Università degli Studi "Roma Tre"

Dipartimento di Economia

Scuola Dottorale in "Economia e Metodi Quantitativi"

Dottorato in

"Istituzioni, Ambiente e Politiche per lo Sviluppo Economico"

Tesi

On the Relationship among Education, Development and Food Security through the Capability Approach

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Acknowledgments

I am grateful to many people for helping me conduct the PhD dissertation. First of all, I would like to thank Pasquale De Muro, Associate Professor of Human Development Economics at the University Roma Tre, for his close supervision and support in these three years of work. Next, I would like to thank Alessia Naccarato, Assistant Professor at the Department of Economics of the University Roma Tre, who gave me fundamental advices regarding chapter five and six that refer to the quantitative analyses. Then, I greatly appreciate the commitment and the contribution of Elaine Unterhalter, Senior Lecturer at the Institute of Education, University of London, whose insights were fundamental especially regarding the theoretical sections of this research. Next, I am grateful to Lavinia Gasperini, FAO Agriculture Education Senior Officer and coordinator of the ERP initiative, for her brilliant suggestions. Precious comments by Jaya Krishnakumar, Mario Biggeri, Nancy Folbre, Enrica Chiappero-Martinetti, Massimiliano Bratti, Enrica Chiappero-Martinetti, Sabina Alkire and Paola Salardi are gratefully acknowledged.

I am also grateful to all participants of the International Conference on 'Human and Economic Resources', held in Izmir in May 2006, of the International Conference of the Human Development and Capability Association (HDCA) on 'Freedom and Justice', held in Groningen during summer 2006, and of the International Working Group on Education (IWGE) seminar organized by UNESCO and hosted in Rome by FAO, in June 2006. The comments of development experts as well as education experts on earlier drafts of this publication were essential to improve the quality of the research. I would also like to thank the participants of the March 28, 2007 seminar held at FAO, where we had the opportunity to have an in-depth discussion on the results of this research. I also acknowledge the important editing work made by James H. Williams on chapter five of the thesis. I also greatly benefited from discussions with the following colleagues at the Department of Economics: Riccardo Crescenzi, Sara Vicari, Laura Silici, Giulio Tarditi, Andres Lazzarini and Davide Zurlo.

Last but not least, the advices by Eszter Kollár and her daily emotional support were fundamental to undertake the whole research.

List of Abbreviations

BMI	Body Mass Index
BNA	Basic Needs Approach
CA	Capability Approach
DHS	Demographic and Health Surveys
EFA	Education for All
ERP	Education for Rural People
FAD	Food Availability Decline
FAO	Food and Agriculture Organization of the United Nations
HAZ	Height-for-Age Z-score
HCA	Human Capital Approach
HDI	Human Development Index
HFI	Household Food Insecurity
HNP	Health, Nutrition and Population
ICN	International Conference on Nutrition
IFAD	International Fund for Agricultural Development
ISCED	International Standard Classification of Education
MDGs	Millennium Development Goals
OLS	Ordinary Least Squares
PRSPs	Poverty Reduction Strategy Papers
SD	Standard deviation
SOFI	State of Food Insecurity
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WAZ	Weight-for-Age Z-score
WFP	World Food Programme
WHZ	Weight-for-Height Z-score
2SLS	Two-Stage Least Squares

CHAPTER 1

INTRODUCTION

Illiteracy and food insecurity are two of the most relevant development challenges that nowadays low-income countries have to cope with. It was estimated that in the world the number of both illiterate adults and food insecure people is nearly 800 million, and the majority of them lives in low-income countries (UNESCO 2004; FAO 2005). Most of low-income countries are, in fact, out of track for the achievement of the Millennium Development Goals (MDGs) regarding both food security (MDG 1)[1] and education (MDG 2[2] and 3[3]). The similarities in the number of people suffering from these deprivations were among the reasons that led me to address the issue of the relationships between these phenomena in my PhD dissertation.

The research intends to investigate the linkages between education, development, and food security, especially in rural areas of low-income countries since they are traditionally neglected in both education and development governmental policies. The core research question is the following: *How important is education to promote development and enhance food security in low-income countries?* This question is immediately followed by another sub-set of questions: 1) *Which theoretical approach to development allows to address the topic in a comprehensive way?* 2) *What are the most adequate definitions and indicators of food security?* 3) *What level of education is crucial to promote food security in a low-income country?* 4) *If there is empirical evidence in favour of the relevance of education, through which channels does it affect food security?*

The topic is quite new in development studies and development economics. As an evidence of its relevance in current academic and institutional debates, after the beginning of the research, in 2006 the World Food Programme published a report on 'Hunger and Learning'. Previous

[1] MDG 1: 'Eradicate extreme poverty and hunger'.
[2] MDG 2: 'Achieve universal primary education'.
[3] MDG 3 'Promote gender equality and empower women'. MDG 3 relates to education since the associated target is to 'eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015'. For the entire list of MDGs, see the following web site: http://www.un.org/millenniumgoals/

literatures, such at that on human capital and economic growth have outlined the importance of education and food security/nutrition as key elements of human capital. In a separate debate, that on food security, the topic of education has been usually faced from the perspective of technical training for the enhancement of agricultural productivity. On the contrary, in this research it is argued that this subject should be addressed following the capability approach, since only this approach recognizes the multiple – social and economic – benefits of education. The capability approach becomes particularly suitable for the analysis of the relationship between education and food security, once we follow a more recent (and less economistic) conceptualization of food security.

In order to address this relatively innovative topic, first a theoretical methodology is presented, and then an empirical methodology, which mainly consists of correlation and econometric analysis. The thesis consists of seven chapters, each of them building on the conclusion of the previous one, gradually addressing more complex research questions. Although each chapter can be read independently, each of them is set in order to provide information for the comprehension of following sections. Leaving aside chapter 1 (the current one) and chapter 7, which include respectively the introduction and the conclusions of the whole research project, the contents of the other sections are designed as follows.

Chapter 2 aims to review the role of education for development within four development approaches: the human capital approach, the basic needs approach, the rights-based approach and the capability approach. These approaches derive from different disciplines and are founded on different conceptualizations of development. In turn, also the role of education within each of them varies. The chapter aims to examine which of the four approaches provides better insights for the analysis of socio-economic topics such as food security.

Once argued that the capability approach seems to be better in addressing these subjects, chapter 3 shifts the focus to the second variable of interest, food security. In order to justify why food security should be viewed as a socio-economic factor of development, the first part contains the review of the influent contribution of Thomas Malthus, who predicted the spread of hunger due to scarcity of food per capita. Then, the following section analyzes

Amartya Sen's entitlement approach, which poses the basis for an analysis of hunger and food security at household and individual level, rather than at macro-level. Sen's contribution in this field, which led him to win the Nobel Prize in economics in 1998, was essential to address the overall concept of food security from a multi-dimensional perspective, and not just from the perspective of food production and trade. This theory has been a key reference point especially for institutions such as the Food and Agricultural Organization (FAO) and the World Food Programme (WFP) that extended the debate in theoretical terms and found the ways to apply these concepts in food policies. The impact of Sen's thinking is visible in the commonly accepted definition of food security given at the 1996 World Food Summit.

It is only through a comprehensive conceptual framework – that provided by the capability approach – and by taking a comprehensive view of food security, it becomes possible to investigate the theoretical linkages between the two basic capabilities: 'being educated' and 'being adequately nourished'. Chapter 4 analyzes these relationships. First, it briefly outlines the mechanisms through which food security and nutrition promote education. This is the direction of the relationship more known in academics and in development policy. Then, a theoretical model is presented, aiming at explaining how the capability being educated affects the capability being adequately nourished. This causal relationship involves different agents, different generations, and also different pathways. Regarding the latter, two core macro-channels – 'economic production' and 'social change' – are identified.

Chapter 5 mainly contains the first quantitative study; however, there are also key theoretical aspects such as the construction of an indicator of food security. Such an indicator is based on nutritional values of children and women, which are an 'outcome' of food security. This chapter explains why this indicator better than others related to food or calories availability reflects the concept of food security. The following part of chapter 5, built on the theoretical framework highlighted in previous sections, analyzes with different statistical means the intensity of the bilateral relationship among the different levels of education and food security in rural areas of low-income countries. Then, a cross-country econometric model is applied in order to assess the incidence of different levels of education on the food insecurity indicator.

Chapter 6 focuses on one specific type of impact of education on food security, which is the impact of mother's education on child food security. Its interesting theoretical insights are the following: firstly, the review of this specific literature and then the conceptual framework explaining direct and indirect relationships between mother's education and child food security. Regarding the empirical study, a micro-econometric model is applied on household data in one country, Mozambique, identified as case-study. This quantitative analysis intends to answer four key questions: 1. Does mother's education significantly affect long-run child food security? 2. On which level of mother's education should policy-makers invest the most? 3. What is the main pathway of influence? 4. Do results differ whether households live in rural or urban areas?

The aim of both quantitative analyses is to find a strict correlation between these two basic capabilities, especially with respect to primary and basic levels of education. In fact, following a capability perspective rather than a human capital perspective, general knowledge more than skills are relevant in developing countries. Thus, in particular the sign of the contribution of education to food security is expected to be positive and statistically significant, primary or basic education to be the key level of education, and, where measurable, to have the 'social change' channel to be at least as important as 'economic production' as transmission mechanism. This would provide empirical evidence of the validity of the capability approach in explaining socio-economic phenomena in marginalized (rural) areas of low-income countries. Furthermore, whether the second econometric model outlines the significant contribution of mother's education, this would point out an important gender issue, which, as will be explained in chapter 2, cannot be properly addressed using traditional economic approaches.

CHAPTER 2

EDUCATION *AS* DEVELOPMENT AND *FOR* DEVELOPMENT: A CAPABILITY PERSPECTIVE

2.1 Introduction

The relationship between education and development has not been adequately explored until recently. Although nowadays it is widely recognized that an educated society is an important determinant of national development, the exact role that education plays varies depending on the theoretical framework in which development is conceptualized. This chapter critically reviews the role of education within four major development approaches: 1. Human capital approach; 2. Rights-based approach to education; 3. Basic needs approach; 4. Capability approach. The objective is to identify which approach provides more comprehensive insights for the analysis of education and for the policy implementation of education and development projects. The main point in the light of the global scope of this research is to identify which framework should be adopted in order to study socio-economic dimensions, such as food security.

The chapter is structured as follows. Section 2.2 introduces the general characteristics of the human capital approach, the rights-based approach to education, and the basic needs approach, stressing the causal relationship between education and development in each of them. Section 2.3 presents the capability approach: features, application to education, and criticisms. Section 2.3.1 discusses the open debate whether or not the capability 'being educated' can be defined as a *basi*c capability. Section 2.4 compares the capability approach with the other three approaches. Comparison is made on the basis of both theoretical foundations and practical applicability. The last section concludes with a brief overview of previous findings.

2.2 Human Capital, Rights and Basic Needs

2.2.1 Human Capital Approach

Economists usually consider development as a synonym of economic growth and they struggle to identify its determinants in both affluent and poor countries. The most influential theories (Harrod 1948; Domar 1946; Solow 1956) have primarily pointed out the necessity of capital accumulation in order to boost growth. Such theories have recognized the presence of residual determinants of growth, but were unable to explain them. Schultz (1961) and Becker (1962) have tried to fill this missing gap, by providing both theoretical and empirical evidence that an additional crucial factor of production was human capital.

The concept of human capital embraces four main components: 1) health; 2) on-the-job training; 3) formal education; 4) study programs for adults such as extension services in agriculture (Schultz 1961, p. 9). They are a 'capital' because they are a source of future economic benefits and are 'human' because they are strictly 'embodied in men' (Schultz 1971, p. 48). Among all human capital dimensions education has proved to be the crucial instrument to achieve earnings and growth (Becker 1993, p. 17).

The introduction of the human capital approach (HCA) contributed to overcome two main shortcomings of previous growth theories.[4] First, the assumption of constant technical progress. Technical progress, according to Schultz (1971, p. 8), is not constant and exogenous to the production process, but it is a result of improvements in the quality of production factors, mainly due to investments in human capital. It is not difficult, in fact, to imagine that healthy, educated, and well-trained workers can achieve higher levels of productivity, all the remaining inputs being the same. Similarly, Becker (1993, pp. 23–24) points out that it is 'the expansion of scientific and technical knowledge that raises the productivity of labour and other inputs in production'.

Second, the definition of labour as homogenous capital. In the classical tradition, labour was mainly viewed as manual work, which does not need particular skills. In the real world, different jobs require different skills and

[4] Since now on the human capital approach refers to the early works on human capital.

qualifications. Thus, growth theories should take into account the human capital embedded in the labour force.

The theoretical literature on human capital was complemented by applied works. Psacharopoulos (1973) has provided an empirical analysis of the contribution of educational capital to the rate of economic growth across countries. His work starts from the following assumptions:

- Human capital is measured by its most important dimension: education.
- Education is entirely treated as a 'producer good', with all the benefits of expenditures in education going to earnings. This assumption leads to results that underestimate the returns to education.
- Educational capital is calculated in the labour force.
- Education is considered in two different growth models: the Schultz-type model and the Denison-type model. In the former, the capital is distinguished in physical and human capital. The Denison growth model, instead, does not consider human capital as a separate input of production, but distinguishes the labour force according to its educational level.[5]

Building on this theoretical framework and using data from several parts of the world from the period between 1960 and 1965, Psacharopoulos achieved the following results: 1. schooling matters for economic growth; 2. this relevance is higher in developing countries; 3. investments should be made primarily in elementary education since it ensures higher rates of growth.[6]

2.2.2 Rights-based Approach

In the last few decades, the rights-based approach has become very influential, also in the field of education, partly due to the relevance attributed to it by international organizations such as UNESCO. UNESCO, in fact, is the UN agency with the mandate to promote education as a human right.[7] The primordial mention of education as a right lies in Article 26 of the Universal Declaration of Human Rights (UN 1948). This article states that 'Everyone has the right to education. Education shall be free…Education shall be directed to…the strengthening of human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or

[5] See Annex 1 for the formalization of the two growth equations.
[6] For updated results see Psacharopoulos (1994; 2002).
[7] This is clearly only one of the UNESCO mandates.

religious groups'. Later on, Article 13 of the Covenant on Economic, Social, and Cultural Rights (UN 1966), Article 28 of the Declaration and Convention on the Rights of the Child (UN 1989), the recent World Conference on Education for All (EFA), held in Jomtien (UNESCO 1990) and the World Education Forum (UNESCO 2000), held in Dakar have re-affirmed the human rights approach.

The core principle of this approach, primarily supported by UNESCO, is that education is a human right, thus it should be guaranteed to all. Education is valued *per se*. This does not mean that the capacity of an educated society or individual to promote socio-economic development is neglected by the advocates of this approach. The claim that education is a human right does not even bring its instrumental role into discussion (Robeyns 2006, p. 75).

The policy implications of this view are visible in the outcomes of the EFA World Conference held in Jomtien in 1990, under the coordination of three international organizations: UNESCO, UNICEF, and the World Bank. The conference was preceded by many documents, workshops, and meetings, which gave a clear printing to the conference's final outcome. The EFA Declaration stressed the relevance of universal access to basic education in order to meet basic learning needs and the associated Framework for Action gives (non-binding) guidelines to nation-states for progressing towards this goal (UNESCO 1990). Ten years later, in Dakar, the same framework and policy guidelines were strongly re-advocated.

2.2.3 Basic Needs Approach

In the second half of 1970s, the International Labour Organization (ILO) has proposed a new model of development, the basic needs approach (BNA), with the intention of incorporating even non-economic dimensions of development (ILO 1976; 1977). The problems of poverty, unemployment, and under-employment, registered in periods of rising economic growth, were the primary causes of the policy shift. Later on, two economists: Streeten (1981) and Stewart (1985) contributed to re-launch such an approach.

The BNA advocates viewed development as a process aiming to ensure to all the people the satisfaction of their basic needs. The fulfilment of basic needs, according to Stewart (1985), was a precondition for a 'full-life',

composed of material and non-material elements. Her main objective was to construct a theory that could be translated into a development policy in a 'feasible' way. Feasibility requires a minimal interpretation of the full-life; according to Stewart, *health* and *basic education* were the two core dimensions.[8] She concluded that health and basic education are *basic* because they are objective preconditions for the enjoyment of other elements of the full-life and because they are 'physiological needs' and only physiological needs can be labelled *basic* without value judgments (Stewart 1985, pp. 1–7). In a following stage, Stewart analyzed the bundle of goods indispensable to the enjoyment of these basic needs, with the scope of identifying an approach directly relevant for planning.

This brief description of the BNA helps to understand the role of education for the satisfaction of basic needs. ILO (1977, p. 28) stated that 'education is itself a basic need and equality of access to educational services, particularly in rural areas, is therefore an important ingredient of a basic needs strategy'. Stewart (1985) considered education, together with health, as a core element of development, and not just as a means to achieve it. Education is a basic need, an end in itself, and at the same time a means to fulfil other basic needs such as health and nutrition (Tilak 2002).

The analysis of early works on the BNA suggests that this approach originated from an urgent matter: providing poor people with the most essential means to have a minimally decent life. This approach was attracting because it was of immediate and practical use for planning, but it did not provide deep clarification of the meaning of 'needs' and 'basic needs'. Theorizing on these concepts helps to understand whether education belongs to the set of basic needs. More recently, scholars such as Doyal and Gough (1991), and Wiggins (1985) have worked on the philosophical foundations of this approach.

Firstly, Doyal and Gough (1991, p. 39) identified needs as 'universalisable' goals.[9] Wiggins (1985) related these goal-needs to harm, where harm is a constraint to the achievement of the goals people value or, in another way, it is the incapacity to participate in social life due to external constraints and limitations that do not depend on individual decisions (Doyal

[8] ILO and the World Bank supported a wider list of basic needs, composed of the following elements: health, education, clothing, shelter, sanitation and hygiene. The interventions undertaken by these institutions on the basis of this list took the name of Basic Needs Strategy.
[9] The definition of needs as goals contrasts with that of needs as drives, guided by human biology.

and Gough 1991, p. 50). Needs are universalisable goals, which whenever unmet, produce serious harm to the person.

Doyal and Gough indicated two preconditions for the avoidance of harm: physical health and autonomy. *Physical health* is a necessary condition 'to lead an active and successful life in your own terms' (Doyal and Gough 1991, p. 59). It goes beyond the minimal concept of survival: even a person that has a physical impairment that does not directly undermine her existence is seriously harmed. *Autonomy*, instead, refers to individual capacity 'to formulate consistent aims and strategies which they believe to be in their interests and their attempts to put them into practice in the activities in which they engage' (Doyal and Gough 1991, p. 60). Autonomy is mainly achieved through quality basic education. Besides cross-cultural differences in the way of learning and in the subjects studied, education should lead to the autonomy of the individual. Quality education, whether formally or informally acquired, promotes people's participation in public life, improving also their self-esteem. On the contrary, an irrelevant academic curriculum, low quality of education, an excess of vocational training, or, market-distant education can objectively harm people. Therefore, education, within this approach, becomes a proxy for 'basic need' (Doyal and Gough 1991, pp. 59–61).[10]

Concluding from this chapter, the BNA recognizes both the intrinsic and instrumental role of education: it is a basic need and influences the enjoyment of other needs. Doyal, Gough, and Wiggins developed a more rigorous theoretical framework for the BNA proposed by ILO, Stewart, and Streeten, especially by clarifying the concept of need and linking basic needs to the concept of harm.

2.3 Capability Approach

In the early 1980s, Amartya Sen has proposed a new approach to welfare and development – the capability approach (CA) – with the intention of overcoming most of the limits incorporated in previous (economic and philosophical) theories such as utilitarianism. Utilitarians base the assessment of wellbeing on estimated utility. The individual, in this framework, is treated

[10] More precisely, according to Doyal and Gough (1991, pp. 157–159), education is an *intermediate need*, which is a universal human characteristic that enhances autonomy and physical health. Intermediate needs are sub-components of basic needs.

as *homo economicus*, who acts for the maximization of his utility, conceived as the only thing people value. On the contrary, Sen launched the CA with the aim of shifting the attention from utility to more valuable dimensions of human life. For this purpose he developed two key concepts for the evaluation of development and wellbeing: *functionings* and *capabilities*.

Functionings consist of beings and doings; what people finally manage to *be* and to *do* in life. Functionings vary from elementary functionings, such as 'being adequately nourished' and 'being educated', to more complex ones, such as 'participating in political life' and 'achieving self-respect' (Sen 2003, p. 5). *Capabilities* are the set of potential functionings of a person; they reflect the freedom a person has to live one type of life rather than another (Sen 1995, p. 40). Functionings are human achievements, while capabilities represent the opportunities to achieve functionings (Robeyns 2005, p. 95).

The definition of these key concepts is indispensable to understand the meaning of development within this framework. According to Sen, development is 'a process of expanding the real freedoms [capabilities] that people enjoy' (Sen 1999) in order to live a life 'they have reason to value'.[11] In a slightly different way, development can be defined as 'a process of enlarging people's choices' (UNDP 1990, p. 10). Thus, it is a broad concept, which should be studied in a multidisciplinary setting. The CA provides the theoretical background for the human development approach, promoted by the UNDP.[12]

The new conceptualization of development focuses on human beings. Development, in both affluent and poor countries, should be measured in terms of progress towards human achievements. What ultimately counts is that people are well-nourished, educated, or that they have a long and healthy life, and, more precisely, that they have the capability to achieve these results in life. These are *ends* of development. On the contrary, income, the focal variable of the economistic view on which the HCA lies, is only a *means* to development (Sen 1995; 1999; 2003). The ownership of income does not provide information on the real quality of life of a person; what counts is how income is finally converted into something people value. Since human beings differ in their age, sex, metabolism, health, and the environment in which they

[11] The meaning of the sentence 'they have reason to value' will be discussed in section 3.1.
[12] For the translation of the CA into the human development approach, see Fukuda-Parr (2003).

live (including the institutional environment), the capacity to convert income into functionings varies (Sen 2003, pp. 6–7). Similar arguments could be addressed with respect to commodities.[13]

This people-centred framework opened a new space for the analysis of education. In his article 'Human Capital and Human Capability' (1997, p. 1959), Sen briefly pointed out the double role of education for capability expansion. First, a 'direct' role because being educated enriches people's life. People might be interested in enjoying a cultural event just for the sake of enjoying culture, with no other scope in mind. Some people could study foreign languages just for the passion of learning or for the atmosphere that language evocates, besides the use they make of it (Robeyns 2006, p. 70). Similar examples might be drawn from other aspects of education/culture.

Second, education has an 'indirect' role for development. Such a role can be realized through 'economic production' and through 'social change' (Sen 1997, p. 1960). Education is conceived as a central factor in the identification of the individual's ability to choose among and to live different types of life, beyond being relevant to augment the productive possibilities. The CA entails the (social) benefits that education produces on the ability to communicate, to be taken more seriously by others, and to take conscious decisions, even when household and personal income is constant. The central point is that education enhances *critical thinking* and *responsibility*, essential elements for improving people's wellbeing. For this reason, Radja et al. (2003) have used the terminology 'life-skills' to indicate those abilities that the individual acquires during the whole life-time, in school and in the daily life. The authors have identified four main categories of life-skills enhanced by quality education: *learning to know, learning to be, and learning to live together* in addition to a practical ability: *learning to do* (Radja et al. 2003, pp. 7–8).

Ingrid Robeyns (2006, pp. 70–71) has made a further distinction between 'collective' and 'personal', 'non-economic' and 'economic' instrumental roles of education. While the concept of 'non-economic' contribution is approximately the same of 'social change' defined by Sen,

[13] Robeyns (2005, pp. 98–99) used the example of the bicycle, well-known in the capability literature. A bicycle is important to enhance the capability 'being able to move freely' or 'being independent', but it is not valuable for its own sake. The ownership of a bicycle by a disabled person does not add anything to her quality of life, since she cannot use it as a means of transportation; with or without bicycle, she does not have the capability to move freely.

Robeyns rightly explains how the positive contribution of education can be extended to the collective level. Here, these four categories are briefly summarized.

- The *instrumental economic* contribution of education occurs by increasing the likelihood of a person to find a better job and to increase her earnings.
- Education has a *collective economic* role because it facilitates economic growth at national level, and because it can be essential for a shift in economic structure (e.g. from agricultural to industrial economy).
- Education has a *personal non-economic* role because it 'can open the mind of people', by enhancing, for example, their capacity to access information, to communicate, and to be knowledgeable about contraception and health.
- Finally, the *collective non-economic* role. Women, for example, who are in a marginalized position and together acquire knowledge about different cultures and traditions, can realize they could live different lives and make pressure in order to change their condition.

Thus, Sen provided the rudimental basis for the analysis of the capability 'being educated' within his approach. He is not an educationalist, but his perspective is perfectly compatible with an approach that studies education in its full dimension (Saito 2003, p. 17).

Sen's attempt to incorporate education in the capability setting has received some criticisms. According to Unterhalter (2003) and Saito (2003), education in this approach is 'undertheorized'. In order to explain why Sen's account of education might suffer from this problem, an example is taken from Unterhalter (2003, pp. 12–18). She examined the case of women and girls in South African schools, where they are at constant risk of being raped by male teachers and classmates. This social environment might lead to the destruction, rather than to the enlargement of girls' capabilities. Therefore, one might question whether education is really valuable for girls in these areas. This type of example entails two main criticisms:

1. Education is not simply an outcome of schooling. Dreze and Sen (1989) analyze the value of education, drawing attention to literacy and school enrolments. One of the main merits of Sen's work is the development of a people-centred approach, where the ultimate aim is to improve people's life. However, while Sen has usually criticized income because it offers limited information compared to achieved functionings (and capabilities), he does not

investigate how schooling (attending school, the school curriculum, the general learning environment) is finally converted into an education capable to enlarge people's freedoms. What counts at the end of the day is having at least basic skills for life and work, and not going to school.

2. Partly connected to point 1, the assumption that education (or better schooling) enlarges capabilities is far too simplistic and valid only in ideal situations. In the South African case, Unterhalter argued that the educational analysis should primarily encompass gender injustices present in the society, out of which the rapes are only one single manifestation. Therefore, the CA should be integrated with a social theory in order to analyze the overall educational field.

According to Unterhalter, education is a valuable achievement, but the role of the institutions is fundamental to transform schooling into an effective and quality education, without negatively affecting other aspects of life. Institutions have the task to remove disparities, discriminations, which are obstacles to exercise freedoms such as being and feeling free to go to school, learn, and reflect (Unterhalter 2003, p. 3). Also Radja et al. (2003, p. 9) have considered a 'learning friendly context' as an essential element to make education a pillar for enhancing human capabilities especially for currently marginalized people.

This is a good criticism based on both theoretical foundations and empirical evidence. The suggested analysis can lead to a more rigorous examination of *how* education *can* extend peoples' capabilities, going beyond the general assumption that education *does* extend peoples' capabilities. This critique has relevant policy implications, but, in my view, it does not undermine the value of the theory. With reference to the same problem, Saito (2003, p. 28) argued that 'education which plays a role in expanding the child's capabilities should be a kind of education that makes people autonomous'. The focus on quality aspects is not in contradiction with the application of the CA to education.

Finally, the CA is an educational approach. Sen has drawn the guidelines for investigating the role of education by pointing out its double contribution to development: intrinsic and instrumental. Thus, the focus on people's education as a valuable end, and the stress on education's impact on agency are the main innovative elements.

2.3.1 Being educated as a basic capability

Previous paragraphs stressed the intrinsic and instrumental roles of education. This section makes a step further by addressing the question: is education conceivable as a basic capability? The CA has provided an innovative theoretical framework for the analysis of poverty as multidimensional phenomenon. The first challenge is to identify the basic capabilities without which people are poor. The main proponents of the CA, Martha Nussbaum and Amartya Sen, have acquired divergent positions.

Nussbaum (2003, p. 40) argues that the minimum requirement for a human life is *dignity*. Therefore, she developed a list of ten central functional human capabilities, which are required to live a life with dignity (Nussbaum 2000). According to Nussbaum (2003, p. 40) these capabilities 'are part of a minimum account of social justice'. She embraces a list of universal basic capabilities, which is a common ground among people with diverse cultures and different conceptions of the good life (Nussbaum 2003, pp. 42–43). Her position is somehow open with respect to the contents of such a list.

Sen has sustained an apparently opposite view on the question of the capability list. Summarizing his conception of development: each person has her own values, but she has to identify these valuable capabilities *reasonably*. The term 'reason to value' implies that people should select their basic capabilities and defend them in a reasonable public debate. People, in fact, might live a very deprived life, or simply have a very small informational basis and this lack of information and aspiration is likely to affect their choice. Public debate should expand the range of information the individual has access to and deepen the process of reasoning. This position implies the rejection of *a priori* list; the identification of such a list is an exercise that depends on the objective (e.g. assessing absolute poverty in a developing country) and the context of analysis (Sen 2004, pp. 77–78).

Following Sen's perspective, one should ask whether it is possible to set up some criteria for the selection of capabilities. The work of Alkire (2002) helps to find some possible solutions. She takes inspiration from the work of Wiggins on basic needs, in order to arrive to a definition of basic capabilities (Alkire 2002, pp. 166–169). As pointed out in section 2.2.3, basic needs are those needs indispensable to avoid harm. Alkire (2002, pp. 159–160) has

proposed to connect basic needs to the functionings that are undermined if basic needs are not met. This way, she finally defined a basic capability as 'a capability to enjoy a functioning that is defined at a general level and refers to a basic need, in other words a *capability to meet a basic need*' (Alkire 2002, p. 163).

Terzi (2007) combined the above perspective with Williams' point of view. According to Williams (1987, pp. 100–101), 'basic' means 'foundational' or 'fundamental' to human wellbeing: basic capabilities, thus, are those underlying more complex capabilities. The capability 'being educated'[14] can be labelled as basic if the following two postulata are true (Terzi 2007, p. 30):

1. Not being educated necessarily harms or substantially disadvantages a person.
2. The capability 'being educated' is fundamental for the achievement of more complex capabilities.

To address the first point, Terzi (2007, p. 30) used the example of feral children, living in a situation of total deprivation. These children do not grow up in an environment that allows them to have social relations and to communicate; thus, their capacity to reflect and learn is seriously undermined. This extreme example shows how, broadly speaking, being educated enlarges a set of capabilities and lack of education harms and disadvantages people. Some might argue that children can learn even from being just with animals and the environment, in a small space such as a cage. Here, the point concerns the concept of 'education'. It seems that Terzi has an idea of 'education' narrower than 'learning', but at the same time broader than schooling: her view of education embodies both education achieved in school and informal education (Terzi 2007, p. 30). Moreover, she suggests that not all learning is education. This way, the capability being educated fulfils the first requirement.

The second point concerns whether being educated is fundamental to human wellbeing. The argument that can be used to address this point is the same previously adopted: education has an intrinsic and an instrumental value. Terzi (2007, pp. 31–32) argues that education enlarges capabilities, by 'promoting reflection, understanding, information and awareness' and,

[14] Terzi uses the term 'to be educated'; however, the terminology 'being educated' seems to be closer to Sen's definition of capabilities and functionings and better emphasizes the active role of people.

therefore, providing the tools to identify the life to lead. Thus, the capability 'being educated' is 'basic' even in Williams' sense.

