in carbohydrate price (and this effect is highly elastic). This implies the non-poor's substitution of carbohydrate for protein and fat as the carbohydrate price increases. With the increase in carbohydrate price, the consumption of protein in absolute terms increases more for the non-poor than for the poor, while protein as a share of total calorie increases more for the poor than for the non-poor. This implies relatively lower total calorie intake in absolute terms for the poor compared to the non-poor, which is already illustrated in chapter 3. All these effects are highly elastic for both groups. In terms of own-price elasticity, only the fat price is statistically significant for both poor and non-poor groups. For the poor, it is elastic while for the non-poor, it is inelastic but still of sizeable magnitude.

In terms of own price elasticity of micronutrient intakes, the poor's intakes of vitamin A, vitamin C and calcium are highly elastic and more responsive compared with the corresponding intakes of the non-poor (table 5.14). Prices of these nutrients and that of the folate also seem to very substantially and significantly affect the intakes of several other nutrients particularly for the poor. Although the own price response is sizeable but inelastic for a number of nutrients, such as iron, both the own and cross-price elasticity of some of these nutrients are also substantial in magnitude, particularly for the poor.

Overall, for a large number of nutrients, the poor's responsiveness to prices are much larger than that of the non-poor. These findings have significant policy implications in terms of price-subsidy of nutrients in developing countries.

5.6 Summary and Conclusion

The findings of the past literature on food demand analysis were mixed. Some studies claim relatively high price elasticity of calorie and other nutrient intakes to food price changes while others view the opposite. Given that people typically consumes hundreds of different food items, which are motivated by the nutritive and non-nutritive attributes, controlling for the prices of a few basic food items (as done in many of the studies) may not necessarily provide a good picture of the nutrient intake behaviour of the people.

Using implicit nutrient prices, I find that calorie, macronutrients, and a set of micronutrients are inelastic in response to implicit calorie price. In terms of the broad order of magnitude, calorie is the most inelastic, followed by the macronutrients, and the micronutrients. Therefore, if alleviating hunger is a key priority of the government, the scope of addressing this issue by subsidizing prices of calorie-dense food items may be limited. This is particularly because for both poor and non-poor, the calorie intake is highly inelastic to implicit calorie price. Conversely, an increase in the prices of carbohydrate-dense food items (which are basically staples in many developing countries like Bangladesh), ceteris paribus, may have some beneficial impacts of people's consumption of protein (although mainly for the non-poor) and a range of micronutrients as higher share of carbohydrates in total calorie is also negatively associated with the share of protein, fat, and the set of micronutrients considered here in individuals' calorie intakes.

More than its impact on calorie, a decrease in calorie-price, however, will have limited but positive impact on people's consumption of a range of micronutrients. Although inelastic, the magnitude of calorie price elasticity for the micronutrient intakes is relatively higher than the calorie intake itself. Moreover, both in terms of macronutrients and micronutrients, the poor's intakes while broadly inelastic are nonetheless more responsive to calorie price than the intakes of the non-poor. Therefore, calorie price subsidy will have relatively more beneficial effect on the poorer segment of the population in Bangladesh.

In contrast with calorie price, peoples' micronutrient intakes are highly elastic to micronutrient prices, and for a number of critical micronutrients, such as vitamin A, vitamin C, and calcium, the poor have higher own price elasticities compared to non-poor. Furthermore, for these and some other micronutrients the cross-price elasticities are also highly elastic and higher for poor than non-poor.

Altogether this imply that the conventional way of addressing people's hunger and nutrition needs by typically subsidising one or two key staples need to be revisited. Moreover, in light of growing micronutrient malnutrition problem, food policy needs to be revisited not only in light of hunger but also in light of meeting people's micronutrient needs. And in this connection, as the results of this paper imply, price policy of a wide variety of food items rich in different micronutrients can play an important role to meet people's, particularly poor people's nutritional need and well-being. Obviously, in this connection, awareness also need to be built around on the importance of various nutrients in diet and their usefulness for health and wellbeing.

Finally, beyond the price subsidy policy, people's responsiveness to different micronutrients and cross-price effects of the macronutrients suggest agricultural marketing potential of various nutrient-dense as opposed to calorie or carbohydrate-dense food items in rural Bangladesh in the long run. With technological advancement and further development of food-processing industry, which should increase competition and thus increased availability of nutrient-rich processed food items at lower prices. This will eventually enhance the market mechanism to meet people's nutritional needs and eventually reduce the role of the government's price subsidy policies to address nutritional requirement of the people.

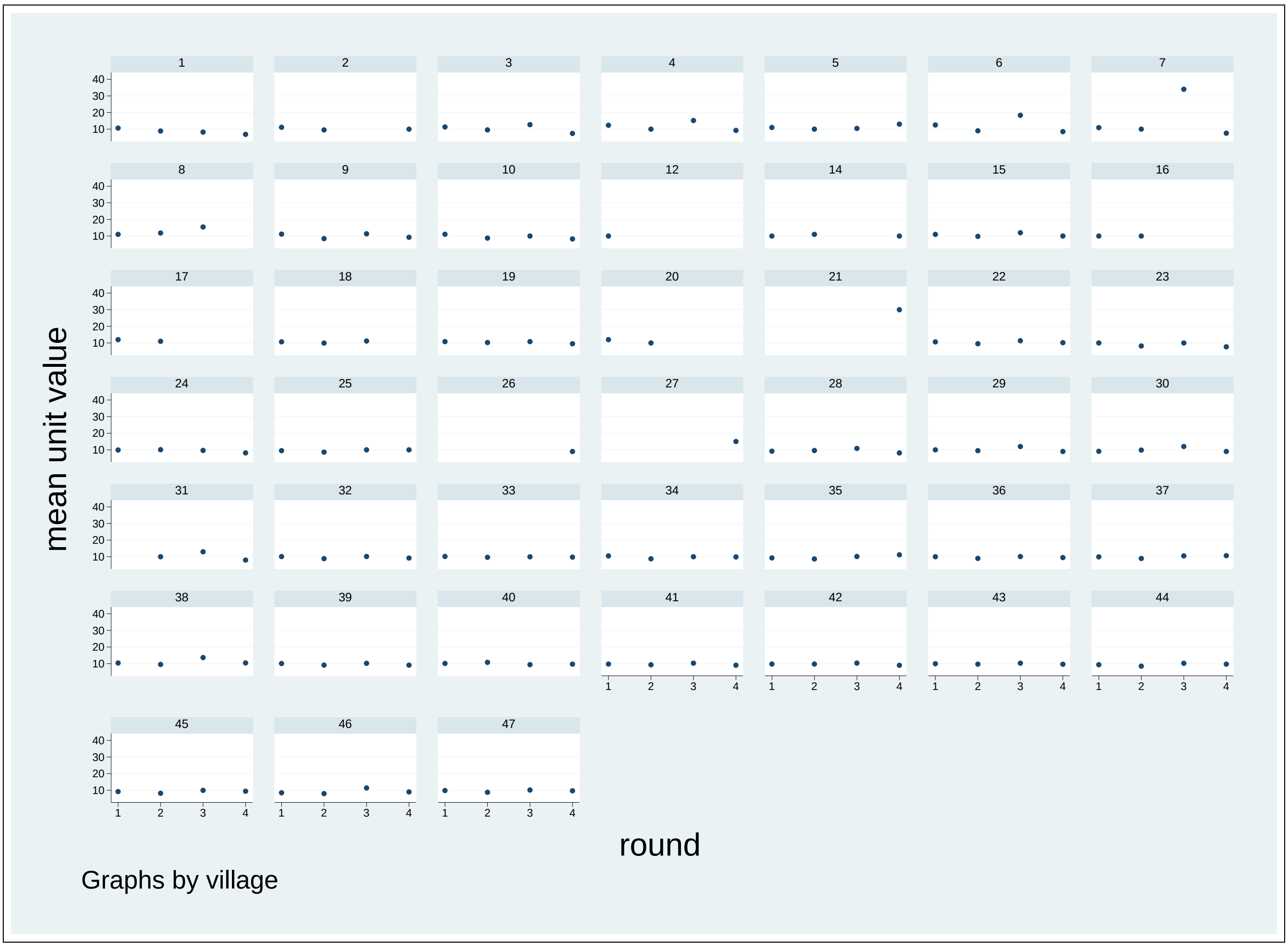

Figure 5.1: Unit Value of Rice across Villages and Rounds

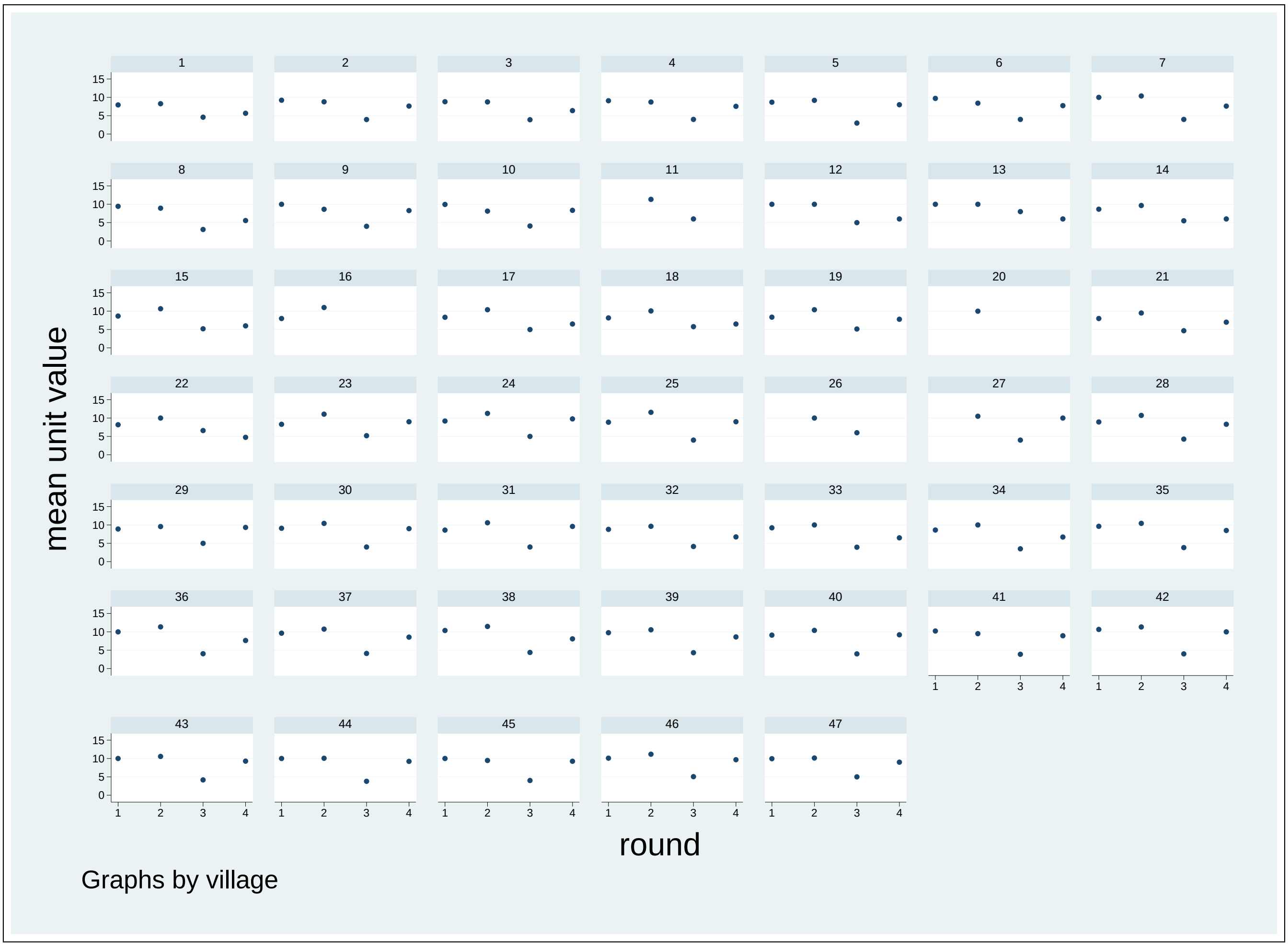

Figure 5.2: Unit Value of Potato across Villages and Rounds

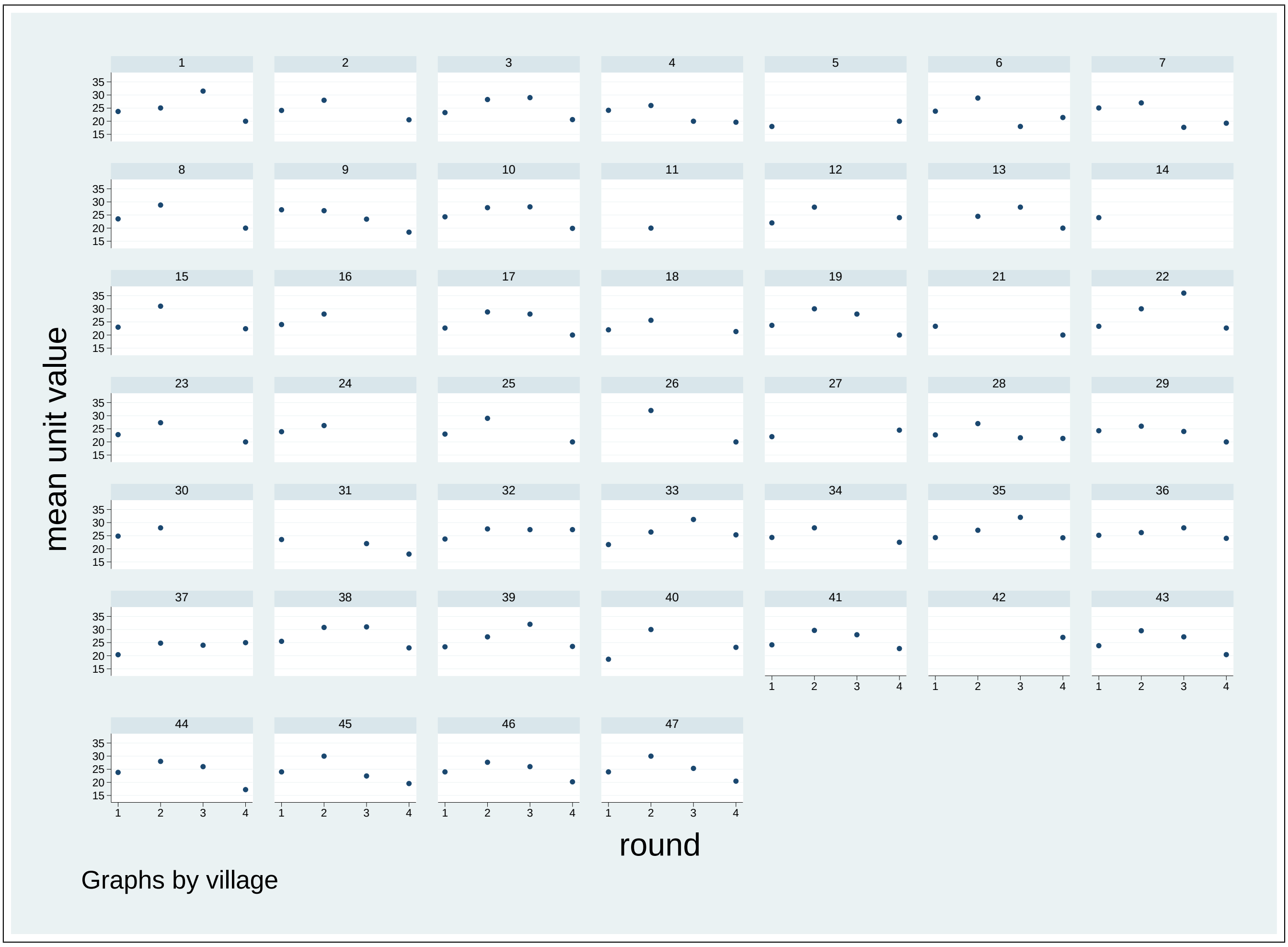

Figure 5.3: Unit Value of Lentil (Khesari) across Villages and Rounds

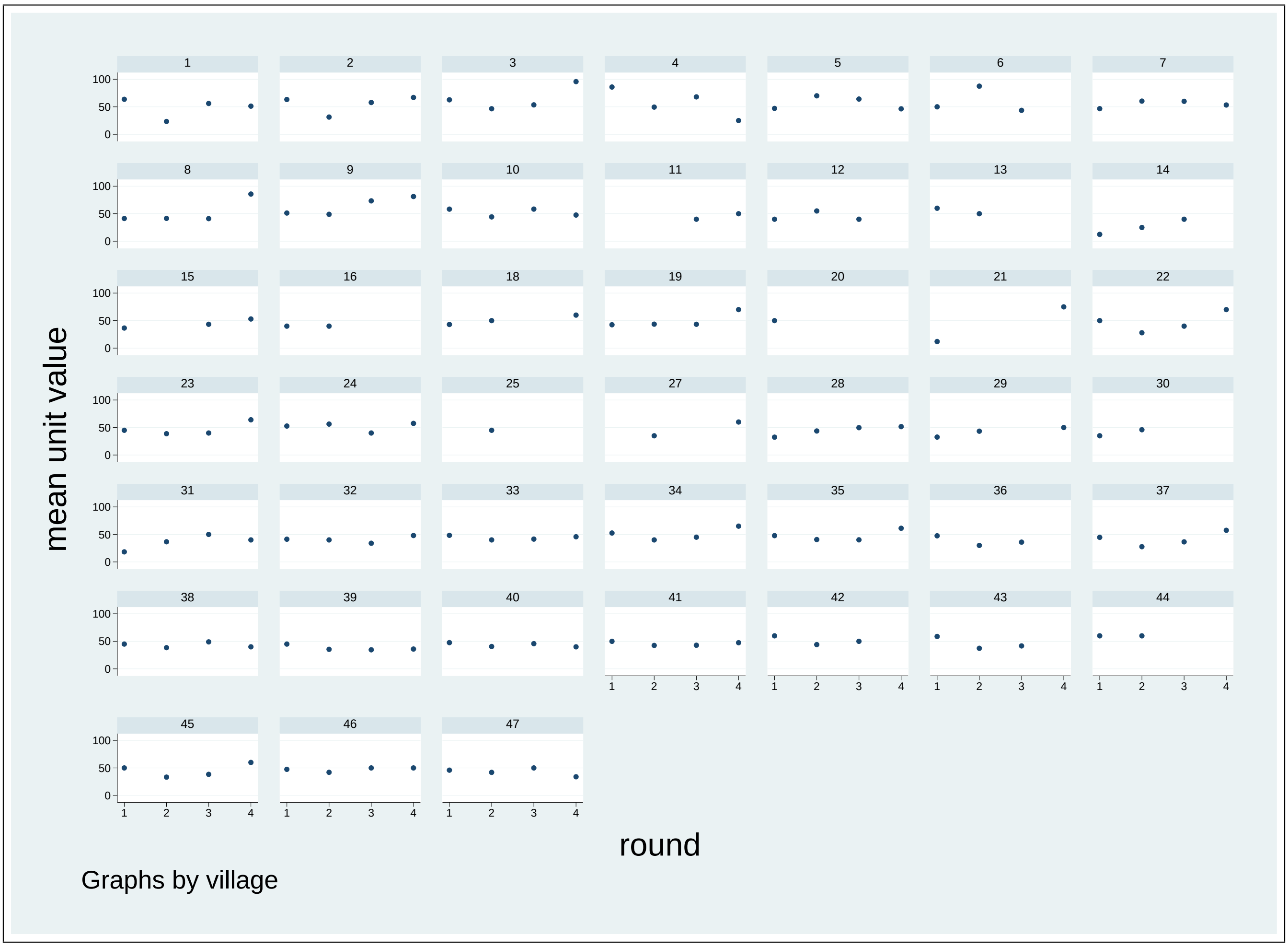

Figure 5.4: Unit Value of Carp (Rui Fish) across Villages and Rounds

Figure 5.5: Unit Value of Beef across Villages and Rounds

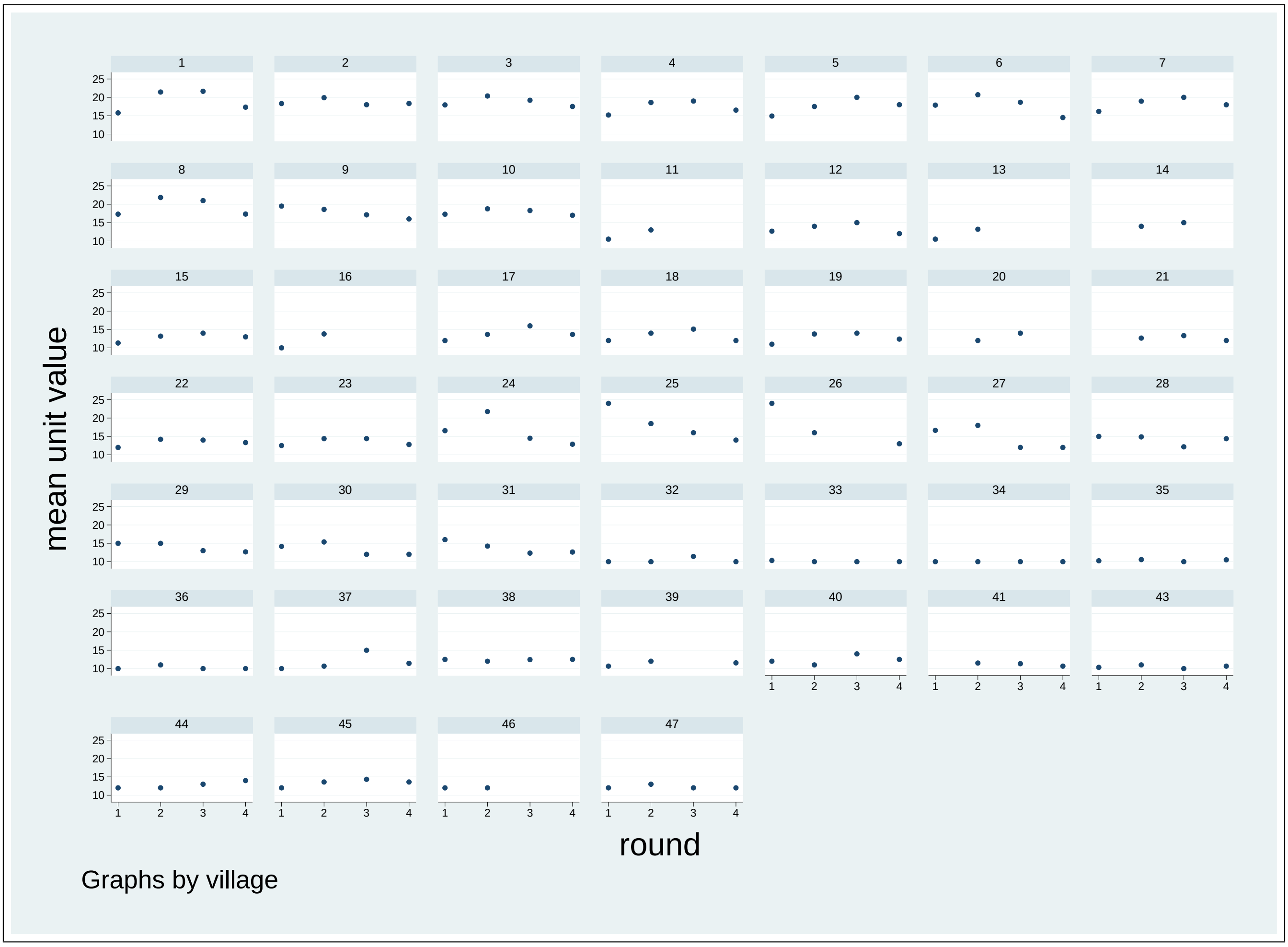

Figure 5.6: Unit Value of Cow Milk across Villages and Rounds

Table 5.1: Variation in Log Unit Values of Foods in Rural Bangladesh

Food Group	Analysis of Variance		
	F	*Prob* > *F*	R^2
Rice	3.25	0.00	0.14
Wheat	1.73	0.01	0.19
Other cereals	2.87	0.00	0.14
Lentils	5.66	0.00	0.10
Potato	2.61		0.06
Leafy Green Vegetables	7.48	0.00	0.18
Other vegetables	3.47	0.00	0.01
Fruits	2.06	0.00	0.02
Big fish	3.69	0.00	0.05
Small Fish	6.77	0.00	0.06
Meat	1.93	0.00	0.04
Egg	2.01	0.00	0.09
Milk	12.42	0.00	0.35
Oil	2.65	0.00	0.04
Sugar and sweets	12.42	0.00	0.10
Spices	13.03	0.00	0.05
Other	24.59	0.00	0.13