Summarizing, the capability 'being educated' falls into all the definitions of 'basic capabilities' because being educated is fundamental for the enjoyment of more complex capabilities and because lack of this capability causes serious harm to the person. Does it contrast with Sen's rejection of a list with fixed central capabilities? It seems so; however, it also seems that these authors define 'basic' as something similar to the 'very elementary' capabilities identified by Sen (2004, p. 79) for the main purpose of studying absolute poverty. Elementary capabilities seem to be just a sub-set of basic capabilities. In my personal interpretation of Sen's thought, the term 'basic' embraces both 'indispensable' and 'valuable': indispensable capabilities such as 'being educated' are valid everywhere, while 'valuable' capabilities are context-based. Following this perspective, Sen would provide a fixed list only of indispensable capabilities, leaving to individual judgment and public debate the list of 'valuable' capabilities.

Whenever Sen discusses elementary capabilities, he always includes the capability 'being educated' as well as the capability 'to be well-nourished' (Sen 2003; 2004). On the other hand, Sen does not advocate a more detailed list of basic capabilities for the full realization of human flourishing (as Nussbaum does).

Secondly, the central role that Sen assigns to public debate, in my view, makes it possible to consider the capability 'being educated' as a basic capability also because, together with few other factors such as basic health, it is a preliminary condition for engaging in public debate. According to me, if all people have basic education, this could limit the monopolistic position of certain people or pressure groups in the debate, leading to a non-biased selection of relevant capabilities. Thus, being educated is relevant in the procedural phase as well as an outcome.

The result is that 'being educated' is a basic capability, thus it *is* development and it is a *means* to development. That is why education is one of the three dimensions of the Human Development Index (HDI).[15]

[15] The HDI is a summary indicator that does not entirely reflect the CA. It is composed of three dimensions: life expectancy, economic opportunities, and knowledge (education). Besides practical reasons related to availability of education data for cross-country comparisons, the

2.4 Comparing the Approaches

This chapter aims to pinpoint the differences between the role of education in the capability approach and in the other three approaches discussed in previous sections.

2.4.1 CA vs. HCA

The CA and the HCA were born for different purposes. While the CA focuses on life dimensions people might have reason to value, the HCA draws attention only to economic factors. This does not necessarily mean that authors such as Schultz ultimately intended to value only these factors. However, the problem lies in the application of such a theory by neoclassical economists, who interpret the extension of production possibilities as an increase in happiness or satisfaction of needs. That is why, according to me, it makes sense, and it is even extremely relevant to compare the two approaches and the different policy recommendations suggested by them.

The main difference between these two approaches, in view of the objective of this research, is that the HCA stresses only the indirect role of education played through economic production, while the CA recognizes also the intrinsic role and the instrumental role through the 'social change' channel. Studies on the returns to education stress 'the economic value of education' (Schultz 1963, title). One of the underlying assumptions of the HCA is that the educational achievements are confined to the labour sector. Those people that go to school, but will not be 'economic agents' because they will not be part of the productive system, are not counted. The unit of analysis is the worker. In the same way, at macro level, the unit of analysis is not the whole society, but a sub-category of it: the productive sector. These are also explicit assumptions in the empirical literature on human capital. On the contrary, the CA is a people-centred approach, which takes into account the, individual and collective, multiple benefits that the education acquired by all individuals provides.

A part of these criticisms to the human capital framework is not outlined only by the advocates of the CA. Regarding the *type* of instrumental

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education component is included because it is a crucial element for the analysis of a country's development.

role of education, among others Woodhall (2001), who directly contributed to the human capital theory, criticized it for encompassing only the direct, monetary, and short term returns to education. Being educated has also an impact on family relationships, social structures, and health (e.g. Coleman 1988). The HCA lacks recognition of these non-economic benefits of education, thus it neglects major part of the role of women's and girls' education (Woodhall 2001, p. 6953).

Another crucial distinction between the HCA and the CA concerns the gender issue. Schultz's approach implies that governments and enterprises focus on the most profitable sector. Provided that investments in education, and broadly in human capital, are often more convenient than investments in physical capital, next step concerns: education of *whom*? Psacharopoulos (1973, pp. 68–69) estimated that investments in male education provide larger economic returns, principally in primary education (+6.5 percent). This is of easy explanation: women, especially in the past and in developing countries, are often reluctant or institutionally impeded to become members of the labour force (Psacharopoulos 1973, p. 69); thus, investments in their education are more likely to get 'lost'. The HCA works within existing social and economic structures. Women 'work' less than men, will have no or lower earnings, thus they are less profitable than men.[16] Finally, since empirical estimates outline that the highest rates of returns to education occur in primary education, and in primary education there is the largest difference in male-female returns to education, the adoption of the HCA risks to emphasize gender disparities. On the contrary, the CA encompasses all the contributions of women's and girls' education. Especially by recognizing the social channel, the CA attributes a primary role to women and admits the possibility of a social change derived from their education. Therefore, unlikely the HCA, the CA does not work in the *status quo* hypothesis.

Choosing the CA or the HCA as a reference framework has significant policy implications in the educational sector. An example might help to understand better the points outlined in this section. Building on the enlightening work of Alkire (2002), comparison is made among the different policy recommendations suggested by the two approaches in the specific case

[16] Here, 'work' means a labour activity providing economic returns in the market: the whole range of domestic works within the family, usually realized by women, does not belong to this category.

of an education project. Alkire (2002, pp. 255–269) analyzed a literacy project undertaken by Oxfam in Pakistan, which aims to increase women's capacity to read, write, and be knowledgeable about daily matters such as health and nutrition, with a further intention to increase their income.

Following the HCA, i.e. applying cost-benefit analysis, the project would be considered as a failure. On the one hand, traditional and opportunity costs for women were high; on the other hand, economic benefits had proved to be very limited. Due to social constraints, there was no employment market for women; thus, they ended up making handicrafts, for which literacy did not produce an increase of income. However, as Woodhall (2001) suggests, it is necessary to consider a wider set of benefits, rather than just economic ones. Therefore, Alkire tried to assess the capabilities expanded through the project, by letting students identify and rank the capabilities enlarged by the project. Women indicated *knowledge* and *empowerment*[17] as core benefits. Following the CA, the project would have been financed because it affects key aspects of women's life, producing social transformations, which, on the contrary, are not recognized in the human capital framework. The latter could be useful to see if similar results could be obtained at lower costs. Finally, the price for a more comprehensive approach is complexity: evaluating a project through the CA, that is, measuring a wider range of contributions of education is clearly more problematical than evaluating it following a human capital framework.

2.4.2 CA vs. Rights-based Approach

Education, in the rights-based approach, is valued intrinsically. Whether or not it also enhances other relevant rights does not matter in the conceptualization of education in this framework. In section 2.3.1, it was argued that being educated could be considered as a basic capability mainly because of its intrinsic role: this is the commonality between the two approaches. However, the CA explicitly recognizes also the instrumental role of education, which is an important extension, especially once we try to operationalize the approach. A human rights setting would suggest extending (primary) education in a specific context, without making an adequate analysis

[17] 'Empowerment indicated their [women's] awareness of what they themselves could do and be' (Alkire 2002, p. 266).

of the socio-economic conditions of the area. According to me, a development policy/project should also take into account costs and benefits, both economic and social. In order to make interventions more effective, different fields should be strategically analyzed, always keeping in mind the inter-linkages between the different capabilities that could be expanded. Given a fixed budget, only if the educational field provides more social and economic, short and long term, returns than, say, the health or nutrition sector, the project should focus on education.[18]

A further aspect to consider pertains to the *type* of education to promote. An analysis that tries to incorporate the intrinsic and all relevant instrumental roles of education might suggest expanding secondary education, even where primary education is not yet accessible to all. On the contrary, the rights-based approach would push for primary education, as the EFA Declaration does. The conclusion from these two paragraphs is not that the CA is necessarily a better approach for the realization of a development project, but that the CA offers a more comprehensive setting in which investigating education.

Finally, a set of criticisms has been moved towards the specific rights-based approach to education followed by UNESCO. The first one concerns the *rhetoric* behind UN reports and international conferences such as EFA. According to Chabbott (1998; 2003) and Mundy (1998), the rights language has not been properly justified on a theoretically basis, and it is just the result of a process of standardization of ideas circulating among development professionals.[19] The second criticism outlines the contradictions of assumptions and conclusions of the EFA conferences. One of the leading organizations, the World Bank, clearly denies the intrinsic role of education and since the beginning of 1990s re-launched the HCA (Mundy 1998, pp. 474–475). Education interpreted only as a *means* rejects the intrinsic value of education. The World Bank, nowadays, shares with UNESCO and UNICEF the focus on primary education, but the approaches are deeply different.[20] Finally, this

[18] Since this issue is analyzed from a merely strategic point of view this conclusion does not contrast with the vision of the capability 'being educated' as a basic capability.
[19] For this purpose, Chabbott (1998) defines it 'institutionalist approach'.
[20] The World Bank educational policy until the beginning of 1990s has stressed the role of tertiary education and vocational training to promote economic development. Only recently, even under the influence of Psacharopoulos' writings, it shifted its focus towards primary education and literacy.

section did not intend to criticize an approach founded on the human right to education; the problems are that recognizing only the intrinsic role of education can be limiting for policy matters, and that it is difficult to find theoretical tracks of the language and terminology adopted by institutions such as UNESCO.

2.4.3 CA vs. BNA

Both the BNA and the CA stress the intrinsic and instrumental role, and within the last category they distinguish social impacts from economic impacts of education. This reflects the overcoming of strictly economics-oriented development theories. The comparison between these two approaches, according to me, should be made on some key differences in the theoretical foundations. Some of them are discussed below.

First, basic needs 'are defined in terms of commodities' (Sen 1984, p. 513). Broadly speaking, this is 'erroneous' (Alkire 2002, p. 168) because, for instance, Stewart (1985) has explicitly rejected a vision of basic needs as goods: goods are only instruments to fulfil these needs. Drawing an example from education, Stewart would argue that commodities such as schools and books are converted into people's education depending on individuals' characteristics.[21] Thus, this criticism could only be addressed to the way the BNA was applied by international organizations (ILO and World Bank), but not to the approach *per se* (Reader 2006, p. 342). However, in Stewart's (1985) work there is an impressive reference to goods. For example, in outlining the limits of income-based development theories, Stewart (1985, p. 11) asserted that the BNA 'sees access to the basic goods and services as the objective; incomes remain important but as a means of acquiring these goods, not an end in themselves'. This sentence suggests that access to schools is the final end rather than 'being educated'. Following this interpretation, there is no large distance between theory and the 'basic needs strategies'. From my point of view, the main problem with the BNA is that it misses an exhaustive definition of education. Stewart seems to view education in terms of *schooling*, rather than in a wider sense of *learning*. Besides the limits of Sen's analysis of

[21] The jargon used by Stewart and Streeten to identify this conversion is 'metaproduction function'.

education outlined in section 2.3, a capability perspective views education as a wide concept, which includes other concepts such as learning and dialogue, going beyond that of schooling. Furthermore, most of the basic needs strategies applied in developing countries during early 1980s focused on the simple delivery of education as an economic good. Constructing schools, employing teachers, increasing the expenditures in education were at the heart of these strategies. However, a similar remark could not be made with reference to Doyal, Gough and Wiggins, since they have provided a fuller description of the meaning of basic needs.[22]

Second, basic needs reflect the minimum required for a full life; thus, this theory works only for absolute deprivations of developing countries (Sen 1984, p. 514). On the contrary, the CA is 'more general' because it can deal with both absolute and relative poverty, and because it provides information on what happens above a theoretical poverty line.[23]

Finally, the most relevant aspect: the CA is founded on stronger philosophical basis (Sen 1984, p. 515) because it directly includes in the framework elements such as *choice* and *participatio*n. On the one hand, the advocates of the BNA conceive participation and choice as basic (or intermediate) needs, at the same level of others, because they are fundamental to achieve autonomy. The BNA 'tries to incorporate desirable choice into the framework as a separate variable' (Alkire 2002, p. 170); thus, it does not explicitly value the *process* aspects. On the other hand, the simultaneous attention on functionings and capabilities, suggested by Sen, strengthens the value of individual choice.[24] This is useful, for instance, to distinguish between two undernourished people: one that is starving (has no choice), and one that is fasting (chooses not to eat). Furthermore, according to Sen, participation is indispensable for selecting relevant capabilities. Thus, the CA explicitly recognizes the value of *process*, in addition to the final outcome in the evaluation of a state of affair. The fact that at macro level, for operational purposes, some basic functionings such as basic education for girls are

[22] It should also be outlined that, in addressing the critiques of the BNA, Sen (1984) refers specifically to the work of Streeten, Stewart, Griffin, and other economists.
[23] Reader (2006, p. 342) argues that state and individual obligations are related to needs; 'Once needs are met, although further ends might morally permissibly be sought, there is no obligation on agents of justice to seek them'. Thus, the fact that the BNA is applicable only for situations of absolute deprivations is not a limit.
[24] Sen (1987) adopts the terminology 'refined functionings' to mean functionings adjusted according to the capabilities set.

identified although not uniformly valued, does not undermine the value of freedom to achieve such functionings.

In brief, the CA is an improvement and an extension of the BNA and the points above outlined contribute to provide a positive answer to the question: 'Does a Basic Needs Approach Need Capabilities?'.[25]

2.5 Concluding Remarks

Human capital has been a revolutionary concept in economics. The introduction of the HCA was fundamental for evaluating the contribution of education to development and overtaking some limits of previous growth theories. However, such approach is totally embedded in an economistic framework, which confines education to its instrumental role for productivity and earnings. The rights-based approach to education, on the contrary, dominantly outlines the intrinsic value of education: it is a right and as such it should be guaranteed to all. This is restrictive especially when it comes to apply a development policy. Furthermore, the specific use of this approach in institutional documents fails to provide a theoretical justification of the 'rights' language.

The BNA and the CA encompass both instrumental and intrinsic roles of education for development. Focusing on theoretical elements of the approaches, rather than on the specific application to education, it was argued that the CA is an improvement and an extension of the BNA because it attributes more relevance to people's participation and choice and because the policies derived from it ultimately focus on people, and not on commodities.

It follows that the CA is a larger box and a more advanced framework in which education can be investigated. The intrinsic value of education, social factors such as empowerment and gender issues in schools and in the society can be better addressed following this approach. However, there is a strong need of further research in this field. In particular, the measure of benefits of education projects, as well as the evaluation of other development policies, is far more complicated adopting the capabilities setting than a cost-benefit analysis. Theoretical works as those of Saito and Unterhalter, and applied studies as that of Alkire should be taken as primary guidelines.

[25] This is the title of Reader's paper (2006).

Finally, this chapter offered the tools to understand why the capability approach should be taken as conceptual framework for the analysis of a phenomenon – food security – which is not just an economic one.

CHAPTER 3

FOOD SECURITY: A CRITICAL REVIEW

3.1 Introduction

Following the capability approach, 'being educated' is at the same time an end in itself and a means to enlarge other capabilities. The main focus of chapter 4 will be on the capability 'being educated' as a means to achieve another capability, namely 'being adequately nourished'. The latter, from my point of view, is well reflected in the comprehensive definition of food security given at the 1996 World Food Summit. In order to understand the relationship between these two capabilities, it is necessary to explain the concept of food security. Only after a full comprehension of the several dimensions that are incorporated in the concept of food security and their evolution over time, we can realize the full potential of an educated society to reduce food insecurity. This chapter aims at addressing this issue.

The chapter is divided in 5 sections: the first part reviews the influential contribution of Thomas Malthus; the second part explains the innovative framework for the investigation of hunger and famine offered by Amartya Sen with his *entitlement approach*; part three addresses the implications of Sen's work on the theory and policy related to food security arriving to the world-accepted definition given at the 1996 World Food Summit; the last part outlines the reason why food security can be reasonably conceived as a valuable end of development, thus the other subject of analysis in the next section of this research.

3.2 Malthus' Thesis

Thomas Malthus' work 'An Essay on the Principle of Population',[26] has been a very influential piece for the literature on population, food, and political

[26] For this book, originally written in 1798, the on-line version printed in 1998 was used as a reference. See references.

economy. This section reviews his thought in the light of its impact on food studies.

Malthus (1998, p. 4) started his reflection with two 'postulata':

1. Without food men cannot exist.
2. 'The passion between the sexes is necessary and will remain nearly in its present state' (Malthus 1998, p. 4).

According to him, the first statement is so obvious that nobody can reject it. Thus, there is no need for further examination. Regarding the second postulate, there is no explanation of evolution of mankind that can suggest a decline in the passion between the sexes. It is a *natural* fact that men are attracted to women, and *vice versa*.

As a second step, Malthus (1998, p. 6) combined the contents of these two postulata. In a society where all people have enough means of subsistence to buy at least the minimum amount of food required for survival, population will inevitably tend to increase at a very high rate. The United States of America in the 18th century offer empirical evidence of this phenomenon (Malthus 1998, p. 7). There, in a period of abundance of means of subsistence and 'manners of people more pure', the population doubled itself in only twenty five years. In the same time-frame, the most modern European States did not achieve the same results in terms of population growth. This, from Malthus' point of view, was due to a larger proportion of population that lives in 'misery' in Europe. The inequality of a society produces misery, which acts as the only 'check' to population (Malthus 1998, p. 7). In order to confirm his conjecture, Malthus (1998, pp. 19–20) showed the counterexample of the main European states in the same period. Population grew rapidly during the 18th century, but at a much slower speed than in the United States. According to him, the doubling of the population could occur only in three or four hundreds years, rather than twenty-five. What negatively affects this situation is the economic conditions in which many families lived in Europe. Poverty acts as positive check to population because people who think that they will not be able to properly feed their children are more reluctant to have children at all. (Malthus 1998, p. 20). Only misery can limit the natural explosion of world population.

As a conclusion from this comparative study Europe-U.S. 'Population, when unchecked, increases in a geometrical ratio' (Malthus 1998, p. 4). To the

opposite, ‘the means of subsistence increase in an arithmetical ratio’ (Malthus 1998, p. 7). Food production cannot grow at the same speed of population for several reasons. With the best land and agricultural policies, he argues, it is possible to double the food production in a twenty-five years period. However, it is impossible to think that in the next twenty-five years food availability can be quadrupled; it can, at the most, double itself again. Thus, the ratio of increase cannot be more than arithmetical.

Summarizing Malthus’s thought, of which here only a very brief and superficial introduction was given, in absence of large misery to work as a positive check to population, the intensity of population growth is ‘immense’ compared with that of food availability growth (Malthus 1998, p. 4). Basing his arguments on the opinion that these two phenomena will keep going on with the same pattern due to natural causes, Malthus predicted that in the future starvation will be widespread due to the scarcity of food availability per capita. However, since misery did exist, he did not specify the moment in which there will not be enough food to feed all the human beings.

3.3 Entitlements and Capabilities

The theory developed by Malthus, who pointed out the fallacy of mankind and the dramatic future that is waiting for it, was surely fascinating in addition to being extremely powerful. However, already before his writings Condorcet addressed other elements that potentially could affect the demographic trends. An example is the focus on birth controls, which Malthus does not take into consideration. A birth control would limit the results predicted by Malthus by acting on the side of population: its growth would be lower than the forecasted one.

A punctual study of Malthus’ contribution falls out of the scope of this research. The main point here is that Malthus heavily affected all economic theories concerning food production and hunger (or food security). ‘Since Malthus, *food availability* has been a core argument of the population scare’ (Cuffaro 1997, p. 1152). As Sen (1981) pointed out, until the 1970s hunger and

famine were explained only with market mechanisms in the food sector.[27] If at global, national, or finally regional level food supply and demand meet, there is enough available food per capita, thus hunger and starvation cannot exist. Similarly, famine is conceived as a sharp decline in food availability. However, this explanation of hunger and famine was proved to be wrong by empirical evidence: these dramatic phenomena still occur in the current world, although everywhere, even in most of African countries, there is sufficient food availability per capita. Thus, Malthus was right in predicting the persistence, and even the raise of hunger in a faraway future, but he was deeply wrong in identifying the causes of this outcome. As Sen argues: 'starvation is a matter of some people not *having* enough food to eat and not a matter of there *being* not enough food to eat' (Sen 1981, p. 434, emphasis in original). Behind this apparently simple sentence, there is an innovative theory – the *entitlement approach* – that is now going to be examined.

In traditional neoclassical general equilibrium models, starvation can be only conceived as a result of insufficient food per capita because it is assumed that each individual has necessary resources and labour to survive (Sen 1981, p. 436). However, this assumption is clearly unrealistic. Sen, instead, defined starvation as an 'entitlement failure'. Quoting Sen (1981, p. 434): 'The entitlement approach concentrates on each person's entitlements to commodity bundles including food, and views starvation as resulting from a failure to be entitled to any bundle with enough food'. Entitlements depend on two elements: 1. the personal endowments, which are the resources a person legally owns such as house, livestock, land, and non-tangible goods (Osmani 1995); 2. the set of commodities the person can have access to through trade and production, i.e. the 'exchange entitlement mapping' (Sen 1981, p. 435). Starting from a situation in which an individual has just enough means of subsistence, a decline of endowments can obviously lead the person to starvation. However, with the same endowments, a person can still fall into the hunger trap because of a decline in the exchange entitlement mapping; for

[27] As next paragraphs will outline, in all his works Sen does not use the terminology 'food security', and prefers terms like 'hunger', 'starvation', or 'food deprivation'. The food security literature is relatively more recent, although strictly connected to Sen's studies.

instance, a sharp reduction of the price of the commodity that the individual produces, due to external causes, reduces its capacity to buy food.[28]

Moreover, Sen (1981, pp. 439–440) argues that the entitlement failure might take different forms. Given an economy in which each group, for simplicity, produces one commodity (including labour), and given a food exchange rate (commodity price/food price), any group risks to starve due to an entitlement failure either because of a reduction of food production for personal consumption or because of a fall in the food exchange rate (Sen 1981, p. 440). In the first case, there is a 'direct entitlement failure', in the second case a 'trade entitlement failure'. This distinction is particularly relevant to examine which group is at risk of starvation if something changes. The 'direct entitlement failure' occurs for food-producers as a result of decline in their production; the 'trade entitlement failure' occurs for the groups that produce other than food when their terms of change fall or when the total availability of food declines. Furthermore, those groups living upon both consumption of the produced good (e.g. meat) and its sale to obtain other food, risk suffering from both direct and trading entitlement failures (Sen 1981, p. 440). This last case shows that this simple modelling could be, then, easily extended in order to incorporate, for example, a food sector decomposed in several sub-sectors (e.g. cereals, grain, fruit, and meat).

Sen used this theoretical framework in order to test empirically the validity of his theory in the case of famine.[29] A famine involves 'acute starvation and a sharp increase of mortality', while chronic hunger involves 'sustained nutritional deprivation on a persistent basis' (Dreze and Sen 1989, p. 7). The final part of this sub-chapter will show that the same approach can be applied in the case of chronic hunger.

Sen's investigation of the famines in Bengal, Ethiopia, and Bangladesh aimed at examining the nature and the causes of these famines by answering three main questions (Sen 1981, p. 440):

[28] Sen (1981, pp. 437–438) has explained this mechanism using a simple graph representing an economy with only two sectors: food and non-food and where the exchange entitlement mapping is represented by the price exchange. A relative decline of the non-food price produces a shift of the exchange entitlement mapping, and the individual might fall in the 'starvation set'.

[29] The whole entitlement approach is not only verified through empirical methodology, but it is even shaped according to some results of empirical studies on famine and hunger. Sen's writings on famine are, sometimes, presented as one of the few theories partly derived by empirical studies.

a) Was there a food availability decline preceding or during the famine?
b) Which group was mainly hit by the famine?
c) If there was a substantial entitlement failure, was it a 'direct' or a 'trade' entitlement failure?

The following paragraphs examine the three famines keeping in mind these three questions.

In the Great Bengal Famine (1943), both total and per capita availability (production and trade) of foodgrains increased from 1941 to 1943, although it slightly decreased between 1942 and 1943. In Calcutta nobody died from starvation during the famine year; who suffered were people from rural areas. Among these, the destitution indices showed that the most affected were fishermen, transporters, and agricultural labourers, while the least affected were peasants and sharecroppers (Sen 1981, p. 443).[30] Pointing the attention on entitlements, data on rice exchange rates (the amount of rice that can be bought with one unit of occupational commodity) showed the steep fall of the food purchasing power. The reason is that rice prices rose while prices of the other commodities were more rigid; this negatively affected many categories of rural workers, except for peasants and sharecroppers. Fishermen, instead, were hit because of a national restrictive policy on fishing. This reduced fishermen's exchange entitlement mapping. Thus, 'The pattern of destitution suggests that the failure of entitlements, which was widespread and massive, was mainly *trade* entitlement failure rather than *direct* entitlement failure. Evidence of *endowment* loss was found for fishermen and rural transporters, but evidence of collapse of *exchange entitlement mapping* is much more widespread' (Sen 1981, p. 446, emphasis in original). A further analysis of the causes of food price increase showed that it is not due to rice availability failure (supply side), but it is due to some problems on the demand side of the food sector (Sen 1981, p. 447).

The second case-study used by Sen was the famine that in 1973 hit the Wollo Province of Ethiopia (Sen 1981, pp. 447–451). Data from local sources suggested that during the famine year there was no food decline in Ethiopia. Since only the Wollo Province was affected, Sen firstly treated Wollo as the unit of analysis. Here, unlikely the whole Ethiopia, there was a large food

[30] The destitution indices are based on two indicators: 1. transition percentage to 'living on charity'; 2. transition percentage to 'living on charity' or 'husking paddy' (Sen 1981, p. 443).

production decline. At the same time food even moved out of Wollo. The second point to address concerned the groups that were victims of this famine. While urban residents were not hit much, in rural areas many people died or suffered from hunger. Among rural people, mainly pastoralists of three sub regions started starving. Finally, from an entitlement perspective, food-growers had an entitlement failure due to decline in production, associated to a fairly stable relative price of food. Thus, there was a 'direct entitlement failure' for this group of people. On the other hand, the approximately unchanged food exchange rate should have prevented the other categories of people from starving; to the opposite even other groups were hit by famine. How can this be explained? How is it possible that with the same purchasing power of Wollo residents, food left from, rather than go to, Wollo? According to Sen, there were two reasons: the first is that it was necessary to take the whole Ethiopia and not just Wollo as a unit of analysis to understand even the trade between regions; the second is that Wollo residents 'lacked the market command' (Sen 1981, p. 450). This means that in a country where there was no food availability decline there was a 'trade entitlement failure'.

The last study on famine refers to the Bangladesh Famine. In 1974, the famine year, there was no substantial decline in food availability in Bangladesh, so as outlined by local data on foodgrains output. Victims were, again, prevalently residents of rural areas. In absolute terms the main victims of the famine were 1) farmers; 2) agricultural labourers; 3) other labourers. To the opposite, in relation with the proportion of labourers, the 'rural labourers' (agricultural plus non-agricultural labourers) were affected three times more than farmers. A parallel study focusing on the regions mainly affected outlines the existence of three 'famine districts'. In all of them rice production rose significantly. Shifting attention to entitlements, there was a very sharp fall of the food exchange rate, which implies that non-food growers groups could buy less food with their unity of commodity in the period immediately before the explosion of the famine. This explains why 'rural labourers' were the main victims of the famine. Furthermore, the most marked decline of the food exchange rate was reported exactly in the three famine districts. This decline was surely due to an increase in rice price, but even to the substantial decrease of nominal wages registered in two of the three famine districts. The reason of this sharp raise of rice prices just before the flood started was not very clear;

what is sure is that it was not due to a decline in food supply since such a decline did not take place (Sen 1981, pp. 458–459).

The analysis of these three famines led Sen to conclude that famines *can* occur even without any food availability decline. As Osmani (1995, pp. 260–268) rightly pointed out, Sen did not intend to neglect the validity of the food availability decline (FAD) 'hypothesis'. The hypothesis that a fall in food availability can be the cause of starvation and famine has never been denied by Sen. This is very different from saying 'that the best way to understand famines – all famines – is to look at what has happened to aggregate food availability' (Osmani 1995, p. 265). What Sen has criticized is the FAD 'Approach' and not the FAD hypothesis: there can be many famines, as in the case of the three studies outlined, that cannot be understood by simply focusing on aggregate food availability. Through the entitlement approach, instead, two possible causes of famines can be identified: endowment loss and entitlement mapping failure. Any original cause of famine (FAD or anything else) must operate through one of these two channels, affecting the entitlement set; thus, the entitlement approach can outline the existence and the nature of the famine (Osmani 1995, p. 266). Therefore, the relationship between the FAD Approach and the entitlement approach is 'one of subsumption rather than contradiction' (Osmani 1995, p. 264).

The same rationale works for regular hunger and endemic undernourishment. Using the words of Dreze and Sen:

> If people go hungry on a regular basis all the time, or seasonally, the explanations of that have to be sought in the way the entitlement system in operation fails to give the persons involved adequate means of securing enough food. Seeing hunger as entitlement failure points to possible remedies as well as helping us to understand the forces that generate hunger and sustain it' (Dreze and Sen 1989, p. 24). Thus, seeing hunger and famine as entitlement failures helps to focus *also* beyond food availability.
>
> (Dreze and Sen 1989, pp. 24–25).

The entitlement approach contributed to re-address the problem of hunger and famine, diminishing the role of aggregate food supply and giving more relevance to the demand side of the food sector: the socio-economic conditions of people. However, Sen's contribution in this field went further since he connected the two innovative concepts of entitlements and

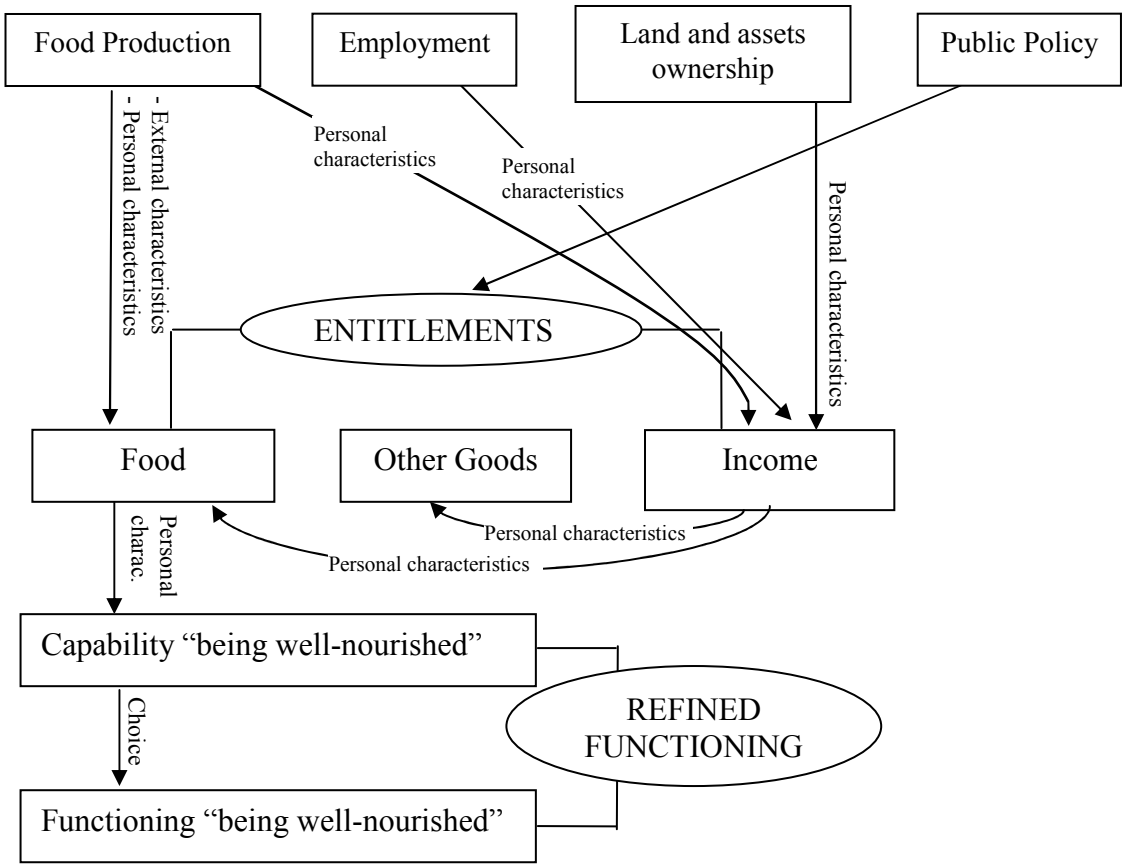
capabilities. According to him, entitlements explain only a part of the story because they just reflect people's command over commodities, including food. In his struggle to focus on human condition, Sen argues that entitlements are only instrumental to the achievement of basic human capabilities (Dreze and Sen 1989, p. 13). The final concern should be shifted from food entitlements, whose failure generates hunger, to the functioning 'being adequately nourished', which is strictly dependent on personal characteristics ('conversion factors') such as gender, age, health, and metabolism.
Quoting again Dreze and Sen,

> the capability approach draws attention to the general need to consider inputs other than food as determinants of nutritional functioning and capability. Nutritional achievements may be strongly influenced by the provision of and command over certain crucial non-food inputs such as health care, **basic education**, clean drinking water, or sanitary facilities.
>
> Dreze and Sen (1989, p. 44, emphasis added).

Finally, the capability approach provides further insights for the analysis of hunger and famine. According to Sen, food entitlements affect nutritional capabilities, which, in turn, influence nutritional functionings. It can be generally argued that whether people have the capability to be well-nourished they will finally be well-nourished. This consideration, albeit reasonable, is not always true: there might be reasons why people could *choose* differently. The most relevant reason in the context of food security studies is that some people might choose to be partially deprived in the current period in order to reach higher food security in the future. This situation can be properly caught only by examining simultaneously capabilities and functionings, defined in section 2.4.3 as 'refined functionings'. By investigating the temporal dimension of deprivations it is possible to understand people's adaptation mechanisms and general behavior when encountering food deprivations.

The diagram 1 summarizes the linkages among food entitlements, nutritional capabilities and nutritional functionings.

Diagram 1. Food Entitlements and Nutritional Capabilities



Source: Author's elaboration of Dreze and Sen (1989)

3.4 Food Security: Theory and Policy

The terminology 'food security' is not used by Sen, who prefers hunger or food deprivation. However, this concept has been often utilized in current discourses within international organizations (e.g. FAO, WFP and IFAD) and even in food economics and policy literature. Besides the fact that these two literatures seem to be quite different, in reality the researches on food insecurity in the last two decades have been heavily affected by Amartya Sen's contribution, and have affected food policy accordingly.

Food security is a very complex, multi-faced, and comprehensive concept, which has evolved along time (Maxwell 1996, p. 155). It embraces studies from several disciplines, such as economics, sociology, nutrition, health, and anthropology; thus, it is very different to give a well-designed and all-inclusive definition of this term. Broadly speaking, 'Famine and hunger are both rooted in food insecurity' (Ayalew 1997). In order to understand the link

between these concepts, it is useful to briefly review the history of food security concept with reference to developing countries.

It is possible to sustain that the concept of food security was originally adopted in the 1974 World Food Conference. During this conference, food security was defined as 'the availability at all times of adequate world supplies of basic foodstuffs, so as to avoid acute food shortages in the event of widespread crop failure, natural or other disasters, to sustain a steady expansion of consumption in countries with low levels of per capita intake, and offset fluctuations in production and prices' (FAO 1974). This declaration clearly pointed the attention on food security as national self-sufficiency; every state should have a sufficient amount of food to meet the nutritional needs of its population. This definition of food security reflects Malthus' thought and the consequent Food Availability Decline approach, outlined in the first part of this chapter. Since that time on two main paradigm shifts occurred in the examination of this topic (Maxwell 1996, pp. 156–158).[31]

The first change of perspective in the study of food security was the shift from a national and global vision to a household and individual perspective (Maxwell 1996, p. 156). While until the end of 1970s the aggregate *availability* of food was the key element of food insecurity, during the 1980s the main dimension of food security gradually became the *access* to food at micro-level. It was the contribution of Amartya Sen, described in the previous section, to revolutionize drastically the literature.[32] His entitlement theory stresses the *access* to food (entitlements), rather than the production or the availability of this resource. Therefore, according to Sen what counts is the *access* to food.

A further remark concerns the difference between household and individual level (Maxwell and Frankenberger 1996, pp. 19–23). A household perspective is founded on the general assumption that all members receive the same amount of food, which seems very unrealistic according to many empirical studies**.** What was demonstrated, instead, is that if there is a shock

[31] Maxwell has highlighted three main shifts in food security analysis: the third one, 'From objective indicators to subjective perception' (Maxwell 1996, pp. 158–160) is not going to be discussed here.

[32] Maxwell (1996, pp. 156–157) recognizes the fundamental contribution of the entitlement approach in this paradigm shift; however, he remarks that Sen's work helped mainly to build up a comprehensive framework for the analysis of famine and hunger, while the access-based point of view was already present in nutrition planning.

usually women reduce their daily food intake to a greater extent than men, increasing their vulnerability. The other assumption is the equal distribution of income and assets among members, which is clearly false. This substantially affects household food insecurity. Since the individual-centred approach better captures the intra-household differences in access to resources, food, productive labour, assets, and decision making, more recently it received a larger consensus. All these reflections were already incorporated in the definition of food security given by the World Bank in 1986: 'Food Security is access by all people at all times to enough food for an active, healthy life'.

The second paradigm shift was from a food first perspective to a livelihood perspective (Maxwell 1996, p. 157). This change occurred after 1985 due to the analysis of the effects of famine on food security in Africa. In emergency situations such as famine and drought, people have acted following a long-run perspective, choosing in some cases to go hungry in order not to become even hungrier in a second time. They preferred eating less now and avoid selling assets in order to maintain their possibilities to get out of the crises and go back to their previous life. Therefore, in the analysis of food security it is essential to consider this multi-temporal vision of food security. This is possible only by looking at wider factors than food: the livelihoods, which reflect the possibility to keep and use in the future all the essential assets for daily life and activities. Chambers and Conway (1992) have defined livelihood as 'adequate stocks and flows of food and cash to meet basic needs'. Thus, livelihoods consist of different forms of capitals: physical, natural, human, and social capital. Furthermore, this general argument about livelihoods takes us much further in the inter-temporal decision-making process of individuals/households about their food consumption: the idea of sustainable livelihoods. 'Livelihoods are sustainable if they persist over time despite shocks and long-term adverse trends' (Maxwell and Frankenberger 1992, p. 33). Sustainable livelihoods are a necessary condition for household food security. Sustainability is the outcome of an interaction between two elements: sensitivity and resilience (Maxwell and Frankenberger 1992, p. 36).

A livelihood system is sensitive if it significantly changes as a consequence of a positive or negative shock (Maxwell and Frankenberger 1992, p. 33). Broadly speaking, following a risk-adversity idea that is well-connected to the objective of having a smoothed consumption of food along

time, we can state that low sensitivity is a better condition for a livelihood system. Instead, a livelihood system is resilient if it has the capacity 'to absorb change [due to a shock] without serious modification' (Maxwell and Frankenberger 1996, p. 36). Therefore a highly resilient system is more desirable because it can revert easily to the previous state. How can a livelihood system be resilient? By having people more flexible in changing economic activities, shifting productions, being willing to emigrate temporarily, to protect crops productions from drought, to accumulate food storages, to construct social and political networks for risk-sharing (Maxwell and Frankenberger 1992, p. 37).

All these new inputs for food security analysis flew into the most comprehensive definition, that given during the World Food Summit: 'Food security exists when all the people, at all times, have the physical and economic access to sufficient, safe, nutritious food for a healthy and active life' (FAO 1996). Therefore, food security is composed of four main dimensions:

1. *Availability* of food at global and national level. This is a necessary but not sufficient condition for food security.
2. *Physical access* to food, which stresses the role of distances, infrastructures, transportations.
3. *Economic access*, which depends on the immediate and future economic conditions of the household or individual. An analysis focusing on livelihoods is essential to investigate if households are food secure.
4. *Utilization*, which focuses on different dietary needs of people, methods to cook food, and cultural acceptability of certain types of food. Food is important for the calories that it produces, but even for its nutrients and other characteristics; access to quality, diversified, and acceptable food is fundamental to meet human needs and have 'a healthy and active and life'.
5. *Stability* in the availability and access to quality, acceptable and diversified food during the whole life-time ('at all times'). With respect to the dimension *stability* a further distinction can be made between chronic and acute food security (Chang 2005, p. 5). Acute food security is the result of a short-term lack of access to food. For example, seasonal, rather than constant jobs and sources of income are the causes of acute food insecurity and, more generally, household vulnerability to food insecurity. Chronic food security, instead,

occurs when individuals do not have access to sufficient, safe, and nutritious food on a continuing basis due to income and asset poverty (Chang 2005, p. 5).

Only taking into account these complex and interrelated dimensions we can face the problem of food insecurity. Amartya Sen's work on entitlements, human diversity, nutritional capabilities, and refined functionings, explained in section 3.3, gave a substantial imprinting to this literature and policy framework.

3.5 Food Security as development goal

This chapter has given a survey on the evolution of the concept of food security. What still remains to address in these last paragraphs is *why* food security should be considered as a valuable objective of development in low-income countries. This is relevant in order to justify the theoretical and quantitative analysis of the impact of education on food security. Although it seems immediate that achieving food security is something valuable, next paragraphs intend to connect the literature on capabilities with that on hunger and food security in order to provide a more satisfactory answer.

Following the critiques addressed by the advocates of the capability approach to traditional economic theories, the final goal of development is not economic growth; there are other valuable ends, among which there is food security enhancement. The reason, according to Sen, is that especially in developing countries, where a large part of the population faces constant absolute deprivations, income is not a good indicator of the quality of life; there, the consistent elements of life include 'being adequately nourished' (Sen 2003, p. 5). Analogous to the argument that Sen (1998, pp. 2–5) has used to promote the value of freedom from early mortality, it is possible to consider the value of freedom from starvation and hunger as a desire widely shared among people for its intrinsic value and for its capacity to promote other freedoms. Furthermore, adopting the same type of argument used for the capability 'being educated' in chapter two, also 'being adequately nourished' is a 'basic capability' because its lack causes immediate harm and because it is foundational to the achievement of other, more complex, capabilities. Not being well-nourished affects the capacity of people to work, to participate in community life, to be respected, to concentrate in school, thus this problem

should be urgently addressed. Finally, being adequately nourished as well as being educated is always in the list of the 'elementary capabilities' enclosed by Sen (2004, p. 79).

The last point concerns the direct relation between this capability and food security. The elementary capability 'being adequately nourished' is well expressed by the way household food security was conceptualized at the 1996 World Food Summit. As mentioned earlier, following this definition, to be 'adequately nourished' a person should not just have the average number of calories for minimal survival, but should have even a proper diet, quality and acceptable food 'for a healthy and active life'. Without food security an individual cannot be well-nourished.[33]

[33] For a better understanding of the linkages between nutrition and food security, see among the others: Beaudry (1996) and Maxwell and Frankenberger (1992, pp. 24–27).

CHAPTER 4

EDUCATION AND FOOD SECURITY: BILATERAL AND CAUSAL RELATIONSHIPS

4.1 Introduction

Chapter 2 and 3 have provided useful information on the two key concepts: education and food security. Now, the research analyzes the linkages between these two phenomena. The main objective of chapter 4 is to provide the theoretical background for the 'macro' quantitative analysis. The chapter is structured as follows. Since there is a two-way relationship between education and food security, section 4.2 briefly addresses the causal relationship between food security and education; then, section 4.3 addresses the reverse side of the relationship, which is the main subject of analysis of this research.

No much work has been produced to study the last direction of the relationship, thus reference is made with respect to different literatures, and focusing on rural areas of developing countries. The recently published report on 'Hunger and Learning' (WFP 2006) provides interesting insights.

4.2 Impact of Food Security on Education

The food insecurity-education direction of the relationship has been studied more deeply. In order to explain it in a comprehensive way, it is necessary to differentiate current from future effects of hunger and to distinguish three main phases in the educative process: early childhood (age 0-5), school age (6-17), and adulthood (18 and above).

During early childhood, undernourishment is likely to limit the stimulation a child should receive and to undermine the basic learning capacities of a child. The main negative effects of food insecurity in this stage are visible during the school-age phase (WFP 2006, pp. 41–44).

In school-age, food insecurity causes several damages to children (WFP 2006, pp. 45–46). It can lower school enrolment and attendance, and then it can

limit the capacity to concentrate and perform in school. Since schooling is seen as an essential opportunity for learning, these are large impediments to child mental development. The problem occurs even when children are not chronically undernourished but are temporarily hungry because, for instance, they did not have the possibility to have a morning meal before going to school. In this case researches have shown that they are less capable of performing complex tasks (Del Rosso 1999, p. 5). Another relevant problem at this stage is that food insecure families face higher opportunity costs in sending children to school because they could earn and provide means of subsistence to the household members. Such opportunity costs are even larger if school fees exist.

Finally, also adults could develop their knowledge, abilities and skills through specific programmes such as literacy training or agricultural extension programmes. Although 'By adulthood, an individual's cognitive capacity to learn is already largely established' (WFP 2006, p. 46), these are important learning occasions for both daily life matters and employment and earning opportunities. The main obstacle consists in the larger opportunity costs since at this stage people spend the major part of the day in the workplace. This is true even when classes are organized after working hours (WFP 2006, p. 48).

In terms of policy, both governments and international organizations such as FAO and WFP prevalently intervene during early childhood and school-age stages. In the first case, through iron and micronutrients supplementary diet, and in the second case, mainly through school feeding.

School feeding is a typical policy applied to increase children school attendance and concentration in the classroom, by providing them with food at school. This type of intervention, within a wider policy, can ensure several benefits (Del Rosso 1999, pp. 6–8). First, it can reduce short-term hunger of school-age children; second, it contributes to lower the opportunity costs of food insecure families, since they have to feed fewer members. Third, the opportunity of giving a meal is also an opportunity to address specific nutrition problems, such as iron or iodine deficiencies. Finally, school feeding programmes are an important moment to make parents more aware of the school system, to promote their interaction with teachers and, therefore, to improve the whole learning environment of their children.

4.3 Impact of Education on Food Insecurity

Having defined the objective (to improve food security), and the capability approach as conceptual framework, this chapter aims at studying the causal relationship between education and food security in low-income countries. Since 70 percent of world poor live in rural areas (World Bank 2003) the proposed theoretical model stresses the *instrumental* role played by basic and higher education in tackling food insecurity among rural people.

Although 'acclaimed as one of the most powerful engine for reducing hunger and poverty' (FAO 2005, p. 14), the impact of education on food security is often exclusively conceived in economic terms. The same FAO report clarifies that 'lack of education undermines productivity, employability and earning capacity, leading directly to poverty and hunger'. This reflects the human capital approach, following which education is relevant insofar as it increases personal earnings and productivity, and economic growth at national level (Schultz 1961 and 1971; Becker 1962 and 1993; Psacharopoulos 1973). More specifically, in rural areas, education improves agricultural productivity, leading to food security (e.g. Jamison et al. 1982; Pudasaini 1983; Koffio-Tessio et al. 2005). For example, Jamison et al. (1982, p. 54), on the basis of the results derived from 18 studies conducted in several geographical areas (17 in low-income countries and 1 in Japan), estimated that completing the first four years of formal schooling results in a 7.4 percent increase of agricultural productivity.

However, this approach has been criticized because it is very economistic; it only recognizes the instrumental economic role of education (Sen 1997; Woodhall 2001; Robeyns 2006). Education, on the contrary, can have a double 'indirect' role: through 'economic production' and through 'social change'. The latter is neglected in the human capital framework. This approach is especially more suitable to the new conceptualization of food security, which goes beyond the simple attention on food supply. Considering both the contributions has relevant policy implications with respect to the type and level of education to focus on.

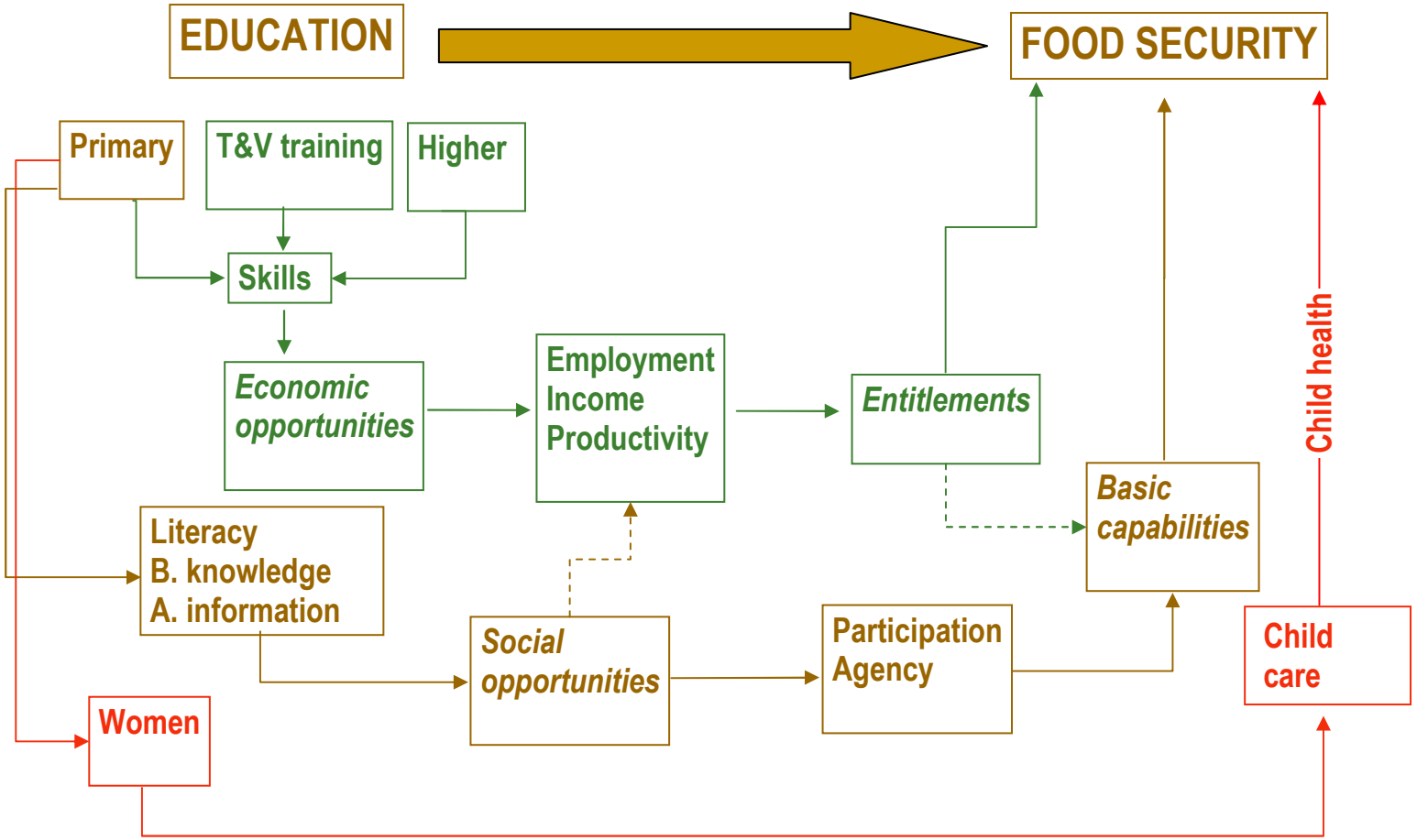
Using as main theoretical framework the capability approach, and counting on different kinds of literature, the main mechanisms through which rural people with more education are more likely to experience higher levels of

food security are identified. The various contributions of education to food security can be viewed in diagram 2. Here, some of these channels are explained more in depth.

First, the impact of education can occur through *social* and *institutional change* (brown in the diagram). As Mukudi (2003) claimed, education has a key role in accessing public *information*, especially concerning health, nutrition, and hygiene because it 'can open the mind of people' (Robeyns 2006, p. 3). Acquiring knowledge about how to avoid and face illnesses is essential since people with diseases require more calories to be food secure. Furthermore, nowadays it is well known that people need to have, where possible, an adequate and diversified diet in order to build a stronger immune system and avoid morbidity and mortality. Finally, even following right hygienic practices is essential to prevent diseases like diarrhoea. Mass media such as radios are widely spread in African countries, even among poor people living in rural areas; therefore only people with a minimum level of education can properly capture and elaborate that information.[34] Even more relevant is the role of primary education and literacy in acquiring this type of information from written messages. Such argument, indeed, should be extended in an inter-temporal dimension: 'parental education…has been found to invariably influence nutritional outcomes of the children. Children of less educated parents and those of parents with no educational exposure consistently score poorly on nutritional status indices' (Mukudi 2003, p. 246). Moreover, there is a gender aspect that does matter for ensuring long-term food security (red in the diagram). In fact, the specific impact of women's education is higher: girls who attend school and obtain at least basic skills can even teach right health and hygienic practices to their children once they become mothers. This means that female education should be at the centre of the analysis because it has an additional direct effect on nutritional status. Empirical researches, such as that carried out by Glewwe in Morocco, show that mother's 'education improves child health primarily by increasing health knowledge' and that it does not depend prevalently on the subjects studied in class, but on the very general abilities to read, write, reflect, and process information (Glewwe 1997, p. 151).

[34] See among others Schnell-Anzola et al. (2005, pp. 20–21) drawing this conclusion from an empirical study undertaken by Thomas (1999).

Diagram 2. Direct and Indirect Contributions of Education to Food Security



Since the specific impact of parents' education on child food security is a key pathway of influence of education on food security, this literature is in depth discussed in chapter 6.[35]

Education, then, is fundamental to promote *agency* (Sen 1999). 'Agency refers to a person's ability to pursue and realize goals that he or she values and has reason to value' (Alkire 2005), but here it is just interpreted as the ability of rural poor to escape from poverty and hunger with their own means. As Tilak (2002, p. 197, emphasis in original) put it, 'Education can be a life-empowering experience for all, and what the poor need most is empowerment. In other words, education is not only *for* empowerment, but also education itself *is* empowerment'. Furthermore, who is educated is more likely to find a job, but has also a capacity to use more rationally the resources he or she owns. Educated and informed people are more likely to select valuable objectives in life, such as having stable access to food for their household. Even here there is a gender aspect. Mothers showed to assign a higher value to the wellbeing of their children, allocating more resources to health, and nutrition (Sen 1999, pp. 195-196). Quoting again Sen (1999, p. 197), 'female literacy…is found to have an unambiguous and statistically significant reducing impact on under-five mortality, even after controlling for male literacy'. Therefore, a more active role of women in the family is likely to lead to lower mortality rates, which, in low-income countries, are mostly due to malnutrition.

Another possible effect of promoting a quality education aiming to enhance individual agency and participation in collective decision making is that it can lead to the identification of certain capabilities as basic rather than others at community level. As Sen has argued, engaging in public debate and, generally, public reasoning are key factors for the selection of relevant capabilities. Household food security is likely to be one of the core elements emerging from this selection process.

A third 'social' benefit of education for food security and wellbeing in general, is enhanced through an improvement of *social relations*. In rural Africa, for instance, the role of community actions is impressive. Some authors have defined 'social capital' (Woolcock and Narayan 2000) as the social networks in which a person is included, arguing that the larger these nets are the larger the possibility to find assistance in emergency situations. To make an example, many communities organize common meals, systems for a common access to credit, labour division, and

[35] In particular, section 6.2 (literature review) and section 6.3 (conceptual model and econometric strategy) are useful for this purpose.

public participation in ceremony expenditures. This way the risk, even to become food insecure, is alleviated, making individuals less vulnerable. The next question is: how does education affect social relations? Lanzi (2004, p. 13) has argued in favour of the 'positional' value of education, with reference to the ability to relate well to others and to cooperate (OECD 2003), achieved through education, even here conceived in its more general form rather than the specific topics studied in school.

Finally, education provides an *inner* contribution to food security, making people more ambitious and self-confident. Being educated is considered a relevant weapon against feelings like shame and lack of hope, whose overcoming is indispensable to promote food security through the other mechanisms mentioned above.

Education influences food security through the *economic production* channel (green in the diagram). This is the main channel recognized by human capital theorists (see section 2.2.1). In rural areas, it is typically achieved through the increase of agricultural productivity and efficiency in that sector. That is, by increasing the amount of output per unit of input, and by choosing and allocating in the best way the inputs of production. Studies such as those undertaken by Jamison et al. (1982) outlined at the beginning of the section, give empirical evidence of the relevance of education for this purpose. However, most of these researches have two main shortcomings: first, they focus only on the main crop. This occurs mainly in order to simplify the task of researchers. Second, they often do not take address the issue of economic contribution of education to non-farm activities. The role of rural non-farm activities has been frequently neglected; instead, they can be a fundamental direct source of food or income, and, even more, a resource for the long-run. Non-farm activities can ensure household food security by improving *economic access* to food, by reducing vulnerability and giving higher opportunity to recover more rapidly from emergencies like natural disasters. In fact, the diversification of income generating activities as well as the diversification of crops within the agricultural activities are essential to ensure the *stability* dimension of food security. Within non-farm rural activities, non-formal and informal productive activities play a significant role within low-income countries.

The recent World Food Programme publication on 'Hunger and Learning' (2006) contributed to systematize the relationship between education and food security. Although not directly referring to a particular approach, it has recognized the multiple benefits of education and learning on household, child, and overall food

security. In particular, it makes a temporal distinction of such benefits. Although the quantitative study, which will follow this section, concentrates on the whole (rural) society, without distinguishing by units of analysis (children, women, or households), in this part it is important to outline that the impact of education varies depending on the stage of life in which it is acquired: early childhood (0-5), school age (6-17), or adulthood (18 and above).

In the early childhood, lack of proper stimulation undermines child's capacity to learn and be food secure in the future. There are no direct, immediate effects on his or her food security (WFP 2006, pp. 51–53). The school-age is crucial for both current and future dimensions of food security (*availability*, *access*, and *utilization*). In school, children directly learn subjects related to nutrition, health, and hygiene (*utilization* dimension), acquire life-skills, and finally obtain knowledge and skills to use in future working experiences. During adulthood specific programmes such as extension services in agriculture can increase household food *availability* and income (*access* to food). Moreover, adults have the opportunity to learn certain behaviours connected with food *utilization* that they did not learn previously.

As a conclusion, it is important to pinpoint that this chapter has provided brief but fairly exhaustive examination of linkages between the two phenomena. Due to data constraints and limits related to the modelling of economic and social relationships, the quantitative analysis will be able to reproduce only partly this theoretical framework.

Finally, a wider approach than the human capital approach allows assessing the multiple channels through which an educated and skilled society can reduce food insecurity among rural people of low-income countries. Furthermore, this has important policy implications: the type of education that could be useful for the purpose could go much beyond the simple functional literacy and agricultural extension services. The capability approach, in fact, stresses the importance of education for general children's and adults' development. The empirical analysis will intend to assess also the level of (formal) education countries should invest in for the purpose of alleviating rural food insecurity.

CHAPTER 5

EDUCATION AND FOOD SECURITY: A CROSS COUNTRY ANALYSIS IN RURAL AREAS [36]

5.1 Introduction

The 2005 State of Food Insecurity Report (FAO 2005, pp. 28–29) highlighted the strong relationship between food insecurity on one hand and illiteracy and lack of education on the other. Data for rural areas in 22 developing countries showed how a high level of undernourishment – used as a proxy for food insecurity – was correlated with a low level of literacy. The current empirical study is intended to take this line of analysis one step further.

The key element of the current research is the construction of an econometric model based exclusively on rural data. The theory outlined in chapter 4 provides a strong case for the positive impacts of education on food security. From a broader capability perspective, the impact of education goes far beyond the enhancement of productive skills to be used in the labour world. Education contributes to development in social, institutional, as well as economic spheres. Based on this theory, education is expected to have strong explanatory power in relation to food security in rural areas. The current analysis examines the data to see if the evidence supports the theory.

Section 5.2 describes the methodology, data, variables and choice of indicators, and analytic strategy. Section 5.3 presents results, first of exploratory analyses – graphical and correlational – of the relationships between rural education and food insecurity. This is followed by multiple regression analyses, which allow the estimation of the effects of educational security on food insecurity, controlling for the effects of other factors likely to be associated with food insecurity. Section 5.4 concludes the chapter, discussing the implications of findings for policy in development and food security.

[36] This is a slightly modified version of the paper 'Education for Rural People and Food Security: A Cross-Country Analysis', written with Pasquale De Muro and published in 2007 by the FAO. Web site: http://www.fao.org/docrep/010/a1434e/a1434e00.htm

5.2 Methods

5.2.1 Dataset and Aggregate Indicators

Household data represent the best source of information on hunger and education. Among the best household surveys in developing countries is the Demographic and Health Survey (DHS).[37] DHS relies primarily on household schedules and questionnaires for women aged 15-49. Women are asked a range of information concerning their household on topics such as nutrition, fertility, prevalence of HIV-AIDS and other diseases, access to media, and educational participation and attainment.

This analysis is carried out on DHS data from rural[38] areas of 48 low-income countries (see Annex 2 for further details on the sample). Data from rural households were aggregated to the country level for analysis. Thus the sample consists of 30 countries from Africa, 10 from Asia, and 8 from Latin America (see Annex 3). DHS administered its surveys in different years, from the late 1980s to 2004. It was decided to consider data only from the 10-years period 1995 to 2004, during which time it is assumed that the structural relationship between education and food security was sufficiently stable to make analysis meaningful.[39] In those countries where there are multiple years of data, the average value was used.[40] Data were processed using the Stata econometric analysis software package.