Individual Food	Food Group	Analysis of Variance		
		F	*Prob* > *F*	R^2
Flour	Wheat	1.67	0.02	0.30
Cabbage	Leafy green vegetables	4.29	0.00	0.39
Lal shak	Leafy green vegetables	2.07	0.00	0.27
Palang-Shak	Leafy green vegetables	3.18	0.00	0.42
Pui shak	Leafy green vegetables	5.49	0.00	0.37
Chichinga	Other vegetables	3.29	0.00	0.55
Cauliflower	Other vegetables	4.09	0.00	0.47
Bitter Gourd	Other vegetables	21.94	0.00	0.59
Lau	Other vegetables	1.91	0.00	0.22
Radish	Other vegetables	3.37	0.00	0.25
Patal	Other vegetables	8.50	0.00	0.37
Jack fruit	Fruits	2.65	0.00	0.23
Orange	Fruits	4.77	0.00	0.49
Hilsha	Big fish	3.67	0.00	0.20
Silver carp	Big fish	4.40	0.00	0.21
Chapila	Small fish	1.62	0.05	0.34
Shrimp	Small fish	3.95	0.00	0.28
Beef	Meat	5.98	0.00	0.18
Chicken	Meat	2.15	0.00	0.20
Mutton	Meat	9.36	0.00	0.54
Duck egg	Egg	4.72	0.00	0.45
Cow milk	Milk	30.87	0.00	0.61
Dalda	Oil	1.78	0.01	0.23
Dried Chili	Spices	26.37	0.00	0.43

Table 5.2: Expenditure Elasticity of Quality in Rural Bangladesh

Dependent Variable: Log Unit Value

Food group	ln x	S.E.	Food group	Food Items	ln x	S.E.
Rice	0.026	[0.019]	Milk	Cow milk	0.021*	[0.011]
Wheat	0.181	[0.114]	Milk	Ice cream	0.024	[0.107]
Other Cereals	0.097	[0.099]	Fruits	Mango	0.093	[0.077]
Lentils	0.006	[0.013]	Fruits	Banana	0.121**	[0.051]
Potato	0.001	[0.010]	Fruits	Papaya	-0.030	[0.438]
Leafy green vegetables	0.046	[0.030]	Fruits	Orange	0.026	[0.098]
Other vegetables	0.019*	[0.011]	Fruits	Apple	-0.143	[0.207]
Fruits	0.110**	[0.048]	Fruits	Coconut	0.091**	[0.040]
Big fish	0.068***	[0.020]	Fruits	Jack Fruit	0.262***	[0.099]
Small Fish	0.042**	[0.020]	Fruits	Grapefruit	0.085	[0.423]
Meat	0.035*	[0.019]	Fruits	Grapes	0.095	[0.148]
Egg	-0.025	[0.046]	Fruits	Lemon	0.002	[0.169]
Milk	0.170***	[0.054]	Fruits	Pineapple	0.058	[0.071]
Oil	0.001	[0.011]	Fruits	Guava	0.038	[0.202]
Sugar	0.093**	[0.037]	Fruits	Ambada	-0.486	[0.376]
Spices	0.087***	[0.020]	Fruits	Date	0.001	[0.062]
Other	0.014	[0.042]	Fruits	Olive	-0.114	[0.369]
			Meat	Beef	-0.002	[0.007]
			Meat	Chicken	0.016	[0.034]
			Meat	Mutton	0.017	[0.017]
			Meat	Pigeon	-0.207	[0.211]
			Meat	Duck	0.065	[0.403]
			Big Fish	Rui	0.053	[0.047]
			Big Fish	Mrigel	0.017	[0.076]
			Big Fish	Katal	0.475	[0.448]
			Big Fish	Hilsha	0.042	[0.031]
			Big Fish	Silver Carp	0.063**	[0.032]
			Big Fish	Tilapia	0.025	[0.048]
			Big Fish	Saulted Hilsha	-0.043	[0.037]
			Big Fish	Carfu	0.071	[0.335]
			Big Fish	Ritha	-0.045	[0.148]

Heteroscedasticity consistent robust standard errors allowing for correlation among observations of the same household in different rounds are in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. For description of additional controls see section 6.2.

Table 5.3: Correlation Matrix of Nutrient Intake per unit of Calorie

	protein	fat	carbohydrate	vitamin A	vitamin C	vitamin D	niacin	riboflavin	thiamin	folate	iron	zinc	calcium
protein	1.00												
fat	0.17	1.00											
carbohydrate	-0.48	-0.94	1.00										
vitamin A	0.23	0.12	-0.18	1.00									
vitamin C	0.04	0.09	-0.09	0.33	1.00								
vitamin D	0.50	0.13	-0.28	-0.01	-0.02	1.00							
niacin	0.56	0.21	-0.37	0.20	0.13	0.19	1.00						
riboflavin	0.47	0.29	-0.42	0.66	0.27	0.00	0.41	1.00					
thiamin	0.59	0.18	-0.35	0.30	0.21	0.07	0.68	0.59	1.00				
folate	0.37	0.11	-0.22	0.48	0.28	-0.07	0.18	0.34	0.42	1.00			
iron	0.58	0.16	-0.33	0.47	0.20	-0.04	0.57	0.59	0.80	0.70	1.00		
zinc	0.70	0.08	-0.30	0.18	0.01	-0.04	0.62	0.42	0.77	0.39	0.76	1.00	
calcium	0.38	0.31	-0.40	0.59	0.29	-0.01	0.23	0.74	0.38	0.50	0.50	0.28	1.00

Table 5.4: Correlation Matrix of Log Implicit Nutrient Prices

	calorie	protein	fat	carbobhydrate	vitamin A	vitamin C	vitamin D	niacin	riboflavin	thiamin	folate	iron	zinc	calcium
calorie	1.00													
protein	-0.14	1.00												
fat	0.14	-0.38	1.00											
carbobhydrate	0.66	0.18	-0.04	1.00										
vitamin A	0.03	0.16	-0.15	0.12	1.00									
vitamin C	-0.14	0.49	0.17	0.17	-0.05	1.00								
vitamin D	0.01	-0.11	0.48	0.08	-0.05	0.02	1.00							
niacin	0.12	-0.74	0.35	-0.33	-0.14	-0.31	-0.26	1.00						
riboflavin	-0.11	-0.05	-0.08	0.08	-0.37	-0.02	-0.02	-0.14	1.00					
thiamin	-0.13	-0.19	-0.09	-0.08	0.16	-0.47	-0.35	0.22	0.04	1.00				
folate	0.13	-0.50	0.40	-0.20	0.11	-0.12	-0.16	0.78	-0.20	0.10	1.00			
iron	-0.06	0.55	-0.38	0.18	-0.14	0.09	0.30	-0.82	0.12	-0.30	-0.87	1.00		
zinc	0.37	-0.60	0.18	0.42	0.07	-0.24	0.37	0.02	0.09	-0.01	-0.04	-0.04	1.00	
calcium	-0.02	-0.01	-0.05	-0.08	-0.10	-0.12	-0.11	-0.07	-0.03	0.14	-0.13	0.02	0.08	1.00

Table 5.5: Calorie and Macronutrient Intake Response to Implicit Calorie Price

VARIABLES	ln calorie		ln protein		ln fat		ln carbohydrate		$ln\frac{protein}{calorie}$		$ln\frac{fat}{calorie}$		$ln\frac{carbohydrate}{calorie}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE
llcalpricr	-0.048	-0.056**	-0.114***	-0.108***	-0.484***	-0.231***	-0.003	-0.034	-0.066***	-0.052***	-0.436***	-0.175***	0.045***	0.022***
	[0.035]	[0.024]	[0.039]	[0.026]	[0.056]	[0.039]	[0.036]	[0.024]	[0.019]	[0.012]	[0.048]	[0.033]	[0.006]	[0.004]
lrtex	0.431***	0.305***	0.509***	0.374***	1.149***	0.331***	0.365***	0.284***	0.078	0.069**	0.718***	0.026	-0.066***	-0.021*
	[0.091]	[0.061]	[0.111]	[0.067]	[0.179]	[0.101]	[0.090]	[0.063]	[0.052]	[0.032]	[0.140]	[0.086]	[0.016]	[0.011]
lrtex2	-0.040***	-0.026***	-0.044***	-0.032***	-0.090***	-0.022**	-0.035***	-0.025***	-0.004	-0.005	-0.051***	0.005	0.004**	0.001
	[0.010]	[0.007]	[0.012]	[0.007]	[0.019]	[0.011]	[0.010]	[0.007]	[0.006]	[0.003]	[0.015]	[0.009]	[0.002]	[0.001]
llands	0.019***	0.000	0.016***	0.000	0.023***	0.000	0.019***	0.000	-0.002	0.000	0.004	0.000	0.000	0.000
	[0.004]	[0.000]	[0.004]	[0.000]	[0.007]	[0.000]	[0.005]	[0.000]	[0.002]	[0.000]	[0.007]	[0.000]	[0.001]	[0.000]
ladeq	0.037**	0.144***	0.061***	0.134***	0.002	0.245***	0.038**	0.129***	0.024***	-0.010	-0.035	0.101**	0.001	-0.015***
	[0.016]	[0.030]	[0.017]	[0.033]	[0.027]	[0.050]	[0.018]	[0.031]	[0.009]	[0.016]	[0.025]	[0.042]	[0.003]	[0.005]
age	0.041***	-0.106	0.043***	0.365***	0.041***	0.664***	0.042***	-0.250**	0.001***	0.470***	0.000	0.770***	0.000**	-0.144***
	[0.001]	[0.116]	[0.001]	[0.126]	[0.001]	[0.191]	[0.001]	[0.119]	[0.000]	[0.061]	[0.001]	[0.161]	[0.000]	[0.021]
age^2	-0.000***	-0.001***	-0.001***	-0.001***	-0.000***	-0.000	-0.000***	-0.001***	-0.000***	-0.000	0.000***	0.001***	-0.000***	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
female	-0.223***		-0.233***		-0.217***		-0.222***		-0.010***		0.006		0.000	
	[0.008]		[0.008]		[0.011]		[0.009]		[0.003]		[0.009]		[0.001]	
pregnant	0.015	-0.123***	0.036	-0.100***	0.058	-0.033	0.010	-0.133***	0.022*	0.023	0.043	0.090**	-0.005	-0.010*
	[0.023]	[0.030]	[0.026]	[0.033]	[0.036]	[0.049]	[0.023]	[0.031]	[0.013]	[0.016]	[0.031]	[0.042]	[0.004]	[0.005]
lactating	0.084***	0.010	0.084***	0.006	0.053**	-0.010	0.086***	0.013	0.001	-0.003	-0.030*	-0.019	0.002	0.003
	[0.014]	[0.026]	[0.015]	[0.028]	[0.021]	[0.043]	[0.015]	[0.026]	[0.006]	[0.014]	[0.018]	[0.036]	[0.002]	[0.005]
round1	-0.059***	-0.258**	-0.027*	0.244*	-0.061***	0.560***	-0.062***	-0.407***	0.032***	0.502***	-0.002	0.818***	-0.003	-0.150***
	[0.012]	[0.116]	[0.014]	[0.127]	[0.023]	[0.192]	[0.012]	[0.119]	[0.008]	[0.061]	[0.020]	[0.162]	[0.002]	[0.021]
round2	-0.037***	-0.181**	-0.030**	0.157*	-0.064***	0.340**	-0.035***	-0.279***	0.007	0.338***	-0.027	0.521***	0.002	-0.099***
	[0.012]	[0.082]	[0.014]	[0.090]	[0.022]	[0.136]	[0.012]	[0.085]	[0.007]	[0.043]	[0.019]	[0.115]	[0.002]	[0.015]
round3	-0.114***	-0.196***	-0.105***	-0.009	-0.019	0.224***	-0.123***	-0.261***	0.009	0.187***	0.095***	0.421***	-0.009***	-0.065***
	[0.014]	[0.045]	[0.016]	[0.049]	[0.024]	[0.074]	[0.015]	[0.046]	[0.009]	[0.023]	[0.021]	[0.062]	[0.003]	[0.008]
site1	-0.021		-0.013		-0.319***		0.005		0.009		-0.297***		0.026***	
	[0.014]		[0.015]		[0.026]		[0.015]		[0.008]		[0.024]		[0.003]	
site2	-0.026*		0.026*		-0.323***		-0.001		0.051***		-0.297***		0.025***	
	[0.015]		[0.015]		[0.025]		[0.016]		[0.008]		[0.023]		[0.003]	
constant	5.859***	10.492***	1.587***	-6.305*	-2.119***	-17.032***	4.585***	13.020***	-4.272***	-16.797***	-7.978***	-27.524***	-1.274***	2.528***
	[0.252]	[3.143]	[0.297]	[3.427]	[0.474]	[5.199]	[0.253]	[3.233]	[0.140]	[1.649]	[0.373]	[4.389]	[0.044]	[0.567]
$adjR^2$	0.365	0.046	0.364	0.034	0.322	0.030	0.347	0.049	0.047	0.021	0.178	0.048	0.104	0.032
observations	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804
individuals	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
llcalpricr=ln calorie price, real; lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.6: Micronutrient Intake Response to Implicit Calorie Price - Individual Fixed Effect Estimates

VARIABLES	$ln\frac{vitA}{calorie}$	$ln\frac{vitC}{calorie}$	$ln\frac{vitD}{calorie}$	$ln\frac{niacin}{calorie}$	$ln\frac{riboflavin}{calorie}$	$ln\frac{thiamin}{calorie}$	$ln\frac{folate}{calorie}$	$ln\frac{iron}{calorie}$	$ln\frac{zinc}{calorie}$	$ln\frac{calcium}{calorie}$
llcalpricr	-0.412***	-0.305***	0.137	-0.058***	-0.170***	-0.099***	-0.141***	-0.114***	-0.036***	-0.264***
	[0.085]	[0.065]	[0.133]	[0.021]	[0.028]	[0.023]	[0.045]	[0.027]	[0.012]	[0.045]
lrtex	0.426*	0.348**	2.216***	0.061	-0.014	-0.036	-0.091	-0.193***	-0.049	0.010
	[0.219]	[0.167]	[0.338]	[0.055]	[0.073]	[0.059]	[0.117]	[0.071]	[0.030]	[0.117]
lrtex2	-0.041*	-0.033*	-0.226***	-0.005	0.002	0.004	0.011	0.020***	0.005	0.003
	[0.023]	[0.018]	[0.036]	[0.006]	[0.008]	[0.006]	[0.012]	[0.008]	[0.003]	[0.013]
ladeq	0.290***	0.264***	0.112	-0.029	0.044	-0.022	-0.046	-0.036	-0.021	0.115**
	[0.108]	[0.082]	[0.164]	[0.027]	[0.036]	[0.029]	[0.058]	[0.035]	[0.015]	[0.058]
age	-0.098	-1.299***	6.349***	0.102	-0.126	0.064	-0.464**	0.028	0.082	-0.381*
	[0.413]	[0.315]	[0.663]	[0.104]	[0.137]	[0.112]	[0.220]	[0.133]	[0.057]	[0.221]
age^2	-0.001	-0.002***	0.002*	0.000**	0.000	-0.000	-0.000	-0.000*	-0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	0.086	0.127	-0.108	0.049*	0.036	0.055*	0.054	0.064*	0.020	0.070
	[0.107]	[0.082]	[0.156]	[0.027]	[0.035]	[0.029]	[0.057]	[0.035]	[0.015]	[0.057]
lactating	-0.075	-0.070	-0.231*	0.002	0.000	0.006	0.012	0.007	0.011	-0.052
	[0.092]	[0.070]	[0.140]	[0.023]	[0.030]	[0.025]	[0.049]	[0.030]	[0.013]	[0.049]
round1	-0.068	-1.599***	6.463***	0.132	-0.042	0.113	-0.508**	0.089	0.119**	-0.268
	[0.415]	[0.316]	[0.665]	[0.105]	[0.137]	[0.112]	[0.221]	[0.134]	[0.057]	[0.222]
round2	-0.231	-1.462***	5.034***	0.061	-0.176*	-0.005	-0.490***	-0.067	0.061	-0.265*
	[0.294]	[0.224]	[0.473]	[0.074]	[0.097]	[0.080]	[0.157]	[0.095]	[0.041]	[0.157]
round3	-0.053	-0.520***	2.278***	0.202***	0.019	0.241***	-0.186**	0.115**	0.077***	-0.044
	[0.160]	[0.122]	[0.256]	[0.040]	[0.053]	[0.043]	[0.085]	[0.052]	[0.022]	[0.085]
constant	-0.709	31.567***	-188.447***	-8.853***	-5.283	-9.736***	10.254*	-5.892	-7.751***	6.928
	[11.241]	[8.571]	[18.121]	[2.841]	[3.723]	[3.037]	[5.995]	[3.630]	[1.553]	[6.000]
R^2	0.014	0.085	0.054	0.094	0.068	0.160	0.021	0.075	0.037	0.025
observations	14785	14785	12869	14804	14804	14804	14804	14804	14803	14804
households	4513	4513	4423	4516	4516	4516	4516	4516	4515	4516

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
llcalpricr=ln calorie price, real; lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.7: Macronutrient Intake Response to Implicit Macronutrient Price