5.2.2 Measures of Outcomes – Rural Food Insecurity

This analysis seeks to understand whether in rural areas of the 48 countries examined food insecurity varies in relation to educational participation. If a strong

[37] Also the World Bank *Health, Nutrition and Population (HNP) Poverty Data* are based on DHS surveys.
[38] There is no common definition of rural areas across countries: DHS follows the definition provided by each country. In general terms, rural areas are those with less than a fixed number of residents (e.g. 2,500 in some countries in Sub-Saharan Africa), far from cities, and with poor infrastructures.
[39] Most developing countries adopted new educational policies in the middle 1990s. Criticism of structural adjustment policies of the World Bank and the International Monetary Fund led to adoption of new approaches to development assistance, represented by the use of Poverty Reduction Strategies (PRSPs) and the Millennium Development Goals (MDGs). The MDGs represent a new consensus on the need for greater balance among growth and equity, and social and economic investments such as education and health. (See, for example, Stiglitz 2001; Cornia et al. 1987; Psacharopoulos and Woodhall 1985).
[40] For more information on data treatment see Annex 2.

relationship is found to exist, it will be concluded, as theory suggests, that education in rural areas leads to greater food security.

To carry out this analysis, a theoretically and empirically sound measure of food security must be constructed. Food security is a multi-faceted phenomenon, and its appropriate measurement varies according to the purpose of analysis and use. A study seeking to predict food crises, for example, would require different measures than a study such as this one which seeks to understand causal relationships among structural factors. Here, anthropomorphic, nutritional, and survival data were utilized because they point directly to undernourishment, an adequate and reliable measure of human deprivation (see Annex 4 for a more complete theoretical discussion of these issues).

The final outcome consists of three components:

- *Adequate survival status* (Wiesmann 2002), which serves as a proxy for premature death due to malnutrition. We average the infant mortality rate and the under-5 mortality rate.[41]
- A second component reflecting Wiesmann's ideas of both *adequate nutritional status* and *food adequacy*. Here, they are expressed by the prevalence of stunting,[42] underweight,[43] and wasting.[44] We average the values of the three indicators, weighting by 2/3 the percentage of the rural population with moderate stunting (underweight and wasting), and weighting by 1/3 the percentage of the population with severe stunting (underweight and wasting).
- *Female malnutrition*. We use the percentage of rural women whose body mass index is less than an internationally fixed threshold of 18.5.[45]

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[41] While Wiesmann has used only the variable under-5 mortality rate, here an average value between this variable and the infant mortality rate is used because the causes of very early death can show a different intensity and typology of malnutrition (Wiesmann 2002).

[42] 'Stunting' is defined as children with a height-for-age score two or more standard deviations below the mean of a normal distribution of children's height for age. 'Severe' refers to children who are three or more standard deviations below the mean; 'moderate' refers to children who are between two and three standard deviations below the mean.

[43] 'Underweight' refers to weight-for-age indices. 'Severe' denotes scores of three or more standard deviations below the mean, while 'moderate' refers to scores of two to three standard deviations below the mean.

[44] 'Wasting' is defined as children with a weight-for-height score of two or more standard deviations below the mean on an index of children's weight for height. Again, 'severe' denotes scores of three or more standard deviations below the mean, while 'moderate' refers to scores of two to three standard deviations below the mean.

[45] Although many experts do not use this indicator, it is extremely important in order to check both the nutritional situation of one of the most disadvantaged groups (women) and, to forecast possible food insecurity problems for the future. Most women will be mothers, and their nutritional status decisively affects the health of their children. Using this variable also provides an element of 'stability' over time in food security.

As the first indicator of household food insecurity (*rurHFI1*), a simple arithmetical mean of the three components was calculated. This method assigns equal weight to each of the three measures of deprivation. The case could be made, however, that the more extreme deprivation should be weighted more heavily, as any area of extreme deprivation cannot easily be counterbalanced by a higher score in another area. To allow for this possibility, a second measure (*rurHFI2*) was constructed by applying a power mean to the same three components, and where power is two. This gives greater relevance to extreme deprivation.[46] (See Annex 4 for the formulas used).

As shown in Table 1, the index of food insecurity was calculated using data on infant and child mortality; stunting (height-for-age indices), wasting (weight-for-height), underweight (weight-for-age); and female malnutrition (BMI).

Table 1. Components used to construct measures of food insecurity

Indicators of	Variable
Child Survival	
Rural infant mortality rate (%)	rurinfantmortality
Rural child mortality rate (%)	rurchildmortality
Rural under 5 mortality rate (%)	rurund5mortality
Child Malnutrition	
Rural severe stunting rate (%)	rursevstg
Rural moderate stunting rate (%)	rurmodstg
Rural severe wasting rate (%)	rursevwstg
Rural moderate wasting rate (%)	rurmodwstg
Rural severe underweight rate (%)	rursevundwght
Rural moderate underweight rate (%)	rurmodundwght
Female Malnutrition	
Percentage of rural women whose BMI is less than 18.5	rurlowbmi

5.2.3 Policy Variables – Educational Participation

DHS captures educational participation by asking questions about school attendance. This is an imperfect measure. While school attendance rates for different

[46] For both theoretical and mathematical explanation see Anand and Sen (2003, pp. 211–218).

age-groups can be considered reasonably good proxies for educational participation, they do not capture all relevant information, leaving out, for example, information on school completion or transition, or on cognitive achievement. As argued in section 2.3, the concept of education goes much beyond that of schooling; however, for empirical analysis especially in rural areas of developing countries, it is not possible to go above measures of schooling. Furthermore, there could be situations in which students go to school, attend class, but learn little, not passing to next class or acquiring a sufficient amount of the curriculum. There is also the possibility of overage children biasing the statistics, for example an 18 year old in primary school.[47] To partially compensate for the weakness of school attendance data, variables reflecting the 'highest level of school attended' as a percentage of the rural population were introduced.

Table 2. Measures of educational participation

Indicators of	Variable
Attendance	
Attendance rate of rural children, ages 6-10	rurattendance610
Attendance rate of rural children, ages 11-15	rurattendance1115
Attendance rate of rural youth, ages 16-20	rurattendance1620
Attendance rate of rural youth, ages 21-24	rurattendance2124
Highest Level of Education	
Percentage of rural population with no education	rurnoedu
Percentage of rural population with upper secondary or higher education	rurminsecondary
Percentage of rural population with tertiary education	rurtertiary

The variables included in these two groups were used as proxies of access to different levels of education, as follows.

[47] Literacy, which identifies the basic capacities to read and write, could provide complementary information. However literacy data are available only for a very small number of countries.

- *Primary Education* corresponds approximately to Level 1 of the International Standard Classification of Education 1997 (ISCED 1997).[48] Primary education was measured here by two variables, 1) the school attendance rate for the rural population in the age-group 6-10, and 2) by the percentage of rural people with no education.
- *Lower Secondary Education* corresponds to Level 2 of ISCED (1997). Here it was measured by the school attendance[49] rate for the rural population ages 11-15.
- *Basic Education*, consisting of primary and lower secondary school, corresponds to ISCED Levels 1 & 2. It was measured by the school attendance rate for the rural population ages 6-15.
- *Upper Secondary Education* corresponds to ISCED Levels 3 and 4 (upper secondary and post-secondary but not tertiary education). It was measured by school the attendance rate, upper secondary school, for the rural population ages 16-20.
- *Upper Secondary and Higher Education* corresponds to ISCED Levels 3, 4, and 5. It was measured by the proportion of rural people who have attended at least secondary school.
- *Tertiary Education* corresponds to ISCED Level 5. It is measured in two ways: 1) by the attendance rate for the rural population ages 21-24, and 2) by the percentage of the rural population which has attended tertiary education.

5.2.4 Control Variables – Other Factors Affecting Food Security

In order to understand the true effects of education, it was necessary to control for other factors that are also expected to affect food insecurity. Holding those other factors constant allows to gauge the relative size of the educational effect, given other relevant factors. These factors relate to sanitation, health, access to potable water, access to media, asset-based poverty, and context (whether or not it is an African country; whether or not there was a conflict at the time of the survey or immediately before).[50]

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[48] The DHS education data do not reflect precisely the ISCED 1997 international standards. The age-groups for school attendance are, instead, the same used by UNICEF. See, for example, UNICEF TransMONEE 2006 Glossary: http://www.unicef-icdc.org/resources/transmonee/2006/glossary_2006.pdf. Comparability is also complicated by the different structures of education systems in different countries. Most systems are organized roughly according to the ISCED classification. However the length of different cycles can vary across countries. Primary education cycles, for example, vary from 5 to 8 years.

[49] Attendance is used here to refer to enrollment or participation as opposed to daily attendance.

[50] These factors were included as they were reasonably assumed to have an important relevance on the level of food insecurity at the household level. There was no income data, but one variable related to the ownership of different types of assets. The lack of any of these non-productive assets was here

Table 3. Control variables

Factor	Variable
Sanitation, Health, Water	
% of rural households without toilet facility	rurnofacility
% of rural children under 5 with diarrhoea[51]	rurhealth
% of rural households with access to potable water	rurwater
Access to Media	
% of rural households with access to radio	rurradio
% of rural households with no basic asset[52]	rurnoasset
Context	
dummy variable for continent[53]	dcontinent
dummy variable for presence of conflict[54]	dconflict

5.3 Exploratory Analysis

As noted, the overall purpose of this analysis is to understand the relationship between educational participation in rural areas and food insecurity, independently of other factors associated with food security. The study begins with a series of exploratory analyses, followed by econometric analyses using multiple regression, which allows for more credible causal inferences as well as precise estimation and comparison of effects.[55]

The exploratory analysis consisted of four parts, discussed as follows: the first part presents descriptive statistics to describe the overall extent of participation in different levels of education in the sample. The next section presents and discusses scatterplots of the two variables, noting important country cases. The final section

used as a proxy for poverty. Finally, it was decided not to include most of the factors related to physical environment (clime, natural disasters and so forth) and institutional environment (democracy, political freedom, participation and so forth).

[51] Calculated for the two weeks preceding the survey.

[52] A measure of assets-based poverty.

[53] This dummy variable takes a value of 1 if the country is African, value 0 if it is from another continent.

[54] The presence of a conflict refers to the period in which the survey was carried out or immediately before.

[55] Causality cannot be fully assumed from the statistical models utilized here, which only examine correlational relationships. However, these models can examine the evidence in support of a theoretical argument. Moreover, with the regression models the researcher is able to examine the 'effect' of multiple factors simultaneously, thus enhancing the credibility of inferences.

presents results of correlation analysis, permitting a more precise estimation of the bidirectional relationships examined here.

5.3.1 Descriptive Statistics – Educational Participation

First, it is useful to present a general idea of the extent of educational participation in the sample. Table 4 presents basic descriptive statistics for the sample of 48 countries of rural data.[56]

Table 4. Educational participation rates in rural areas (%)

Variable	Mean	Min.	Max.
Primary Education			
Attendance of rural children ages 6-10	60.4	13.4	91.7
Percentage of rural children with no education	38.4	4.1	87.2
Lower Secondary Education			
Attendance of rural children ages 11-15	67.2	14.3	98.0
Basic Education			
Attendance of rural children ages 6-15	63.4	13.7	93.2
Upper Secondary Education			
Attendance of rural children ages 16-20	28.8	1.4	73.9
Upper Secondary &Tertiary Education			
Percentage of rural population who have attended secondary or tertiary education ages 16-24	19.2	1.3	76.7
Tertiary Education			
Attendance of rural youth ages 21-24	7.3	0.2	30.6
Percentage of rural population who have attended tertiary education	1.6	0.001	8.8

[56] Countries were not weighted according to population, consciously, to ensure that more populous countries did not skew the results. As a consequence, however, these figures must be understood as representing the mean country value for rural educational participation rather than the overall average.

It is clear from this table that educational participation rates in rural areas vary considerably across levels of education and among countries in the sample.

While a majority of rural children appear to be taking part in primary and basic education, for example, there are country cases where the rates are substantially lower.[57] Upper secondary and tertiary participation rates are substantially lower in all cases. In most developing countries, it would seem, a majority of rural children do not attend secondary school. Participation is particularly low in tertiary education. Using *rurattendance2124* as a proxy for tertiary education, an average of only 7.3 percent of rural youth between 21 and 24 attend school across the sample of countries, with a minimum of 0.2 percent in Niger and a maximum of 30.6 percent in South Africa. Participation in tertiary education is even lower if measured by *rurtertiary*, ranging from 0.001 percent in Mozambique to 8.84 percent in Jordan.[58] A key policy question for this analysis is whether a given level of education is more closely associated with food security than others.

5.3.2 Graphical Tools: Scatterplots

Scatter plots are a useful way to analyze more precisely relationships such as these.[59] These graphs display the distribution of countries with Educational Participation on the x-axis and Food Insecurity 1 (*rurHFI1)* on the y-axis. The black line represents the best fitting line.

Figure 1 graphs the relationship between food insecurity (*rurHFI1*)[60] and the 6-10 year old rural attendance rate.

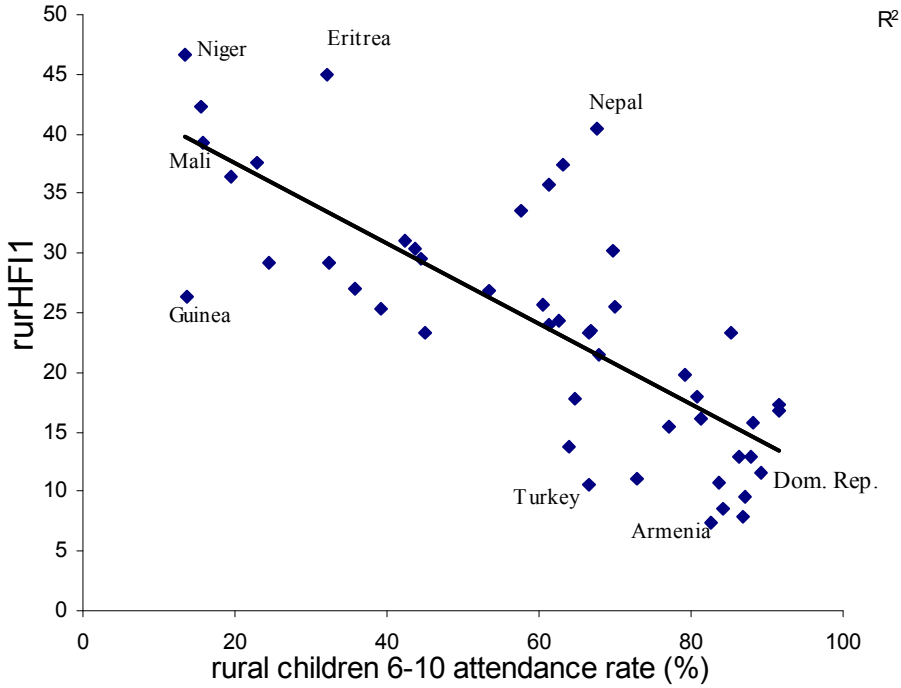
[57] It must be remembered that attendance does not necessarily entail successful completion or mastery of the curriculum, or even literacy.

[58] These differences can be understood as differences in the variables used as proxies for access to tertiary education. For instance, *rurattendance2124* reflects the percentage of rural people aged 21-24 attending school, while *rurtertiary* is the percentage of total current population in rural areas that has ever taken part in tertiary education. An African country, for example, might have a relatively large number of people of tertiary attending age, who are attending some level of school, though not necessarily at the tertiary level. To the extent that some children and youth are overage and attend school at a level below that corresponding to the proper age, these figures overstate participation in higher levels of education, and may understate participation in lower levels.

[59] Both scatterplots and correlations measure the bi-directional relationship outlined in chapter 4.

[60] For purposes of the discussion in this section, *rurHFI1* is used to represent food insecurity. Results are quite similar with *rurHFI2*.

Figure 1. 6-10 Rural School Attendance Rate and Food Insecurity (*rurHFI1*)



The scatter plot reveals a clear pattern, the greater the rate of school attendance among rural children, the lower the average rural food insecurity. In the upper left corner, countries such as Mali have low access to primary education coupled with high levels of food insecurity. On the other hand, countries such as the Dominican Republic, situated in the bottom-right of the graph, have high levels of participation in primary education and correspondingly low levels of food insecurity.

As noted, the black line represents the best fitting linear relationship between the two variables. To the extent that the data points are clustered close to the line, the 6-10 rural attendance rate is a good predictor of food insecurity. By that criterion, there would appear to be a strong negative correlation between these two variables.

It is useful to note the overall pattern and also to note the exceptions, those countries identified as 'outliers', which are further from the line and whose names are displayed. For instance, Turkey is in the middle of the distribution of 6-10 attendance rate, but it has a very low level of food insecurity. In Guinea the school attendance rate is very low, but the level of food insecurity is not as low – relatively speaking – as might be expected. Nepal, on the other hand, has a relatively high rate of school attendance among rural 6-10 year olds, but it is the fourth highest country in terms of

food insecurity. Niger has the unenviable record of scoring lowest on both attendance rates of rural 6-10 year olds and rural food insecurity.[61]

Figure 2 shows the relationship between 11-15 attendance rates and food insecurity.

Figure 2. 11-15 Rural School Attendance Rate and Food Insecurity (*rurHFI1*)

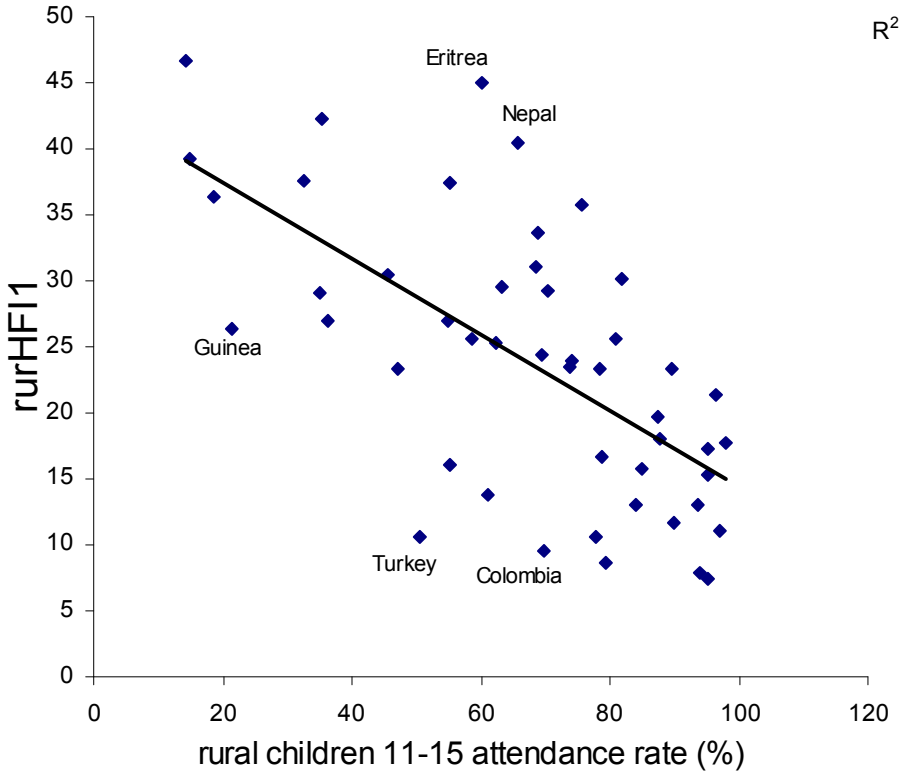
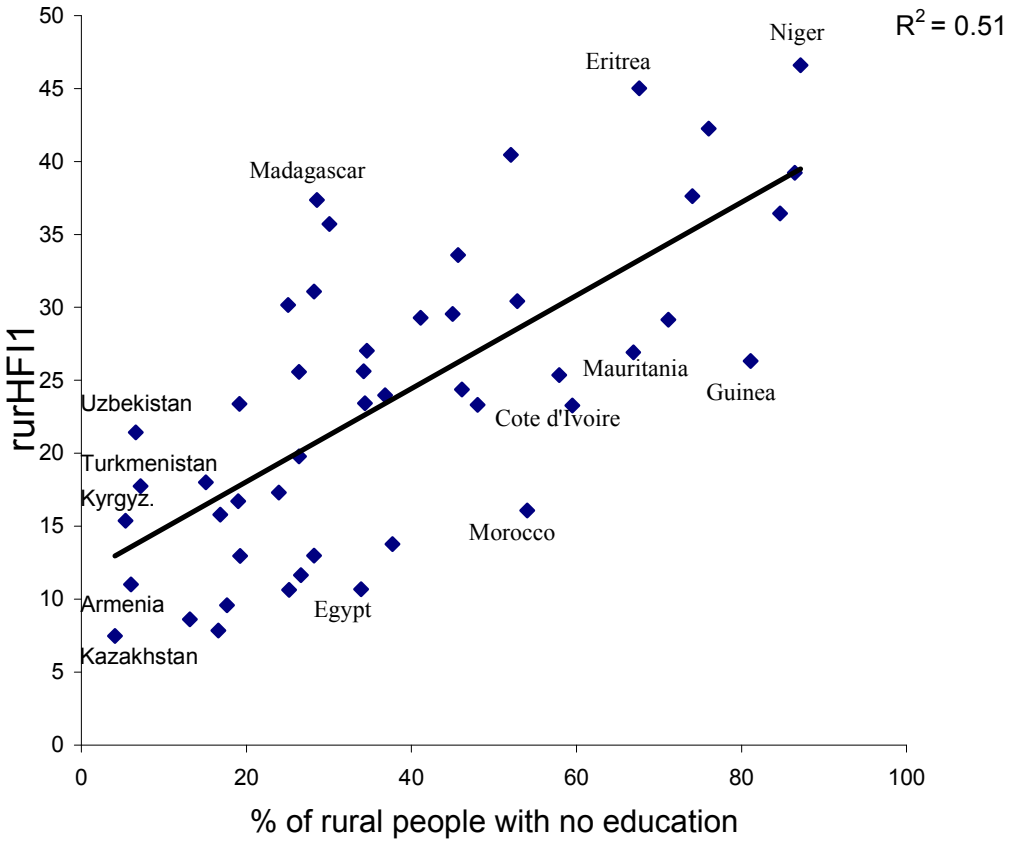


Figure 2 shows a less distinct linear relationship than Figure 1. A number of countries are further from the line. Both the number of outliers and their distance from the line are greater than in the previous case. Colombia represents the clearest case, with its 11-15 attendance rate very close to the overall mean but with a very low proportion of the rural population suffering from food insecurity.

Figure 3 shows the relationship between the percentage of the rural population with no education and food insecurity.

[61] The pattern for 6-15 attendance rates were much the same (see Annex 5).

Figure 3. Percent with No Education and Food Insecurity (*rurHFI1*)

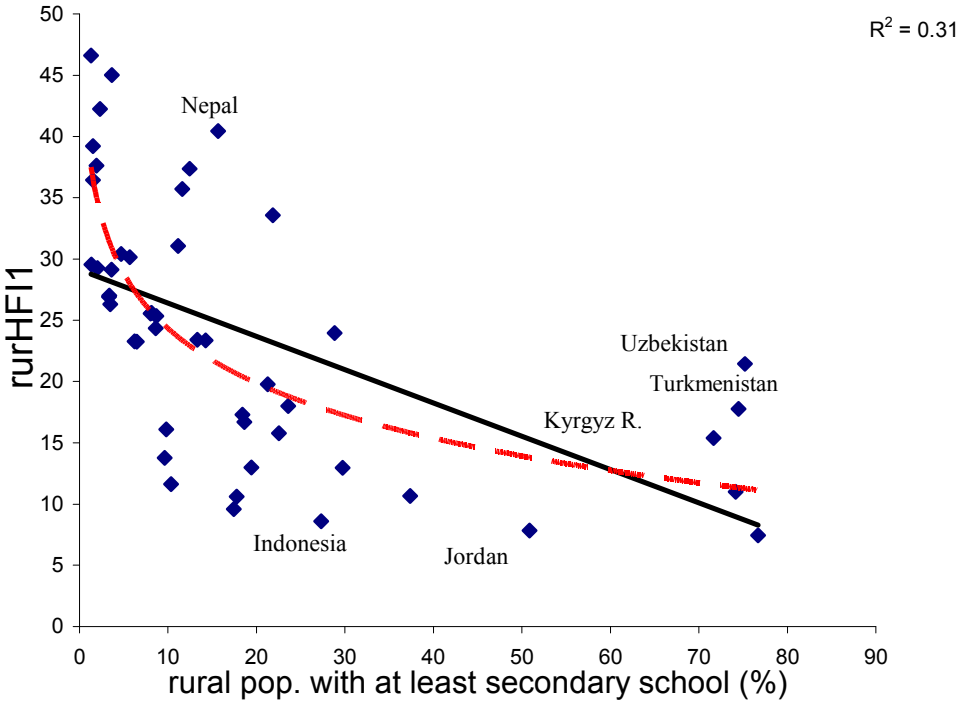


Not surprisingly, the greater the percentage of the rural population with no schooling, the greater the food insecurity. A number of countries fit the pattern, and thus lie close to the fitted line. One group of countries does not. This group scores relatively low on food insecurity relative to their (high or very high) rural populations with no formal education. Given the overall pattern, one would have expected more food insecurity in these countries: Morocco, Guinea, Cote d'Ivoire, Mauritania and Niger.

A second group of countries, including Armenia, Kazakhstan, the Kyrgyz Republic, Turkmenistan, and Uzbekistan, though varying in food insecurity show similar and extremely low percentages of their rural populations with no education. This is a consequence no doubt of the well-known massive investments in education made by the states of the former Soviet Union. It would appear that beyond a certain point, variations in educational participation have little to do with food security. This point is illustrated by countries on the other end of educational participation. Again in these African countries, at a certain point in lack of education, differences across countries have little impact on food insecurity.

Figure 4 shows the relationship between food insecurity and percentage of the rural population with secondary or more education.

Figure 4. Percent with at least Secondary and Food Insecurity (*rurHFI1*)



Here as the analysis shifts to higher levels of education, it becomes clear that the relationship is no longer linear. The trend is better represented by a logarithmic curve. This suggests that higher levels of secondary education are associated with lower levels of food insecurity especially among countries with low overall levels of rural participation in secondary and higher education. The effect diminishes above a certain point, but then would appear to increase sharply for the Central Asian countries noted earlier. Given the small number of cases and their geographical and shared past, it is assumed that this is more likely an artefact of their particular and recent history than a reflection of the effects of education.

Scatter plots of the relationships between food insecurity and the 6-15 rural attendance rate, 16-20 rural attendance rate, 21-24 rural attendance rate, and tertiary education are presented in Annex 5. These graphs reveal much the same patterns, a close correlation between the educational participation of young students, presumably at lower levels of education, and correspondingly weaker relationships at higher levels of education, among older rural students. Indeed, at the tertiary level, the relationship is not linear at all.

These results suggest one the one hand that increasing access to primary education might be a way to reduce food insecurity. Of course, given the

bidirectional nature of the relationship, this relationship might be understood in reverse, with increasing food security as a way to increase access to primary education.

5.3.3 Correlation Analysis

Correlation analysis allows to quantify the relationships we have been examining. Two measures – Pearson's *r* and Spearman's *rho* – were considered. Both measures range in value between -1 (perfect negative correlation) and +1 (perfect positive correlation), but they have an intrinsic difference, which can affect the results.[62] The following paragraphs discuss results for both correlation coefficients in relation to the first measure of Food Insecurity (*rurHFI1*).

Table 5 presents correlation coefficients between education variables and food insecurity (*rurHFI1*).

Table 5. Correlations between education and food insecurity (*rurHFI1*)

Variable	Pearson	Spearman
Attendance Rate 6-10	-0.77	-0.79
Attendance Rate 6-15	-0.74	-0.76
Attendance Rate 11-15	-0.64	-0.64
Attendance Rate 16-20	-0.46	-0.45
Attendance Rate 21-24	-0.18	-0.24
No Education	0.72	0.71
Secondary or More	-0.56	-0.72
Tertiary	-0.55	-0.71

The two coefficients are similar except for percentage of the rural population with secondary or higher education and percentage of the rural population with tertiary education. Except for these two indicators, there appears to be a high degree of linearity.

[62] Pearson's *r* is a linear correlation coefficient, and is seriously affected by the presence of outliers and non-linearity in the relationship. Spearman's *rho* is defined as a 'quasi ordinal' correlation coefficient because it is calculated by applying the Pearson correlation formula to the ranks of the data rather than to the actual value of the data. This is useful because it allows outliers to have less influence that in Pearson's *r*. It is useful to look at them both to assess the linearity of the relationship. If Pearson's *r* is much smaller than Spearman's *rho* applied to the same variables, then one can reasonable conclude that the variables are substantially correlated, but not linearly. When both correlation coefficients show similar values, there is linearity.

More importantly in terms of policy is the numerical confirmation of the finding that food insecurity is most highly (though negatively) correlated with the participation of younger children in primary education. By contrast, the correlation between *rurHFI1* and *rurattendance2124* is not statistically significant. Stated more declaratively, it is possible to conclude:

- Countries with high levels of primary schooling in rural areas are more likely to be food secure.
- Countries with high levels of secondary schooling in rural areas are not necessarily more likely to be food secure.
- High levels of rural participation in tertiary education have little to do with food insecurity.

5.4 Econometric Models

Thus far the two-way relationships between education, measured at different levels, and food insecurity in rural areas were examined. In this section, multiple regression analyses were used to develop a series of econometric models to estimate the 'effects' of educational participation, again measured at different levels, on food insecurity. Regression analysis allows to measure more precisely the effects of predictor variables, in this case educational participation. It also allows us to examine simultaneously the effects of different levels of education on food insecurity and thus to test the notion that the primary level is most closely associated with food insecurity. Regression analysis also permits the inclusion of 'control' variables, that is, factors identified in section 5.2.4 that are also associated with food insecurity. By controlling for such factors as sanitation or access to clean water it is possible to assess the unique contribution of education to food insecurity, independently of other associated factors. This type of analysis also gives greater confidence in the findings, and it moves us much closer to an understanding of the likely causal relationships.[63] The key questions these models aim to answer are:

[63] Econometrics does not automatically show causality. The quantitative analysis is built on the theoretical framework outlined in chapter 4. However, since there is no comprehensive literature on this topic, causalities can only partially be modelled. Therefore, this section presents correlation reinforced by control variables and built on the theoretical foundation highlighted in chapter 4. Thus, the strongest possible case for causality is made.

- What is the quantitative impact of education for rural people on food insecurity in rural areas?
- What is the level of education that most affects food insecurity?

To answer these questions, ordinary least squares (OLS) regression analysis was used. The first model used all education variables as predictors, in an effort to see which type of education has the greatest 'effect' impact on food insecurity. The second model regressed both education and control variables on food insecurity, in order to obtain a more realistic assessment of the independent effects of education. Both models were estimated twice, with each of the two outcome measures *rurHFI1* and *rurHFI2*.[64]

5.41 Models with only educational variables

Table 6 presents the results of the first regression estimates, which examined the effects of all education variables, but which included in the final model only those predictors statistically associated with food insecurity independently of the other terms.[65]

Table 6. Models 1.1 and 1.2: Educational determinants of food insecurity in rural areas

Model	1.1 Food Insecurity 1	1.2 Food Insecurity 2
Constant	43.4*** (2.56)	53.7*** (3.26)
6-10 Attendance Rate	-0.28*** (0.04)	-0.34*** (0.05)
Percent with at least Secondary Education	-0.12* (0.05)	-0.16* (0.06)
Adjusted R-squared	0.62	0.60
F-Statistic	39.7	36.6
Degrees of freedom	2, 45	2, 45

*** = significant at 0.001-level, ** = significant at 0.01-level, * = significant at 0.05-level.
Figures in parentheses are standard errors

[64] Step-wise regression was used to end up with final models, reported here, in which all predictors are statistically associated with the outcome, food insecurity. Variables that are not statistically significant were rejected in an iterative process.

[65] The model has the following statistical properties required for reliable OLS estimates: statistical significance of each coefficient (0.05 level) and of the model as a whole, normality in the distribution of error terms, lack of multi-collinearity, homoskedasticity, linearity of the relationship, and correct specification.

Overall model statistics suggest that this combination of independent variables jointly predicts food insecurity (overall p-value < 0.001). These two educational factors, percentage of the rural population with at least secondary education and 6-10 rural attendance rate, explain 62 and 60 percent of the variation in food insecurity (the difference depending on the measure). As expected, both education terms are negatively associated with food insecurity, that is the greater the educational participation, the lower the average food insecurity. Both education terms are statistically significant. The magnitude of the effect of the 6-10 rural attendance rate is more than twice that of percentage of the rural population with at least secondary education. It is interesting that of the education variables included in the analysis, only these two remained statistically significant predictors of food insecurity when examined in conjunction with the others. The model can be formalized in the following way:

Model 1.1: Food Insecurity 1 = 43.4 – 0.28 x Percent at least Secondary + – 0.12 x 6-10 Attendance Rate

Model 1.2 differs from model 1.1 in using *rurHFI2*, which gives greater weight to extreme deprivation in the indicator of food insecurity. The coefficients of the educational terms are somewhat higher, indicating a greater 'effect' of education on food insecurity, measured with greater weight on extreme deprivation.

5.42 Models with control variables

In addition to education variables, the seven control variables discussed earlier were included in the step-wise regression. Table 7 reports the models finalized after running appropriate sensitivity analyses and with all the statistical properties required for regression analysis which were reported earlier.

Table 7. Models 2.1 and 2.2: Determinants of food insecurity in rural areas, education and control variables

Model	1.1 Food Insecurity 1	1.2 Food Insecurity 2
Constant	27.5*** (3.72)	34.5*** (5.00)

6-10 Attendance Rate	-0.20*** (0.04)	-0.25*** (0.05)
Percent with No Assets	0.13** (0.04)	0.16* (0.06)
Percent with No Toilet Facilities	0.11*** (0.33)	0.13** (0.31)
Adjusted R-squared	0.75	0.71
F-Statistic	48.3	39.1
Degrees of freedom	3, 44	3, 44

*** = significant at 0.001-level, ** = significant at 0.01-level, * = significant at 0.05-level. Figures in parentheses are standard errors

Not surprisingly given the additional predictive information in new variables, Models 2.1 and 2.2 explain more of the variation in Food Insecurity (75 and 71 percent respectively, as compared to 62 and 60 percent). Again, the 6-10 rural attendance rate remains a significant predictor of food insecurity, especially when greater deprivation is weighted more heavily. Not surprisingly, lack of economic wellbeing and lack of sanitation are also statistical significant predictors of food insecurity.

Model 2.1: Food Insecurity = 27.5 – 0.20 x 6-10 Rural Attendance Rate +
+ 0.13 x Percent with no Assets + 0.11 x Percent with no Toilet Facilities

With this model, food insecurity in rural areas can be predicted by:

- *School attendance* of children ages 6 to 10, which is found to be the best predictor of food insecurity
- *Lack of access to toilet facilities*, as a proxy for lack of sanitation, the second best predictor of food insecurity
- *Assets-based poverty,* lack of ownership of non-productive assets, as a proxy for an asset based measure of absolute poverty

These results suggest that one of the best ways to reduce food insecurity in rural areas may be to promote primary education. Interestingly, primary education was highly correlated with lower levels of food insecurity, whereas most other assets, e.g. percent of rural households with access to radio, were not. It may be that the literacy acquired in primary education is a necessary or strongly facilitating condition for effective use of the messages concerning sanitation, health, and food utilization

conveyed by radio. Still, it is interesting that lack of primary education contributes more to food insecurity than the poverty measure, lack of ownership of assets. Finally, as suggested by earlier exploratory analysis, primary education was also a better predictor of food insecurity than basic, secondary, or tertiary education.
Thus, the determinants of food insecurity in rural areas can be expressed as follows:

Model 2.2: Food Insecurity 2 = 34.5 – 0.25 x 6-10 Rural Attendance Rate +
+ 0.13 x Percent with No Toilet Facilities + 0.16 x Percent with No Assets

These estimates are quite similar to those obtained in model 2.1. The conclusion from this model is that doubling rural children's participation in primary education would produce a reduction of around 25 percent in food insecurity. Of course, these results likely underestimate the true impact of education which has effects at community and national as well as at individual levels.[66]

5.5 Concluding Remarks

Education is widely recognized as one of the key dimensions of development. Millennium Development Goals 2 and 3 focus directly on education. In the same way, the Education for All initiative, and especially the first World Conference held in Jomtien in 1990 and the successive conference held in Dakar in 2000 concentrate on education, and more specifically, on primary and basic education. Indeed, the World Food Summit in 1996 acknowledged the critical role of education in achieving food security. This research attributes further value to education: education of rural people is a key factor in fighting food insecurity in low-income countries. Recognizing the inter-linkages between rural people deprivations such as lack of education on the one hand, and food insecurity and malnutrition on the other, is fundamental to a more comprehensive view of the MDGs.

This research deliberately focused on rural areas of developing countries. Despite their statistical predominance, where they still represent more than 70 percent of the overall population, rural people are usually discriminated against by national policies in many sectors, including education. Although a number of studies

[66] Another possible problem regarding the model is the feedback effect: education affects food security, but, in turn, food security could affect education. This risks the generation of biased OLS estimates. However, since there is no empirical literature on this specific field, no econometric tool is available to overcome such a problem.

have considered the 'urban bias' (e.g. Lipton 1977; 1981), only few documents of international organizations consider the vulnerability of rural areas. Most national and international studies and statistics are not disaggregated by rural-urban areas, and thus fail to present an accurate picture of the situation of low-income countries. This research suggests that, in rural areas of low-income countries, there is a high correlation between food insecurity and lack of education, especially at lower levels of education. Indeed, of the factors examined, the measure of rural primary education was by far the best predictor of rural food security.

Perhaps the most relevant result of this research is the finding that primary education more than secondary or tertiary levels contributes to the promotion of food security in rural areas. Of all the educational variables examined in the full econometric model, only primary education remained significant holding controls constant. The analysis suggests that, if a developing country such as Mali, which is among those with lowest levels of education, managed to double access to primary education, it could substantially reduce the intensity of food insecurity (by 20 percent or 25 percent depending on the indicator adopted).

Finally, because the majority of people in low-income countries live in rural areas (see Annex 3), and since it is in these areas that the largest proportion of world poverty and hunger exists, education for rural people is a key factor for promoting overall national food security.

CHAPTER 6

DECOMPOSING THE IMPACT OF MOTHER'S EDUCATION ON CHILD FOOD SECURITY IN MOZAMBIQUE: *SCHOOLING*, *HUMAN CAPITAL* OR *NUTRITION KNOWLEDGE*?

6.1 Introduction

Food insecurity and lack of education are two of the most challenging problems that developing countries are currently facing. Following the capability approach (e.g. Sen 1997; 1999), both education and food security are ends (and means) of development, while economic factors are just means. Chapter 4 has explained the possible contribution of education on food security in rural areas, while chapter 5 has tried to quantitatively assess such an impact. This chapter aims at studying one of the linkages between these two dimensions: the impact of mother's education on child food security, using Mozambique as a case study. The focus is not anymore on the society as a whole, but on two specific key units of analysis: mothers and children. Drawing attention to food security of children in the age-group between 0 and 5 can at the same time provide information about past and current food insecurity/malnutrition in a country and provide information about future risks of food insecurity.

There is a vast literature on the contribution of mother's schooling on child malnutrition and child health, but this research intends to address a larger set of issues by applying quantitative techniques on household data. The first objective of the econometric model is to analyze *how important* is mother's schooling for child food security; the second objective is to examine *which* level of mother's education is crucial. Then, the chapter aims at answering a third question: what are the main *channels* through which mother's education affects child food security? These mechanisms, following a Capability perspective, can be incorporated in two macro-channels: 'economic production' and 'social change' (Sen 1997). Finally, it is interesting to estimate the rural-urban differences in the role played by mother's education. The latter is particularly important in view of a larger presence of poverty and food insecurity in rural areas.

This research focuses on Mozambique because of its low attainments in both education and food security. Regarding education, adult literacy rate in the period 1995-2005 is nearly 38.7 percent and the net secondary enrolment rate in 2005 is only 7 percent (UNDP 2007). Furthermore, Mozambique is ranked at the 172nd position out of 177 countries using the Education Index measured by the UNDP for the Human Development Reports (UNDP 2007). Moving to food security data, it was estimated that nearly 45 percent of the total population was undernourished in the period 2001-2003 (FAO 2006). Moreover, Mozambique is predominantly a rural country – 64.4 percent of its population lives in rural areas (2003 data, source: IFAD) – and this makes possible to better address the issue of rural-urban disparities. Whether the analysis showed that the determinants of child food security in the two areas are different, and especially that the most significant levels of mother's education are not the same, this would suggest a specific policy focus for rural areas.

The chapter is structured as follows. Section 6.2 presents a literature review; section 6.3 explains the theoretical model on which the econometric estimates are based; section 6.4 addresses the controversial methodological problem of possible endogeneity of some explanatory variables; section 6.5 describes the dataset; the following section reports the descriptive statistics and the two-way graphs showing the relationship between the main variables; section 6.7 shows the results of the econometric models; finally, conclusions are presented in the last section of the chapter.

6.2 Literature Review

In the last two decades much work has been produced with respect to the contribution of formal schooling on socio-economic conditions. Following the main theoretical work on household models, proposed by Becker (1965), many authors have tried to assess the specific impact of mother's schooling on fertility, on child schooling, and on child survival. One branch of these studies deals with child malnutrition or child health; between these two, in practical terms, there is no significant difference as long as both are measured by the proxy 'children nutritional attainments'.[67] The work of some of these experts (e.g. Thomas et al. 1991; Glewwe 1999) primarily focused on the impact of mother's education on child health, while

[67] In this literature there is usually a reference to child nutrition or health, and much less on child food security. However, section 6.5 will point out that the same indicators are even good proxy for child food security.

some other contributions on this field come from broader studies on the determinants of child health (Garrett and Ruel 1999; Girma and Genebo 2002; Morales at al. 2005). There is even a body of literature that has addressed this topic in developed countries such as the United States, but here the discussion will include only that concerning low-income countries.

Economists, mainly drawing on Schultz's (1964) theory, usually assume that among mother's education and child health/nutrition there is a positive relationship because an educated mother can allocate inputs more efficiently ('allocative efficiency') and can acquire more knowledge regarding child health/nutrition, through which she can increase the efficiency of the chosen inputs ('technical efficiency'). Starting from this theoretical framework many empirical results have been obtained adopting different quantitative methodologies, from simple ordinary least squares (OLS) econometric estimation to two stage least squares (2SLS), logit models, and context fixed effects. The choice of a methodology over another one might heavily affect the outcome, but here this issue is temporarily left apart. The literature review focuses on latest empirical results, which affected policies in developing countries.

Recent studies on the impact of mother's schooling on child nutrition have usually applied the following strategy. First, they have estimated the broad impact of mother's education, controlling just for few characteristics, such as child, household, and sometimes context characteristics. Then, since many scholars (rightly) argue that education could just reflect the impact of household income or economic resources on child health, they have also controlled for economic factors (Strauss and Thomas 1995, p. 1922). The result, in many cases, is that the positive effect of mother's education still remained significant. In the North-East region of Brazil, Thomas et al. (1991), using data from the 1986 Demographic and Health Survey (DHS), found out that mother's years of schooling has a significant influence on child health so as measured by the relation height-to-age of children below five.[68] Once the authors controlled for household (instrumented) income, maternal education is still highly significant and the coefficient associated to it declines by only 8.5 percent in rural areas and by 12 percent in urban areas. In Mozambique, Garrett and Ruel (1999, p. 1971), using data from the 1996-1997 national household demographic and expenditure survey, concluded that mother's education has a positive impact on child

[68] This measure of child anthropometrics is commonly used in the literature. Since it is also the variable used in this empirical analysis, the section dealing with the dataset will explain better the characteristics of this indicator.

food security of children in the age-group 0-5 – whether measured by calories availability or height-for-age – 'above and beyond the income effect'. In Ethiopia, Girma and Genebo (2002) have run a logistic regression model to identify the determinants of child anthropometry. One of the main findings was that in rural areas 'The likelihood of being stunted was found to be double among children of mothers with no education compared with children whose mothers have some secondary or higher education', while in urban areas it was 1.6 times higher (Girma and Genebo 2002, p. 18).

Biological models suggest to add mothers' anthropometrics since these directly affect child nutritional status. Omitting this variable risks to lead to an overestimation of the contribution of mother's education (Barrera 1990, p. 87). Therefore, many studies have incorporated variables such as mother's and father's height, and still find a highly significant influence of mother's education on child nutrition (Barrera 1990; Glewwe 1999; Morales et al. 2005).

There is abundant empirical evidence that mother's education is positively correlated with child food security, especially when the temporal dimension of food security is the long run. The majority of studies, in fact, suggests that mother's education, as well as other factors such as economic resources, provides a larger contribution to child height-for-age (HAZ), commonly accepted as a good proxy for long-term nutritional status, than to child weight-for-height (WHZ), a better proxy for short-term nutritional status (Haddad et al. 2002; Webb and Block 2003).[69] Haddad et al. (2002) have analyzed sixteen household datasets in twelve different developing countries and have concluded that parental education has a (positive) significant influence on WHZ in only one third of them.[70] However, there is a minority of studies that has reported a non-significant difference in the impact on HAZ or WHZ (Morales et al. 2005, in Bolivia), or even a lower impact on HAZ (Penders et al. 2002 in Mali). Penders et al. (2002), using DHS data for Mali, have found out that maternal education affects more WHZ than HAZ, that maternal education does not have a significant contribution on child HAZ, and, finally, that it has a significant contribution on child WHZ.

Results might also vary if the analysis focuses on rural or urban areas of low-income countries. Leaving aside discrepancies in the methodologies adopted to

[69] See section five for a specification of indicators.
[70] Mother's education, in most of the countries, has a larger influence than father's education. This is especially true in developing countries such as Mozambique, where family roles are clearly assigned and mothers have the precise tasks to take care of the house and of the children.

estimate these disparities, the largest part of the literature has showed that mother's education has a more significant influence on child anthropometrics in rural areas (Thomas et al. 1991; Girma and Genebo 2003).

Finally, results can differ if we do not focus on the whole population of a country, but, for instance, on the ten or twenty percent of the children population at higher risk of malnutrition. Aturupane et al. (2006) first have run a traditional OLS model on DHS household data collected in Sri Lanka in 2000, and have obtained similar results to those presented above. Then, applying a different methodology – quantile regression – they have acquired further information: in Sri Lanka the impact of mother' education on child health is higher for the children at the highest quantiles, i.e. those that are better off in terms of nutritional status. This type of information, still not properly studied in the field, can be relevant for policy interventions.

Given that the substantial part of the literature confirms that mother's schooling is highly correlated with child nutrition, only few studies go further, trying to estimate the channels through which this correlation works. It is improbable that schooling, i.e. the subjects studied in the classroom, reflects the whole relationship. To the opposite, it is reasonable to think that such a relationship is mediated by some other factors. Following the capability approach, education (including mother's education) can promote development and generally improve the quality of people's life by enhancing 'economic production' and promoting 'social change' (see section 2.3). The same relationship operates between mother's education and child nutrition.

Thomas et al. (1991) are the first to address the problem of pathways. They include three possible mechanisms: 1. economic conditions (income instrumented by asset wealth); 2. mother's access to mass media (newspapers, televisions and radios), which is likely to influence child nutrition only if they provide some information regarding health and nutrition; 3. general ability to read and write. While with the addition of the income variable the coefficient of mother's education is reduced by only a small proportion, with the further addition of access to media that mother's education becomes non-significant. The three dummy variables, indirectly reflecting nutrition knowledge, are jointly significant and even jointly significant with mother's schooling. This suggests that in North-East Brazil schooling does not account for much of the impact of mother's education on child health, economic resources account just for a small part, and, instead, access to information explains almost the whole impact of mother's education (Thomas et al. 1991, p. 209).

Glewwe (1999) and Webb and Block (2003) have improved this methodology by using variables more directly reflecting mother's nutrition and health knowledge. Glewwe (2003) has used a Moroccan dataset with further information on health knowledge and general knowledge, obtained through specific tests submitted to interviewees. He concluded that mother's schooling does not have a straight influence on child health, but through income (one third of the total impact) and, primarily, through mother's health knowledge (Glewwe 1999, p. 151). Finally, Webb and Block (2003) in rural Central Java, Indonesia, have used a test where respondents (mothers) identify the potential benefits of vitamin A: the number of correct answers was taken as a proxy for overall nutrition knowledge. They found out that nutrition knowledge is highly significant and absorbs the whole contribution of mother's education when the subject of analysis is child WHZ. The situation is the opposite for child HAZ: mother's schooling and household income are important determinants, while mother's nutrition knowledge is not significant. This suggests that nutrition knowledge might be more important in the short-run, and that in the long-run there are other factors – e.g. education and economic resources – that better explain the causes of child malnutrition (Webb and Block 2003, pp. 19–20).

6.3 Conceptual Model and Econometric Strategy

In the scientific literature, three main household models have been applied to study the determinants of child nutrition. The original one is the household production function, which 'seek[s] to understand the underlying production process of child health or nutrition (Strauss and Thomas 1995, p. 1917). Following this approach, which derives from Becker's (1965) application of the traditional production function to human capital dimensions, child nutrition is a function of health and nutrition inputs selected by child's household and of other determinants that are outside household's control (Glewwe 1999). The latter are usually exogenous household factors and context factors.

Child nutrition production models have the main shortcoming of requiring an incredible amount of information concerning all the possible health inputs. Therefore, many authors preferred to apply the so called reduced form. A reduced form aims to explain child nutrition through a limited set of (exogenous) variables: mother's and father's schooling, household assets, and household and context factors (Glewwe 1999, p. 129). The reduced form approach assumes that these variables can

reflect the unobserved health and nutrition inputs, and therefore, unlike the general household production approach, it incorporates a model of household choice (Strauss and Thomas 1995, p. 1917).

Finally, the last category is the conditional production function, which is a 'hybrid' of the first two models (Strauss and Thomas 1995, p. 1917). It estimates the influence of a small number of endogenous covariates on child nutrition.

This section firstly aims to study the general impact of mother's education on child food security, measured by the height-for-age indicator. Since there is scarcity of detailed health data in Mozambique, the nutrition production function cannot be applied. Therefore, in the first estimates a reduced form model was adopted in order to study a functioning production function (e.g. Klasen 2000; Kuklys 2005), where child food security is the basic functioning. Equation 1 explains the relationship between the dependent variable – 0-5 child height-for-age (HAZ) – and the exogenous regressors.

$$ChildHAZ = \alpha + \sum_{i=1}^{I} \beta_i Child_i + \sum_{j=1}^{J} \gamma_j HH_j + \sum_{w=1}^{W} \delta_w Moth_w + \sum_{p=1}^{P} \phi_p Fath_p + \\ + \sum_{q=1}^{Q} \lambda_q Cont_q + \varepsilon \quad (1)$$

where α is the intercept; $Child_i$ is the i-th characteristic of the child, such as sex and age; HH_j is the j-th characteristic of the household, such as its size and the proportion of members below five; $Moth_w$ and $Fath_w$ are respectively the w-th mother's characteristic and the p-th father's characteristic. Parents' characteristics are, for example, age and education. $Cont_q$ is the q-th context factor. This set of variables includes education and health environment, quality of education, plus binary variables for province and place of residence; finally, ε is the error term. In particular, context variables are very important since they show even the 'quality' side of mother's and father's education, in addition to some other aspects that directly affect children's life and food security.

In the following step mother's nutrition is added for the purpose of investigating whether the contribution of mother's education changes compared to equation 1. As mentioned in the literature review, Barrera (1990) points out that parents' education might just reflect family background. In equation 2, the new group of covariates, which reflects mother's nutritional status, is outlined separately from the other mother's characteristics:

$$ChildHAZ = \alpha + \sum_{i=1}^{I} \beta_i Child_i + \sum_{j=1}^{J} \gamma_j HH_j + \sum_{w=1}^{W} \delta_w Moth_w + \sum_{p=1}^{P} \phi_p Fath_p + \quad (2)$$
$$+ \sum_{q=1}^{Q} \lambda_q Cont_q + \sum_{y=1}^{Y} \mu_y MothNutr_y + \varepsilon$$

Equation 2 is, again, a reduced form model, where all variables are specified as exogenous. Section 6.4 will provide the theoretical justifications of their exogeneity.

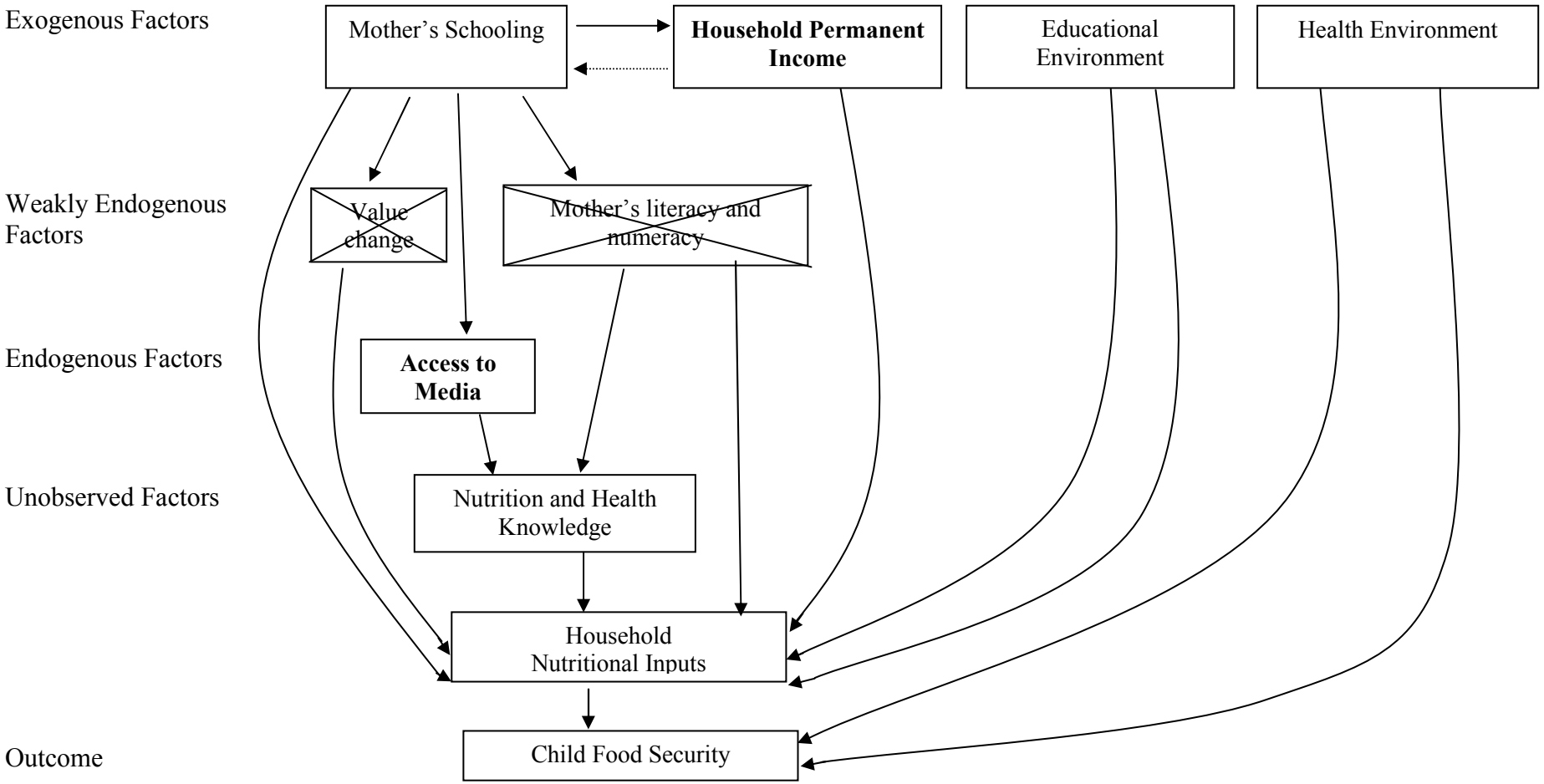
The other point this work aims to address concerns the channels through which mother's education affects child food security. Diagram 3 helps to discuss the issue.

The simple fact that a mother went to school or completed some levels of formal education is unlikely to directly account for the whole positive influence of her education on child food security. Glewwe (1999, p. 130), counting on Schultz's theory and data for Morocco, originally encloses five main channels: ability to read and write (literacy), ability to make calculations (numeracy), values' shift, health knowledge, and income generation. Since only rare datasets provide information about values, Glewwe has finally considered the remaining four channels.

The DHS dataset, used in this study, unfortunately has no information about values and numeracy, and since literacy is poorly measured final estimations will take into account only the nutrition knowledge and income generation mechanisms (bold in diagram 3).[71] The nutrition knowledge effect is indirectly measured, through the use of regressors for mother's access to information via media (radio, television, and newspaper). The theoretical rationale is that these media are used even by national governments to disseminate messages concerning nutrition and health practices, and more educated mothers are likely to process better this information. However, differently from Glewwe, here mother's schooling variable is always kept in the model in order to check its variation with addition of other covariates; schooling alone counts for information directly acquired in school (school subjects) and, more generally, for knowledge and values. Thus, the sequential steps of this study are the following.

[71] That is why in diagram 3 the cells related to value change and mother's literacy and numeracy are crossed.

Diagram 3. Linkages between mother's education and child food security



Source: Author's elaboration based on Glewwe (1999, p. 126)

The first issue to address concerns the impact of mother's schooling on household permanent income.[72] While Glewwe (1999), Thomas at al. (1991), Webb and Block (2003), and many others in the field have used a conditional estimate function counting on the endogeneity of income, here, again, a reduced form is adopted, where permanent income is specified as exogenous. Next section will explain the reason. Therefore, the reduced form model makes possible to isolate the impact of household income from that of mother's schooling:

$$ChildHAZ = \alpha + \sum_{i=1}^{I} \beta_i Child_i + \sum_{j=1}^{J} \gamma_j HH_j + \sum_{w=1}^{W} \delta_w Moth_w + \sum_{p=1}^{P} \phi_p Fath_p + \\ + \sum_{q=1}^{Q} \lambda_q Cont_q + \sum_{y=1}^{Y} \mu_y MothNutr_y + \sum_{x=1}^{X} \eta_x Inc_x + \varepsilon \quad (3)$$

In the following step, the variables reflecting access to information are incorporated. In this case, for reasons outlined in next section, these covariates might be endogenous; thus, equation 4 is a conditional estimate function, where *Info* is the set of *L* conditional variables:

$$ChildHAZ = \alpha + \sum_{i=1}^{I} \beta_i Child_i + \sum_{j=1}^{J} \gamma_j HH_j + \sum_{w=1}^{W} \delta_w Moth_w + \sum_{p=1}^{P} \phi_p Fath_p + \\ + \sum_{q=1}^{Q} \lambda_q Cont_q + \sum_{y=1}^{Y} \mu_y MothNutr_y + \sum_{x=1}^{X} \eta_x Inc_x + \sum_{l=1}^{L} \varphi_l Info_l + \varepsilon \quad (4)$$

Finally, an attempt was made in order to assess the mechanisms through which mother's schooling affects child food security by including the interaction terms between: a. mother's schooling and household permanent income; b. mother's schooling and her access to information. In diagram 3 there are two arrows connecting mother's schooling with household permanent income: however, one of them is 'dotted', which symbolizes a weaker linkage. The reasonable assumption is that, in order to influence child HAZ, it is more mother's schooling affecting income than *vice versa*. Interaction terms are labelled *Inter* in equation 5:

[72] Since the study focuses on mother's education, ideally it should consider mother's earned income. However, all the surveys (including DHS) in developing countries are carried out at household level, without the possibility to separate mother's income from father's income. Furthermore, the choice of household as unit of analysis precisely derives from the assumption that resources, 'productive' and domestic work, and leisure belong to the household and decisions over them are made for the household and not for personal interests.

$$
\begin{aligned}
(5) \quad & ChildHAZ = \alpha + \sum_{i=1}^{I} \beta_i Child_i + \sum_{j=1}^{J} \gamma_j HH_j + \sum_{w=1}^{W} \delta_w Moth_w + \sum_{p=1}^{P} \phi_p Fath_p + \\
& + \sum_{q=1}^{Q} \lambda_q Cont_q + \sum_{y=1}^{Y} \mu_y MothNutr_y + \sum_{x=1}^{X} \eta_x Inc_x + \sum_{l=1}^{L} \varphi_l Info_l + \sum_{z=1}^{Z} \sigma_z Inter_z + \varepsilon
\end{aligned}
$$

Through the analysis of the coefficient associated to mother's schooling and of the significance of household income and mother's access to information, and, finally, by assessing whether there is an interaction between mother's education and these two channels, it is possible to have a better view of the mechanisms that are in place.

Last consideration pertains to the temporal dimension of the whole model. The micro model applied in this section is static from an econometric point of view. However, in theoretical terms, it is dynamic, in the sense that not all the variables refer to the same period. For instance, mother's schooling, or better her educational attainment, is a stock variable accumulated in the past. Another example of dynamicity is the income effect. Child food security is influenced by household permanent income and not by current income. Permanent income is, again, a stock variable. Even the quality of mother's education should refer to the period in which she studied.

6.4 On the (possible) endogeneity of some covariates

In the real world everything is endogenous, that is, every individual or household could take everything into consideration in order to make a decision (N. Folbre 2007, personal communication, March 26, 2007). However, in order to construct a model, most of the factors must be treated as exogenous; the general guideline would be to rank factors according to their degree of endogeneity and treat as endogenous only those that are on the top of the list.