VARIABLES	ln(calorie)		ln(protein)		ln(fat)		ln(carbohydrate)		$ln\frac{protein}{calorie}$		$ln\frac{fat}{calorie}$		$ln\frac{carbohydrate}{calorie}$	
	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
ln implicit prices:														
protien	-0.151	-0.276***	-0.135	-0.209*	-1.174***	-1.143***	-0.055	-0.202*	0.017	0.067	-1.022***	-0.866***	0.097***	0.075***
	[0.155]	[0.103]	[0.169]	[0.112]	[0.262]	[0.169]	[0.160]	[0.105]	[0.080]	[0.054]	[0.241]	[0.143]	[0.026]	[0.019]
fat	-0.572***	-0.813***	-0.663**	-0.800***	-1.124***	-1.050***	-0.506**	-0.792***	-0.090	0.013	-0.551*	-0.238	0.066*	0.021
	[0.221]	[0.164]	[0.275]	[0.179]	[0.319]	[0.272]	[0.231]	[0.169]	[0.153]	[0.086]	[0.313]	[0.229]	[0.036]	[0.030]
carbohydrate	1.808	2.531*	2.622	6.739***	-8.989**	-3.522	2.902	2.478	0.814	4.209***	-10.797***	-6.053***	1.094**	-0.053
	[2.340]	[1.509]	[2.564]	[1.644]	[4.053]	[2.492]	[2.417]	[1.552]	[1.303]	[0.791]	[3.664]	[2.105]	[0.456]	[0.272]
ln village rice price	0.032	0.029	0.094**	0.065**	0.501***	0.212***	-0.016	0.008	0.062***	0.036***	0.469***	0.183***	-0.048***	-0.021***
	[0.036]	[0.025]	[0.040]	[0.027]	[0.059]	[0.041]	[0.037]	[0.025]	[0.020]	[0.013]	[0.051]	[0.034]	[0.006]	[0.004]
lrtex	0.427***	0.303***	0.505***	0.372***	1.152***	0.350***	0.361***	0.280***	0.077	0.068**	0.725***	0.046	-0.067***	-0.023**
	[0.090]	[0.061]	[0.110]	[0.067]	[0.180]	[0.101]	[0.089]	[0.063]	[0.052]	[0.032]	[0.140]	[0.085]	[0.017]	[0.011]
lrtex2	-0.039***	-0.026***	-0.044***	-0.031***	-0.091***	-0.024**	-0.035***	-0.024***	-0.004	-0.005	-0.052***	0.002	0.004**	0.002
	[0.010]	[0.007]	[0.012]	[0.007]	[0.019]	[0.011]	[0.010]	[0.007]	[0.006]	[0.003]	[0.015]	[0.009]	[0.002]	[0.001]
llands	0.019***	0.000	0.016***	0.000	0.024***	0.000	0.019***	0.000	-0.002	0.000	0.005	0.000	-0.000	0.000
	[0.004]	[0.000]	[0.004]	[0.000]	[0.007]	[0.000]	[0.005]	[0.000]	[0.002]	[0.000]	[0.007]	[0.000]	[0.001]	[0.000]
ladeq	0.037**	0.146***	0.061***	0.137***	-0.000	0.246***	0.038**	0.132***	0.024***	-0.009	-0.037	0.099**	0.001	-0.015***
	[0.016]	[0.030]	[0.017]	[0.033]	[0.027]	[0.050]	[0.018]	[0.031]	[0.009]	[0.016]	[0.025]	[0.042]	[0.003]	[0.005]
age	0.041***	-0.156	0.043***	0.339***	0.041***	0.568***	0.042***	-0.299**	0.001***	0.494***	0.000	0.724***	0.000**	-0.144***
	[0.001]	[0.116]	[0.001]	[0.127]	[0.001]	[0.192]	[0.001]	[0.120]	[0.000]	[0.061]	[0.001]	[0.163]	[0.000]	[0.021]
age2	-0.000***	-0.001***	-0.001***	-0.001***	-0.000***	-0.000	-0.000***	-0.001***	-0.000***	-0.000	0.000***	0.001***	-0.000***	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
female	-0.223***		-0.233***		-0.216***		-0.222***		-0.010***		0.007		0.000	
	[0.008]		[0.008]		[0.011]		[0.009]		[0.003]		[0.009]		[0.001]	
preg	0.016	-0.123***	0.038	-0.100***	0.054	-0.034	0.011	-0.133***	0.022*	0.023	0.039	0.089**	-0.005	-0.010*
	[0.023]	[0.030]	[0.026]	[0.033]	[0.035]	[0.049]	[0.023]	[0.031]	[0.013]	[0.016]	[0.031]	[0.042]	[0.004]	[0.005]
lact	0.084***	0.008	0.084***	0.005	0.054**	-0.010	0.086***	0.011	0.001	-0.004	-0.030*	-0.019	0.002	0.003
	[0.014]	[0.026]	[0.015]	[0.028]	[0.021]	[0.042]	[0.015]	[0.026]	[0.006]	[0.013]	[0.018]	[0.036]	[0.002]	[0.005]
round1	-0.066***	-0.320***	-0.035*	0.188	-0.057	0.443**	-0.070***	-0.465***	0.030***	0.507***	0.009	0.762***	-0.005	-0.145***
	[0.018]	[0.117]	[0.021]	[0.127]	[0.035]	[0.193]	[0.018]	[0.120]	[0.011]	[0.061]	[0.031]	[0.163]	[0.004]	[0.021]
round2	-0.055**	-0.239***	-0.057**	0.079	0.032	0.325**	-0.064***	-0.339***	-0.001	0.318***	0.087**	0.564***	-0.009**	-0.100***
	[0.024]	[0.083]	[0.026]	[0.091]	[0.040]	[0.137]	[0.024]	[0.086]	[0.013]	[0.044]	[0.036]	[0.116]	[0.004]	[0.015]
round3	-0.119***	-0.221***	-0.112***	-0.042	0.023	0.213***	-0.132***	-0.286***	0.006	0.179***	0.141***	0.434***	-0.014***	-0.065***
	[0.017]	[0.045]	[0.019]	[0.049]	[0.030]	[0.074]	[0.018]	[0.046]	[0.010]	[0.024]	[0.026]	[0.063]	[0.004]	[0.008]
site1	-0.012		-0.003		-0.273***		0.011		0.009		-0.261***		0.023***	
	[0.015]		[0.016]		[0.028]		[0.016]		[0.009]		[0.026]		[0.003]	
site2	-0.020		0.030*		-0.281***		0.001		0.051***		-0.261***		0.021***	
	[0.015]		[0.016]		[0.027]		[0.016]		[0.008]		[0.025]		[0.003]	
constant	5.918***	11.952***	1.667***	-5.424	-2.247***	-14.410***	4.663***	14.457***	-4.252***	-17.377***	-8.165***	-26.363***	-1.255***	2.505***
	[0.255]	[3.167]	[0.298]	[3.451]	[0.491]	[5.233]	[0.255]	[3.258]	[0.144]	[1.661]	[0.385]	[4.419]	[0.046]	[0.572]
$adj.R^2$	0.366	0.048	0.364	0.038	0.325	0.034	0.347	0.051	0.047	0.023	0.183	0.052	0.107	0.033
observations	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804	14804
individuals	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516	4516

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.8: Micronutrient Intake Response to Implicit Micronutrient Prices - Individual Fixed Effect Estimates

VARIABLES	$ln\frac{vitA}{calorie}$	$ln\frac{vitC}{calorie}$	$ln\frac{vitD}{calorie}$	$ln\frac{niacin}{calorie}$	$ln\frac{riboflavin}{calorie}$	$ln\frac{thiamin}{calorie}$	$ln\frac{folate}{calorie}$	$ln\frac{iron}{calorie}$	$ln\frac{zinc}{calorie}$	$ln\frac{calcium}{calorie}$
ln implicit prices:										
vitamin A	-20.577	-32.480***	68.011***	8.360**	-6.125	8.225**	-7.749	5.780	4.614***	-19.139***
	[13.173]	[10.024]	[19.355]	[3.295]	[4.314]	[3.516]	[7.010]	[4.212]	[1.788]	[6.999]
vitamin C	-6.651***	-3.042***	-3.668*	-1.891***	-2.706***	-2.285***	-0.598	-1.758***	-0.434**	-3.328***
	[1.302]	[0.990]	[1.923]	[0.326]	[0.427]	[0.348]	[0.694]	[0.417]	[0.177]	[0.693]
vitamin D	-0.024	-0.077**	0.068	-0.009	-0.029*	0.020	-0.022	0.001	0.005	-0.076***
	[0.048]	[0.037]	[0.068]	[0.012]	[0.016]	[0.013]	[0.026]	[0.016]	[0.007]	[0.026]
niacin	-0.357***	0.156	-0.133	-0.253***	-0.412***	-0.344***	-0.086	-0.383***	-0.148***	-0.420***
	[0.138]	[0.105]	[0.205]	[0.035]	[0.045]	[0.037]	[0.074]	[0.044]	[0.019]	[0.074]
riboflavin	-0.001	-0.039***	0.036	0.013***	0.000	0.015***	0.012	0.020***	0.011***	-0.015*
	[0.015]	[0.011]	[0.022]	[0.004]	[0.005]	[0.004]	[0.008]	[0.005]	[0.002]	[0.008]
thiamin	-0.033**	0.043***	-0.034	-0.009**	-0.015***	-0.019***	-0.024***	-0.025***	-0.009***	-0.012
	[0.015]	[0.011]	[0.023]	[0.004]	[0.005]	[0.004]	[0.008]	[0.005]	[0.002]	[0.008]
folate	-21.129	3.643	100.871***	-28.308***	-34.115***	-39.135***	-19.182**	-39.769***	-26.151***	-11.535
	[14.963]	[11.383]	[22.585]	[3.751]	[4.911]	[4.002]	[7.979]	[4.794]	[2.036]	[7.967]
iron	-0.214	0.269	2.030***	-0.259***	-0.376***	-0.416***	-0.167	-0.524***	-0.307***	-0.184
	[0.258]	[0.197]	[0.389]	[0.065]	[0.085]	[0.069]	[0.138]	[0.083]	[0.035]	[0.138]
zinc	0.177**	0.259***	-0.028	0.112***	0.205***	0.131***	0.142***	0.136***	0.057***	0.264***
	[0.069]	[0.052]	[0.100]	[0.017]	[0.023]	[0.018]	[0.037]	[0.022]	[0.009]	[0.037]
calcium	-13.759	-39.581***	27.551*	-11.493***	-16.525***	-7.327***	1.993	-7.396**	-3.826***	-14.585***
	[9.934]	[7.563]	[14.685]	[2.489]	[3.259]	[2.656]	[5.295]	[3.182]	[1.351]	[5.287]
ln village rice price	0.324***	0.217***	0.112	-0.015	0.061**	0.013	0.083*	0.017	-0.016	0.167***
	[0.090]	[0.068]	[0.140]	[0.023]	[0.029]	[0.024]	[0.048]	[0.029]	[0.012]	[0.048]
lrtex	0.424*	0.344**	2.366***	0.040	-0.034	-0.057	-0.080	-0.208***	-0.065**	0.012
	[0.219]	[0.167]	[0.338]	[0.055]	[0.072]	[0.059]	[0.117]	[0.070]	[0.030]	[0.117]
lrtex2	-0.040*	-0.033*	-0.242***	-0.003	0.004	0.006	0.010	0.022***	0.006**	0.002
	[0.023]	[0.018]	[0.036]	[0.006]	[0.008]	[0.006]	[0.012]	[0.008]	[0.003]	[0.012]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	0.306***	0.261***	0.180	-0.028	0.043	-0.021	-0.049	-0.036	-0.024	0.117**
	[0.108]	[0.082]	[0.164]	[0.027]	[0.035]	[0.029]	[0.058]	[0.035]	[0.015]	[0.058]
age	0.223	-1.261***	5.722***	0.316***	0.215	0.370***	-0.246	0.404***	0.265***	-0.114
	[0.430]	[0.327]	[0.682]	[0.108]	[0.141]	[0.115]	[0.230]	[0.138]	[0.059]	[0.229]
age^2	-0.001	-0.002***	0.002**	0.000**	0.000	-0.000	-0.000	-0.000	-0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	0.094	0.133	-0.101	0.053**	0.043	0.061**	0.057	0.068**	0.022	0.077
	[0.107]	[0.081]	[0.155]	[0.027]	[0.035]	[0.029]	[0.057]	[0.034]	[0.015]	[0.057]
lactating	-0.072	-0.070	-0.207	-0.000	-0.003	0.005	0.009	0.004	0.009	-0.055
	[0.092]	[0.070]	[0.139]	[0.023]	[0.030]	[0.025]	[0.049]	[0.029]	[0.013]	[0.049]
round1	0.394	-1.661***	6.050***	0.459***	0.458***	0.572***	-0.236	0.615***	0.370***	0.111
	[0.442]	[0.336]	[0.694]	[0.111]	[0.145]	[0.118]	[0.236]	[0.142]	[0.060]	[0.235]
round2	-0.308	-1.463***	4.254***	-0.023	-0.267***	-0.091	-0.471***	-0.091	0.061	-0.378**
	[0.315]	[0.240]	[0.505]	[0.079]	[0.103]	[0.084]	[0.168]	[0.101]	[0.043]	[0.168]
round3	0.099	-0.479***	2.250***	0.234***	0.099*	0.295***	-0.121	0.183***	0.098***	0.039
	[0.165]	[0.125]	[0.263]	[0.041]	[0.054]	[0.044]	[0.088]	[0.053]	[0.022]	[0.088]
constant	-9.531	30.552***	-171.993***	-14.614***	-14.526***	-18.018***	4.334	-16.072***	-12.684***	-0.347
	[11.707]	[8.907]	[18.640]	[2.933]	[3.840]	[3.129]	[6.240]	[3.749]	[1.592]	[6.231]
R^2	0.018	0.092	0.064	0.113	0.089	0.180	0.026	0.094	0.070	0.035
observations	14785	14785	12869	14804	14804	14804	14804	14804	14803	14804
individuals	4513	4513	4423	4516	4516	4516	4516	4516	4515	4516

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.9: Poor's vs Non-Poor's Calorie and Macronutrient Intake Response to Implicit Calorie Price: Individual Fixed Effect

VARIABLES	ln(calorie)		ln(protein)		ln(fat)		ln(carbohydrate)		$ln\frac{protein}{calorie}$		$ln\frac{fat}{calorie}$		$ln\frac{carbohydrate}{calorie}$	
	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
llcalpricr	0.011	-0.022	-0.108**	-0.073**	-0.267***	-0.109*	0.043	-0.003	-0.119***	-0.051***	-0.279***	-0.087*	0.032***	0.019***
	[0.043]	[0.028]	[0.049]	[0.032]	[0.069]	[0.056]	[0.044]	[0.029]	[0.024]	[0.018]	[0.060]	[0.050]	[0.008]	[0.006]
lrtex	0.003	0.034***	0.019	0.061***	0.068***	0.114***	-0.001	0.023**	0.016*	0.027***	0.065***	0.080***	-0.004	-0.012***
	[0.016]	[0.010]	[0.018]	[0.012]	[0.025]	[0.020]	[0.016]	[0.010]	[0.009]	[0.006]	[0.022]	[0.018]	[0.003]	[0.002]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	-0.104*	0.043	-0.121**	0.082*	-0.045	0.180**	-0.112**	0.024	-0.017	0.039	0.059	0.137**	-0.008	-0.019**
	[0.053]	[0.038]	[0.061]	[0.044]	[0.087]	[0.075]	[0.056]	[0.039]	[0.029]	[0.024]	[0.075]	[0.067]	[0.010]	[0.009]
age	-0.673***	0.008	-0.296	0.450***	0.241	0.387	-0.841***	-0.061	0.377***	0.442***	0.914***	0.379	-0.168***	-0.069**
	[0.203]	[0.139]	[0.231]	[0.161]	[0.329]	[0.277]	[0.211]	[0.143]	[0.112]	[0.090]	[0.283]	[0.246]	[0.037]	[0.032]
age^2	-0.001**	-0.001***	-0.001**	-0.001***	-0.000	-0.000	-0.001**	-0.001***	-0.000	-0.000	0.001	0.001*	-0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	-0.059	-0.120***	0.002	-0.110***	0.015	-0.068	-0.067	-0.129***	0.061*	0.010	0.075	0.052	-0.008	-0.008
	[0.061]	[0.034]	[0.069]	[0.039]	[0.098]	[0.067]	[0.063]	[0.035]	[0.033]	[0.022]	[0.085]	[0.060]	[0.011]	[0.008]
lactating	-0.007	0.044	-0.028	0.045	-0.027	-0.011	-0.002	0.053	-0.021	0.000	-0.020	-0.055	0.005	0.009
	[0.043]	[0.033]	[0.049]	[0.038]	[0.069]	[0.066]	[0.044]	[0.034]	[0.024]	[0.021]	[0.060]	[0.059]	[0.008]	[0.008]
round1	-0.763***	-0.087	-0.397*	0.397**	0.175	0.355	-0.931***	-0.162	0.366***	0.484***	0.938***	0.442*	-0.168***	-0.075**
	[0.203]	[0.139]	[0.231]	[0.161]	[0.330]	[0.278]	[0.211]	[0.144]	[0.112]	[0.090]	[0.284]	[0.247]	[0.037]	[0.032]
round2	-0.550***	-0.034	-0.305*	0.285**	0.091	0.171	-0.663***	-0.075	0.245***	0.319***	0.641***	0.205	-0.114***	-0.041*
	[0.144]	[0.099]	[0.163]	[0.114]	[0.233]	[0.197]	[0.149]	[0.102]	[0.079]	[0.064]	[0.201]	[0.175]	[0.026]	[0.023]
round3	-0.347***	-0.084	-0.234***	0.090	0.106	0.175	-0.416***	-0.118**	0.114***	0.174***	0.454***	0.259***	-0.069***	-0.034***
	[0.078]	[0.054]	[0.088]	[0.062]	[0.126]	[0.107]	[0.081]	[0.056]	[0.043]	[0.035]	[0.108]	[0.095]	[0.014]	[0.012]
constant	25.797***	8.308**	12.123**	-8.238*	-4.494	-8.889	28.672***	8.815**	-13.674***	-16.546***	-30.291***	-17.197**	2.875***	0.507
	[5.222]	[3.915]	[5.936]	[4.531]	[8.475]	[7.796]	[5.426]	[4.039]	[2.881]	[2.522]	[7.295]	[6.940]	[0.951]	[0.900]
R^2	0.018	0.026	0.016	0.020	0.026	0.025	0.023	0.032	0.019	0.028	0.053	0.044	0.032	0.032
observations	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567
individuals	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
llcalpricr=ln calorie price, real; lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.10: Poor's vs Non-poor's Micronutrient Intake Response to Implicit Calorie Price - Individual Fixed Effect Estimates

VARIABLES	$ln\frac{vitA}{calorie}$		$ln\frac{vitC}{calorie}$		$ln\frac{vitD}{calorie}$		$ln\frac{niacin}{calorie}$		$ln\frac{riboflavin}{calorie}$	
	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
llcalpricr	-0.715***	-0.493***	-0.489***	-0.198**	0.456*	-0.098	-0.212***	-0.045	-0.390***	-0.106***
	[0.167]	[0.119]	[0.119]	[0.095]	[0.259]	[0.192]	[0.041]	[0.031]	[0.056]	[0.038]
lrtex	0.279***	-0.047	0.183***	0.004	-0.045	0.144**	-0.007	0.029***	0.030	0.016
	[0.061]	[0.043]	[0.044]	[0.034]	[0.088]	[0.066]	[0.015]	[0.011]	[0.020]	[0.014]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	0.812***	0.154	0.401***	0.002	-0.239	0.029	-0.059	0.075*	0.165**	0.062
	[0.209]	[0.161]	[0.149]	[0.128]	[0.300]	[0.270]	[0.052]	[0.042]	[0.070]	[0.052]
age	-0.567	-1.449**	-2.076***	-0.845*	4.862***	7.910***	0.154	-0.084	-0.217	-0.570***
	[0.792]	[0.594]	[0.565]	[0.472]	[1.227]	[0.984]	[0.196]	[0.155]	[0.264]	[0.191]
age^2	0.000	-0.001	-0.001	-0.002**	-0.000	0.003*	0.000	0.000*	-0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	-0.051	0.097	0.138	0.080	-0.071	-0.419*	0.023	0.023	0.072	-0.007
	[0.236]	[0.144]	[0.168]	[0.114]	[0.346]	[0.215]	[0.058]	[0.037]	[0.079]	[0.046]
lactating	-0.151	-0.262*	-0.065	-0.122	-0.204	-0.315	-0.050	-0.004	-0.008	-0.062
	[0.167]	[0.142]	[0.119]	[0.113]	[0.261]	[0.221]	[0.041]	[0.037]	[0.056]	[0.046]
round1	-0.442	-1.527**	-2.352***	-1.144**	4.455***	8.125***	0.160	-0.045	-0.186	-0.494***
	[0.793]	[0.596]	[0.566]	[0.473]	[1.231]	[0.983]	[0.196]	[0.155]	[0.265]	[0.192]
round2	-0.466	-1.228***	-1.933***	-1.148***	3.616***	6.088***	0.090	-0.067	-0.279	-0.496***
	[0.562]	[0.423]	[0.400]	[0.336]	[0.874]	[0.701]	[0.139]	[0.110]	[0.187]	[0.136]
round3	-0.001	-0.785***	-0.733***	-0.382**	1.174**	3.026***	0.188**	0.124**	-0.037	-0.190**
	[0.303]	[0.230]	[0.216]	[0.183]	[0.471]	[0.381]	[0.075]	[0.060]	[0.101]	[0.074]
constant	8.645	39.264**	48.842***	21.663	-131.932***	-234.742***	-10.163**	-3.850	-3.680	7.366
	[20.422]	[16.749]	[14.564]	[13.289]	[31.987]	[27.710]	[5.047]	[4.356]	[6.806]	[5.378]
R^2	0.041	0.015	0.106	0.078	0.092	0.035	0.115	0.078	0.101	0.059
observations	6225	8560	6224	8561	5357	7512	6237	8567	6237	8567
individuals	3316	3866	3316	3867	3057	3679	3320	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
llcalpricr=ln calorie price, real; lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size.

Table 5.11: Table 10: Continuation From Previous Page

VARIABLES	$ln\frac{thiamin}{calorie}$		$ln\frac{folate}{calorie}$		$ln\frac{iron}{calorie}$		$ln\frac{zinc}{calorie}$		$ln\frac{calcium}{calorie}$	
	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
llcalpricr	-0.276***	-0.026	-0.415***	0.052	-0.264***	-0.062	-0.092***	-0.022	-0.468***	-0.288***
	[0.044]	[0.033]	[0.084]	[0.065]	[0.051]	[0.039]	[0.023]	[0.017]	[0.085]	[0.065]
lrtex	0.012	0.008	0.076**	0.024	-0.014	0.013	-0.010	0.001	0.096***	0.045*
	[0.016]	[0.012]	[0.031]	[0.023]	[0.019]	[0.014]	[0.008]	[0.006]	[0.031]	[0.023]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	0.075	0.006	0.220**	-0.083	0.113*	-0.034	-0.016	0.008	0.338***	0.126
	[0.055]	[0.044]	[0.105]	[0.088]	[0.064]	[0.053]	[0.029]	[0.023]	[0.106]	[0.087]
age	0.161	-0.217	0.082	-1.116***	0.192	-0.479**	0.172	-0.100	-0.791**	-0.999***
	[0.209]	[0.162]	[0.399]	[0.324]	[0.241]	[0.194]	[0.109]	[0.083]	[0.403]	[0.323]
age^2	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]
pregnant	0.091	0.016	0.019	0.064	0.086	0.036	0.044	0.004	-0.018	0.088
	[0.062]	[0.039]	[0.119]	[0.078]	[0.072]	[0.047]	[0.033]	[0.020]	[0.120]	[0.078]
lactating	-0.051	0.004	-0.121	0.053	-0.061	-0.015	-0.020	0.010	-0.137	-0.060
	[0.044]	[0.039]	[0.084]	[0.077]	[0.051]	[0.046]	[0.023]	[0.020]	[0.085]	[0.077]
round1	0.148	-0.150	-0.068	-1.124***	0.205	-0.398**	0.200*	-0.058	-0.721*	-0.915***
	[0.209]	[0.163]	[0.400]	[0.325]	[0.242]	[0.195]	[0.109]	[0.084]	[0.403]	[0.324]
round2	0.043	-0.214*	-0.117	-0.972***	0.046	-0.431***	0.131*	-0.072	-0.551*	-0.734***
	[0.148]	[0.115]	[0.283]	[0.231]	[0.171]	[0.138]	[0.077]	[0.059]	[0.286]	[0.230]
round3	0.228***	0.128**	-0.051	-0.428***	0.159*	-0.094	0.107**	-0.001	-0.151	-0.379***
	[0.080]	[0.063]	[0.153]	[0.125]	[0.092]	[0.075]	[0.042]	[0.032]	[0.154]	[0.125]
constant	-12.805**	-1.792	-5.644	29.281***	-11.126*	7.894	-10.221***	-2.859	16.073	24.602***
	[5.374]	[4.565]	[10.272]	[9.124]	[6.209]	[5.468]	[2.806]	[2.351]	[10.370]	[9.094]
R^2	0.176	0.144	0.027	0.029	0.091	0.072	0.042	0.033	0.052	0.019
observations	6237	8567	6237	8567	6237	8567	6236	8567	6237	8567
individuals	3320	3869	3320	3869	3320	3869	3319	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
llcalpricr=ln calorie price, real; lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size.

Table 5.12: Poor's vs Non-Poor's Calorie and Macronutrient Intake Response to Implicit Macronutrient Prices: Individual Fixed Effect

VARIABLES	ln(calorie)		ln(protein)		ln(fat)		ln(carbohydrate)		$ln\frac{protein}{calorie}$		$ln\frac{fat}{calorie}$		$ln\frac{carbohydrate}{calorie}$	
ln implicit prices	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
protein	-0.499***	-0.026	-0.224	-0.025	-0.281	-1.359***	-0.538***	0.092	0.274***	0.001	0.218	-1.333***	-0.039	0.117***
	[0.184]	[0.122]	[0.209]	[0.141]	[0.298]	[0.243]	[0.191]	[0.126]	[0.101]	[0.079]	[0.257]	[0.216]	[0.034]	[0.028]
fat	-1.030***	-0.336*	-1.021***	-0.235	-1.811***	-0.628*	-0.966***	-0.332*	0.009	0.100	-0.781*	-0.292	0.064	0.004
	[0.306]	[0.183]	[0.348]	[0.212]	[0.496]	[0.364]	[0.318]	[0.189]	[0.169]	[0.118]	[0.427]	[0.323]	[0.056]	[0.042]
carbohydrate	0.555	5.321***	6.606**	9.116***	-14.109***	-0.092	0.812	5.402***	6.051***	3.795***	-14.664***	-5.413*	0.257	0.081
	[2.795]	[1.723]	[3.178]	[1.992]	[4.527]	[3.424]	[2.905]	[1.777]	[1.539]	[1.110]	[3.899]	[3.044]	[0.510]	[0.396]
lricepric	-0.041	-0.003	0.053	0.037	0.306***	0.082	-0.074	-0.021	0.094***	0.040**	0.346***	0.085*	-0.033***	-0.018***
	[0.046]	[0.029]	[0.052]	[0.033]	[0.074]	[0.057]	[0.047]	[0.030]	[0.025]	[0.019]	[0.064]	[0.051]	[0.008]	[0.007]
lrtex	0.005	0.034***	0.020	0.061***	0.069***	0.114***	0.001	0.022**	0.015*	0.027***	0.064***	0.080***	-0.004	-0.012***
	[0.016]	[0.010]	[0.018]	[0.012]	[0.025]	[0.020]	[0.016]	[0.010]	[0.009]	[0.006]	[0.022]	[0.018]	[0.003]	[0.002]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	-0.089*	0.042	-0.108*	0.082*	-0.029	0.177**	-0.097*	0.023	-0.019	0.039	0.059	0.135**	-0.009	-0.019**
	[0.054]	[0.038]	[0.061]	[0.043]	[0.087]	[0.075]	[0.056]	[0.039]	[0.029]	[0.024]	[0.075]	[0.066]	[0.010]	[0.009]
age	-0.731***	0.017	-0.337	0.502***	0.095	0.346	-0.894***	-0.053	0.394***	0.485***	0.825***	0.329	-0.163***	-0.070**
	[0.203]	[0.141]	[0.231]	[0.163]	[0.329]	[0.280]	[0.211]	[0.145]	[0.112]	[0.091]	[0.284]	[0.249]	[0.037]	[0.032]
age^2	-0.001**	-0.001***	-0.001**	-0.001***	-0.000	-0.000	-0.001**	-0.001***	-0.000	-0.000	0.001	0.001*	-0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	-0.054	-0.120***	0.006	-0.110***	0.008	-0.074	-0.060	-0.128***	0.060*	0.010	0.062	0.046	-0.007	-0.008
	[0.060]	[0.034]	[0.069]	[0.039]	[0.098]	[0.067]	[0.063]	[0.035]	[0.033]	[0.022]	[0.084]	[0.059]	[0.011]	[0.008]
lactating	-0.007	0.043	-0.030	0.042	-0.036	-0.017	-0.001	0.052	-0.023	-0.000	-0.029	-0.059	0.006	0.009
	[0.043]	[0.033]	[0.049]	[0.038]	[0.069]	[0.066]	[0.044]	[0.034]	[0.024]	[0.021]	[0.060]	[0.059]	[0.008]	[0.008]
round1	-0.833***	-0.099	-0.467**	0.408**	0.122	0.260	-1.001***	-0.170	0.366***	0.506***	0.955***	0.358	-0.168***	-0.071**
	[0.204]	[0.141]	[0.232]	[0.163]	[0.330]	[0.279]	[0.212]	[0.145]	[0.112]	[0.091]	[0.284]	[0.248]	[0.037]	[0.032]
round2	-0.597***	-0.074	-0.400**	0.247**	0.088	0.186	-0.708***	-0.120	0.197**	0.320***	0.685***	0.259	-0.110***	-0.047**
	[0.146]	[0.100]	[0.166]	[0.116]	[0.236]	[0.199]	[0.151]	[0.103]	[0.080]	[0.064]	[0.203]	[0.177]	[0.027]	[0.023]
round3	-0.369***	-0.100*	-0.275***	0.076	0.117	0.176	-0.437***	-0.136**	0.094**	0.176***	0.486***	0.276***	-0.068***	-0.036***
	[0.078]	[0.054]	[0.089]	[0.063]	[0.127]	[0.108]	[0.081]	[0.056]	[0.043]	[0.035]	[0.109]	[0.096]	[0.014]	[0.012]
constant	27.312***	8.171**	13.306**	-9.521**	-1.020	-7.597	30.075***	8.708**	-14.005***	-17.692***	-28.332***	-15.768**	2.763***	0.537
	[5.235]	[3.967]	[5.952]	[4.586]	[8.480]	[7.884]	[5.441]	[4.092]	[2.883]	[2.556]	[7.303]	[7.008]	[0.955]	[0.911]
R^2	0.023	0.029	0.020	0.024	0.034	0.032	0.027	0.036	0.027	0.031	0.060	0.054	0.034	0.036
observations	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567	6237	8567
individuals	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.

lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;

llands=ln household landholdings; ladeq=ln adult equivalent household size; FE estimate include R^2.

Table 5.13: Poor's vs Non-poor's Micronutrient Intake Response to Implicit Micronutrient Prices - Individual Fixed Effect Estimates

VARIABLES	$ln\frac{vitA}{calorie}$		$ln\frac{vitC}{calorie}$		$ln\frac{vitD}{calorie}$		$ln\frac{niacin}{calorie}$		$ln\frac{riboflavin}{calorie}$	
ln implicit price:	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
vitamin A	-47.936*	-40.967**	-48.518***	-61.825***	106.327***	16.502	-2.619	14.967***	-39.504***	-1.065
	[26.512]	[18.155]	[18.712]	[14.372]	[39.860]	[28.384]	[6.502]	[4.699]	[8.657]	[5.800]
vitamin C	-6.437***	-6.137***	-3.672**	-1.454	-0.500	0.880	-0.968*	-2.089***	-1.876**	-2.375***
	[2.387]	[1.935]	[1.684]	[1.532]	[3.466]	[3.025]	[0.585]	[0.501]	[0.779]	[0.618]
vitamin D	-0.191*	-0.062	-0.048	-0.072	0.065	0.175*	-0.042*	0.045***	-0.109***	-0.011
	[0.098]	[0.066]	[0.069]	[0.052]	[0.134]	[0.096]	[0.024]	[0.017]	[0.032]	[0.021]
niacin	-0.416	0.021	-0.029	0.586***	0.455	-0.321	-0.164**	-0.272***	-0.304***	-0.261***
	[0.288]	[0.192]	[0.203]	[0.152]	[0.417]	[0.296]	[0.070]	[0.050]	[0.094]	[0.061]
riboflavin	-0.079***	0.026	-0.122***	-0.016	0.108***	-0.025	-0.001	0.018***	-0.038***	0.014**
	[0.027]	[0.021]	[0.019]	[0.017]	[0.040]	[0.032]	[0.007]	[0.006]	[0.009]	[0.007]
thiamin	-0.023	-0.032*	0.022	0.074***	-0.046	-0.015	-0.018**	-0.002	-0.010	-0.010*
	[0.035]	[0.019]	[0.025]	[0.015]	[0.049]	[0.030]	[0.009]	[0.005]	[0.011]	[0.006]
folate	-22.404	-0.421	-37.823	17.652	52.713	83.978***	-42.392***	-23.451***	-63.693***	-18.586***
	[34.086]	[19.321]	[24.055]	[15.296]	[48.190]	[30.525]	[8.358]	[5.000]	[11.128]	[6.172]
iron	-0.345	0.558*	-0.141	0.464*	1.537*	1.095**	-0.429***	-0.189**	-0.772***	-0.056
	[0.586]	[0.337]	[0.414]	[0.267]	[0.834]	[0.534]	[0.144]	[0.087]	[0.191]	[0.108]
zinc	0.143	0.277***	0.338***	0.196**	-0.416**	0.022	0.111***	0.074***	0.220***	0.223***
	[0.141]	[0.097]	[0.100]	[0.076]	[0.199]	[0.145]	[0.035]	[0.025]	[0.046]	[0.031]
calcium	-0.723	-21.372	-38.394**	-55.594***	103.794***	-31.241	-24.673***	-0.518	-39.070***	-6.461
	[22.637]	[13.840]	[16.018]	[10.957]	[33.187]	[21.301]	[5.536]	[3.580]	[7.371]	[4.418]
ln village rice price	0.623***	0.392***	0.324**	0.110	-0.152	0.250	0.120***	-0.000	0.218***	0.020
	[0.180]	[0.126]	[0.127]	[0.100]	[0.278]	[0.201]	[0.044]	[0.033]	[0.059]	[0.040]
lrtex	0.268***	-0.035	0.159***	-0.003	-0.035	0.150**	-0.009	0.022**	0.022	0.014
	[0.061]	[0.043]	[0.043]	[0.034]	[0.088]	[0.066]	[0.015]	[0.011]	[0.020]	[0.014]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	0.826***	0.166	0.411***	-0.048	-0.236	0.118	-0.071	0.082*	0.142**	0.069
	[0.211]	[0.161]	[0.149]	[0.127]	[0.302]	[0.270]	[0.052]	[0.042]	[0.069]	[0.051]
age	-0.719	-0.910	-2.391***	-0.326	4.440***	8.214***	0.241	0.131	-0.113	-0.213
	[0.810]	[0.631]	[0.572]	[0.500]	[1.238]	[1.033]	[0.199]	[0.163]	[0.264]	[0.202]
age^2	0.000	-0.001	-0.001	-0.002**	-0.001	0.003*	0.000	0.000**	-0.000	0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]	[0.000]	[0.000]	[0.000]	[0.000]
pregnant	-0.050	0.107	0.174	0.073	-0.096	-0.400*	0.025	0.030	0.083	0.000
	[0.236]	[0.143]	[0.167]	[0.114]	[0.345]	[0.214]	[0.058]	[0.037]	[0.077]	[0.046]
lactating	-0.162	-0.254*	-0.049	-0.126	-0.206	-0.286	-0.051	-0.003	-0.011	-0.064
	[0.167]	[0.142]	[0.118]	[0.112]	[0.260]	[0.220]	[0.041]	[0.037]	[0.054]	[0.045]
round1	-0.461	-0.846	-2.662***	-0.851*	4.163***	8.576***	0.325	0.299*	0.020	-0.008
	[0.837]	[0.645]	[0.591]	[0.511]	[1.264]	[1.045]	[0.205]	[0.167]	[0.273]	[0.206]
round2	-0.774	-1.107**	-2.332***	-0.520	3.346***	6.149***	-0.033	-0.166	-0.450**	-0.536***
	[0.585]	[0.465]	[0.413]	[0.368]	[0.915]	[0.764]	[0.144]	[0.120]	[0.191]	[0.148]
round3	0.045	-0.463*	-0.748***	-0.158	1.126**	3.332***	0.180**	0.153**	-0.044	-0.083
	[0.308]	[0.241]	[0.217]	[0.191]	[0.476]	[0.398]	[0.076]	[0.062]	[0.101]	[0.077]
constant	12.468	24.005	56.881***	7.152	-120.759***	-243.851***	-12.396**	-9.914**	-6.329	-2.720
	[20.875]	[17.796]	[14.734]	[14.084]	[32.255]	[29.084]	[5.113]	[4.603]	[6.807]	[5.681]
R^2	0.049	0.023	0.132	0.090	0.104	0.047	0.138	0.095	0.146	0.077
observations	6225	8560	6224	8561	5357	7512	6237	8567	6237	8567
individuals	3316	3866	3316	3867	3057	3679	3320	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size

Table 5.14: Table 13: Continuation From Previous Page

VARIABLES	$ln\frac{thiamin}{calorie}$		$ln\frac{folate}{calorie}$		$ln\frac{iron}{calorie}$		$ln\frac{zinc}{calorie}$		$ln\frac{calcium}{calorie}$	
ln implicit price:	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor	poor	non-poor
vitamin A	-5.355	10.637**	-13.146	-21.909**	-14.187*	14.121**	-3.717	13.470***	-51.763***	-16.670*
	[6.873]	[4.909]	[13.368]	[9.889]	[7.970]	[5.901]	[3.586]	[2.514]	[13.415]	[9.850]
vitamin C	-1.755***	-2.124***	-1.291	0.042	-1.392*	-1.502**	-0.421	-0.435	-2.259*	-3.160***
	[0.618]	[0.523]	[1.202]	[1.054]	[0.717]	[0.629]	[0.322]	[0.268]	[1.207]	[1.050]
vitamin D	-0.038	0.075***	0.013	-0.059*	-0.041	0.033	-0.005	0.027***	-0.156***	-0.050
	[0.025]	[0.018]	[0.050]	[0.036]	[0.030]	[0.021]	[0.013]	[0.009]	[0.050]	[0.036]
niacin	-0.443***	-0.237***	-0.243*	0.250**	-0.500***	-0.191***	-0.148***	-0.158***	-0.268*	-0.290***
	[0.074]	[0.052]	[0.145]	[0.105]	[0.086]	[0.062]	[0.039]	[0.027]	[0.145]	[0.104]
riboflavin	-0.007	0.023***	-0.023*	0.011	-0.010	0.027***	0.002	0.015***	-0.053***	-0.004
	[0.007]	[0.006]	[0.014]	[0.012]	[0.008]	[0.007]	[0.004]	[0.003]	[0.014]	[0.012]
thiamin	-0.018**	-0.008	-0.010	-0.006	-0.021**	-0.016***	-0.016***	-0.005**	-0.002	-0.004
	[0.009]	[0.005]	[0.018]	[0.010]	[0.011]	[0.006]	[0.005]	[0.003]	[0.018]	[0.010]
folate	-45.121***	-36.523***	-21.319	-9.797	-47.773***	-31.913***	-36.002***	-22.513***	-35.327**	10.324
	[8.834]	[5.224]	[17.183]	[10.524]	[10.244]	[6.280]	[4.609]	[2.676]	[17.243]	[10.483]
iron	-0.446***	-0.323***	-0.296	0.338*	-0.795***	-0.181*	-0.507***	-0.210***	-0.524*	0.367**
	[0.152]	[0.091]	[0.295]	[0.184]	[0.176]	[0.110]	[0.079]	[0.047]	[0.297]	[0.183]
zinc	0.165***	0.107***	0.199***	0.195***	0.143***	0.151***	0.055***	0.049***	0.254***	0.294***
	[0.037]	[0.026]	[0.071]	[0.053]	[0.042]	[0.031]	[0.019]	[0.013]	[0.071]	[0.052]
calcium	-27.785***	1.537	-15.802	1.103	-33.304***	5.306	-11.912***	3.497*	-22.719**	-0.736
	[5.851]	[3.740]	[11.382]	[7.533]	[6.785]	[4.496]	[3.053]	[1.916]	[11.421]	[7.504]
ln village rice price	0.172***	-0.040	0.323***	-0.107	0.146***	-0.008	0.021	-0.013	0.316***	0.236***
	[0.047]	[0.034]	[0.091]	[0.069]	[0.054]	[0.041]	[0.024]	[0.017]	[0.091]	[0.068]
lrtex	0.010	0.004	0.076**	0.027	-0.013	0.011	-0.009	-0.004	0.089***	0.045*
	[0.016]	[0.012]	[0.031]	[0.023]	[0.018]	[0.014]	[0.008]	[0.006]	[0.031]	[0.023]
llands	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
ladeq	0.046	0.013	0.209**	-0.085	0.085	-0.022	-0.034	0.013	0.327***	0.137
	[0.055]	[0.044]	[0.106]	[0.088]	[0.063]	[0.052]	[0.028]	[0.022]	[0.107]	[0.087]
age	0.352*	0.137	0.186	-0.926***	0.458*	-0.218	0.287***	0.031	-0.783*	-0.739**
	[0.210]	[0.171]	[0.408]	[0.344]	[0.243]	[0.205]	[0.110]	[0.087]	[0.410]	[0.343]
age^2	-0.000	-0.000	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000
	[0.000]	[0.000]	[0.001]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.001]	[0.001]
pregnant	0.100	0.024	0.040	0.061	0.087	0.042	0.043	0.008	0.003	0.096
	[0.061]	[0.039]	[0.119]	[0.078]	[0.071]	[0.047]	[0.032]	[0.020]	[0.120]	[0.078]
lactating	-0.053	0.004	-0.111	0.041	-0.063	-0.020	-0.021	0.007	-0.139*	-0.059
	[0.043]	[0.038]	[0.084]	[0.077]	[0.050]	[0.046]	[0.023]	[0.020]	[0.084]	[0.077]
round1	0.532**	0.336*	0.094	-0.920***	0.614**	-0.010	0.364***	0.154*	-0.670	-0.522
	[0.217]	[0.174]	[0.422]	[0.351]	[0.252]	[0.210]	[0.113]	[0.089]	[0.424]	[0.350]
round2	-0.183	-0.227*	-0.241	-0.898***	-0.043	-0.520***	0.107	-0.137**	-0.714**	-0.871***
	[0.152]	[0.126]	[0.295]	[0.253]	[0.176]	[0.151]	[0.079]	[0.064]	[0.296]	[0.252]
round3	0.245***	0.201***	-0.028	-0.326**	0.184**	-0.044	0.103**	-0.000	-0.156	-0.259**
	[0.080]	[0.065]	[0.155]	[0.132]	[0.093]	[0.078]	[0.042]	[0.033]	[0.156]	[0.131]
constant	-17.712***	-11.797**	-8.375	23.960**	-17.995***	0.528	-13.157***	-6.534***	15.872	17.209*
	[5.404]	[4.809]	[10.512]	[9.686]	[6.267]	[5.781]	[2.820]	[2.463]	[10.548]	[9.649]
R^2	0.210	0.166	0.034	0.038	0.121	0.089	0.082	0.067	0.069	0.030
observations	6237	8567	6237	8567	6237	8567	6236	8567	6237	8567
individuals	3320	3869	3320	3869	3320	3869	3319	3869	3320	3869

Heteroscedasticity consistent robust standard errors allowing for within household correlation are in brackets. *** p<0.01, ** p<0.05, * p<0.1.
lrtex=ln real monthly per capita adult equivalent household expenditure and lrtex2=square of lrtex;
llands=ln household landholdings; ladeq=ln adult equivalent household size

CHAPTER VI

Household Structure and Child Outcomes: Nuclear vs. Extended Families – Evidence from Bangladesh

Abstract: The nuclear family has long characterized the European family. In Asia, by contrast, the extended family has been the norm. A potentially important difference between these family forms is the allocation of headship: vested in a child's father in the nuclear family, but in the child's grandfather in the extended family. This chapter utilises the fact that extended families eventually convert to nuclear families on the death of the grandfather. Treating the death of the patriarch as an exogenous event, we ask if children are better off in nuclear than extended families. A reason this might be the case is that the father is more likely to be around when the child reaches adulthood and therefore better positioned to benefit from investments made in the child's human capital, than the grandfather. On the other hand, extended families may provide better household public goods. We analyze household survey data from Bangladesh and focus on education and health outcomes. We find child education, but not height-for-age, to be substantially better in nuclear families. These findings are consistent with children in nuclear families benefitting from privileged provision of private goods, but suffering from lower levels of household public goods, compared to children in extended families. We provide both OLS and 2SLS estimates of the effects.

6.1 Introduction

The nuclear family has long characterized the "European family" (Goody, 1983). In Asia, by contrast, the extended family has been the norm. As the terms suggest, the demographic composition typically differs between these families, but need not. A nuclear family may well contain grandparents and other family members. Instead, a potentially important, but largely ignored, difference may lie in the allocation of headship: a nuclear family is headed by the child's father, whereas an extended family is headed by the grandfather. While the extended family is commonly viewed as a family form that ensures support of the elderly by their adult children, little is known about its effect on child wellbeing, the focus of this chapter.

This is an important question in the context of a developing country, where a great number of children live under the rubric of the extended family for at least a part of their childhood. This chapter investigates whether and how household type, headship in particular, matters for children's health and education outcomes in rural Bangladesh using household survey data collected by the International Food Policy Research Institute (IFPRI) in 1996-97.

Why would allocation of headship matter? Edlund and Lagerlöf (2002) argued that since a child's father may expect to live longer than its grandfather, the father may have a greater interest in the human capital of the child than the grandfather. Biologically motivated altruism may be another reason why parents would devote more resources to their children than grandparents to grandchildren. Still, sufficient altruism or capital markets may render headship immaterial. Yet another possibility is that the extended-family system has evolved precisely because it is conducive to investments in child human capital.