Endogeneity affects the validity of the model because the endogenous variable is correlated with the error term of the structural equation; therefore, OLS estimates are inconsistent. The sources of this bias can be essentially three: omitted variables, measurement errors, and feedback effects. Omitted variables provoke an underspecification of the model: an explanatory variable is correlated with the omitted (unobserved) variable, thus it is correlated with the error term (Wooldridge 2003, chap. 15); measurement errors occur because of lack of data (Wooldridge 2003, chap. 9); feedback effects are present when a regressor affects the dependent variable, but the latter has a return effect on the former (Wooldridge 2003, chap. 16).

Most of the early literature on child height and survival did not address the problem of endogeneity (see Behrman and Deolalikar 1988), and even many recent empirical studies have not mentioned the problem (e.g. Morales et al. 2005; Girma and Genebo 2002). To the opposite, there is a body of literature that includes some variables such as household income and health knowledge as endogenous. This section discusses this topic for the most controversial variables here adopted: household permanent income, mother's schooling, and mother's access to information.

The first and most important argument concerns household income. Authors such as Thomas et al. (1991), Glewwe (1999), and Gebreselassie (2005) have explicitly explained why, in their opinion, household permanent income, measured by expenditures, should be treated as endogenous. Other researchers, instead, just relied on the most common literature, and treated income as endogenous without providing further explanation. Here below the main arguments will be reviewed, and, keeping in mind diagram 3, it will be justified why permanent income should not be considered 'more endogenous' than other variables.

Firstly, it is argued that countries and households with higher income record lower levels of child malnutrition. Although this might seem reasonable, there are other studies, especially in developing countries, that testify how this is not necessarily true. For instance, Benson (2004, p. 16) has outlined that in Mali the prevalence of stunted children raised in a period of high economic growth. Furthermore, from a strictly theoretical point of view, there is no certainty if mother's income generating activity increases child height because it raises nutritional inputs, or decreases it because it reduces mother's time spent for child care (Dancer and Rammohan 2005, p. 6).

Second, taking the same discourse from a slightly different perspective, this neoclassical framework works in the '*ceteris paribus*' hypothesis. This means that household income affects positively child nutrition, keeping the other household and mother's capabilities (factors), especially the level of mother's education, as fixed. In that case, it is reasonable to claim that mother's education, with fixed income, is likely to be positively correlated with child food security. Thus, theoretically there would not be evidence that income is 'more endogenous' than, for instance, mother's education.

Third, in developing countries data on consumption and expenditures are not reliable, and do not reflect properly permanent income. Permanent income, derived

from Friedman's (1957) conceptualization, is not a variable measured in a fixed time, but it is the result of wealth accumulation of a household in the long run. In my view, a wealth index based on assets ownership, available in DHS surveys, is a better proxy of this concept. The assumption made by the dominant literature on child health is that expenditure is endogenous and that asset-wealth is exogenous, thus the second can be used as an instrumental variable for the former. The rationale behind it is that assets reflect 'unearned' income. However, if this assumption is realistic, there is the serious risk that expenditures are not highly correlated with the wealth index; therefore, one of the necessary requirements for the wealth index to be a good instrument would not be satisfied. If, instead, one argues that 'nonlabor income is the return to assets built up with previous labor earning' (Strauss and Thomas 1995, p. 1900), there is correlation between the two economic factors. However, the wealth index is correlated with the error term in the structural equation (that one with child HAZ as dependent variable); therefore it does not meet the second requirement of instrumental variables (Wooldridge 2003, pp. 463–464). The result is that many of these studies utilize poor instruments (Strauss and Thomas 1995, p. 1949). If one accepts this reasoning, she or he accepts also that inadequate instruments undermine the effectiveness of the Wu-Hausman test, applied by some of these authors to verify, even with statistical tools, the endogeneity of household expenditures (or income).[73]

Another potential source of bias in OLS estimates with endogenous permanent income is the interaction among regressors. For this reason, equation 5, which includes the interaction between mother's schooling and the two pathways, will be finally estimated. The fifth point on the issue of endogeneity versus exogeneity of income is a practical one. The 2003 DHS survey in Mozambique does not contain information on consumption and expenditures. Information is available on a set of assets owned by the households, which are already aggregated in an indicator of wealth.[74] Since it is very hard to find reliable instruments for wealth, this study cannot report together OLS and 2SLS estimates, and apply the Wu-Hausman endogeneity test. Thus, the wealth index is treated as exogenous and as a channel through which mother's schooling influences child food security.[75] Finally, while there is a feedback effect between income and nutrition (Strauss and Thomas 1995,

[73] The Wu-Hausman test verifies if there is significant difference between OLS and 2SLS estimates. If this difference exists, it follows that the variable is endogenous and it is preferable to use 2SLS.
[74] Details on the components and on the methodology of aggregation are reported in section 6.5.
[75] The fact that also the core part of the literature here cited specifies an asset-based indicator of wealth as exogenous should not be misleading: the meaning of this variable and the reasons of its exogeneity mark a clear departure from this tradition.

p. 1897), there is no feedback effect between household (or mother's) income and child nutrition; only in extreme cases, when child is seriously malnourished, the mother might decide to work in order to have more income for food and medicines. Thus, OLS estimates with exogenous permanent income (whether expenditures or wealth) are not likely to suffer from a large bias.[76]

A discussion is needed also regarding mother's schooling. In the previous paragraphs it was argued that it is not so evident why mother's schooling, theoretically, should be conceived as 'less endogenous' than household income. In the literature on mother's fertility, for instance, Bratti (2003) has treated mother's schooling as endogenous, and chose the availability of context schools as instruments. However, a different argument can be adopted with reference to developing countries. Glewwe (1999, p. 129, n.6) asserts: 'The assumption that parental education is exogenous seems reasonable for Morocco, where average schooling for men and woman between the ages of 18 and 65 is only 4.7 and 2.3 years, respectively'. Since this seems a reasonable line of arguments, this work follows the same procedure, but just referred to parents of children in the age group 0-5. DHS data show that in Mozambique the average years of schooling is 2.23 for mothers and 4 for fathers. Furthermore, in the case of mothers the standard deviation is not very high, and almost half of them have zero years of formal education. This low and fairly homogenous values are probably due to lack of an adequate number of quality schools, and especially, to a very low number of secondary and higher schools. The conclusion is that the hypothesis of exogeneity of mother's schooling in Mozambique seems acceptable.

One final point is about mother's access to information. Here, the same arguments of Thomas et al. (1991) are proposed. Mother's frequency of watching TV, listening to radios, and reading newspapers is a pathway between mother's schooling and child food security only behind the assumption that these media disseminate information about good nutrition, health, and hygienic practices. These variables reflect something that cannot be observed: nutrition knowledge. Thus, due to omitted variables, OLS estimates are inconsistent and mother's access to information should be specified as endogenous. This assumption is tested using the Wu-Hausman statistic, using the availability of radios and televisions in the cluster area as instruments.

[76] Among others, Gibson (2002) analyzes the possible bias in OLS models due to measurement error.

6.5 Dataset

The source of data is the 2003 Demographic and Health Survey (DHS) in sample areas of Mozambique. The sample is stratified at three levels: 604 'primary units' (229 urban and 375 rural), 299 clusters, and 11 Provinces. Data were available for 8,957 children below five, who were still alive at the moment of the survey. Children dead in the period preceding the survey were not considered due to the impossibility of measuring their height. In a second step, other 1,836 observations were dropped due to missing or 'flagged' values in child HAZ, mother's nutritional status, and father's schooling. Thus, the final analysis was carried out on 7,121 Mozambican children in the crucial age between 0 and 5. Here below the full set of variables used for the quantitative analysis is described.

6.5.1 Child Characteristics

Child HAZ

Child height-for-age, the dependent variable, is firstly a proxy for child nutritional status; however, it has been frequently used to indicate child health. This research advocates the use of this indicator as a proxy for (long-run) food security. Some authors (e.g. Garrett and Ruel 1999) have used food or calories availability as a measure of child food security; however, this is associated to an older and unsatisfactory conceptualization of food security. Taking as a reference the definition given at the World Food Summit (FAO 1996), the concept of food security takes into account many more dimensions than just food availability: economic and physical access to food, stability in the access, and utilization of food. With reference to household food security, Maxwell (1992, pp. 98–99) defines height-for-age and weight-for-height as indirect 'outcome' indicators of food security. Height-for-age measures long-term food security, while weight-for-height measures short-term food security. When using one of the two indicators it is always necessary to keep in mind that anthropometric variables measure something more than food security.[77] However, from the time of Maxwell's writing and the year (1996) of the World Food Summit, there seems to be a further movement towards a nutrition-oriented concept

[77] Maxwell argues that another limit of a nutritional indicator such as height-for-age is that it responds only late to food crisis. However, this does not undermine its use in this analysis, since the aim is just to identify the determinants of child long-term food security, and not timely policies to respond to food crisis.

and indicator of food security. The same arguments can be extended from the household level to the level of children.

The variable adopted for this research is the height-for-age Z-score for children below five of age because the aim is to assess how mother's education affects child food security in the long run. The Z-score is adjusted for child's sex and age, and measures how close the child is to the NCHS/WHO reference population.[78] A child is defined 'moderately stunted' when her or his Z-score is -2 or less, and 'severally stunted' when it is -3 or less.

Child's Age

In theory, child HAZ already incorporates the age differentials. Thus, there should not be any 'age effect'; however, many studies prove the opposite. As Morales et al. (2005, p. 5) pointed it out, 'the age effect can be interpreted as *the effect of some non-observed variables affecting child health at a specific age*' (emphasis in original). For such a reason, this study included a quantitative variable for child's age, measured in months.

Child's sex

A similar argument works with regard to child's sex, whose effect should already be caught by HAZ. Unlike child's age, there is no empirical evidence whether nutritional indicators are better for male or female children.

6.5.2 Mother's Characteristics

Mother's Age

Differently from others, this study uses a quantitative variable for mother's age (in years), rather than a set of binary variables for mother's age groups. In this way, less information is lost.

Mother's Age at first child's birth

Mother's age at first child's birth might reflect mother's health and other background characteristics of mother and household.

[78] The nutritional parameters of North American children and women at the beginning of the 20th century were conceived as 'ideal'; thus, such a population was defined by WHO as the reference one for both children's and women's anthropometry.

Mother's current Marital Status

One binary variable was added to show if child food security differs depending on the current marital status of the mother. It takes value 1 if the woman is currently married and value 0 if she was married in the past or never married.

Mother's Schooling

The whole literature on returns to education measures the economic benefits deriving from one additional year of formal education. The variable, usually selected for this purpose, is 'years of schooling'. The (unrealistic) assumption is that the marginal return to education is constant, i.e. it is the same at any level of the distribution. The majority of authors dealing with child health have used this variable (Glewwe 1999; Thomas et al. 1991; Morales et al. 2005). Another substantial problem is connected to the use of this variable: it does not provide information on school drop-rates. Here, on the contrary, mother's educational attainments were measured by four binary variables, expressing whether the mother has reached that level of education or not. The variables are: 'incomplete primary education', one for 'complete primary education',[79] one for 'incomplete secondary education', and one for 'completed secondary or higher education'.[80] This way, it is assumed that the marginal returns to education are neither constant nor linear because the number of years of each educational attainment is variable. Although still related to only formal education, it reflects an outcome, and allows to answer the second crucial question of this research: which level of mother's education is crucial for child food security?

None of the models contains a variable for mother's literacy. This is because in DHS surveys the ability to read and write is tested only on those that do not have completed primary education, while it is assumed that those with complete primary education are necessarily literate. It follows that literacy data do not provide much further information than formal education data.[81]

Mother's Nutrition

In the DHS dataset, there are two main anthropometric measures for mothers. The first is the height-for-age Z-score, which is calculated with the same rationale

[79] In Mozambique, a person has to successfully overcome seven years of formal education to complete the primary education cycle, and additional five years to complete secondary education.

[80] For example, 'complete primary education' takes value 1 when the mother has at least completed primary schooling and value 0 when she has no years of education or just some years of primary schooling.

[81] Furthermore, in the models it is likely to cause multi-collinearity.

outlined for children. The second is the body mass index (BMI), a typical indicator of nutritional status for adult women. Body mass index is obtained dividing mother's weight in kilograms by the square of her height in meters. Even in this case, nutritionists fixed a cut-off point, 18.5, below which a woman suffers from poor nutritional status.

Mother's Access to information

It was measured by whether child's mother frequently watches television, reads a newspaper, or listens to radio.[82] However, as pointed out in section 6.4, access to information is endogenous. In order to apply 2SLS technique for the estimation of equation 4, it is required to have one single, quantitative, variable of access to information.[83] Following literature and governmental documents, the aggregate indicator *Accessinfo*, which is a proxy for total mother's access nutrition information, was constructed. Further information on the construction of this indicator is reported in Annex 6.

6.5.3 Father's Characteristics

Data on father's age and nutrition cover only a small part of the observations, thus these two variables are not used in the analysis.[84] The only father's characteristic is his education. Since the focus of this research is on mother's education, it was decided to use the quantitative variable 'father's years of schooling'. This avoids to add other binary variables, since a model is better specified when there are more quantitative variables; at the same time, the informational capacity of father's education is sufficiently caught by this variable.

6.5.4 Household Characteristics

Household composition

Household size is the number of household members. Another variable (*membunder5*) is the proportion of household members with less than five years of age.

[82] Frequently here means 'at least once a week'.
[83] With a binary variable as endogenous predictor, performing the first-stage of 2SLS is complicated.
[84] The original unit of analysis of DHS data is the household. Here mother's husband or partner is assumed to be child's father.

Household Permanent Income

In the DHS surveys there are no questionnaires on household consumption or expenditures, and the wealth index is used as a proxy for permanent income. Many studies have showed that in developing countries an asset-based indicator of wealth 'represents a more permanent status than does either income or consumption' (Rutstein and Johnson 2004, p. 4). Thus, it is closer to an idea of permanent income. Some of these works have even outlined how a wealth index might perform better especially in explaining child nutrition, mortality, and educational attainment (Sahn and Stifel 2000; Montgomery et al. 2000; Filmer and Pritchett 1999). A good part of this literature directly refers to the DHS wealth index or to other indicators constructed with the same methodology and similar variables.

The DHS wealth index aggregates a set of variables concerning the ownership of assets (e.g. car, bicycle and refrigerator), ownership of land, the type of flooring, and use of public utilities (e.g. electricity, water, public well and public sewerages), in addition to few quantitative variables such as number of persons per sleeping room. First, categorical variables were broken into groups of dichotomous variables and quantitative variables are adjusted for household size and age (Rutstein and Johnson 2004, p. 7). Then, weights to each component were assigned through principal component analysis.[85] In the following step, each household was assigned a standardized score for each asset, depending on whether or not the household owned that asset, or depending on the number of people per room. The final household wealth index, obtained summing all the indicator values, is a standardized score with mean zero and standard deviation one; thus, poor households have negative values because they lack several assets (Rutstein and Johnson 2004, p. 9).

6.5.5 Context Characteristics

Availability of Media

The proportion of households owning a television and the proportion owning a radio in a geographical area were used as instrumental variables for the endogenous factor 'mother's access to information'. Data on potential household ownership of these two assets were aggregated at the level of clusters. Thus, communities, here, are the 299 'clusters' of the DHS survey. While it would be preferable to use data from a different source, this was not possible due to data scarcity.

[85] This procedure is usually preferred to one that implies an arbitrary choice by researchers.

Availability of Electricity

The proportion of households in a geographical context that has electricity at home is an important aspect of the physical and social environment in which a child lives.

Availability of Toilet Facilities

Toilet facilities are a widely used proxy for hygienic conditions at household and geographical context level. A household was considered as having toilet facilities besides the quality and typology of them. This variable was, finally, aggregated at clusters' level.

Children Mortality Rate

Mortality rate of children below 5 in the five years preceding the survey represents the health environment of a cluster area. Building on the capability approach, this is a relevant 'functioning', distinguished by health resources that are instruments to improve children health. The aggregation procedure was the same applied to previous covariates.

Quality of Education

The DHS dataset does not contain data on the quality of education.[86] However, following also in this case the capability approach, it is possible to argue that the educational environment can be better represented by functionings such as literacy in a geographical area, rather than by indicators related to number of schools or teachers. The variable used here was mother's literacy rate at cluster level. Mothers were assumed to live in the same geographical context where they lived during school age.

Place and Province of Residence

Finally, eleven dummy variables for the Provinces were included, together with a dummy for the place of residence (0=urban, 1=rural).[87]

[86] Basic information such as number of schools per population and number of teachers per pupils was obtained from the Mozambican Ministry of Education and Institute of National Statistics; however, they refer only to provinces and are not broken down by place of residence (urban and rural areas).

[87] As stated in section 5.2.1, DHS follows the definition of 'rural areas' provided by each country. Rural areas are those with low population density, far from cities, and with poor infrastructures.

6.6 Descriptive Analysis

Table 8 presents descriptive statistics.[88] The first element of concern pertains to child HAZ. Since children with more than -2 standard deviations have a poor nutritional outcome, the fact that, on average, a Mozambican child has -1.680 as Z-score is alarming. Furthermore, the minimum value is 6, i.e. far below the condition of severe malnutrition. The situation regarding mothers is only slightly better: their mean height-for-age Z-score is -1.377.

Women have the first child at an early age (18, on average) and this is likely to contribute negatively to child nutrition. For instance, they cannot attend school besides the very first years: more than half of them did not even start primary education and only 0.4 percent of them have at least completed secondary education.

Table 8. Descriptive Statistics

	Mean	St. Dev.	Min.	Max.
Child HAZ (0-5)	-1.680	1.415	-6	4.78
Child ‘s age (in months)	27.973	17.160	0	59
Child is female?	0.501	0.500	0	1
HH Size	7.119	3.551	2	34
Proportion of HH members < 5	0.322	0.122	0.029	0.750
Mother’s age	28.673	7.208	15	49
Mother’s age at first birth	18.388	3.432	10	39
Mother is currently married	0 .902	0.296	0	1
Mother’s primary incomplete	0.572	0.494	0	1
Mother’s primary complete	0.069	0.254	0	1
Mother’s secondary incomplete	0.043	0 .203	0	1
Mother’s secondary complete/higher	0.004	0.063	0	1
Mother’s HAZ	-1.377	1.013	-5.320	4.230
Mother’s Body Mass Index	22.050	3.070	13.150	49.760
Father’s years of schooling	3.999	3.214	0	19
Wealth index	-0.125	0.842	-0.755	4.715
Mother’s Access to information (*Accessinfo*)	1.568	1.607	0	4.5
Mother frequently watches TV	0.099	0.298	0	1
Mother frequently listens to radio	0.482	0.499	0	1
Mother frequently reads newspaper	0.023	0.151	0	1
Cluster TV availability	0.105	0.025	0.060	0.428
Cluster radio availability	0.616	0.022	0.486	0.711
Children 0-5 mortality rate	0.112	0.063	0	0.418
Availability of electricity	0.561	0.034	0.490	0.777
Toilet facilities	0.537	0.043	0.423	0.781
Quality of education	0.282	0.254	0	1
Rural area?	0.670	0.469	0	1

Sample size = 7,121

[88] Statistics on the Provincial dummies are not reported.

Regarding mother's access to information, these data show that both availability and frequency of use of radios is much higher than that of other mass media.[89]

The wealth index, as explained in the previous section, takes both positive and negative values; the mean is -0.125. Since it is a standardized score constructed on the whole households sample, a negative mean shows that the households with children below five of age are relatively poorer than the other households (see Annex 7). Finally, another interesting point concerns children mortality rate: in different communities it varies between an ideal zero and a dramatic 55.5 percent.

In a second stage, an exploratory analysis is undertaken in order to investigate the correlation between the covariates more interesting for this research. Table 9 reports Pearson's coefficients.

Child HAZ is highly correlated with mother's height and household wealth index, but also with father's years of schooling and the aggregate indicator of mother's access to information. The linear relationship between child food security and the first two covariates of mother's schooling – incomplete and complete primary education – is fairly high: 0.137 and 0.131. This linear relationship sensitively decreases with the other two dummy variables, i.e. mother's incomplete secondary education and complete secondary education or higher: Pearson's rho is 0.107 and 0.055, respectively. Correlation between mother's educational attainments and household permanent income (wealth index) is also high, but it follows a different pattern. The wealth index is more correlated with incomplete primary education, then with incomplete secondary education, thirdly with incomplete primary education, and finally with complete secondary education or higher. Therefore, it seems that the form of the relationship between mother's education and wealth, on the one hand, and mother's education and child HAZ on the other, is different. A further examination, through scatter plots, is necessary.

[89] Data on availability of newspapers in the communities are not included in the DHS dataset.

Table 9. Correlation Matrix [a]

	Child HAZ	Mother's HAZ	Inc.Primary	Comp.Primary	Inc.Secondary	Comp.Sec/ Higher	Wealth index	Father's Schooling	Accessinfo
Child HAZ	1.000								
Mother's HAZ	0.250	1.000							
Inc.Primary	0.137	0.121	1.000						
Comp.Primary	0.131	0.095	0.236	1.000					
Inc.Secondary	0.107	0.085	0.183	0.777	1.000				
Comp.Sec/Higher	0.055	0.051	0.055	0.233	0.300	1.000			
Wealth index	0.230	0.192	0.363	0.491	0.474	0.272	1.000		
Father's Schooling	0.180	0.126	0.435	0.402	0.375	0.181	0.534	1.000	
Accessinfo	0.122	0.085	0.229	0.227	0.210	0.086	0.406	0.313	1.000

All coefficients are statistically significant at 0.01 level.

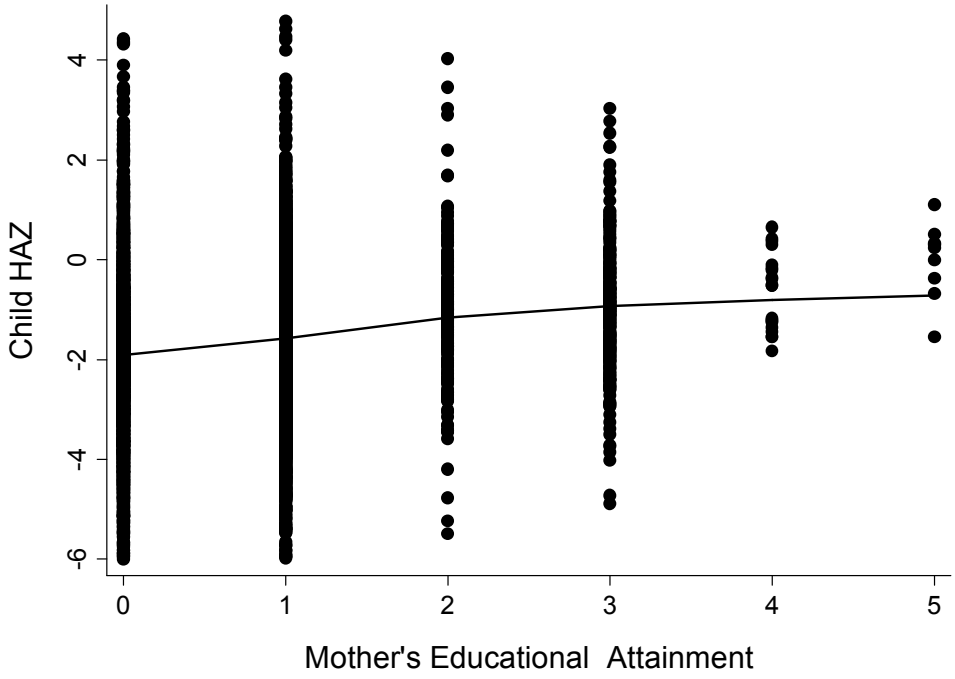
Figure 5 shows the two-way relationship between child HAZ and the original regressor 'educational attainment', before being split into categories: its modalities are 0 = 'no education', 1 = 'incomplete primary', 2 = 'complete primary', 3 = 'incomplete secondary', 4 = 'complete secondary', and 5 = 'higher'. The curve represents the fractional polynomial prediction plot of the distribution with child HAZ as dependent variable. The contribution of an additional level of education is significant and large until the woman reaches level 2; every further level of education does not seem to provide a significant additional contribution to child food security. Furthermore, the line in the interval 1-2 is more sloped than in the interval 0-1. Therefore, this graph suggests that mothers should complete primary education once they have started it, while going beyond that level would provide a marginal contribution to child HAZ close to zero.

Figure 6 shows that a difference exists in this relationship whether mothers live in rural or urban areas. In rural regions, marginal returns of child food security to mother's educational attainment are still close to zero, after completing primary school. To the opposite, in urban regions, these marginal returns seem to be always fairly positive and even increasing especially once mothers complete secondary studies and join higher education.

Different is the relationship between mother's educational attainment and household wealth. Figure 5 shows that mother's education has an increasing marginal influence on household wealth, for any level of education attained. Although this is just a two-way graph with a fitting line, which does not take into consideration all the other possible interacting factors, this empirical evidence is quite relevant, especially if compared with that derived from figure 5. Permanent income, in fact, is considered as one of the channels through which mother's schooling might affect child food security. The link between these two relationships appears more evident if also figure 7 is differentiated according to the place of residence (figure 8).

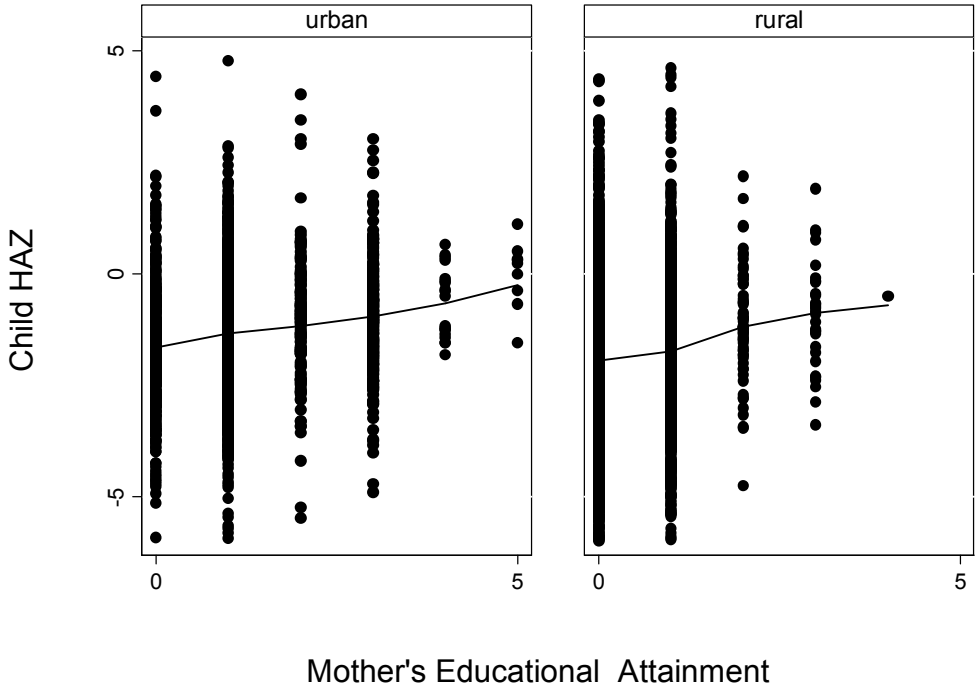
Therefore, combining the preliminary information derived from the four graphs, the econometric results are expected to outline that: a. household wealth does not explain a considerable part of the relationship between mother's education and child food security since figure 5 and 3 are different; b. the impact of mother's education, as well as of other factors, on child food security varies between urban and rural areas. The last point justifies once more the need for a final comparison between rural and urban areas.

Figure 5. Relationship mother's education – child HAZ



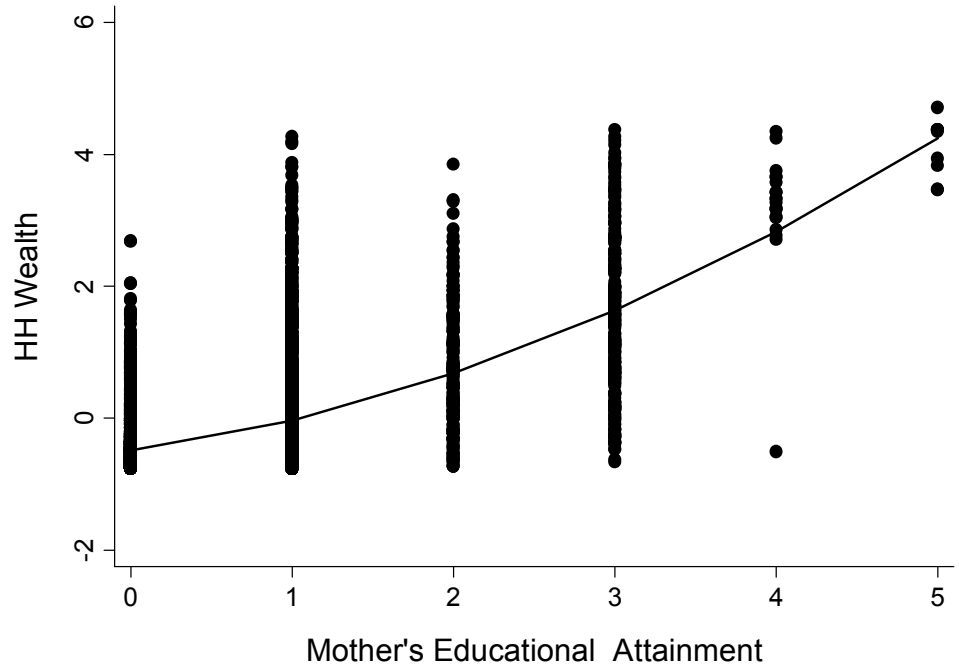
0= No Education; 1= Incomplete Primary; 2= Complete Primary; 3= Incomplete Secondary; 4= Complete Secondary; 5= Higher

Figure 6. Relationship mother's education – child HAZ, by place of residence



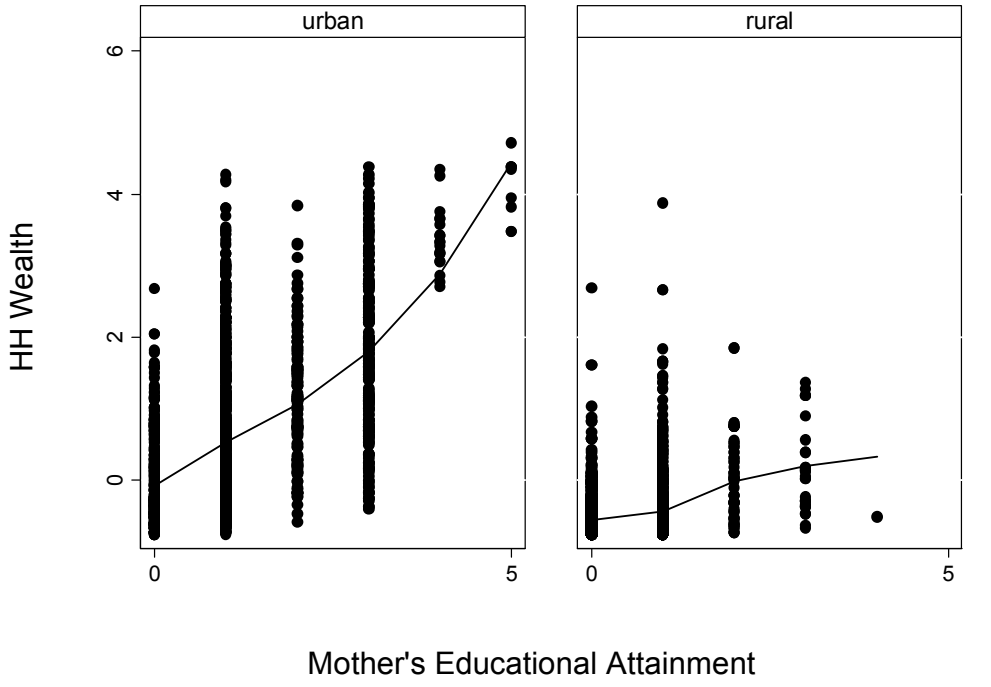
0= No Education; 1= Incomplete Primary; 2= Complete Primary; 3= Incomplete Secondary; 4= Complete Secondary; 5= Higher

Figure 7. Mother's education – household wealth index



0= No Education; 1= Incomplete Primary; 2= Complete Primary; 3= Incomplete Secondary; 4= Complete Secondary; 5= Higher

Figure 8. Mother's education – household wealth, by place of residence



0= No Education; 1= Incomplete Primary; 2= Complete Primary; 3= Incomplete Secondary; 4= Complete Secondary; 5= Higher

6.7 Estimation Results

This section discusses the estimation results of the equations presented in section 6.3. It is a sequential strategy for the estimation with additional explanatory variables. A preliminary analysis showed that estimates suffer from heteroskedasticity, which leads to biased results. Therefore, all the models presented in this section were run with robust standard deviations.