We focus on child education and health. Both are important contributors to child human capital but capture different mechanisms. The former is an example of a private good, while the latter is produced by a combination of private goods (e.g., food intake, medication) and household public goods (e.g., quarters). Following Edlund and Lagerlöf (2002), we hypothesize that outcomes that are particularly related to private goods allocation towards children, such as education, are better in families where the father (instead of the grandfather) is the head. By contrast, headship may not matter for child outcomes related to household public goods, such as health. If a household public good, individual health outcomes may be determined by household wealth, not by who controls resources. Thus, to the extent that extended families are wealthier, child health may be better in those.

We find that, beyond age 10, children in nuclear families tend to have higher levels of education than their counterparts in extended families, controlling for household composition, wealth and parental education. By contrast, nuclear families are not associated with better health outcomes for children, a result we believe may derive from health being a household public good, as just mentioned. We provide both OLS and 2SLS estimates. Both are motivated by the social norms governing household formation in Bangladesh.

In Bangladesh, there is a strong presumption that adult sons continue to live under the headship of their father until the latter's death, e.g., Amin (1996), also Foster (1993).[1] Thus, children whose (paternal) grandfather has passed away live under the headship of their father, while children whose grandfather is alive are likely to live under his headship. This motivates the identifying assumption for our OLS estimates: social norms in combination with mortality results in exogenous variation in a child's exposure to extended and nuclear households.

However, we remain mindful of the potential endogeneity of household form. Although prescribed, not all adult sons co-reside with their fathers. Crowding and disagreements may mar the extended family, and the strain is likely to be particularly pronounced if there are several adult sons. In that case, the solution may be a household partition, by which an adult son leaves the extended family to head his own nuclear family, e.g., Foster and Rosenzweig (2002). Therefore, we

[1] A phenomenon well-reflected in our data as well.

also present 2SLS estimates where we instrument for household form using information on the father's birth family: father's birth order, number of brothers of father, whether grandfather is alive, whether grandmother is alive, whether father or his parents' choose the bride for father, father's age at marriage, father's age when grandfather's land was divided, number of brothers of father who inherited grandfather's land, a dummy for natural disaster; and their interactions.

These instruments are variables that we believe can be assumed to have first order effects on household type in Bangladesh, but not on child health or education outcomes. If the grandfather is alive, then it is more likely that the child will be in extended households. This is particularly likely if the father has few brothers. In the case of a partitioning prior to the death of the grandfather, birth order may influence who remains with the extended household and who branches off. Partitioning of grandfather's land leads to formation of individual families of his sons and more so if the partitioning happens after his death.

Individual consent in marriage was introduced in Europe in the Middle Ages while outside the Western world, arranged marriages prevailed well into the 20th century, and still is the predominant marriage form in South Asia, the Middle East and parts of Africa. Parental consent and extended families remain important features of marriage in Bangladesh. Headship with the grandfather until his death (extended families) is the characteristic of societies in which marriage is by parental consent. On the other hand, headship with the father of dependent children (nuclear families) may be linked to individual consent in marriage (see e.g., Edlund and Lagerlöf (2002)). Hence, if the father choose his bride and particularly in the absence of the patriarch (i.e., upon grandfather's death), this provides indication of the formation of his own family. Finally, natural disaster can be an external shock that can cause death, dislocation, and thus breaking up of an extended family. One of the three survey sites in our sample, i.e., Saturia thana of Manikganj district, was hit by one of the deadliest tornado in 1989 that killed about 1300 people (Sarker and Ferdousi, 2004). Geographically, this survey site compared to the other two is also more prone to natural disasters, such as tornado and flood and indeed later on in 1999 some of the villages of this site were devastated by flood. We thus also use a natural disaster dummy to instrument for family types.

We, however, are concerned about the suitability of a number of our instruments, particularly, the father's birth order, his number of brothers, and whether or not the grandfather and grandmother are alive. A father's birth order may influence his family's investment on his human capital, and his human capital is linked with his children's human capital. However, this may be less of a critical issue as we control for the effect of a father's human capital on his children's by controlling for father's education in the regression. A father's brothers may also affect a child's human capital. However, the literature in the context of Bangladesh suggests that, it is typically a mother's brothers who can positively affect her children's human capital through financial support, and in exchange the mother might give up her share of inheritance from her parental family for her brothers at the time of her marriage (Hallman, 2003).

Being mindful of these concerns, we undertake redundancy test of these instruments in 2SLS estimation, and the test results are strongly in support of the validity of these instruments particularly in modeling children's education.

The chapter, however, has its limitations. Our argument that a child's health is relatively sensitive to household public good and education is not may be invalid as there are also private good elements to health and public good elements to education. A child's height could be influenced by growth nutrients through food allocation, while education can be influenced by a household's electricity access and quietness level. Extended families may also enjoy greater economies of scales being bigger in size and thus could provide for more supervised learning. In future work, we attempt to explore the relative contributions of some of these public vis-a-vis private good elements to a child's health and education in this dataset.

Also, while our focus is on public vs private good aspect of inputs to a child human capital, there could be also a public vs private good aspect of returns from that human capital. For example, failing to invest in a child's health could make her more prone to infectious diseases, which in turn could infect other members of the household and affect their earnings because of their own sickness or because they now need to take care of the sick child. If parents are aware of market returns to education but not this type of public good returns from health, then they may favour investing in education over health. Also, in an agrarian economy characterised by manual labour, productivity return from health might be more relevant than that from education, so it is not obvious why nuclear families would invest in education but not in a child's health. All these motivate further exploration of household behaviour regarding investment in children's human capital, which we attempt to do in our future work.

The remainder of the chapter is organized as follows. The next section reviews the related literature. Section 6.2 presents the empirical analysis, and Section 6.3 concludes.

6.1.1 Related literature

This chapter is in the tradition of the literature on bargaining power and intra-family allocation provoked by the suggestion of the former's irrelevance for the latter by Becker (1974). Bourguignon et al. (1994) proposed an alternative framework that allows for the intra-family income distribution to affect the allocation of consumption, subject to the outcome being efficient; and there is a growing empirical literature that documents the importance of bargaining power for intra-household resource allocation (e.g., Altonji et al. (1992); Lundberg et al. (1997); and Quisumbing and Maluccio (2003)). Note that human capital may be viewed as an investment rather than consumption. Therefore different levels of education may represent not only different points on the utility frontier, but different frontiers.[2]

A related strand of literature concerns family form and old age support. In South Asia, the extended family is widely viewed as a vehicle for old age support, e.g., Kochar (2000). However,

[2]Thus, a lower human capital investments achieved under, say, the grandfather's headship can still be Pareto efficient, since he is less likely to be around when the children reach adulthood.

at least theoretically, support of the elderly need not be premised on the allocation of headship or the living arrangement. For instance, prime-age men may support their fathers (co-residing or not) lest failure to do so would result in their own children refusing to support them in turn, as proposed by Ehrlich and Lui (1991). While the extended family may provide for the elderly, and result in higher provision of public goods (suggested by, e.g., Foster and Rosenzweig (2002)) the consequences for human capital investments in children have received relatively little attention (an exception is Foster (1993)).

The papers most closely related to ours are Foster (1993) and Joshi and Sinha (2004). In line with our hypothesis, Foster (1993) found that within an extended family, children to the household head did better, education-wise, than grand-children. Joshi and Sinha (2004) found that children in a household that had partitioned did worse than the children who remained in the originating household. If partitioning is more likely on the death of the patriarch (suggested by our data, and Foster (1993)), their findings are consistent with this chapter's. That is, children's doing better in the original family may come off headship having passed from the child's grandfather to its father. Both Foster (1993) and Joshi and Sinha (2004) were primarily concerned with household *partitions*. By contrast, this chapter focusses on the devolution of headship. While correlated, these are not synonymous events, further elaborated on below.

The prototypical household under the extended-family system goes through a life-cycle (for references see Foster (1993)) that can be illustrated by the following example. A patriarch has two adult sons. The sons marry and form families. These families may continue to co-reside with the patriarch, or form their own households. Typically, at least one son stays with the patriarch, and inherits headship on the patriarch's death. If a son does not inherit headship, but acquires headship by forming his own household (possibly in the same *bari* (compound)), this is a household partition. Hence, a son may head a household as the result of a partition or the passing of his father. The patriarch may also voluntarily cede headship in old-age, although this is rare (as is female headship in the presence of an adult male family member). The nuclear households of the two sons remain nuclear until their sons, in turn, take wives, and the cycle repeats itself. Thus, the extended-family system gives rise to both extended and nuclear families, and, consequently, dependent children may live under the headship of their grandfather or their father.

6.2 Empirical investigation

We use household survey data collected by the International Food Policy Research Institute (IFPRI) in rural Bangladesh. The survey was conducted every four months from June 1996 to September 1997 (four rounds) in 47 villages from three sites: Saturia, Jessore and Mymensing. The questionnaire was administered to 5,541 individuals in 955 rural households in each round. We restrict our analysis to Muslim households that were male-headed and monogamous (the overwhelming majority) with children 16 years or younger.

Our outcome variables are height-for-age and class completed. Both capture important aspects of a child's current and future well-being and productivity. Height-for-age is a composite measure of the child's nutritional status and morbidity. It is particularly meaningful for children of young age, and therefore we restrict attention to children aged 0-10 years. An advantage of this measure is that it is robust to transitory spells of disease or seasonality in diet (unlike, e.g., weight-for-height). However, health is likely to partly be a household public good (for instance, from shared quarters or relatedness). Height-for-age was collected in all four rounds, and we have about 3,778 child-round observations.

A, for our purposes, useful feature of education is that it is a private good, and thus reflects resources intentionally directed to the child.[3] We measure education by class completed. This measure is only meaningful for children aged 6-16 years. This variable was collected once for each individual, and we have about 1,297 observations.

We conceptualize the family as potentially consisting of dependent children, their parents and grandparents. Unless otherwise specified, the terms parent and grandparent indicate relationship to child, where we define child to be an individual who is no more than 16 years old, is not a parent himself/herself, and still resides with his or her birth family. Grandparents in our data are paternal. The terms grandfather and patriarch will be used interchangeably, as will the terms household and family.

We classify families according to headship and demographic composition. Nuclear families are headed by the father and extended families are headed by the grandfather. Among, nuclear families, we distinguish between those with and without co-residing grandparents (chiefly grandmothers), nuclear^{w} and nuclear$^{w/o}$ respectively[4]. Hence, in terms of demographics, extended and nuclear^{w} families are similar, whereas with respect to headship, the nuclear$^{w/o}$ and nuclear^{w} families are equivalent.

The majority (68 percent) of our households are nuclear$^{w/o}$. Nuclear^{w} and extended families make up 10 and 22 percent, respectively.[5] The distribution of children across family types essentially mirrors the above, see Table (6.1).

6.2.1 Household type and its correlates

This section examines the data in order to provide a picture of the in-sample evidence of a household life-cycle and/or other factors influencing household formation, in order to gauge the likely direction of any selection or omitted variable bias.

We find that our sample households exhibit characteristics largely consistent with a life-cycle of households dictated by the social norms described earlier. To the extent that household types are

[3]Schooling is not compulsory in Bangladesh.

[4]If the head is the grandfather of some but the father of other children (in the household), we classify this as an extended family. Similarly, while in an extended family parents of the grandfather may present in the household, in the data we have only 10 such households and we drop them from the analysis. There is also no household in the sample which a child's great grandfather is the head.

[5]The high fraction of nuclear households is consistent with the findings of other studies in South Asia, e.g., Caldwell et al. (1984); Niranjan et al. (1998).

systematically different in terms of wealth or parental education, the nuclear families, nuclear$^{w/o}$ families in particular, appear poorer along a number of dimensions, which arguably works against finding support for our hypothesis that child outcomes are better in nuclear families.

Demographic characteristics by household type Table (6.2) presents descriptive statistics (means) of the household heads, adult sons, spouses and parents, by households types. Average age of parents in nuclear$^{w/o}$ and nuclear^{w} are similar.[6] This suggests that nuclear$^{w/o}$ families do not form solely from the passing of non-head grandparents (given the substantial spousal age gap, widowers are rare), since this would predict heads in nuclear$^{w/o}$ families to be older. Since presumably a fraction of nuclear$^{w/o}$ families form from nuclear^{w} families, this suggest that either junior sons form their own households at around the same time as the older son inherits headship, or that there is a partition before the patriarch dies.

Consistent with a household life-cycle, we find that both parents and children were significantly younger in extended families. Fathers were on average about nine years younger in extended families, and children three years younger, Tables (6.1) and (6.2). Average ages of children in the different family forms are not easily comparable since any additional births after the grandfather's death lowers the average age of children in nuclear families.[7]

Consistent with the existing literature, we find our modal extended family to consist of several adult sons (of head), their wives and children; while the nuclear$^{w/o}$ families were rarely "laterally extended" (not reported). Moreover, less than a quarter of children in nuclear$^{w/o}$ have their grandfather and half have their grandmother. As expected, these figures are much larger for children in extended families, Table (6.1).

Parental education We find that parents, fathers in particular, are better educated in nuclear^{w} and in extended families than in nuclear$^{w/o}$ families, Table (6.2). Thus, it does not seem to be the case that educated males (whose preferences for education may be higher than uneducated men's) are more prone to form nuclear families.

Another concern is that factors liable to be correlated with grandparental mortality may also cause high investments in child human capital. For instance, if educated men have children later (but their fathers do not live longer), then their children may be both better educated and more likely to grow up in nuclear families, without there being a causal interpretation to the correlation. To check whether more educated men have children later compared to less educated men, we estimate the following equation by OLS:

$$\texttt{child-age}_{ij} = \alpha_0 + \alpha_1 \texttt{father-edu}_j + \alpha_2 \texttt{father-age}_j + \tag{6.1}$$

[6]The survey collected information on marriage and parental characteristics only for the heads and their wives. Thus, we do not have the information on age at marriage for the adult married sons in extended households.

[7]For each of the characteristics, we conduct an F-test to see whether two, middle, and extended families are significantly different from each other (p-values not reported but available upon request).

$$\beta_1 \texttt{nuclear}_j^{w/o} + \beta_2 \texttt{nuclear}_j^{w} + \epsilon_{ij},$$

where the dependent variable $\texttt{child-age}_{ij}$ is the age (in years) of child i of father j. The variable $\texttt{father-edu}_j$ is the education of the father. We also account for the father's age, $\texttt{father-age}_j$, since obviously, fathers and children age at the same rate. $\texttt{nuclear}_j^{w/o}$ and $\texttt{nuclear}_j^{w}$ are dummies for nuclear$^{w/o}$ and nuclear^{w} households respectively, and ϵ_{ij} is the stochastic error term. The omitted category is the extended households. In the last specification, we interact father's education with the dummies for nuclear$^{w/o}$ and nuclear^{w} households to see whether within each household category, more educated men tend to have children later than less educated men.

Results are in Table (6.4), panel A. In column (1) we regress child's age on father's education and age only, in column (2) dummies for household types are added, and in column (3) we add interactions between household type and father's education. We find that, controlling for own age, educated men tend to have older, not younger children. α_1 is negative in all three specifications, albeit not significant when the interaction terms are added. Children also tend to be older in nuclear families, as would be expected if households form according to the described life-cycle.

To explore further whether a more educated father tends to have children later, we also estimate the analogue of regression (6.1) above, for the age of the oldest child. Since we only have information on children under 16 currently in the household, we restrict the sample to fathers aged 45 or less. However, we find no relationship between father's education and age of his oldest child, panel B, Table (6.4).[8]

In sum, neither do we find any evidence that more educated fathers tend to form their own families, nor do we see that more educated men tend to marry and have children later than less educated men. While any of these mechanisms could lead to endogeneity problems, our data are not suggestive of such mechanisms.

Household income and wealth The pattern from land-holdings is somewhat mixed. On the one hand, nuclear$^{w/o}$ families appear substantially poorer than the other family types. Landholdings are lower in nuclear$^{w/o}$ families, as evidenced by both a higher fraction landless and lower average land-holdings, Figure (6.3) and Table (6.1).[9]

Seemingly, this would suggest that landlessness is a factor in the decision to partition. However, a similar pattern would result from a process in which nuclear$^{w/o}$ families form before the adult male comes into his land inheritance.[10] Thus, it may indicated lower current income but not necessarily lower lifetime wealth.

On the other hand, when head's (and head's wife's) parental land-holdings are considered, nuclear$^{w/o}$ families look considerably better off, Table (6.2). This measure is instructive since it is likely to contain realized inheritance, and while it may not be indicative of the household's current

[8] Nor do we find that better educated fathers have fewer children, not reported.

[9] Also, landlessness falls with the age of household head in nuclear$^{w/o}$ families, not reported.

[10] Female land holding is minor relative to male land-holding.

income, it can shed light on the selection process, i.e., do nuclear$^{w/o}$ families form disproportionately from land poor or rich families. Considering head's father's land-holdings, the extended families are the wealthiest, and there are no significant difference between nuclear$^{w/o}$ and nuclear^{w} families.[11] On the other hand, with respect to head's father-in-law's land-holdings, the three family types are strikingly similar.

In terms of mean monthly expenditure (per capita adult equivalent, discussed below), nuclear families (nuclear$^{w/o}$ and nuclear^{w}) spend more than extended families. Finally, the survey also collected data on asset brought at marriage by husband and wife, and there were no statistically significant differences across households (see bottom row of Table (6.2)).

In sum, neither do we see that heads of the nuclear$^{w/o}$ families are more educated or wealthier (particularly in terms of land holding – arguably the most valuable asset in agrarian Bangladesh), nor that educated men tend to marry or have children later. The nuclear^{w} families appear similar to extended families in terms of land-holdings and parental education, as would be expected if the main difference between the two were the presence of the grandfather (and his headship). The nuclear$^{w/o}$ families, on the other hand, seem poorer than the other family forms, at least in terms of current land-holdings and, to some extent, (grand-)parental land-holdings. Thus, it appears that for analyzing the effect of the allocation of headship, the closest comparison is that between extended and nuclear^{w} families.

We now turn to the chapter's main focus: child outcomes by household type.

6.2.2 Child Outcomes and Household Types

We begin our analysis by estimating an empirical model of the form:

$$y_{ij} = c + a_{ij} + f_{ij} + a_{ij} \times f_{ij} + \gamma_1 \texttt{nuclear}_j + \gamma_2 (a_{ij} \times \texttt{nuclear}_j) + X_j + a_{ij} \times X_j + \epsilon_{ij}, \tag{6.2}$$

where the dependent variable y_{ij} is the outcome of interest of child i in household j. a_{ij} is age (in completed years) and f_{ij} is a female dummy. **nuclear** is the dummy that takes on the value 1 if the child is in a nuclear family, and ϵ_{ij} is an error term that is assumed to be i.i.d. The omitted category is the extended family. We interact all variables with age, as older children in nuclear households are likely to spent more time not under the headship of their grandfather than younger children. Thus, one would expect the differences in child outcomes between extended and nuclear families to be more pronounced for children of older age groups. This would be particularly relevant for education as completed education and the time a child spend in nuclear family can only increase with age.

[11] Although a higher fraction of nuclear$^{w/o}$ families are from poorer families. Figure (6.3) shows a higher fraction of landless fathers-of-head in nuclear$^{w/o}$ families.

Nuclear families may (nuclear^{w}) or may not (nuclear$^{w/o}$) have co-residing grandparent(s). We saw earlier that in terms of household structure and household wealth, the closest comparison to the extended family were the nuclear families with a co-residing (non-head) grandparent. To allow the effects to be different for the nuclear^{w} and nuclear$^{w/o}$ families, we break up the nuclear dummy accordingly and estimate the following equation:

$$y_{ij} = c + a_{ij} + f_{ij} + a_{ij} \times f_{ij} + \beta_1 \texttt{nuclear}_j^{w/o} + \beta_2 \texttt{nuclear}_j^{w} + \beta_3 (a_{ij} \times \texttt{nuclear}_j^{w/o}) + \beta_4 (a_{ij} \times \texttt{nuclear}_j^{w}) + X_j + a_{ij} \times X_j + + \epsilon_{ij}, \tag{6.3}$$

where **nuclear**$^{w/o}$ and **nuclear**^{w} are dummies that take on the value 1 if the child is in a nuclear$^{w/o}$ or a nuclear^{w} family, respectively.

The key parameters for our analysis are γ_1 and γ_2 in (6.2) and from β_1 through β_4 in equation (6.3). Under our hypothesis, the effect of household type increases with the child's age; i.e., γ_2, β_3, and $\beta_4 > 0$. And the effect of being in a nuclear household instead of an extended household is positive beyond some age less than 16; i.e., $\gamma_1 + \gamma_2 a_{ij}, \beta_1 + \beta_3 a_{ij}, \beta_2 + \beta_4 a_{ij} > 0$ for some $a_{ij} < 16$. X_j is a vector of household level control variables: adult equivalent household size, measures of per capita (adult equivalent) income and wealth, and parental education. These are likely to have independent effects on the outcomes at hand. The demographic composition obviously differs between households. To account for the different needs arising from such differences, we compute the adult equivalent household size and per capita (adult equivalent) wealth measures, using the equivalence scale (based on caloric needs by age and sex) for Bangladesh proposed by Ahmed and Shams (1994), see Table (6.3).[12]

We estimate seven different specifications of equations (6.2) and (6.3) in order to assess the sensitivity and robustness of our key parameters of interest in the presence or absence of different household controls. In the basic specification, column (1), we only control for the adult equivalent household size. Then we introduce the controls for log of per capita (adult equivalent) wealth measures in columns (2)-(5): land in column (2), asset (which does not including housing) in column (3), expenditure in column (4); and all three wealth measures together in column (5). Column (6) presents the specification with parental education but without wealth controls. Finally, parental education and all three wealth controls are in column (7).

We provide both OLS and 2SLS estimates of equations (6.2) and (6.3). As described in the introduction, both are motivated by the social norms governing household formation in Bangladesh. For the OLS estimates, our identifying assumption is that nuclear families form on the death of the grandfather, thus mortality results in exogenous variation in a child's exposure to extended and nuclear households. As just shown in Section (6.2.1), to the extent that adult sons form nuclear households for other reasons, the correlates of such "nuclearisation" are likely to work against

[12]Our results are not sensitive to this. Per capita or even per household measures yield qualitatively similar results.

our hypothesis that children benefit from headship with their father. Recognition of the potential endogeneity of household form prompts us to also instrument for household form. For this, as mentioned above in section 6.1, we use information on the father's birth family. Specifically, the following variables: father's birth order, number of brothers of father, whether grandfather is alive, whether grandmother is alive, whether father or his parents' choose the bride for father, father's age at marriage, father's age when grandfather's land was divided, number of brothers of father who inherited grandfather's land, a dummy for natural disaster; and their interactions. As argued in the introduction, these are variables can be assumed to have first order effects on household form but not child education. As our model involves interactions of age with all other explanatory variables including the potential endogenous household types, we also interact these instruments with age variables of the child. Table 6.13 provides first stage estimation of the 2SLS estimation of the most comprehensive specification (specification 7) for child's health while table 6.14 provides that for child's education. The set of interactions among the instruments can be seen from these tables.