6.7.1 Estimations without interaction terms

The first column of table 10 presents estimation results of equation 1, i.e. the reduced form without mother's nutrition. Two variables for mother's education are highly significant. Children of mothers with 'some' primary education, and even more with complete primary education are likely to be better nourished. Mother's investment in further levels of education does not provide statistically significant marginal contribution to child food security. Coefficients for most of the other variables have the expected sign. Child's age and household size are negatively correlated with child HAZ; mother's age and the fact that the mother is currently married are positively correlated with child HAZ. An unpredictable result concerns child's gender; in Mozambique it seems that girls have lower probability to be malnourished. Finally, the majority of context characteristics are not significant predictors, except for: a. children mortality rate – proxy for bad health environment – which is negatively correlated with child HAZ; and b. the place of residence: *ceteris paribus*, children living in rural areas are more likely to be food insecure.

Column 2 adds to the model mother's HAZ and body mass index. Following Barrera (1990, p. 87), according to whom there is a direct biological link between mother's and child's nutrition, these variables are included to see if column 1 sensitively overestimated the benefits of mother's education. The first change in model 2 is the raise of the r-squared: while the variance of the model in column 1 explains 11.5 percent of the total variance, the variance of the model in column 2 explains 16.5 percent of the total variance. Furthermore, both the coefficients associated to *MotherHAZ* and *MotherBMI* are highly significant (p-value = 0.000). This shows that mother's nutrition has a strong explanatory power on child food security. Regarding mother's education, even in this case, whether or not the woman began or completed secondary education does not affect the dependent variable. The

significance and the size of the positive contribution of mother's incomplete and complete primary schooling are lower than in the previous model.[90] However, even controlling for mother's nutrition, both the regressors are still important determinants of child food security. Results suggest that a child with a mother that has some primary education has a height-for-age Z-score approximately 0.100 higher than that of a child with an uneducated mother. Moreover, a child of a mother that completed primary education has a height-for-age Z-score 0.255 higher than a child whose mother just began primary school. This is what was defined the overall impact of mother's education. The estimates for the other covariates are substantially unchanged, except for the health environment at cluster level: its impact is now significant only at 0.1 level and the size of such an impact declines by about 41 percent.

Column 3 reports estimation results of equation 3, where household wealth is included as first pathway of impact. The fit of the model, measured by the r-squared, increases from 0.165 to 0.169. Household wealth is largely significant, but nothing can be specified about the size of its impact on child HAZ because it is not expressed in a comparable unit of measurement.

The addition of wealth causes a further decline in the influence of mother's schooling. The most evident decline is in mother's complete primary education; its coefficient falls by 27.5 percent (from 0.255 to 0.185) and it is now significant only at 0.1 level (p-value = 0.051). Model 3 presents an unexpected outcome: mother's incomplete secondary education is now significant at 0.1 level and highly negative. The finding is clearly counter-intuitive: a child of a mother that begins secondary studies has around 0.22 height-for-age Z-scores less than a child of a mother who left school after completing primary education. The interpretation of this negative marginal contribution of mother's schooling is not straightforward: in theoretical terms, it might be that mothers with higher education are not willing to accept low paid jobs or that the additional time spent in schools has a negative influence on child nutrition due to lower time spent in child care. However, further estimates will point out that none of these explanations is very powerful.

[90] The size of the impact falls respectively by 25 percent and 18 percent.

Table 10. Determinants of Child Food Security [a]

Dependent variable: Child HAZ	(1) OLS Without Moth_Nutrition	(2) OLS Overall education effect	(3) OLS Add the Wealth Index	(4) 2SLS[b] Add endogenous Accessinfo	(5) OLS Add exogenous Accessinfo
Constant	-1.876***	-2.486***	-2.733***	-2.792***	-2.762***
	(0.362)	(0.371)	(0.373)	(0.525)	(0.374)
Child Characteristics					
Child's Age	-0.017***	-0.018***	-0.018***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Child's sex (female=1)	0.110***	0.109***	0.110***	0.095**	0.109***
	(0.031)	(0.030)	(0.030)	(0.037)	(0.030)
Mother Characteristics					
Mother's Age	0.014***	0.008***	0.008***	0.011***	0.008***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Mother's Age at 1st birth	-0.005	-0.006	-0.007	-0.004	-0.007
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Mother is currently married	0.203***	0.211***	0.187***	-0.064	0.179***
	(0.053)	(0.052)	(0.052)	(0.181)	(0.052)
Mother's Incomplete Primary Education	0.127***	0.095**	0.090**	-0.022	0.087**
	(0.038)	(0.037)	(0.037)	(0.089)	(0.037)
Mother's Complete Primary Education	0.311***	0.255***	0.185*	0.165	0.185*
	(0.100)	(0.095)	(0.095)	(0.113)	(0.095)
Mother's Incomplete Secondary Education	-0.137	-0.129	-0.226*	-0.239*	-0.226*
	(0.121)	(0.117)	(0.117)	(0.137)	(0.117)
Mother's Complete Sec. Education or Higher	0.260	0.021	-0.217	0.151	-0.205
	(0.176)	(0.180)	(0.188)	(0.336)	(0.188)
Mother's HAZ		0.306***	0.300***	0.288***	0.300***
	—	(0.015)	(0.015)	(0.020)	(0.015)
Mother's BMI	—	0.046***	0.041***	0.037***	0.041***
		(0.005)	(0.005)	(0.006)	(0.005)
Mother's Access to Information (*Accessinfo*)	—	—	—	0.577	0.019*
				(0.395)	(0.010)
Father Characteristics					
Father's Years of Schooling	0 .042***	0.034***	0.027***	0.000	0.026***
	(0.006)	(0.005)	(0.005)	(0.020)	(0.006)

Household Characteristics					
Household Size	-0.010**	-0.014***	-0.016***	-0.017***	-0.016***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
Household Members < 5	0.096	0.124	0.196	0.408*	0.203
	(0.143)	(0.142)	(0.143)	(0.218)	(0.143)
Household Permanent Income	—	—	0.191***	-0.193	0.178***
			(0.029)	(0.266)	(0.030)
Context Characteristics					
Availability of Electricity	0.042	0.404	0.241	0.154	0.238
	(0.410)	(0.385)	(0.402)	(0.467)	(0.402)
Availability of Toilet Facilities	0.572	0.678	0.534	0.841	0.544
	(0.518)	(0.510)	(0.507)	(0.627)	(0.507)
Children Mortality Rate	-0.882***	-0.516*	-0.537*	-0.913**	-0.550**
	(0.287)	(0.278)	(0.277)	(0.418)	(0.278)
Mothers' Literacy Rate	0.127	0.079	-0.042	-0.124	-0.045
	(0.131)	(0.123)	(0.124)	(0.154)	(0.124)
Rural Area	-0.169***	-0.135**	-0.064	-0.018	-0.063
	(0.054)	(0.052)	(0.053)	(0.071)	(0.053)
R-squared	0.115	0.165	0.169	—	0.170
Wu-Hausman Endogeneity Test (P-value)				0.100	
C-Statistic (P-value)	—	—	—	0.099	—
Wald Test for joint significance:					
1. Incompl. Primary - Wealth	—	—	F-St = 24.65***	F-St = 0.55	F-St = 20.54***
2. Compl. Primary - Wealth	—	—	F-St = 24.90***	F-St = 1.45	F-St = 21.07***
3. Incompl. Secondary - Wealth	—	—	F-St = 21.86***	F-St = 1.74	F-St = 18.39***
4. Compl. Secondary - Wealth	—	—	F-St = 21.35***	F-St = 0.28	F-St = 17.77***
5. Incompl. Primary - Accessinfo	—	—	—	F-St = 3.31**	F-St = 4.71***
6. Compl. Primary - Accessinfo	—	—	—	F-St = 2.44*	F-St = 3.59**
7. Incompl. Secondary - Accessinfo	—	—	—	F-St = 2.46*	F-St = 3.51**
8. Compl. Secondary - Accessinfo	—	—	—	F-St = 1.56	F-St = 2.27*

*** = significant at 0.01-level, ** = significant at 0.05-level, * = significant at 0.10-level.

Sample size = 7,121

Robust standard errors in parenthesis.

a. For simplicity results for the 11 Provincial dummy variables are not reported.

b. Endogenous variable: *Accessinfo*. Instruments: proportion of households owning a radio in each cluster area (*clusteRadio*).

Regarding the other regressors, father's schooling slightly decreases with the inclusion of the wealth index, but it still has a largely significant influence. A further examination of which level of father's education affects the most child HAZ would be necessary to deepen this correlation. A similar decrease, small in both significance and size, occurs to both mother's HAZ and mother's BMI, while only the (negative) impact of children mortality rate in the communities raises compared to model 2. Whether children live in rural or urban areas, now, does not make a difference.

Finally, column 3 presents the results of Wald tests of joint significance of the different levels of mother's education and household wealth. All the tests are significant at 0.01 level, which means that even the education variable – *Mother's Complete Secondary Education* – that alone is not significant, becomes significant jointly with household wealth.

The following step concerns the estimation of equation 4, which is a conditional estimate function because of the probable endogeneity of mother's access to information, incorporated as second potential channel through which mother's schooling affects child nutrition. Column 4 and 5 present respectively 2SLS (*Accessinfo* specified as endogenous) and OLS estimates.

The 2SLS estimates were obtained with mother's *Accessinfo* instrumented by the proportion of households owning at least one radio. This was found to be the best instrumental variable, so as the first stage confirms (see Annex 8). Two slightly different tests of endogeneity were run on this model: the traditional Wu-Hausman test and the C-statistic. The results are very similar: in both cases the p-value is approximately 0.1, which means that the null hypothesis of exogeneity of *Accessinfo* cannot be rejected. However, due to a certain degree of uncertainty in these tests, the 2SLS estimates are here commented and compared to OLS estimates of column 5.

The education variables are not significant predictors of child food security. Father's schooling, mother's incomplete and complete primary education entirely loose significance, while mother's incomplete secondary education provides a significant, but still negative contribution. These results, compared to all previous ones, drastically downgrade the benefits of education. However, immediate conclusions should not be derived and estimates should be interpreted always keeping in mind that *Accessinfo* in the best case is only weakly endogenous; thus, 2SLS estimates are likely to suffer from larger bias than OLS estimates. Mother's access to information positively influences child HAZ, but its coefficient is significant only at 0.15 level. However, the Wald tests show that mother's

incomplete primary education has a strong significance jointly with her capacity to process information. Finally, the other explanatory variables are smaller in both significance and size of impact compared to model 3, with the exception of health environment.

The fifth model, an OLS estimation of a reduced-form with exogenous mother's access to information, offers a very different picture. Mother's access to information, as a proxy for unobserved nutrition knowledge, is significant at 0.1 level. Mother's schooling, unlikely in model 4, is an important determinant of child HAZ: coefficients and standard deviations are about the same of those in column 3 (without *Accessinfo*). Only incomplete primary education provides a slightly lower contribution. This would partly suggest that, if specified as exogenous, mother's access to information is important, but it is not a key channel through which mother's education affects child nutrition. However, the Wald tests show that an interaction between the two predictors exists. Next step – addition of interaction terms – provides final keys of understanding.

6.7.2 Estimations with interaction terms

The Wald tests in table 10 show that mother's schooling can interact with her capacity to process information and with her contribution to household permanent income in order to improve the food security of her child. Thus, in table 11 it was chosen to include some interaction terms and see more deeply if these regressors are complementary. One important point concerns which interactions should be considered. Adding all the possible interaction terms would produce a multicollinearity bias. Following the significance of Wald tests (column 4 and 5 of table 10), and after some preliminary regressions, it was chosen to add two cross-products: 'mother's incomplete primary education*mother's access to information' and 'mother's incomplete secondary education*wealth index'.

Before presenting estimation outcomes, few words should be spent on the possible theoretical interpretation of the coefficients associated to the newly inserted variables. These interaction terms should be conceived as additional ways to study the pathways of influence of mother's education on child HAZ. This is because it seems reasonable to assume that mother's incomplete primary education affects her ability to access nutrition information; the inverse causality is much weaker. Moreover, having some secondary education is likely to have an impact on

household permanent income, while the reverse relationship is weaker in the context of Mozambique (see top part of diagram 3), due to low level of women's schooling and to the limited availability of school facilities.[91]

Finally, table 11 reports again the outcome of 2SLS and OLS models without interaction terms (column 1 and 2) just for purposes of comparison and presents the new models in the last two columns. Column (3) shows 2SLS estimates. The null hypothesis of endogeneity of *Accessinfo* cannot be rejected using the traditional Wu-Hausman test, while it can be rejected at 0.1 level adopting the C-statistics. The two instruments – availability of radios and televisions in cluster areas – are correlated with *Accessinfo* (see Annex 9), but they are not exactly identified: the likelihood-ratio (LR) test does not reject the hypothesis of redundancy of *clusterTV*. However, when used as the only instrument, *clusteRadio* is not correlated with *Accessinfo*. Although this model suffers from very weak endogeneity and probable overidentification of instruments, it might be interesting to analyze some results.

The inclusion of interaction terms has important repercussions on education variables. Compared to model 1 (table 11), in model 3 the (negative) influence of mother's incomplete secondary schooling looses significance; this suggests that there is some interaction between schooling and wealth, although, in this case, their cross-product is not significant. To the opposite, whether or not a mother has completed primary education is an essential determinant of child food security.

Model 4 – with exogenous *Accessinfo* – is preferable from a statistical perspective.[92] The r-squared is 0.171, perfectly in line with many other OLS estimates of child nutrition models (Barrera 1990; Glewwe 1999; Aturupane et al. 2006). The coefficient associated to the interaction term between secondary schooling and wealth is highly significant, and, differently from model 1 and 2, mother's incomplete secondary education does not alone provide a contribution. Also the size of influence of the wealth index rises. The negative sign of the coefficient of the cross-product should not mislead us: following Wooldridge (2003, p. 191), the joint contribution could be quantified by multiplying the coefficient of the interaction term by the mean of household wealth. Since the latter is negative, the complementary contribution to child nutrition is positive.[93] The combined influence of these two factors should be interpreted with the idea that it is more education that

[91] This is nearly the same explanation used to justify the exogeneity of schooling in Mozambique.
[92] For the full set of post-estimation tests utilized to verify the validity of the model, see Annex 10.
[93] However, due to the nature of the DHS wealth index, it is difficult to interpret the magnitude of this effect.

increases income than *vice versa*, but the latter is not zero.[94] Different is the situation of the categorical variables of incomplete and complete primary schooling: both of them are highly significant. Concluding from this final model, a child whose mother has attended some primary schooling has a better nutritional status than a child whose mother has no education by around 0.114 Z-score. Then, if the mother attends school until the completion of primary studies, her child has 0.171 Z-scores more than a child of a mother with only some primary school. Mother's access to (nutrition) information is, again, significant and its coefficient larger than in model 2. The interaction with primary education, instead, is not significant.

Combining the information from 2SLS and OLS estimations, it is possible to argue that completing primary education is fundamental for mothers who want to improve their children's nutrition. Although the results differ in the two models, and the 2SLS estimator generally tends to underestimate (or the OLS estimator tends to overestimate) the relevance of some determinants, in both cases mother's complete primary education makes a substantial difference. The only difference is that model 3 suggests that child HAZ improves only when mothers complete primary education, while model 4 suggests that this improvement is gradual. With regard to the pathways of influence, these results suggest that primary schooling operates both directly and indirectly. The direct impact occurs because attending school, acquiring knowledge about specific subjects in school, and changing values/preferences are fundamental. Having especially incomplete primary education does not improve child nutrition through increasing household wealth, while it partially acts through nutrition knowledge. In fact, although the interaction of primary education with *Accessinfo* is non-significant, *Accessinfo* alone has a positive impact, which is fairly larger in a model without primary education (here not reported). This suggests that, in some cases, mother's access to information influences child HAZ only if the woman has at least a minimum level of formal education and that possibly the latter affects the former through an additional channel such as literacy or general knowledge. However, the two factors are not highly complementary also because listening to and elaborating information from radio, the most used media, does not require as much as education as, say, reading newspapers. Finally, the use of variables closer to nutrition knowledge such as those utilized by Glewwe, would

[94] The significance of this interaction term could be interpreted in the sense that mother's incomplete secondary schooling is a good proxy for household wealth: this would further limit the influence of this covariate.

probably lead to a larger significance of the individual contribution of such a factor and of its interactive effect with primary schooling.

Access to levels of education beyond primary is not statistically relevant. While the model without interaction terms suggests that having some secondary education might provide a negative contribution, the model with interaction terms emphasizes that incomplete secondary education alone has not significant effect on child food security, and it has a positive effect when interacts with the wealth index. This is perfectly coherent with the results of preliminary analysis: mother's schooling gives a decreasing marginal contribution to child HAZ (figure 5) and an increasing (or constant) marginal contribution to wealth (figure 7). Since, however, increasing wealth is only one of the pathways, the overall impact of secondary education exists, but it is limited.

These results concerning the 'quantity' of formal education are partly integrated by the quality aspect: mother's literacy rate in the cluster area, although by itself non-significant. It follows that those outlined above are the contributions of mother's access to primary and secondary school, given the quality of educational environment.

Table 11. Determinants of Child Food Security: Adding Interaction Terms [a]

Dependent variable: Child HAZ	(1) 2SLS[b] Without Interaction Terms	(2) OLS Without Interaction Terms	(3) 2SLS[c] Add Interaction Terms	(4) OLS Add Interaction Terms
Constant	-2.792***	-2.762***	-3.588***	-2.762***
	(0.525)	(0.374)	(1.040)	(0.375)
Child Characteristics				
Child's Age	-0.018***	-0.018***	-0.018**	-0.018***
	(0.001)	(0.000)	(0.001)	(0.000)
Child's Sex (female=1)	0.095**	0.109***	0.091**	0.110***
	(0.037)	(0.030)	(0.042)	(0.030)
Mother Characteristics				
Mother's Age	0.011***	0.008***	0.006	0.008***
	(0.003)	(0.002)	(0.003)	(0.002)
Mother's Age at 1st birth	-0.004	-0.007	0.010	-0.007
	(0.006)	(0.005)	(0.014)	(0.005)
Mother is currently married	-0.064	0.179***	0.020	0.179***
	(0.181)	(0.052)	(0.134)	(0.052)
Mother's Incomplete Primary Education	-0.022	0.087**	1.433	0.114**
	(0.089)	(0.037)	(0.993)	(0.046)
Mother's Complete Primary Education	0.165	0.185*	0.320**	0.171*
	(0.113)	(0.095)	(0.146)	(0.095)
Mother's Incomplete Secondary Education	-0.239*	-0.226*	-0.042	0.035
	(0.137)	(0.117)	(0.162)	(0.150)
Mother's Complete Sec. Education or Higher	0.151	-0.205	0.104	0.070
	(0.336)	(0.188)	(0.204)	(0.199)
Mother's HAZ	0.288***	0.300***	0.281***	0.300***
	(0.020)	(0.015)	(0.025)	(0.015)
Mother's BMI	0.037***	0.041***	0.042***	0.040***
	(0.006)	(0.005)	(0.007)	(0.005)
Mother's Access to Information (*Accessinfo*)	0.577	0.019*	1.149	0.032*
	(0.395)	(0.010)	(0.841)	(0.017)
Father Characteristics				
Father's Years of Schooling	0.000	0.026***	0.001	0.025***
	(0.020)	(0.006)	(0.019)	(0.006)
Household Characteristics				

Household Size	-0.017***	-0.016***	-0.022***	-0.017***
	(0.005)	(0.004)	(0.006)	(0.004)
Household members < 5	0.408*	0.203	0.337	0.210
	(0.218)	(0.143)	(0.204)	(0.143)
Household Permanent Income (wealth index)	-0.193	0.178***	0.056	0.218***
	(0.266)	(0.030)	(0.129)	(0.032)
Context Characteristics				
Availability of Electricity	0.154	0.238	0.420	0.269
	(0.467)	(0.402)	(0.528)	(0.402)
Availability of Toilet Facilities	0.841	0.544	0.211	0.531
	(0.627)	(0.507)	(0.650)	(0.508)
Children Mortality Rate	-0.913**	-0.550**	-0.752**	-0.559**
	(0.418)	(0.278)	(0.381)	(0.278)
Mothers' literacy rate	-0.124	-0.045	-0.014	-0.053
	(0.154)	(0.124)	(0.155)	(0.124)
Rural Area	-0.018	-0.063	-0.003	-0.048
	(0.071)	(0.053)	(0.077)	(0.053)
Interaction Incompl. Secondary – HH wealth	—	—	-0.049	-0.178***
			(0.117)	(0.060)
Interaction Incompl. Primary – Accessinfo	—	—	-1.086	-0.024
			(0.800)	(0.020)
R-squared	—	0.170	—	0.171
Wu-Hausman Endogeneity Test (P-value)	0.100	—	0.095	—
C-Statistic (P-value)	0.099	—	0.102	—
LR instruments redundancy test P- value (H_0 = clusterTV is redundant)	—	—	0.120	—
Wald Test for joint significance (F-Statistic):				
1. Incompl. Secondary – Wealth	1.74	18.39***		
2. Compl. Secondary – Wealth	0.28	17.77***	—	—
3. Incompl. Primary – Accessinfo	3.31**	4.71***		
4. Compl. Primary – Accessinfo	2.44*	3.59**		

*** = significant at 0.01-level, ** = significant at 0.05-level, * = significant at 0.10-level.

Sample size = 7,121

Robust standard errors in parenthesis.

a. For simplicity results for the 11 Provincial dummy variables are not reported.

b. Endogenous variable: *Accessinfo*. Instrument: proportion of households owning a radio in each cluster area (*clusteRadio*).

c. Endogenous variable: *Accessinfo*. Instruments: proportion of households owning a TV (*clusterTV*) and owning a radio in each cluster area (*clusteRadio).*

6.7.3 Rural vs. Urban Areas

The results of previous models have outlined that there is no significant difference in the likelihood of a child to be food insecure whether he or she lives in rural or urban areas. Now, it is interesting to analyze if size and significance of the impact of each predictor varies whether households live in urban or rural regions. First, each variable was multiplied by the dummy variable for place of residence (1=rural, 0=urban), and finally a regression with all the original variables and the cross-products as predictors of child HAZ was run. Table 12 presents the output.

Table 12. Determinants of child HAZ: Rural-Urban differences [a]

Dependent variable: *child HAZ*	Coef.	Robust Std. Err.
Child's Age	-0.014	0.001
Child's Age*rural	-0.006***	0.001
Child's sex (Female=1)	0.197	0.048
Child's sex*rural	-0.138**	0.062
Mother's Age	-0.004	0.002
Mother's Age*rural	0.001	0.004
Mother's Age at 1st birth	-0.033	0.008
Mother's Age at 1st birth*rural	0.035***	0.010
Mother is currently married	0.159	0.070
Mother is currently married*rural	0.010	0.105
Mother's Incomplete Primary Education	0.045	0.098
Mother's Incomplete Primary Education*rural	0.034	0.113
Mother's Complete Primary Education	0.130	0.121
Mother's Complete Primary Education*rural	0.155	0.194
Mother's Incomplete Secondary Education	0.032	0.189
Mother's Incomplete Secondary Education*rural	0.044	0.305
Mother's Complete Sec. Education or Higher	0.088	0.200
Mother's Complete Sec. Education or Higher*rural	0.232	0.347
Mother's HAZ	0.351	0.024
Mother's HAZ*rural	-0.068**	0.029
Mother's BMI	0.027	0.006
Mother's BMI*rural	0.015	0.010
Mother's Access to information	0.025	0.036
Mother's Access to information*rural	0.000	0.041
Father's years of schooling	0.030	0.009
Father's years of schooling*rural	-0.011	0.012
Household size	-0.023	0.007
Household size*rural	0.013	0.009
Household members < 5	-0.287	0.229
Household members < 5*rural	0.615**	0.291
Household Permanent Income (wealth index)	0.230	0.036
Household Permanent Income*rural	-0.024	0.077
Availability of Electricity	-0.369	0.562
Availability of Electricity*rural	1.427*	0.771
Availability of Toilet Facilities	-0.484	0.400

Availability of Toilet Facilities*rural	1.725**	0.850
Children Mortality Rate	-0.861	0.394
Children Mortality Rate*rural	-0.003	0.532
Mothers' literacy rate	-0.003	0.142
Mothers' literacy rate*rural	0.245	0.190
Rural Area	-0.080	0.060
Interaction Incompl. Secondary – HH wealth	-0.152	0.071
Interaction Incompl. Secondary – HH wealth *rural	-0.803***	0.254
Interaction Incompl. Primary – Accessinfo	-0.031	0.039
Interaction Incompl. Primary – Accessinfo *rural	0.031	0.048

*** = significant at 0.01-level, ** = significant at 0.05-level, * = significant at 0.10-level. Applied only to cross-products.
a. Model without Provincial dummy variables and without constant.

Neither mother's nor father's schooling have different direct impacts depending on their place of residence. Significance and size of influence of the interaction term between mother's incomplete secondary education and household permanent income, instead, are far larger in rural areas. As pointed out in section 6.7.2, the joint impact of mother's secondary education and wealth is positive; multiplying the negative coefficient associated to the interaction term by the mean of the wealth index (which is negative), produces a positive result. The fact that the coefficient of the interaction term is highly significant and negative means that the interaction between these variables contributes to child food security much more in rural areas.

This suggests that mother's schooling is a key determinant of child height in Mozambique, regardless of her place of residence, but its overall relevance – direct and indirect – is larger in rural areas. That is, broadly speaking, because of the decreasing marginal impact of mother's education for higher initial levels of education, which are clearly registered in urban areas. Thus, those areas that suffer from bigger deprivations – the rural areas – have larger possibility to use mother's education as a significant tool to fight children food insecurity.

6.8 Concluding Remarks and Policy Recommendations

6.8.1 Concluding Remarks

This chapter aimed at answering four questions: 1. Is mother's education important for child food security in Mozambique? 2. Which level of mother's education is crucial? 3. What is the main pathway of influence? 4. Do results differ whether households live in rural or urban areas?

The empirical results strongly support the hard body of literature on child height as measure of nutritional status: mother's schooling (and even father's schooling) provides a positive statistical contribution to child food security. Regarding the level of education, marginal returns in terms of child nutrition to mother's schooling are clearly decreasing beyond complete primary school. Both 2SLS and OLS estimates without interaction terms suggest that a child is far more likely to be better nourished if her or his mother has completed the whole cycle of primary studies. More precisely, a child whose mother has completed primary schooling has at least 0.18 height-for-age Z-scores more than a child whose mother has only some years of primary schooling and around 0.30 Z-scores more than a child whose mother has no education. On the contrary, the marginal contribution of a mother having some secondary education would even negatively affect child HAZ. However, some of these results are rejected with the addition of interactions: secondary schooling does not alone affect child HAZ, but it does affect it through increasing household permanent income. Incomplete primary education, more than complete primary, instead, plays a direct role: attending school, learning some subjects in school, and general changes in preferences and values are crucial (as theorized by the capability approach). It also gives a partial indirect contribution, by acquiring more knowledge on nutrition and related aspects, and much more weakly, by increasing income.

Finally, is there a significant statistical difference between urban and rural areas? While the determinants of child food security are approximately the same, the weight of the influence of some factors varies. Regarding mother's education, there is no difference with respect to the role that each level of education alone plays. However, the coefficient associated to the interaction term between mother's secondary schooling and the wealth index is statistically different in the two areas: the economic channel, thus the contribution of mother's secondary schooling, is more relevant in rural areas. Therefore, the overall benefits of mother's education to child food security are slightly larger in rural regions mainly due to the lower initial educational performances.

6.8.2 Policy Recommendations

Child food insecurity is undoubtedly a dramatic problem in Mozambique and a serious constraint to national development. This work provides empirical evidence

that investing in quality education of women could be an effective policy to reduce long-term child food insecurity. A further policy recommendation arising from this study is that, given the current conditions of the whole educational sector in Mozambique, it is better to orient the policy towards reducing disparities in access to primary education, rather than pointing on boosting secondary education for a small part of the population. This statement works slightly more for urban areas, where the mediated influence of secondary education is lower than in rural areas. In strictly economic terms, food insecurity of children below five can be better fought giving incentive to one illiterate woman to join a primary school course rather than giving incentive to one woman with secondary education to access tertiary education. Although this way of reasoning might seem (and it is) very simplistic, it does give relevant broader insights to policy makers.

Another policy implication of this study is that, simply providing people with income, food or assets does not ensure children long-term food security. Food provision can be crucial for short-term crisis, but much less for alleviating chronic food insecurity. Since secondary schooling acts only through income, such a policy would make an investment in this level of education even less useful. To the opposite, it would only catch part of the contribution of mother's primary education, i.e. the capacity of people to buy food, radios and TVs in order to be informed and to pay school fees. However, income is just one of the instruments for child nutrition and food is just one dimension (*availability*) of food security. If people, then, cannot read newspapers, properly elaborate information from media or other sources, or, generally speaking, if they do not have the very basic knowledge acquired during the first years of school, an income distribution would not be adequate and sufficient. An intervention aiming at promoting long-term child (and overall) food security should focus on investments in quality primary education, in Mozambique as well as in many other low-income countries.