While theoretically endogeneity of household type is a possibility, which motivates our 2SLS estimates, empirically we also conduct the test of endogeneity of household types along with other diagnostic tests reported in the following sections[13]. Regarding empirical models of child's education (equation 6.2 and 6.3), almost in all the specifications, we cannot reject the null hypothesis that the household types can be treated as exogenous. This is also the case for equation 6.2 for child's health (see the row "Endogeneity Test" and the corresponding p-values of the 2SLS results for education and health). So OLS estimates as discussed below should be given due importance.

Height-for-age (ages 0-10)

We use the height-for-age z-score as our measure of health outcome of the children. Low height-for-age indicates chronic malnutrition for which poor diet and spells of disease are key contributors. The z-scores are computed using the height-for-age distribution of American children. On average, children are much shorter than their US comparison group (about 2 standard deviations), see Table (6.1). The mean z-score is significantly better for children in extended households (-1.99) than their counterparts in nuclear$^{w/o}$ and nuclear^{w} households (with a z-score of -2.14 and -2.16, respectively). While we hypothesized that fathers, who are heads in nuclear$^{w/o}$ and nuclear^{w} families, would like to invest more in children than the grandfathers (heads in extended households), it may be that the hypothesized negative effect of grandfathers is offset by health being a household public good. Extended families are wealthier and hence could afford a higher level of public goods. For instance, plumbing, flooring, ventilation, insulation, and cleanliness of the dwelling, all correlated with household wealth, are likely to affect the living conditions of all household members. Another reason we might expect health outcomes for children to be better in extended households is that to

[13]2SLS estimation and the diagnostic tests are performed using ivreg2 suite in Stata. Baum et al. (2007) provides a comprehensive analysis of these diagnostic tests.

the extent that there is an inherited component to health, the very presence of the grand father may indicate predisposition towards good health. However, when we conduct the redundancy test of the instruments father's birth order, number of brothers, and whether grandfather and grandmother are alive or not, we fail to accept the null hypothesis that these instruments are redundant (see the row "IV Redundancy Test" and the corresponding p-values of the 2SLS results for education and health) for empirical model 6.2[14].

Tables (6.5) and (6.6) provide OLS and 2SLS estimates of equation (6.2), and Tables (6.7) and (6.8) provide OLS and 2SLS estimates of equation (6.3) using child's height-for-age z-score as the dependent variable. We do not find any significant difference between nuclear (neither nuclear$^{w/o}$ nor nuclear^{w}) and extended families in terms of child's health outcomes. We speculate that the failure to find a positive effect of headship with the father may be due to a counter acting effect of lower household public goods in nuclear households (recall, the extended households are wealthier). The diagnostic tests in table (6.6) show substantial Shea R^2 and although F-statistic are not above 10, they are significant at 1% level. These models are not underidentified as the p-value of underidentification test implies. However, the null of overidentification restrictions is rejected at 95% confidence interval in specification (2) and at 90% confidence interval in specification (1), (3), and (7). On the other hand, in the estimation of equation 6.3, the overidentification restrictions cannot be rejected for any specification, and the test for redundancy of instruments: father's birth order, number of brothers, and whether or not the grandparents are alive, suggest that we cannot accept the null that these instruments are redundant in identifying the equation.

We now turn to children's education, an outcome that to a greater extent measures private goods allocation within the household.

Education (ages 6-16)

We restrict the analysis to children aged 6-16.[15] Schooling typically start at age 6 or 7, but is not compulsory. Primary school encompasses grades 1-5, secondary school grades 6-10, and higher secondary school grades 11-12. Higher secondary schooling is not common, and by the age of 16, daughters may already have left their birth family due to marriage. We use class completed as our measure of education. We use data from round two when estimating equation (6.2).[16]

Tables (6.9) and (6.10) present OLS and 2SLS estimates of equation (6.2). The results are

[14] Without loss of generality, the intuition behind the IV redundancy test can be simply described as follows. If x is an endogenous variable and Z is a set of instruments in which Z_1 is a set of potentially redundant instruments, then a straightforward test of redundancy would imply regressing x on Z and test if the coefficients of Z_1 are zero. For a detailed description of instrument redundancy tests, see Baum et al. (2007).

[15] In the preliminary analysis we used the age group 6-15 and the results were similar. Also in extended families children of age group 6-16 includes both the grand-children and children of the household head. We included dummy for children in extended families to see whether their outcome is significantly different from the grand-children, but we did not find any significant difference (results are not reported).

[16] The school year in Bangladesh starts in January/February and ends in November/December. Thus round two is the last round for which the recorded completed schooling of new entrants into the survey is comparable to the completed schooling of earlier entrants.

supportive of the hypothesized positive effect of headship with the father (as opposed to the grandfather). For all variables, level effects are negative and age interactions positive, in line with the observation that the class completed can only increase with child's age. The 2SLS estimates are in line with the OLS estimates and the diagnostic statistics imply that the strength of the instruments are much stronger than observed in the case of health regressions. Both the Shea R^2 and F-statistic are substantial and the hypothesis of underidentification is strongly rejected in all specifications. Similarly, the hypothesis of redundancy of the instruments: father's birth order, number of brothers, and whether or not grandparents are living are also strongly rejected. We cannot reject the overidentification restrictions either with the exception of specification 3 and 5. More importantly, the endogeneity test of the household types indicate that household type can be treated as exogenous variable, suggesting due importance of the OLS estimates.

In the most comprehensive specification – where we control for adult equivalent household size, per capita (adult equivalent) wealth and income measures and parental education – children nine years or older have higher level of education in nuclear families than children of the corresponding age in extended families, Table (6.9), column (7). When we instrument household type, the coefficients on the nuclear family dummy and its interaction with age are marginally higher and of the expected sign suggestive of a negative bias in the OLS estimates as hypothesized earlier. Children 11 years or older now do better in terms of education in nuclear families than their counterpart in extended families, Table (6.10).

Next, we disaggregate nuclear families into nuclear$^{w/o}$ and nuclear^{w} families, and repeat the above analysis. In the case of the OLS estimation, children eight years or older do significantly better in nuclear^{w} families compared to their counterpart in the extended family, see Table (6.11), column (7). Both the coefficients on the nuclear^{w} dummy and its interaction with child's age are significant at the 5% and the 1% level respectively in all seven specifications. In the case of the 2SLS estimation, column (7), the estimates imply that children 11 years or older are better off in nuclear^{w} families than in extended families. Again both the nuclear^{w} dummy and its interaction with age is significant at least at 10% level throughout in all of the specifications (and at 5% level or less in most of the cases), Table (6.12).

Thus it appears that it is nuclear households with co-residing grandmothers that compares most favorably to the extended family. This is interesting considering that it may be the household type most readily comparable to the extended household. A potential caveat when interpreting this result is that the grandmother may be matched to the household (among her adult sons) that can best accommodate her, presumably the most affluent. Still, there is no reason to think such a mechanism would confound a comparison between nuclear and extended families. Moreover, the results for nuclear^{w} are strengthened rather than weakened when household type is instrumented for.

With the exception of specifications 3 and 5, in all other specifications, the instruments satisfy the overidentification test of the validity of instruments. All other diagnostic tests are also supportive of the hypotheses that the models are not underidentified, and the subset of instruments-father's birth order, grand parents alive or not, and father's number of brothers are not redundant against our concerns discussed in the introduction. Finally, the endogeneity tests again suggest that household types can be treated as exogenous variables indicating that the OLS results should be given due importance.

6.3 Concluding remarks

The organization of the family varies across cultures along a number of dimensions. This chapter has been concerned with the difference between the so called extended and nuclear family, the former being more prominent in Asia, and the latter in Europe. A potentially important difference between the two is the allocation of headship – with the father in nuclear families but the grandfather in extended families. While the literature has noted that the extended family provides for the elderly, its consequences for investments in child human capital, the focus of this chapter, has received relatively little attention.

We hypothesized that outcomes that are particularly related to private goods allocation towards children, such as education, are better in families headed by the father (instead of the grandfather). By contrast, headship may not matter for outcomes mainly determined by household public goods, health being a case in point. Analyzing Bangladeshi household survey data, we found child education to be better in families headed by the child's father, but found no significant difference between household types in terms of child health (measured by height-for-age). We interpreted these findings to be consistent with children in nuclear families benefitting from privileged provision of private goods, but suffering from lower levels of household public goods, compared to children in extended families. We provided both OLS and 2SLS estimates, where number of brothers, birth order and parental mortality of the child's father served as instruments for household type.

However, our hypothesis has weaknesses as health could be also influenced by private good allocations, such as food, while education can be influenced by public good elements in a household, such as scale economies, electricity, quietness, etc. In an agrarian economy, health may influence productivity of manual labour more than education, so it is not obvious why nuclear family would want to invest more on a child's education but not on a child's health. In future analysis, we attempt to investigate the strength of various public vs private good inputs to a child's health and education and household behaviour related to investing in children to further assess the validity of our hypothesis.

Figure 6.1: Land holdings, by household type. Clock-wise from top left: nuclear$^{w/o}$, nuclear^{w}, and extended.

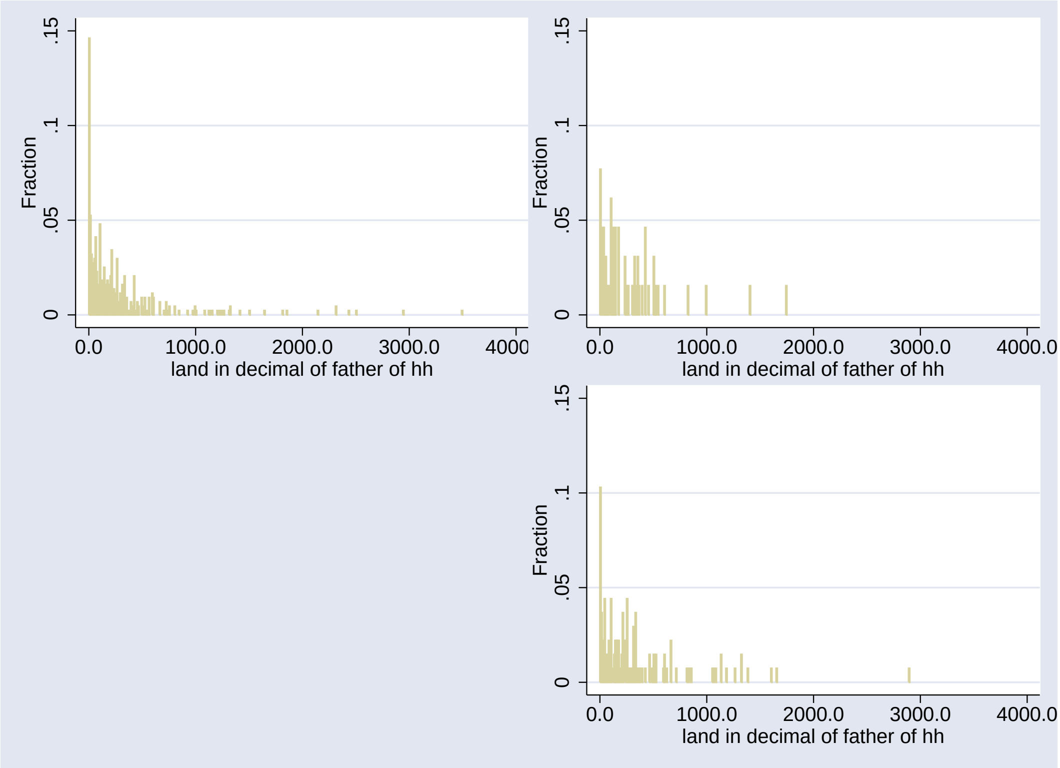

Figure 6.2: Land holdings of head's father, by household type. Clock-wise from top left: nuclear$^{w/o}$, nuclear^{w}, and extended.

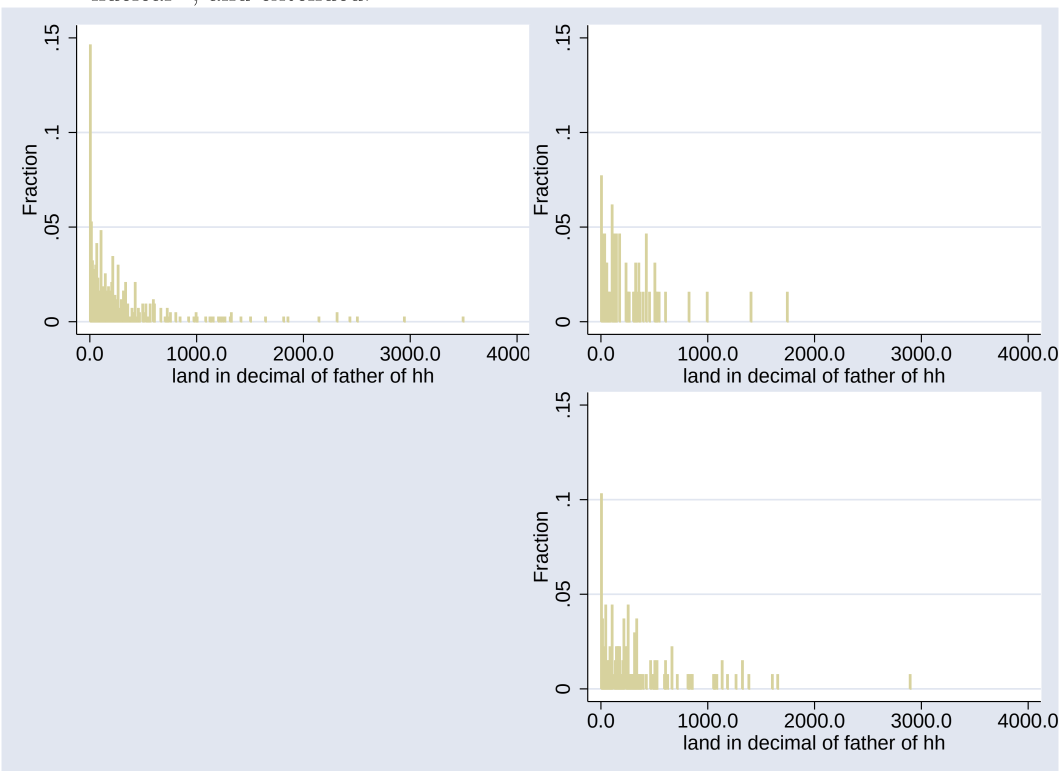

Table 6.1: Household Characteristics and Child Outcomes (means)

	Household type		
	Nuclear$^{w/o}$	Nuclear^{w}	Extended
Height-for-age (ages 0-10)			
z-score	-2.14	-2.16	-1.99
N^a	2601	422	755
Education (ages 6-16)			
class completed	2.36	2.96	2.10
N^b	809	134	354
class completed	1.67	2.12	1.88
Household Characteristics			
Household Size	5.30	6.76	9.03
Adult equivalent	4.23	5.23	6.62
Age of children	8.45	8.58	5.46
Land (1/100 acre)	88.70	170.07	232.35
Assets (Taka)	8880.18	13372.05	17069.33
Expenditures (monthly, per capita adult equivalent)	767.74	746.27	682.27
N^c	464	70	152
Percentage of children whose grandparents are not alive (ages 0-16)			
Grandfather not alive	77.18	79.51	42.20
Grandmother not alive	50.23	10.98	40.27
N^d	1065	173	372

[a] Number of children in four rounds. [b] Number of children in second round. [c] Number of households. [d] Number of children in first round. Age of children refers to children under 16 years of age in survey round 1.

Table 6.2: Summary Characteristics of Adult by Household Types

	Household Type			
	Nuclear$^{w/o}$	Nuclear^{w}	Extended	
			Head	Child's parent
Head				
Age	42.42	41.72	57.79	33.26
Education	3.15	5.00	2.47	4.48
Birth-order	3.26	3.12	3.05	3.59
No. of Brothers	2.50	1.91	2.25	3.45
Wife				
Age	33.76	33.23	48.98	26.79
Education	2.74	2.21	1.09	2.86
Parental Characteristics (pre-wedding)				
Head				
father's land holding	275.14	259.87	344.62	
mother's land holding	14.78	22.52	39.87	
father's education	2.03	2.38	1.82	
mother's education	0.29	0.37	0.25	
Wife				
father's land holding	360.79	327.22	358.14	
mother's land holding	23.43	31.91	30.68	
father's education	2.67	2.91	1.98	
mother's education	0.76	0.80	0.49	
Assets brought at Marriage (Taka)				
Head	25209	30664	37495	
Wife	2665	1885	3454	

Education is class completed. Landholdings are in 1/100 acre, and assets are in Taka.

Table 6.3: Adult Equivalence Weights by Age and Sex

Ages (years)			
From	To	Females	Males
0	1	0.25	0.25
1	2	0.36	0.37
2	3	0.4	0.42
3	4	0.43	0.46
4	5	0.46	0.49
5	6	0.48	0.53
6	7	0.49	0.56
7	8	0.49	0.58
8	9	0.49	0.58
9	10	0.49	0.58
10	11	0.64	0.70
11	12	0.64	0.71
12	13	0.66	0.73
13	14	0.68	0.77
14	15	0.7	0.81
15	16	0.7	0.85
16	17	0.72	0.89
17	18	0.75	0.92
18	30	0.82	1.03
30	60	0.83	1.03
60	–	0.61	0.68

Source: Ahmed and Shams (1994).

Table 6.4: Father's Education, Age and Number of Children

	(1)	(2)	(3)
	Dependent variable:		
Panel A.	Child's age		
Father's education	0.050**	0.048**	0.017
	[0.023]	[0.024]	[0.053]
Father's age	0.271***	0.275***	0.274***
	[0.011]	[0.011]	[0.011]
Nuclear$^{w/o}$		0.648**	0.488
		[0.255]	[0.329]
Nuclear^{w}		0.844**	0.881
		[0.370]	[0.551]
Father's education			0.046
× Nuclear$^{w/o}$			[0.061]
Father's education			0.001
× Nuclear^{w}			[0.083]
Observations	1634	1634	1634
Adjusted R^2	0.29	0.29	0.29
Panel B.	Age of oldest child[a]		
Father's education	-0.011	0.008	-0.12
	[0.037]	[0.038]	[0.081]
Father's age	0.703***	0.684***	0.681***
	[0.027]	[0.029]	[0.029]
Nuclear$^{w/o}$		0.809**	0.141
		[0.382]	[0.537]
Nuclear^{w}		0.579	-0.185
		[0.562]	[0.823]
Father's education			0.162*
× Nuclear$^{w/o}$			[0.093]
Father's education			0.169
× Nuclear^{w}			[0.130]
Observations	413	413	413
Adjusted R^2	0.62	0.62	0.62

[a] The age of the oldest child under 16 in the household is likely to be a poor measure of the age of oldest child for older men, therefore we restricted the sample to fathers 45 years or younger.
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.5: Child's Height-for-Age z-score, Nuclear vs Extended Families – OLS

	Dependent Variable: Child's height-for-age z-score (0-10 years)						
	1	2	3	4	5	6	7
Nuclear	-0.373	-0.33	-0.351	-0.378	-0.355	-0.179	-0.181
	[0.256]	[0.264]	[0.262]	[0.251]	[0.261]	[0.262]	[0.262]
Nuclear×age	0.03	0.029	0.029	0.032	0.03	0.003	0.005
	[0.035]	[0.035]	[0.035]	[0.034]	[0.035]	[0.038]	[0.038]
log (adult equivalent	-0.136	-0.224	-0.173	-0.145	-0.182	-0.071	-0.079
household size)	[0.272]	[0.271]	[0.266]	[0.265]	[0.268]	[0.280]	[0.277]
log (adult equivalent	0.012	0.017	0.01	0.015	0.015	-0.007	-0.004
household size)×age	[0.039]	[0.039]	[0.039]	[0.039]	[0.039]	[0.042]	[0.042]
log(land, per		0.095			0.021		-0.01
capita adult equivalent)		[0.061]			[0.069]		[0.070]
log(land, per capita		-0.002			0		0.004
adult equivalent)×age		[0.009]			[0.010]		[0.010]
log(asset, per capita			0.109		0.055		0.089
adult equivalent)			[0.074]		[0.086]		[0.080]
log(asset, per capita			-0.001		-0.003		-0.01
adult equivalent)×age			[0.010]		[0.012]		[0.011]
log(expenditure, per capita				0.344**	0.264*		0.253*
adult equivalent)				[0.142]	[0.144]		[0.146]
log(expenditure, per capita				0.005	0.008		0.006
adult equivalent)×age				[0.021]	[0.021]		[0.022]
father's education						0.040*	0.023
(class completed)						[0.024]	[0.024]
father's education						-0.004	-0.003
(class completed)×age						[0.004]	[0.004]
mother's education						0.001	-0.01
(class completed)						[0.037]	[0.036]
mother's education						0.006	0.005
(class completed)×age						[0.005]	[0.005]
Adjusted R-squared	0.02	0.03	0.03	0.04	0.05	0.04	0.05
Observations	3778	3778	3778	3778	3778	3590	3590

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. All regressions include child's age (completed in years) dummies for female, site, round and their interaction with child's age. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.6: Child's Height-for-Age z-score, Nuclear vs Extended Families – 2SLS

	Dependent Variable: Child's height-for-age z-score (0-10 years)						
	1	2	3	4	5	6	7
nuclear	-0.030	-0.138	-0.082	-0.176	-0.236	-0.080	-0.401
	[0.373]	[0.358]	[0.371]	[0.380]	[0.369]	[0.417]	[0.409]
nuclear×age	-0.015	-0.005	-0.011	-0.001	0.006	-0.026	0.012
	[0.059]	[0.057]	[0.058]	[0.060]	[0.059]	[0.063]	[0.063]
log (adult equivalent	0.386	0.132	0.303	0.280	0.113	0.364	0.018
household size)	[0.359]	[0.390]	[0.373]	[0.368]	[0.387]	[0.389]	[0.391]
log (adult equivalent	-0.040	-0.015	-0.035	-0.028	-0.011	-0.061	-0.015
household size)×age	[0.058]	[0.063]	[0.060]	[0.059]	[0.063]	[0.062]	[0.063]
log(land, per		0.147*			0.122		0.132
capita adult equivalent)		[0.086]			[0.089]		[0.089]
log(land, per capita		-0.012			-0.012		-0.014
adult equivalent)×age		[0.013]			[0.014]		[0.014]
log(asset, per capita			0.083		-0.036		-0.018
adult equivalent)			[0.094]		[0.108]		[0.110]
log(asset, per capita			-0.005		0.004		-0.003
adult equivalent)×age			[0.014]		[0.015]		[0.016]
log(expenditure, per capita				0.404**	0.344*		0.374*
adult equivalent)				[0.178]	[0.203]		[0.223]
log(expenditure, per capita				-0.023	-0.019		-0.031
adult equivalent)×age				[0.026]	[0.031]		[0.033]
father's education						0.019	0.012
(class completed)						[0.028]	[0.028]
father's education						-0.001	0.000
(class completed)×age						[0.004]	[0.004]
mother's education						-0.039	-0.063
(class completed)						[0.043]	[0.043]
mother's education						0.011*	0.014**
(class completed)×age						[0.006]	[0.006]
constant	-2.876***	-2.823***	-3.298***	-5.218***	-4.617***	-2.795***	-4.604***
	[0.782]	[0.781]	[0.940]	[1.279]	[1.308]	[0.830]	[1.441]
adj R^2	0.009	0.016	0.011	0.022	0.020	0.016	0.025
observations	725	725	725	725	725	691	691
Diagnostic Statistics							
First Stage Summary Statistics				Shea Partial R2			
nuclear	0.54	0.57	0.55	0.53	0.56	0.51	0.52
nuclear×age	0.53	0.54	0.53	0.52	0.53	0.49	0.50
				F -Statistic			
nuclear	8.34	8.79	8.76	8.25	8.83	7.41	7.89
nuclear×age	7.91	8.17	8.06	7.92	8.19	6.67	6.63
IV Diagnostic Tests				P-Value			
Underidentification Test	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV Redundancy Test	0.04	0.04	0.04	0.05	0.07	0.03	0.05
Endogeneity Test	0.36	0.57	0.43	0.30	0.08	0.11	0.63
Overidentification Test	0.08	0.05	0.07	0.12	0.48	0.46	0.09

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. All regressions include child's age (completed in years) female dummy, and their interaction with child's age. See section 6.2.2 for the detailed list of instruments. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.7: Child's Height-for-Age z-score by Family Type – OLS

	Dependent Variable: Child's Height-for-age z-score (0-10 years)						
	1	2	3	4	5	6	7
Nuclear$^{w/o}$	-0.44	-0.38	-0.402	-0.417	-0.387	-0.231	-0.214
	[0.273]	[0.283]	[0.283]	[0.269]	[0.282]	[0.285]	[0.284]
Nuclear$^{w/o}$×age	0.041	0.039	0.039	0.039	0.038	0.013	0.013
	[0.037]	[0.038]	[0.038]	[0.036]	[0.038]	[0.041]	[0.041]
Nuclear^{w}	-0.209	-0.203	-0.223	-0.273	-0.264	-0.053	-0.093
	[0.289]	[0.289]	[0.288]	[0.282]	[0.286]	[0.281]	[0.282]
Nuclear^{w}×age	0.001	0.002	0.003	0.008	0.008	-0.023	-0.017
	[0.041]	[0.041]	[0.041]	[0.041]	[0.041]	[0.042]	[0.042]
log (adult equivalent	-0.193	-0.263	-0.214	-0.177	-0.208	-0.114	-0.106
household size)	[0.282]	[0.280]	[0.278]	[0.277]	[0.279]	[0.290]	[0.288]
log (adult equivalent	0.021	0.025	0.018	0.023	0.022	0.001	0.004
household size)×age	[0.041]	[0.041]	[0.041]	[0.041]	[0.041]	[0.044]	[0.044]
log(land, per		0.092			0.021		-0.01
capita adult equivalent)		[0.062]			[0.070]		[0.069]
log(land, per capita		-0.001			0		0.004
adult equivalent)×age		[0.009]			[0.010]		[0.010]
log(asset, per capita			0.104		0.053		0.088
adult equivalent)			[0.075]		[0.086]		[0.080]
log(asset, per capita			-0.001		-0.002		-0.01
adult equivalent)×age			[0.010]		[0.012]		[0.011]
log(expenditure, per capita				0.335**	0.258*		0.249*
adult equivalent)				[0.145]	[0.146]		[0.147]
log(expenditure, per capita				0.007	0.009		0.007
adult equivalent)×age				[0.021]	[0.021]		[0.022]
father's education						0.039	0.023
(class completed)						[0.024]	[0.024]
father's education						-0.004	-0.003
(class completed)×age						[0.004]	[0.004]
mother's education						0	-0.01
(class completed)						[0.037]	[0.036]
mother's education						0.006	0.005
(class completed)×age						[0.005]	[0.005]
Adjusted R-squared	0.02	0.03	0.03	0.04	0.05	0.04	0.05
Observations	3778	3778	3778	3778	3778	3590	3590

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. Other controls are same as Table 6.5.* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.8: Child's Height-for-Age z-score by Family Type–2SLS

	Dependent Variable: Child's height-for-age z-score (0-10 years)						
	1	2	3	4	5	6	7
nuclear$^{w/o}$	-0.030	-0.092	-0.064	-0.164	-0.193	-0.085	-0.368
	[0.392]	[0.384]	[0.394]	[0.397]	[0.393]	[0.425]	[0.422]
nuclear$^{w/o}$×age	-0.002	0.003	-0.000	0.011	0.013	-0.010	0.022
	[0.061]	[0.060]	[0.061]	[0.062]	[0.061]	[0.065]	[0.065]
nuclear^{w}	0.003	-0.349	-0.141	-0.228	-0.444	-0.108	-0.705
	[0.593]	[0.557]	[0.566]	[0.590]	[0.560]	[0.646]	[0.614]
nuclear^{w}×age	-0.088	-0.050	-0.071	-0.059	-0.035	-0.096	-0.021
	[0.090]	[0.085]	[0.087]	[0.090]	[0.086]	[0.094]	[0.091]
log (adult equivalent	0.382	0.151	0.316	0.286	0.131	0.355	0.031
household size)	[0.376]	[0.412]	[0.393]	[0.385]	[0.406]	[0.396]	[0.404]
log (adult equivalent	-0.022	-0.001	-0.021	-0.012	0.002	-0.039	0.003
household size)×age	[0.060]	[0.065]	[0.063]	[0.061]	[0.065]	[0.064]	[0.065]
log(land, per		0.162*			0.140		0.151*
capita adult equivalent)		[0.087]			[0.090]		[0.091]
log(land, per capita		-0.013			-0.013		-0.016
adult equivalent)×age		[0.013]			[0.014]		[0.014]
log(asset, per capita			0.085		-0.044		-0.032
adult equivalent)			[0.094]		[0.109]		[0.112]
log(asset, per capita			-0.004		0.006		-0.000
adult equivalent)×age			[0.013]		[0.016]		[0.016]
log(expenditure, per capita				0.408**	0.346*		0.379*
adult equivalent)				[0.179]	[0.206]		[0.228]
log(expenditure, per capita				-0.024	-0.021		-0.034
adult equivalent)×age				[0.026]	[0.031]		[0.033]
father's education						0.023	0.020
(class completed)						[0.029]	[0.030]
father's education						-0.001	-0.001
(class completed)×age						[0.004]	[0.004]
mother's education						-0.042	-0.066
(class completed)						[0.044]	[0.043]
mother's education						0.011*	0.013**
(class completed)×age						[0.006]	[0.006]
constant	-2.868***	-2.880***	-3.320***	-5.243***	-4.640***	-2.771***	-4.593***
	[0.798]	[0.809]	[0.959]	[1.304]	[1.342]	[0.834]	[1.475]
adj R^2	-0.004	-0.003	-0.003	0.008	0.003	0.001	0.002
observations	725	725	725	725	725	691	691
Diagnostic Statistics							
First Stage Summary Statistics				Shea Partial R2			
nuclear$^{w/o}$	0.58	0.60	0.59	0.58	0.60	0.55	0.56
nuclear^{w}	0.27	0.28	0.28	0.27	0.28	0.26	0.28
nuclear$^{w/o}$×age	0.55	0.57	0.56	0.55	0.56	0.52	0.53
nuclear^{w}×age	0.28	0.29	0.28	0.28	0.29	0.27	0.29
				F-Statistic			
nuclear$^{w/o}$	9.27	9.88	9.21	9.11	9.43	8.98	8.53
nuclear^{w}	2.02	2.02	2.04	2.02	2.04	2.12	2.18
nuclear$^{w/o}$×age	8.66	9.39	8.71	8.32	8.99	7.57	7.49
nuclear^{w}×age	2.15	2.14	2.17	2.18	2.21	2.33	2.46
IV Diagnostic Tests				P-Value			
Underidentification Test	0.01	0.01	0.01	0.01	0.00	0.01	0.00
IV Redundancy Test	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Endogeneity Test	0.07	0.05	0.07	0.07	0.07	0.03	0.02
Overidentification Test	0.23	0.15	0.19	0.27	0.19	0.37	0.28

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. Other controls and instruments are same as Table (6.6).* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.9: Child's Education, Nuclear vs Extended Families –OLS

	Dependent Variable: Class Completed (6-16 years)						
	1	2	3	4	5	6	7
Nuclear	-0.939**	-0.851*	-0.956**	-0.764*	-0.788*	-0.980*	-0.845*
	[0.472]	[0.438]	[0.412]	[0.431]	[0.407]	[0.508]	[0.484]
Nuclear×age	0.131**	0.129***	0.135***	0.107**	0.117***	0.119**	0.104**
	[0.051]	[0.047]	[0.043]	[0.045]	[0.042]	[0.053]	[0.050]
log (adult equivalent	-1.446**	-1.489***	-1.252**	-1.442***	-1.356***	-1.400**	-1.263**
household size)	[0.606]	[0.565]	[0.523]	[0.544]	[0.523]	[0.591]	[0.535]
log (adult equivalent	0.162**	0.159**	0.125**	0.161***	0.138**	0.161**	0.141**
household size)×age	[0.069]	[0.064]	[0.058]	[0.061]	[0.058]	[0.067]	[0.060]
log(land, per		-0.421***			0.093		0.129
capita adult equivalent)		[0.138]			[0.153]		[0.146]
log(land, per capita		0.067***			0		-0.009
adult equivalent)×age		[0.016]			[0.018]		[0.017]
log(asset, per capita			-0.786***		-0.674***		-0.484***
adult equivalent)			[0.117]		[0.150]		[0.169]
log(asset, per capita			0.112***		0.089***		0.058***
adult equivalent)×age			[0.013]		[0.017]		[0.019]
log(expenditure, per capita				-1.518***	-0.827**		-0.908**
adult equivalent)				[0.331]	[0.364]		[0.382]
log(expenditure, per capita				0.219***	0.118***		0.117***
adult equivalent)×age				[0.038]	[0.042]		[0.043]
father's education						-0.171***	-0.121**
(class completed)						[0.047]	[0.047]
father's education						0.024***	0.017***
(class completed)×age						[0.005]	[0.005]
mother's education						-0.088	-0.036
(class completed)						[0.063]	[0.064]
mother's education						0.021***	0.014*
(class completed)×age						[0.007]	[0.007]
Adjusted R-squared	0.52	0.55	0.6	0.57	0.61	0.62	0.65
Observations	1297	1297	1297	1297	1297	1131	1131

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. All regressions include child's age (completed in years) dummies for female, site, and their interaction with child's age. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.10: Child's Education, Nuclear vs Extended Families – 2SLS

	Dependent Variable: Class Completed (6-16 years)						
	1	2	3	4	5	6	7
nuclear	-1.357**	-0.991*	-0.878	-1.068*	-0.796	-1.315	-1.307*
	[0.654]	[0.596]	[0.583]	[0.617]	[0.554]	[0.821]	[0.743]
nuclear×age	0.190***	0.145**	0.127**	0.151**	0.116**	0.123	0.120*
	[0.071]	[0.064]	[0.062]	[0.067]	[0.059]	[0.079]	[0.069]
log (adult equivalent	-1.910***	-1.510**	-0.919	-1.734***	-0.986*	-1.724**	-1.460**
household size)	[0.680]	[0.630]	[0.588]	[0.659]	[0.575]	[0.729]	[0.637]
log (adult equivalent	0.220***	0.159**	0.084	0.200***	0.092	0.161**	0.129*
household size)×age	[0.078]	[0.071]	[0.066]	[0.077]	[0.065]	[0.078]	[0.068]
log(land, per		-0.508***			-0.007		0.006
capita adult equivalent)		[0.164]			[0.185]		[0.176]
log(land, per capita		0.075***			0.010		0.004
adult equivalent)×age		[0.019]			[0.021]		[0.020]
log(asset, per capita			-0.824***		-0.785***		-0.661***
adult equivalent)			[0.139]		[0.180]		[0.204]
log(asset, per capita			0.114***		0.100***		0.069***
adult equivalent)×age			[0.015]		[0.020]		[0.022]
log(expenditure, per capita				-1.034***	-0.182		-0.389
adult equivalent)				[0.354]	[0.371]		[0.390]
log(expenditure, per capita				0.162***	0.048		0.070
adult equivalent)×age				[0.040]	[0.041]		[0.043]
father's education						-0.106**	-0.029
(class completed)						[0.052]	[0.055]
father's education						0.016***	0.007
(class completed)×age						[0.006]	[0.006]
mother's education						-0.134*	-0.069
(class completed)						[0.071]	[0.070]
mother's education						0.026***	0.018**
(class completed)×age						[0.008]	[0.008]
constant	0.387	1.040	4.479***	6.700***	5.481**	0.750	7.223***
	[1.435]	[1.260]	[1.272]	[2.528]	[2.265]	[1.650]	[2.666]
adj R^2	0.543	0.577	0.617	0.578	0.623	0.629	0.652
observations	945	945	945	945	945	832	832
Diagnostic Statistics							
First Stage Summary Statistics				Shea Partial R^2			
nuclear	0.65	0.65	0.65	0.64	0.64	0.47	0.47
nuclear×age	0.66	0.65	0.65	0.65	0.65	0.51	0.50
				F -Statistic			
nuclear	35.05	35.69	38.69	30.42	33.26	10.81	10.92
nuclear×age	30.67	30.8	31.23	26.84	28.56	10.89	11
IV Diagnostic Tests				P Value			
Underidentification Test	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV Redundancy Test	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Endogeneity Test	0.36	0.53	0.46	0.26	0.40	0.11	0.08
Overidentification Test	0.27	0.14	0.04	0.20	0.07	0.53	0.33

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. All regressions include child's age (completed in years) female dummy, and their interaction with child's age. See section 6.2.2 for the detailed list of instruments. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.11: Child's Education by Family Type – OLS

	Dependent Variable: Class Completed (6-16 years)						
	1	2	3	4	5	6	7
Nuclear$^{w/o}$	-0.880*	-0.796*	-0.908**	-0.672	-0.697	-0.984*	-0.779
	[0.496]	[0.463]	[0.436]	[0.452]	[0.434]	[0.535]	[0.511]
Nuclear$^{w/o}\times$age	0.117**	0.116**	0.124***	0.090*	0.102**	0.111**	0.091*
	[0.053]	[0.049]	[0.046]	[0.047]	[0.045]	[0.056]	[0.053]
Nuclear^{w}	-1.195**	-1.101**	-1.162**	-1.121**	-1.128**	-1.143**	-1.199**
	[0.559]	[0.530]	[0.488]	[0.525]	[0.478]	[0.564]	[0.514]
Nuclear$^{w}\times$age	0.186***	0.181***	0.179***	0.172***	0.174***	0.157***	0.160***
	[0.061]	[0.056]	[0.051]	[0.056]	[0.050]	[0.058]	[0.053]
log (adult equivalent	-1.397**	-1.435**	-1.210**	-1.362**	-1.274**	-1.398**	-1.186**
household size)	[0.629]	[0.584]	[0.542]	[0.567]	[0.542]	[0.623]	[0.561]
log (adult equivalent	0.149**	0.147**	0.115*	0.145**	0.124**	0.153**	0.126**
household size)×age	[0.071]	[0.066]	[0.060]	[0.063]	[0.059]	[0.071]	[0.063]
log(land, per		-0.427***			0.092		0.123
capita adult equivalent)		[0.139]			[0.155]		[0.148]
log(land, per capita		0.068***			0		-0.009
adult equivalent)×age		[0.016]			[0.018]		[0.017]
log(asset, per capita			-0.786***		-0.669***		-0.483***
adult equivalent)			[0.117]		[0.150]		[0.170]
log(asset, per capita			0.111***		0.088***		0.057***
adult equivalent)×age			[0.013]		[0.017]		[0.019]
log(expenditure, per capita				-1.537***	-0.850**		-0.942**
adult equivalent)				[0.331]	[0.363]		[0.384]
log(expenditure, per capita				0.220***	0.121***		0.121***
adult equivalent)×age				[0.038]	[0.041]		[0.043]
father's education						-0.167***	-0.112**
(class completed)						[0.048]	[0.048]
father's education						0.023***	0.016***
(class completed)×age						[0.005]	[0.005]
mother's education						-0.095	-0.045
(class completed)						[0.064]	[0.064]
mother's education						0.022***	0.015**
(class completed)×age						[0.007]	[0.007]
Adjusted R-squared	0.52	0.56	0.6	0.58	0.61	0.62	0.65
Observations	1297	1297	1297	1297	1297	1131	1131

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. Other controls are same as Table (6.9).* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.12: Child's Education by Family Type – 2SLS

	Dependent Variable: Class Completed (6-16 years)						
	1	2	3	4	5	6	7
nuclear$^{w/o}$	-1.163*	-0.789	-0.677	-0.811	-0.560	-1.092	-0.990
	[0.688]	[0.623]	[0.612]	[0.653]	[0.585]	[0.856]	[0.770]
nuclear$^{w/o}$×age	0.172**	0.125*	0.107*	0.126*	0.092	0.103	0.088
	[0.074]	[0.067]	[0.064]	[0.071]	[0.062]	[0.083]	[0.072]
nuclear^{w}	-2.241**	-1.997**	-1.833**	-2.107**	-1.828**	-2.405**	-2.859***
	[0.973]	[0.978]	[0.890]	[0.930]	[0.887]	[1.068]	[1.049]
nuclear^{w}×age	0.270***	0.240**	0.221**	0.253***	0.219**	0.221**	0.269***
	[0.101]	[0.099]	[0.088]	[0.095]	[0.088]	[0.104]	[0.099]
log (adult equivalent	-1.687**	-1.300*	-0.704	-1.463**	-0.775	-1.424*	-1.096
household size)	[0.720]	[0.666]	[0.614]	[0.678]	[0.598]	[0.788]	[0.670]
log (adult equivalent	0.200**	0.139*	0.063	0.174**	0.072	0.135	0.094
household size)×age	[0.081]	[0.074]	[0.067]	[0.078]	[0.066]	[0.083]	[0.070]
log(land, per		-0.475***			0.033		0.054
capita adult equivalent)		[0.168]			[0.192]		[0.185]
log(land, per capita		0.072***			0.007		0.000
adult equivalent)×age		[0.019]			[0.022]		[0.021]
log(asset, per capita			-0.809***		-0.770***		-0.648***
adult equivalent)			[0.140]		[0.181]		[0.205]
log(asset, per capita			0.112***		0.098***		0.067***
adult equivalent)×age			[0.015]		[0.020]		[0.022]
log(expenditure, per capita				-1.091***	-0.291		-0.579
adult equivalent)				[0.359]	[0.377]		[0.396]
log(expenditure, per capita				0.168***	0.059		0.088**
adult equivalent)×age				[0.041]	[0.042]		[0.043]
father's education						-0.088*	-0.005
(class completed)						[0.053]	[0.055]
father's education						0.014**	0.005
(class completed)×age						[0.006]	[0.006]
mother's education						-0.154**	-0.097
(class completed)						[0.072]	[0.071]
mother's education						0.028***	0.021***
(class completed)×age						[0.008]	[0.008]
constant	0.041	0.636	4.040***	6.641***	5.648**	0.265	7.644***
	[1.478]	[1.318]	[1.329]	[2.526]	[2.284]	[1.722]	[2.750]
adj R^2	0.543	0.578	0.617	0.580	0.624	0.628	0.653
observations	945	945	945	945	945	832	832
Diagnostic Statistics							
First Stage Summary Statistics				Shea Partial R2			
nuclear$^{w/o}$	0.64	0.65	0.64	0.63	0.63	0.49	0.49
nuclear^{w}	0.31	0.31	0.31	0.31	0.31	0.31	0.31
nuclear$^{w/o}$×age	0.65	0.65	0.65	0.64	0.64	0.52	0.52
nuclear^{w}×age	0.35	0.34	0.35	0.35	0.34	0.33	0.33
				F-Statistic			
nuclear$^{w/o}$	22.69	23.33	24.67	19.91	22.09	10.37	10.34
nuclear^{w}	2.36	2.38	2.33	2.35	2.38	2.24	2.29
nuclear$^{w/o}$×age	18.66	19.24	20.11	16.8	18.68	10.1	9.98
nuclear^{w}×age	2.3	2.3	2.3	2.28	2.3	2.18	2.22
Tests				P-value			
Underidentification Test	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IV Redundancy Test	0.00	0.00	0.00	0.00	0.00	0.02	0.02
Endogeneity Test	0.20	0.24	0.25	0.27	0.28	0.17	0.46
Overidentification Test	0.27	0.13	0.04	0.20	0.07	0.61	0.28

Heteroscedasticity consistent standard errors clustered at the household level are in parentheses. The omitted household category is the extended family. Other controls and instruments are same as Table (6.10).* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6.13: First Stage of 2SLS: Child's Height-for-Age z-score

VARIABLES	nuclear	nuclear×age	nuclear$^{w/o}$	nuclear$^{w/o}$×age	nuclear^{w}	nuclear^{w}×age
age	-0.052	0.980***	-0.005	1.671***	-0.048	-0.691*
	[0.047]	[0.363]	[0.061]	[0.511]	[0.054]	[0.381]
female	-0.069**	-0.228*	-0.028	-0.199	-0.041	-0.028
	[0.031]	[0.126]	[0.044]	[0.171]	[0.045]	[0.154]
female×age	0.010**	0.046	0.001	0.011	0.010	0.035
	[0.005]	[0.033]	[0.007]	[0.048]	[0.007]	[0.044]
log (household size, adult equivalent)	-0.421***	-0.013	-0.532***	-0.048	0.112	0.035
	[0.057]	[0.201]	[0.085]	[0.260]	[0.091]	[0.247]
log (household size, adult equivalent)×age	0.008	-0.360***	0.004	-0.492***	0.004	0.131
	[0.009]	[0.072]	[0.011]	[0.091]	[0.011]	[0.082]
log (land, per capita adult equivalent)	-0.049**	-0.072	-0.035	-0.159	-0.014	0.087
	[0.020]	[0.063]	[0.028]	[0.098]	[0.032]	[0.096]
log (land, per capita adult equivalent)×age	0.004	-0.007	0.001	0.001	0.003	-0.009
	[0.003]	[0.020]	[0.004]	[0.031]	[0.004]	[0.028]
ln (asset, per capita adult equivalent)	-0.023	0.004	0.009	0.151	-0.032	-0.148
	[0.020]	[0.065]	[0.031]	[0.093]	[0.031]	[0.092]
ln (asset, per capita adult equivalent)×age	0.001	-0.015	-0.005	-0.053*	0.006	0.038
	[0.003]	[0.021]	[0.004]	[0.028]	[0.004]	[0.025]
ln (expenditure, per capita adult equivalent)	0.067**	0.023	0.026	-0.003	0.041	0.026
	[0.030]	[0.118]	[0.058]	[0.223]	[0.060]	[0.193]
ln (expenditure, per capita adult equivalent)×age	-0.005	0.021	0.001	0.028	-0.006	-0.007
	[0.005]	[0.043]	[0.009]	[0.074]	[0.008]	[0.057]
father's education (class completed)	0.013***	0.021	-0.008	-0.021	0.021**	0.041*
	[0.005]	[0.016]	[0.007]	[0.021]	[0.008]	[0.021]
father's education (class completed)×age	-0.001	0.005	0.001	0.006	-0.002*	-0.000
	[0.001]	[0.005]	[0.001]	[0.008]	[0.001]	[0.007]
mother's education (class completed)	-0.019***	-0.045**	-0.009	-0.020	-0.009	-0.025
	[0.006]	[0.021]	[0.008]	[0.029]	[0.010]	[0.029]
mother's education (class completed)×age	0.002*	0.004	0.003*	0.013	-0.001	-0.009
	[0.001]	[0.008]	[0.001]	[0.011]	[0.001]	[0.011]
father's number of brothers	-0.066**	-0.087	-0.116***	-0.032	0.050	-0.055
	[0.031]	[0.137]	[0.044]	[0.150]	[0.044]	[0.101]
father's number of brothers×age	0.003	-0.030	0.006	-0.061	-0.004	0.031
	[0.005]	[0.041]	[0.006]	[0.045]	[0.004]	[0.027]
father's birth order	-0.016	-0.105	-0.058**	-0.201**	0.042	0.096
	[0.020]	[0.079]	[0.029]	[0.102]	[0.033]	[0.095]
father's birth order ×age	0.004	0.027	0.009**	0.042	-0.005	-0.014
	[0.003]	[0.023]	[0.004]	[0.030]	[0.004]	[0.024]
grand father alive	-0.448*	-1.536*	-0.883**	-2.486*	0.435	0.950
	[0.244]	[0.922]	[0.388]	[1.395]	[0.409]	[1.261]
grand father alive ×age	0.041	0.100	0.062	-0.033	-0.021	0.133
	[0.033]	[0.249]	[0.050]	[0.374]	[0.053]	[0.349]
grand mother alive	-0.169	-0.886	0.014	1.395	-0.183	-2.281**
	[0.179]	[0.728]	[0.325]	[1.172]	[0.350]	[1.048]
grand mother alive ×age	0.009	0.050	-0.016	-0.355	0.025	0.405
	[0.030]	[0.237]	[0.046]	[0.359]	[0.046]	[0.318]
father's number of brothers ×father's birth order	0.007	0.028	0.016**	0.039	-0.009	-0.011
	[0.006]	[0.022]	[0.007]	[0.025]	[0.007]	[0.023]
father's number of brothers ×father's birth order×age	-0.001	-0.004	-0.002**	-0.005	0.001	0.001
	[0.001]	[0.007]	[0.001]	[0.008]	[0.001]	[0.006]
grand father alive× grand mother alive	-0.164*	0.071	0.237	-0.029	-0.401***	0.101
	[0.089]	[0.322]	[0.157]	[0.444]	[0.153]	[0.343]
grand father alive× grand mother alive×age	0.006	-0.139	-0.018	0.098	0.025	-0.236*
	[0.012]	[0.095]	[0.017]	[0.143]	[0.016]	[0.125]
father's number of brothers ×grand father alive	0.118***	0.073	0.101**	0.043	0.018	0.029
	[0.042]	[0.114]	[0.041]	[0.132]	[0.045]	[0.134]
father's number of brothers ×grand father alive×age	-0.005	0.068	-0.003	0.079	-0.003	-0.012
	[0.006]	[0.042]	[0.006]	[0.050]	[0.006]	[0.048]
father's number of brothers ×grand mother alive	-0.042*	0.014	0.024	-0.044	-0.066	0.058
	[0.022]	[0.106]	[0.040]	[0.130]	[0.041]	[0.111]
father's number of brothers ×grand mother alive×age	0.001	-0.040	-0.002	0.018	0.002	-0.058*
	[0.004]	[0.032]	[0.005]	[0.036]	[0.005]	[0.035]
father's birth order × grand father alive	0.017	-0.004	0.014	0.084	0.003	-0.087
	[0.044]	[0.138]	[0.045]	[0.146]	[0.050]	[0.146]
father's birth order × grand father alive × age	0.006	0.059	-0.003	-0.014	0.009	0.073
	[0.007]	[0.049]	[0.008]	[0.064]	[0.008]	[0.056]

Table 6.13: First Stage of 2SLS: Child's Height-for-Age z-score

VARIABLES	nuclear	nuclear×age	nuclear$^{w/o}$	nuclear$^{w/o}$×age	nuclear^{w}	nuclear^{w}×age
father's birth order×	-0.011	-0.003	-0.013	-0.010	0.002	0.007
father's number of brothers ×grand father alive	[0.012]	[0.036]	[0.012]	[0.037]	[0.012]	[0.036]
father's birth order ×father's number of	-0.001	-0.017	0.000	-0.011	-0.001	-0.006
brothers×grand father alive×age	[0.002]	[0.012]	[0.002]	[0.015]	[0.002]	[0.013]
father's self choice of bride	-0.063	-0.476**	0.036	-0.394	-0.099	-0.082
	[0.057]	[0.225]	[0.087]	[0.293]	[0.082]	[0.224]
father's self choice of bride ×age	0.015*	0.126**	0.006	0.140**	0.010	-0.014
	[0.008]	[0.061]	[0.011]	[0.071]	[0.009]	[0.043]
father's age at marriage	-0.016***	-0.055	-0.008	-0.011	-0.008	-0.044
	[0.006]	[0.041]	[0.009]	[0.049]	[0.009]	[0.030]
father's age at marriage × age	0.001	-0.001	-0.001	-0.013	0.002	0.011*
	[0.002]	[0.014]	[0.002]	[0.015]	[0.001]	[0.006]
father's number of brothers inherited	0.083***	-0.028	0.090***	-0.100	-0.007	0.072
grand father's land	[0.016]	[0.051]	[0.022]	[0.066]	[0.023]	[0.064]
father's number of brothers inherited	0.001	0.094***	0.002	0.121***	-0.001	-0.027
grand father's land ×age	[0.002]	[0.018]	[0.003]	[0.021]	[0.003]	[0.024]
father's age at marriage ×	0.007	0.039	0.025	0.090	-0.018	-0.051
grand father alive	[0.009]	[0.036]	[0.015]	[0.057]	[0.017]	[0.051]
father's age at marriage ×	-0.001	-0.007	-0.001	0.001	0.000	-0.008
grand father alive× age	[0.001]	[0.008]	[0.002]	[0.015]	[0.002]	[0.014]
father's age at marriage×	0.009	0.023	-0.015	-0.056	0.024*	0.079*
grand mother alive	[0.007]	[0.029]	[0.012]	[0.049]	[0.014]	[0.043]
father's age at marriage×	0.000	0.007	0.001	0.003	-0.001	0.004
grand mother alive×age	[0.001]	[0.010]	[0.002]	[0.016]	[0.002]	[0.013]
father's age at marriage× father's age	0.000**	0.002**	0.000	0.001	0.000	0.001
when grand father land was divided	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.001]
father's age at marriage× father's age when	-0.000*	-0.000	0.000	0.000	-0.000	-0.000
grand father land was divided × age	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
father's self choice of bride×	0.013	0.320	0.020	0.482	-0.006	-0.162
grand father alive	[0.078]	[0.248]	[0.111]	[0.373]	[0.138]	[0.388]
father's self choice of bride ×	0.003	-0.020	-0.016	-0.156	0.019	0.137
grand father alive ×age	[0.012]	[0.089]	[0.014]	[0.120]	[0.015]	[0.112]
father's self choice of bride×	0.073	0.490*	-0.146	-0.114	0.218*	0.604*
grand mother alive	[0.075]	[0.261]	[0.113]	[0.365]	[0.123]	[0.330]
father's self choice of bride×	-0.025**	-0.191***	0.019	0.009	-0.044***	-0.200*
grand mother alive ×age	[0.010]	[0.074]	[0.014]	[0.117]	[0.014]	[0.106]
father's age when grand	-0.006	-0.064***	0.005	-0.017	-0.011	-0.047
father land was divided	[0.005]	[0.024]	[0.009]	[0.034]	[0.011]	[0.030]
father's age when grand father land	0.002**	0.017**	-0.000	0.004	0.002*	0.013*
was divided×age	[0.001]	[0.007]	[0.001]	[0.009]	[0.001]	[0.007]
natural disaster dummy	-0.047	-0.106	-0.142***	-0.284*	0.096*	0.179
	[0.036]	[0.126]	[0.053]	[0.163]	[0.058]	[0.155]
natural disaster dummy×age	0.005	0.001	0.019***	0.053	-0.015*	-0.052
	[0.006]	[0.042]	[0.007]	[0.056]	[0.008]	[0.054]
constant	1.727***	2.299*	1.771***	0.516	-0.043	1.783
	[0.294]	[1.208]	[0.390]	[1.584]	[0.425]	[1.348]
adj R^2	0.694	0.851	0.573	0.717	0.166	0.199
observations	746	746	746	746	746	746

Robust standard errors clustered at the household level are in brackets.

*** p<0.01, ** p<0.05, * p<0.1.

Table 6.14: First Stage of 2SLS: Education

VARIABLES	nuclear	nuclear×age	nuclear$^{w/o}$	nuclear$^{w/o}$×age	nuclear^{w}	nuclear^{w}×age
age	-0.159***	-0.718	-0.190***	-1.114	0.031	0.396
	[0.050]	[0.642]	[0.058]	[0.745]	[0.045]	[0.558]
female	0.058	0.693	-0.079	-0.896	0.137	1.589*
	[0.058]	[0.639]	[0.082]	[0.874]	[0.086]	[0.886]
log (household size,	-0.429***	-1.098	-0.722***	-3.199**	0.294**	2.101*
adult equivalent)	[0.120]	[1.182]	[0.144]	[1.340]	[0.139]	[1.257]
female×age	-0.007	-0.087	0.004	0.051	-0.011	-0.138*
	[0.005]	[0.064]	[0.007]	[0.086]	[0.007]	[0.083]
log (household size, adult	0.007	-0.250**	0.022**	-0.171	-0.015	-0.079
equivalent)×age	[0.010]	[0.126]	[0.011]	[0.139]	[0.010]	[0.122]
log (land, per capita adult	0.015	0.181	-0.020	0.107	0.035	0.074
equivalent)	[0.030]	[0.333]	[0.040]	[0.414]	[0.037]	[0.379]
log (land, per capita adult	-0.003	-0.030	0.000	-0.028	-0.003	-0.002
equivalent)×age	[0.003]	[0.039]	[0.004]	[0.048]	[0.003]	[0.044]
ln (asset, per capita adult	-0.048	-0.409	-0.044	-0.221	-0.003	-0.188
equivalent)	[0.035]	[0.344]	[0.041]	[0.388]	[0.035]	[0.338]
ln (asset, per capita adult	0.003	0.027	0.001	-0.017	0.002	0.043
equivalent)×age	[0.003]	[0.037]	[0.003]	[0.042]	[0.003]	[0.036]
ln (expenditure, per capita	-0.023	-0.449	-0.024	-1.238	0.001	0.790
adult equivalent)	[0.067]	[0.725]	[0.086]	[0.886]	[0.077]	[0.769]
ln (expenditure, per capita	0.005	0.075	0.007	0.173*	-0.002	-0.098
adult equivalent)×age	[0.006]	[0.083]	[0.007]	[0.095]	[0.006]	[0.078]
father's education	0.019**	0.150	0.001	0.050	0.017	0.100
(class completed)	[0.009]	[0.097]	[0.013]	[0.119]	[0.011]	[0.106]
father's education (class	-0.001	-0.009	0.000	-0.002	-0.001	-0.007
completed)×age	[0.001]	[0.010]	[0.001]	[0.013]	[0.001]	[0.012]
mother's education	-0.012	-0.109	0.015	0.050	-0.027	-0.159
(class completed)	[0.013]	[0.139]	[0.017]	[0.164]	[0.017]	[0.141]
mother's education (class	0.001	0.014	-0.000	0.007	0.002	0.006
completed)×age	[0.001]	[0.016]	[0.001]	[0.018]	[0.001]	[0.014]
father's number of brothers	-0.042	0.212	-0.049	0.361	0.006	-0.149
	[0.055]	[0.503]	[0.063]	[0.554]	[0.048]	[0.390]
father's total number	-0.002	-0.090*	-0.004	-0.129**	0.002	0.039
of brothers×age	[0.004]	[0.048]	[0.005]	[0.052]	[0.003]	[0.031]
father's birth order	-0.001	-0.214	0.021	0.245	-0.023	-0.459
	[0.032]	[0.326]	[0.042]	[0.367]	[0.035]	[0.291]
father's birth order	0.001	0.031	-0.002	-0.030	0.004	0.062**
×age	[0.003]	[0.036]	[0.003]	[0.038]	[0.002]	[0.031]
grand father alive	-1.409**	-16.066**	-1.916***	-19.894***	0.507	3.828
	[0.656]	[7.727]	[0.687]	[7.243]	[0.834]	[9.138]
grand father alive	0.140**	1.685**	0.161**	1.773**	-0.022	-0.088
× age	[0.064]	[0.852]	[0.063]	[0.795]	[0.075]	[0.931]
grand mother alive	-0.464	-3.380	0.065	2.661	-0.528	-6.041
	[0.365]	[3.727]	[0.489]	[4.625]	[0.463]	[4.875]
grand mother alive	0.034	0.241	-0.027	-0.509	0.062	0.750
×age	[0.031]	[0.398]	[0.039]	[0.480]	[0.039]	[0.526]
father's number of brothers	0.003	0.021	0.000	-0.051	0.002	0.072
×father's birth order	[0.008]	[0.077]	[0.010]	[0.086]	[0.009]	[0.069]
father's number of brothers	-0.000	0.000	0.001	0.012	-0.001	-0.011*
×father's birth order×age	[0.001]	[0.009]	[0.001]	[0.009]	[0.001]	[0.007]
grand father alive×	0.028	2.197	0.187	1.736	-0.159	0.461
grand mother alive	[0.177]	[2.064]	[0.228]	[2.411]	[0.217]	[2.037]
grand father alive×	-0.016	-0.360	-0.010	-0.088	-0.006	-0.272
grand mother alive×age	[0.018]	[0.244]	[0.021]	[0.295]	[0.018]	[0.231]
father's number of brothers	0.166	0.839	0.193**	1.451*	-0.027	-0.612
×grand father alive	[0.102]	[1.018]	[0.082]	[0.848]	[0.080]	[0.756]
father's number of brothers	-0.007	0.004	-0.012	-0.077	0.005	0.081
×grand father alive×age	[0.010]	[0.115]	[0.008]	[0.100]	[0.007]	[0.078]
father's number of brothers	-0.039	-0.139	0.004	-0.163	-0.043	0.024
×grand mother alive	[0.038]	[0.375]	[0.049]	[0.470]	[0.047]	[0.468]
father's number of brothers	0.002	-0.007	0.003	0.058	-0.002	-0.065
×grand mother alive×age	[0.003]	[0.042]	[0.004]	[0.051]	[0.004]	[0.053]
father's birth order	0.134	0.740	0.192	2.537	-0.058	-1.797
× grand father alive	[0.133]	[1.528]	[0.160]	[1.981]	[0.129]	[1.404]
father's birth order ×	-0.004	0.020	-0.019	-0.262	0.015	0.282
grand father alive × age	[0.014]	[0.185]	[0.019]	[0.251]	[0.014]	[0.174]

Table 6.14: First Stage of 2SLS: Education

VARIABLES	nuclear	nuclear×age	nuclear$^{w/o}$	nuclear$^{w/o}$×age	nuclear^{w}	nuclear^{w}×age
father's birth order×	-0.050	-0.289	-0.064*	-0.651*	0.014	0.362
father's number of brothers ×grand fa-ther alive	[0.031]	[0.319]	[0.034]	[0.387]	[0.028]	[0.288]
father's birth order ×father's number of	0.002	0.003	0.005	0.052	-0.003	-0.049
brothers×grand father alive×age	[0.003]	[0.036]	[0.003]	[0.046]	[0.003]	[0.032]
father's self choice of bride	0.177	2.261**	0.144	1.783	0.033	0.478
	[0.119]	[1.144]	[0.126]	[1.261]	[0.070]	[0.630]
father's self choice of bride ×age	-0.017*	-0.233**	-0.011	-0.148	-0.006	-0.085
	[0.010]	[0.114]	[0.010]	[0.128]	[0.005]	[0.061]
father's age at marriage	-0.038**	-0.323**	-0.045***	-0.371***	0.007	0.047
	[0.017]	[0.147]	[0.016]	[0.140]	[0.011]	[0.097]
father's age at marriage × age	0.003**	0.029**	0.004***	0.031**	-0.000	-0.002
	[0.001]	[0.015]	[0.001]	[0.014]	[0.001]	[0.009]
father's number of brothers inherited	0.060**	-0.513*	0.059*	-0.599*	0.001	0.086
grand father's land	[0.027]	[0.263]	[0.034]	[0.316]	[0.039]	[0.313]
father's number of brothers inherited	0.004*	0.154***	0.005*	0.167***	-0.001	-0.014
grand father's land ×age	[0.002]	[0.027]	[0.003]	[0.032]	[0.002]	[0.026]
father's age at marriage ×	0.035	0.456	0.053**	0.475*	-0.018	-0.019
grand father alive	[0.023]	[0.286]	[0.026]	[0.288]	[0.034]	[0.389]
father's age at marriage ×	-0.004*	-0.055*	-0.004*	-0.037	-0.000	-0.018
grand father alive× age	[0.002]	[0.032]	[0.002]	[0.032]	[0.003]	[0.040]
father's age at marriage×	0.023	0.091	-0.011	-0.073	0.035*	0.164
grand mother alive	[0.015]	[0.150]	[0.020]	[0.192]	[0.020]	[0.219]
father's age at marriage×	-0.001	0.002	0.001	0.003	-0.002	-0.001
grand mother alive×age	[0.001]	[0.016]	[0.002]	[0.021]	[0.002]	[0.024]
father's age at marriage× father's age	0.000	0.004	0.001**	0.013**	-0.001**	-0.010*
when grand father land was divided	[0.000]	[0.005]	[0.001]	[0.005]	[0.000]	[0.005]
father's age at marriage× father's age when	-0.000	-0.001	-0.000***	-0.001**	0.000**	0.001
grand father land was divided × age	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]
father's self choice of bride×	-0.001	-1.387	-0.228	-1.192	0.228	-0.195
grand father alive	[0.162]	[1.846]	[0.211]	[2.081]	[0.224]	[1.888]
father's self choice of bride ×	0.007	0.212	0.015	0.057	-0.008	0.155
grand father alive ×age	[0.016]	[0.223]	[0.019]	[0.249]	[0.018]	[0.198]
father's self choice of bride×	-0.243*	-1.856	-0.262	-4.403**	0.019	2.547
grand mother alive	[0.129]	[1.343]	[0.177]	[1.845]	[0.150]	[1.552]
father's self choice of bride×	0.016	0.112	0.032*	0.510**	-0.016	-0.398**
grand mother alive ×age	[0.012]	[0.152]	[0.016]	[0.218]	[0.014]	[0.185]
father's age when grand	-0.007	-0.174	-0.029**	-0.385***	0.022*	0.211*
father land was divided	[0.011]	[0.118]	[0.014]	[0.134]	[0.012]	[0.122]
father's age when grand father land	0.002*	0.029**	0.003***	0.046***	-0.002*	-0.017
was divided×age	[0.001]	[0.012]	[0.001]	[0.013]	[0.001]	[0.012]
natural disaster dummy	0.078	0.847	0.004	-0.111	0.074	0.958
	[0.069]	[0.742]	[0.093]	[0.863]	[0.085]	[0.729]
natural disaster dummy×age	-0.008	-0.091	0.003	0.053	-0.011*	-0.144**
	[0.006]	[0.081]	[0.008]	[0.089]	[0.006]	[0.071]
constant	2.804***	18.149***	3.445***	25.703***	-0.641	-7.555
	[0.577]	[6.084]	[0.697]	[7.264]	[0.566]	[5.641]
adj R^2	0.669	0.713	0.544	0.576	0.233	0.269
observations	835	835	835	835	835	835

Robust standard errors clustered at the household level are in brackets.
*** p<0.01, ** p<0.05, * p<0.1.

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