Finally, once more, it should be specified that this study does not intend to undervalue the benefits of larger access to secondary education in low-income countries; it only suggests that investing in primary education is more effective if the main goal of a policy-maker is promoting food security.

CHAPTER 7

CONCLUSIONS

Following an economistic view such as that suggested by human capital theorists (e.g. Schultz; Becker) education and food security are two core dimensions of human capital. More educated, skilled and better nourished workers can ensure higher productivity, which is finally reflected in higher levels of economic growth/development.

Following the basic needs approach, education and nutrition are two basic needs, because without them a person would be harmed. Education and nutrition are necessary respectively for mental and physical (survival) development. Looking at policies applied by ILO and the World Bank, and even many NGOs, in accordance with this framework, the distribution of food and education as a good would be the suggested solution to promote development in low-income countries.

Similarly, education and nutrition are two human rights according to some authors and institutions (WFP regarding right to food and UNESCO regarding right to education). As rights, to both it is recognized an intrinsic role.

Finally, the capability approach recognizes 'being educated' and 'being adequately nourished' as two basic capabilities, that is those beings and doings that should be ensured to all. The main innovative elements of such approach, compared to the rights-based and the basic needs approaches, as outlined in chapter 2, are that it focuses on human agency and participation, and that it highlights both economic and social contribution of education to development.

The capability approach offers an appropriate and advanced conceptual framework for the analysis of the relationship between education and food security in developing countries. Education and food security reinforce each other: more food security within a household is likely to lead to more education and *vice versa*. This research has focused on one specific direction of this relationship: how education can promote food security. Therefore, chapter 4 proposed a theoretical model focusing on two main macro-channels: the economic channel and the social channel, with a further stress on the socio-economic role of women (mainly through agency and care), which comes along the two channels. It is clear that, depending on which pathway is stronger, we could come out with policy recommendations pointing on very basic formal education or on more advanced or vocational education.

Quantitative analyses were carried out in order to see if there was empirical evidence about the relationship between education and food security. The first applied study was undertaken using cross-country data from rural areas of 48 low-income countries. The capability approach was taken as a reference first of all in order to construct indicators of food security and education with a consistent theoretical foundation, mainly pointing on 'outcome' variables. In particular, the indicator of food security was constructed mainly counting on anthropometrics data concerning the most vulnerable members of the society: children and women. Such an indicator incorporates the four dimensions of food security: availability, access, utilization, and stability. This work outlines that there is a strong bi-lateral relationship between education and food security; however, it progressively decreases for higher levels of education. Moving to econometric estimations, the main finding was that education is a key factor for achieving food security among rural households. Although the applied model does not strictly assess causalities, it is possible to conclude that investing in education is a crucial policy in order to reduce food insecurity. Furthermore, this model suggests something else: it is primary, more than secondary or tertiary education that influences the capability of rural people to be adequately nourished. Therefore, basic education confirms to be an important 'instrumental freedom', as suggested by Sen (1999).

Due to lack of adequate data regarding rural areas of developing countries, this first model could not adequately investigate the mechanisms through which education can affect food security. However, even through the inclusion of control variables such as a measure of poverty based on the ownership of key assets, results suggest that there are evident social channels, in addition to economic ones, through which the impact occurs. The fact that, given the current educational sector in most of low-income countries, primary education is the crucial level provides insights that are coherent with the theoretical framework chosen for the whole dissertation. Primary education is essential to open the mind of people, to access information through media, to learn subjects important for the daily life, to become aware about own rights, to socialize, in addition to raising individual and household productivity and income. It implies that evaluating through the human capital approach the role of education for a key development objective such as improving household food security is extremely limiting. A possible future extension of the research would be to incorporate aspects related to the quality of education and to identify a methodology to assess better the linkages between the explanatory variables and their

further influence on food security at macro-level. The first point is particularly important, otherwise we risk having similar problems present in previous researches, which just consider education in terms of pure years of schooling.[95]

The second empirical study, broadly speaking, confirmed the results of the first study. In Mozambique, mother's education was shown to be a key factor to reduce child food insecurity. Even in this case, mother's education provides a direct and an indirect contribution: first, all knowledge and information acquired in classes, especially during the primary education cycle, is directly reflected in higher probability of the child to be food secure. Then, having at least primary or basic education allows women to promote a social change even by accessing information regarding food utilization, nutrition, and health from mass media. Also in this case, there is empirical evidence that this channel is activated when the mother joins and completes the full cycle of primary education (7 years in Mozambique); each additional year of formal education does not provide significant contribution. However, moving from primary to secondary education is important because it gives additional skills necessary to increase personal and household income, which is then reflected into better nutrition of the child. The fact that mother's education and wealth on the one hand, and mother's education and child height on the other follow different patterns suggests that child food security is dependent on many factors, not just economic ones. Household income must be then translated in more child food security and this depends on personal, institutional, and environmental conversion factors (Sen 1995; Klasen 2000; Kuklys 2005). The last finding was that mother's education has a larger effect in rural areas of Mozambique.[96]

This study added some interesting elements, i.e. the focus on marginal regions (rural areas) and on vulnerable groups (women). Education is one of the key factors promoting social change and fostering household economy, which is then reflected into higher food security. Furthermore, looking at the relationships between these variables in a dynamic, multi-generational setting, women's education, traditionally neglected in an economistic framework, seems to play an indispensable role within household and society. Quality education of rural women is even more important especially for countries such as Mozambique, where massive poverty exists in rural areas.

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[95] That is, for instance, the critique addressed by Unterhalter (2003) to the works of Sen and Dreze (1989). See section 2.3.

[96] Note that 64.4 percent of the population of Mozambique lives in rural areas (2003 data, source: IFAD).

The last consideration refers to potential extension and reproducibility of this research. First, it is possible to include more channels, such as, for instance, an indicator of child care in order to have a broader view of the mechanisms. Second, it would be interesting to analyze the impact of mother's education not on the whole children population, but on those at higher risk of being food insecure, such as the bottom 20 percent or 30 percent. This would be particularly interesting for policy design. In the very recent literature on child nutrition this has been done using quantile regression (e.g. Aturupane et al. 2006) whose results could be compared with those obtained with 2SLS or OLS estimators. The main benefit of quantile regression is that it works on the median, thus it is less sensitive to outliers. Finally, regarding the reproducibility, it would be interesting to replicate this empirical work in other low-income countries, even with different characteristics than Mozambique, such as a large predominance of urban population, in order to carry out comparative analysis.

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ANNEX 1. Schultz and Denison growth models with human capital

Both the models start from the general equation of growth:

$$g_y = k\, f_k + g_L\, s_L$$

where g_y is the growth rate of the output, k is the ratio investment-output, f_k is the marginal product of capital, g_L is the growth rate of labour, and s_L is the share of output in total income (Psacharopoulos 1973, pp. 111–112). The two models, then, diverge with regards to the space for education in this equation.

In the Schultz-type model, capital is further distinguished in physical capital (K_M) and human capital (K_H). So, the new equation is:

$$g_y = \frac{I_M}{Y} r_M + \frac{I_H}{Y} r_H + g_L s_L$$

where r_M and r_H are the social rate of return to physical and human capital, I_M and I_H the investments in these capitals, and, L is not labour in general, but just row labour. Finally Schultz' model disaggregate the investments in education in investments in the three levels of education. Thus, the term $\frac{I_H}{Y} r_H$ is decomposed in the following way:

$$\frac{I_H}{Y} r_H = \frac{I_p}{Y} r_p + \frac{I_s}{Y} r_s + \frac{I_h}{Y} r_h$$

where the symbols p, s, and h refer to primary, secondary and higher education (Psacharopoulos 1973, 112–113).

The Denison growth model is different (Psacharopoulos 1973, p. 113). Denison does not consider human capital as a separate input of production, but distinguish the labour force according to its educational level: L_h is the labour force with higher education, L_s is the labour force with secondary education, and L_{op} is the labour force with primary or less educational qualification. The new equation of growth is:

$$g_y = k\, f_k + \sum_i g_i\, s_i$$

where i varies between 1 and 3, reflecting the three educational levels. The final impact of education on growth is formalized in this way:

$$g_{op}\, S_{op} + g_s\, S_s + g_h S_h$$

Psacharopoulos outlines the main difference between the two models, difference that might lead to sensitive differences in the results. 'In a Denison-type calculation we multiply the rate of growth of a given educational input by the income share of persons in the labour force with the same educational qualification, whereas in the Schultz-type calculation the contribution of education to growth is derived from measures of factor rentals' (Psacharopoulos 1973, p. 113).

ANNEX 2. Data treatment

Originally, the research focused on 49 developing countries, 30 from Africa, 11 from Asia, and 8 from Latin America. However, several of these countries displayed missing values for some variables. Thus, before proceeding with the correlation analysis, data needed to be cleaned and missing values imputed.

First, all data were transformed into percentage values to make them uniform and facilitate interpretation. Secondly, the 'donor method', based on cluster analysis, was used to impute missing values. This method involves first identifying variables that are most highly correlated to the one with a missing value. In the second step, these variables, which usually vary between one and four, are used to run a cluster analysis. This cluster analysis makes it possible to identify the observations closer to the missing value. Once a relatively homogeneous cluster is found, the missing value is replaced with the mean of the cluster. In this case, the other countries that are in the cluster are the 'donors'. Finally, to check the relative correctness of the procedure, attention was paid to the distribution of 'donor countries' around the original variable (that one in which one value is missing), the lower the standard deviation, the better the analysis.

This procedure was applied to four countries, Namibia, South Africa, Indonesia, and India. In the first three cases, the missing values were found in variables related to food security, and the results were quite satisfying. By contrast, India, which had missing values for several education variables, presented a set of values for both education and food security variables quite different from the general pattern tracked by the other countries. For this reason, it was difficult to find a cluster in which India was included. Even with a very limited number of clusters built up on the other school attendance rates in rural areas, India was always in a 1-country group. The lack of adequate information to fill in the missing values and the relevance of these two variables for the analysis led to the removal of India. As a result, the statistical analysis was carried out on 48 countries.

ANNEX 3. List of countries and statistics on rural population

Country	Continent	Rural population (%)	Source	Year
Benin	Africa	55.5	IFAD[97]	2003
Burkina Faso	Africa	81.4	UNFPA[98]	most recent
Central Africa	Africa	56.2	UNFPA	most recent
Cameroon	Africa	47.8	IFAD	2004
Chad	Africa	74.2	UNFPA	most recent
Comoros	Africa	64.4	IFAD	2004
Cote D'Ivoire	Africa	54.2	UNFPA	most recent
Egypt	Africa	57.2	IFAD	2003
Eritrea	Africa	80.0	IFAD	2003
Ethiopia	Africa	83.4	IFAD	2003
Gabon	Africa	14.8	UNFPA	most recent
Ghana	Africa	67.4	IFAD	2003
Guinea	Africa	63.5	UNFPA	most recent
Kenya	Africa	63.7	IFAD	2003
Madagascar	Africa	69.2	IFAD	2003
Malawi	Africa	83.3	IFAD	2004
Mali	Africa	67.7	IFAD	2003
Mauritania	Africa	35.7	UNFPA	most recent
Morocco	Africa	41.9	UNFPA	most recent
Mozambique	Africa	64.4	IFAD	2003
Namibia	Africa	66.5	UNFPA	most recent
Niger	Africa	76.7	UNFPA	most recent
Nigeria	Africa	53.4	IFAD	2003
Rwanda	Africa	93.4	IFAD	2003
South Africa	Africa	42.1	UNFPA	most recent
Tanzania	Africa	64.6	IFAD	2003
Togo	Africa	63.7	UNFPA	most recent
Uganda	Africa	84.7	IFAD	2003
Zambia	Africa	59.7	IFAD	2003
Zimbabwe	Africa	64.1	UNFPA	most recent
Armenia	Asia	35.7	IFAD	2004
Cambodia	Asia	80.3	UNFPA	most recent
Indonesia	Asia	55.9	IFAD	2003
Jordan	Asia	20.9	UNFPA	most recent
Kazakhstan	Asia	44.1	UNFPA	most recent
Kyrgyz Republic	Asia	66.3	UNFPA	most recent
Nepal	Asia	87.1	IFAD	2003
Turkey	Asia	32.7	UNFPA	most recent
Turkmenistan	Asia	54.2	UNFPA	most recent
Uzbekistan	Asia	63.6	UNFPA	most recent
Bolivia	L. America	35.6	UNFPA	most recent
Brazil	L. America	17.2	IFAD	2003

[97] IFAD statistics: http://www.ruralpovertyportal.org/english/regions/index.htm
[98] UNFPA statistics: http://www.unfpa.org/profile/

Colombia	L. America	22.6	UNFPA	most recent
Dominican Republic	L. America	39.9	UNFPA	most recent
Guatemala	L. America	59.4	IFAD	2003
Haiti	L. America	61.2	UNFPA	most recent
Nicaragua	L. America	42.7	IFAD	2003
Peru	L. America	26.1	IFAD	2003
All surveys[99]		57.1		
Africa		63.2		
Asia		54.1		
L. America		38.1		

[99] Unweighted mean.

ANNEX 4. Indicators of food security

This section explains the creation of indicators of household food security, which must be justified on a theoretical base. To find an appropriate measure of such a phenomenon, it is necessary to examine the existing literature in light of the available data and purpose of analysis. This work aims to overcome the limitations of traditional measures of food security, which are based on the national food balance sheets.

In a broad sense, household food security indicators can be divided into 3 main categories:

1. **Food consumption indicators**: number of meals a day, number of calories, household percentage of expenditures on food, dietary diversity, which can be estimated through different ways, according to the specific context and available data.
2. **Anthropometric indicators**: relation height-for-age (stunting)[100], relation weight-for-height (wasting)[101], relation weight-for-age (underweight), female malnutrition (low Body Mass Index), micronutrients deficiency, iron deficiency, iodine deficiency.
3. **Livelihood indicators**: assets owned, feeling of insecurity, price of food, employment, health, and do forth.

The choice of the indicator depends on the purpose of the exercise. When the purpose is to monitor food security in its complexity in order to predict potential food crises arising from one of these factors in one specific nation or region, it is essential to take all the above indicators into account. In contrast, if the objective is to discover the general explanatory capacity of a variable, such as education of rural people, on a phenomenon such as household food security in rural areas, a different analysis can be carried out. The cross-country model uses several education variables as predictors, while the dependent variable is an aggregate indicator of household food security. This suggests the possibility of using a less detailed indicator, which might even be based on only one category, but which would constitute a good proxy for household food security.

This research is based on DHS household surveys, which are mainly concerned with the nutritional and health statuses of children and women. In such a

[100] Proxy of long term nutritional status.
[101] Proxy of short term nutritional status.

case, it is possible to use only anthropometric indicators and measures of survival as a proxy for household food security in a structural model for several countries. It is assumed that in all the countries in which the surveys were carried out the correlation between household food security and anthropometric indicators and measures of survival is high and approximately at the same level.

Additional support for the use of anthropomorphic variables such as the prevalence of stunting or underweight is that they reflect human deprivations, and 'since our ultimate concern is with the nature of the lives that people can lead, there is a case for going straight to the prevalence of undernourishment, rather than to the intake of calories and other nutrients' (Anand and Sen 2003, p. 209).

With this theoretical justification, it is necessary to construct an indicator encompassing a balanced mix of anthropometric, nutritional, and survival variables. The indicator that is finally used in this research includes three components:

- 'Adequate survival status' (Wiesmann 2002), which serves as a proxy for premature death due to malnutrition. This dimension is measured by a simple mean between infant mortality rate and under-5 mortality rate.[102]
- A second component reflecting Wiesmann's ideas of both 'adequate nutritional status' and 'food adequacy'. Here, they are expressed by the prevalence of stunting,[103] underweight[104] and wasting.[105] This component is calculated by an average of the values of the three indicators, weighting by 2/3 the percentage of the rural population with moderate stunting (underweight and wasting), and weighting by 1/3 the percentage of the population with severe stunting (underweight or wasting).
- Female malnutrition. In order to measure this component, it was decided to use the percentage of rural women whose body mass index is less than an internationally fixed threshold of 18.5.

[102] Again, Wiesmann has used only the variable under-5 mortality rate, while here an average value between this variable and the infant mortality rate is used because the causes of very early death can show a different intensity and typology of malnutrition (Wiesmann 2002).

[103] 'Stunting' is defined as children with a height-for-age score two or more standard deviations below the mean of a normal distribution of children's height for age. 'Severe' refers to children who are three or more standard deviations below the mean; 'moderate' refers to children who are between two and three standard deviations below the mean.

[104] 'Underweight' refers to weight-for-age indices. 'Severe' denotes scores of three or more standard deviations below the mean, while 'moderate' refers to scores of two to three standard deviations below the mean.

[105] 'Wasting' is defined as children with a weight-for-height score of two or more standard deviations below the mean on an index of children's weight for height. Again, 'severe' denotes scores of three or more standard deviations below the mean, while 'moderate' refers to scores of two to three standard deviations below the mean.

Calculating a simple arithmetical mean of the three components, defined as F_a, F_b, and F_c, an indicator of household food insecurity is obtained. The name of the variable, for rural areas, is *rurHFI1* and it is obtained through the following formula:

$$\mathbf{rurHFI1 = 1/3\ F_a + 1/3\ F_b + 1/3\ F_c},$$

which is a specific case with $\alpha=1$ of the general formula:

$$\mathbf{rurHFI = (\ 1/3\ F_a^{\alpha} + 1/3\ F_b^{\alpha} + 1/3\ F_c^{\alpha}\ )^{1/\alpha}.}$$

Keeping the weight of each sub-indicator equal to one third, that is assuming that each of them has the same relative value *ceteris paribus*, this formula varies according to the value of alpha. With alpha equal to one, the index is a simple arithmetic mean of the three components. This implies that, for example, a high value of F_a can be counterbalanced by a low value of F_c. However, since each component reflects a deprivation, it is not unreasonable to claim that the *relative impact* of each one on the total analyzed phenomenon is likely to increase as the absolute level of that deprivation rises. An example might clarify the meaning of 'relative impact':

Considering only one sub-indicator such as F_a and three different levels of it: F_{a1}, F_{a2}, and F_{a3}, with $F_{a3} = kF_{a2} = 2kF_{a1}$, a higher relative impact means that the same absolute variation of the sub-indicator F_a has a higher impact on household food insecurity if the starting level is higher, as formalized here below:

$$\frac{HFI(Fa2) - HFI(Fa1)}{Fa2 - Fa1} < \frac{HFI(Fa3) - HFI(Fa1)}{Fa3 - Fa1}$$

The empirical analysis can incorporate such an argument by selecting a value of alpha higher than 1. In this analysis, the second indicator was constructed with an alpha of 2, in order to gauge the effects when greater relevance is given to extreme deprivation.[106] With alpha greater than 1 there is no perfect substitutability between the sub-indicators. A high value of one sub-indicator cannot be totally counterbalanced by a low one of another.

The formula for alpha = 2 is:

[106] For both theoretical and mathematical explanation see Anand and Sen (2003, pp. 211–218).

$$\mathbf{rurHFI2 = (1/3\ F_a^2 + 1/3\ F_b^2 + 1/3\ F_c^2)^{1/2}.}$$

Thus, *rurHFI1* and *rurHFI2* are the two indicators of food insecurity utilized in the analysis.

ANNEX 5. Additional tables & figures

Table A-1. Correlations between education and food insecurity (*rurHFI2*)

Variable	Pearson	Spearman
Attendance Rate 6-10	-0.75	-0.77
Attendance Rate 6-15	-0.73	-0.75
Attendance Rate 11-15	-0.64	-0.64
Attendance Rate 16-20	-0.47	-0.45
Attendance Rate 21-24	-0.20	-0.21
No Education	0.69	0.70
Secondary or more	-0.57	-0.70
Tertiary	-0.55	-0.69

Figure A-1. 6-15 Rural School Attendance Rate and Food Insecurity

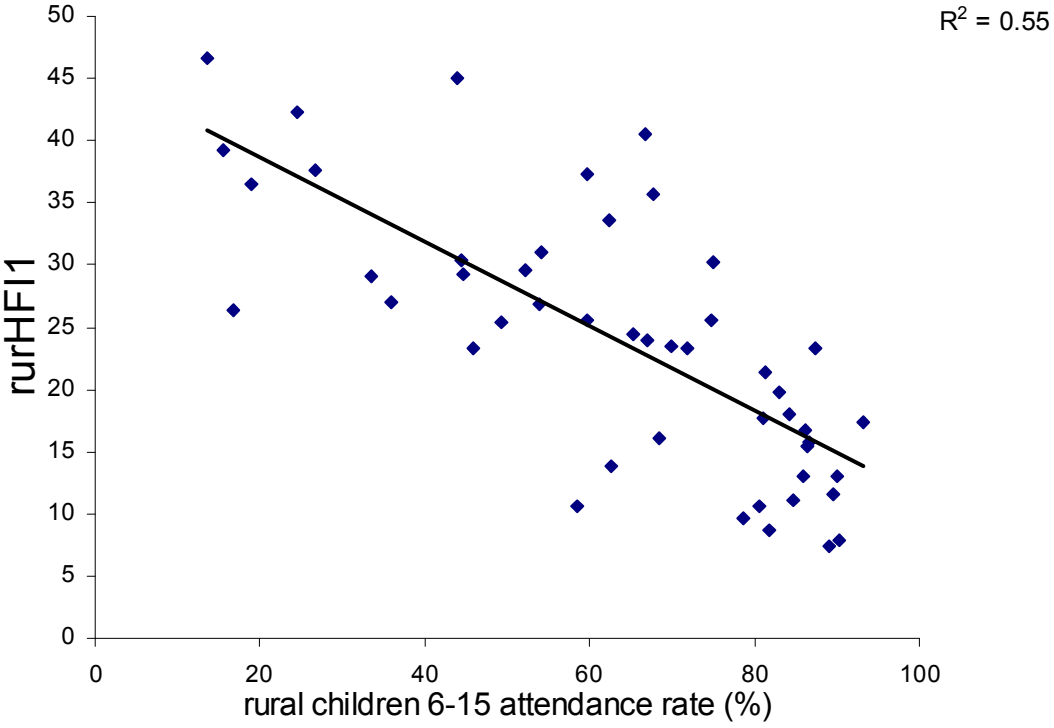


Figure A-2. 16-20 Rural School Attendance Rate and Food Insecurity

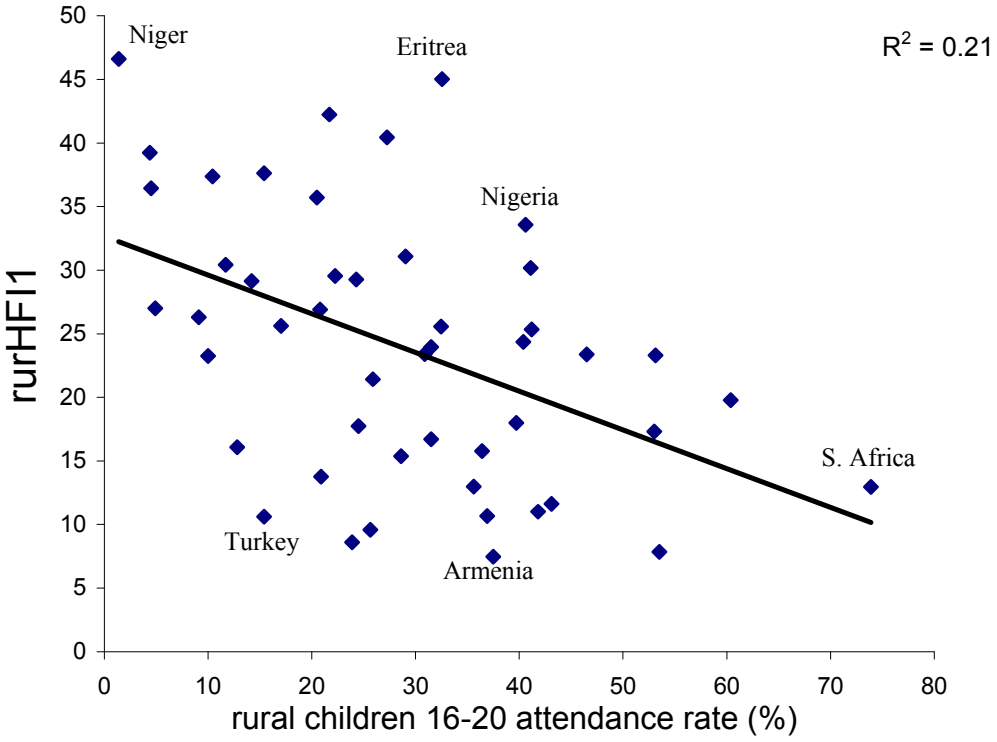


Figure A-3. 21-24 Rural School Attendance Rate and Food Insecurity

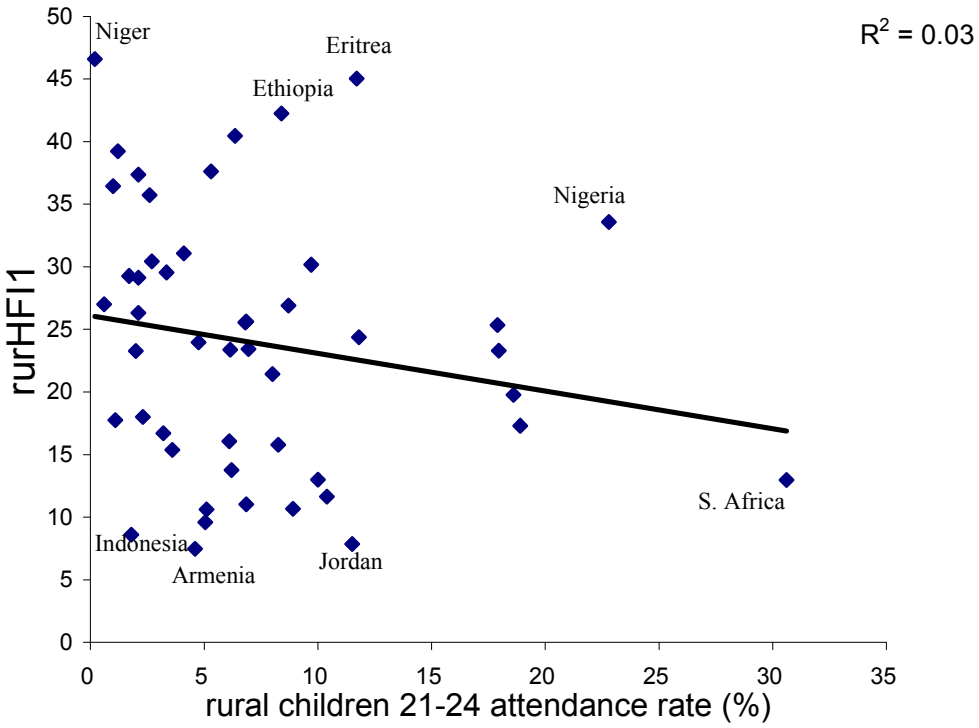
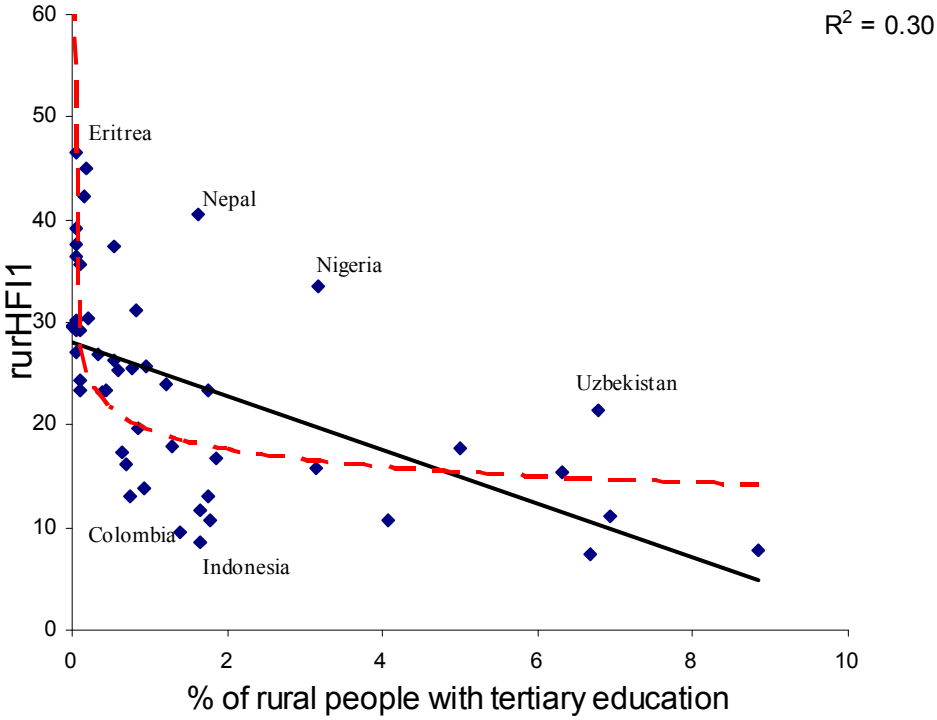


Figure A-4. Percent with Tertiary and Food Insecurity



ANNEX 6. Indicator of Mother's Access to Information

The original variables expressing mother's access to information are three binary variables showing whether or not mothers listen to radio, watch TV, or read newspapers at least once a week. Since mother's access to media might be endogenous, it is necessary to use the 2SLS estimator. To do it, it is necessary to have one single quantitative variable for mother's access to information. This appendix shows how the index *Accessinfo* was constructed.

The DHS dataset provides information concerning the capacity of mass media to increase people's knowledge on certain social and health issues. In particular, it is clear that most of the information concerning family planning and HIV/AIDS is obtained primarily through radios, much less through televisions, and ultimately through newspapers. Furthermore, Governmental programs for the dissemination of nutrition and health knowledge are channeled through the most used instruments, which in both rural and urban areas of Mozambique are radios. Therefore, it is reasonable to assume that a person frequently listening to radios is more likely to acquire this type of knowledge than another person frequently watching TV or, finally, reading newspapers.

The final index is constructed as follows. Counting on the above assumption, the indicator *Accessinfo* has a higher value if the woman only listens to radio, rather than only watching TV or reading a newspaper. Regarding possible combinations of different sources, the rationale is that the indicator takes a lower value than the simple sum of the values for each source because the information obtained in two or three different ways is likely to partially overlap. Finally, frequently listening to radio is so important in order to acquire nutrition knowledge that alone it is assumed to count more than having access to both TV and newspapers. All the modalities are reported below.

Accessinfo = 0	if radio = 0, TV = 0, and newspaper = 0
Accessinfo = 3	if radio = 1, TV = 0, and newspaper = 0
Accessinfo = 1.5	if radio = 0, TV = 1, and newspaper = 0
Accessinfo = 1	if radio = 0, TV = 0, and newspaper = 1
Accessinfo = 4	if radio = 1, TV = 1, and newspaper = 0
Accessinfo = 3.5	if radio = 1, TV = 0, and newspaper = 1

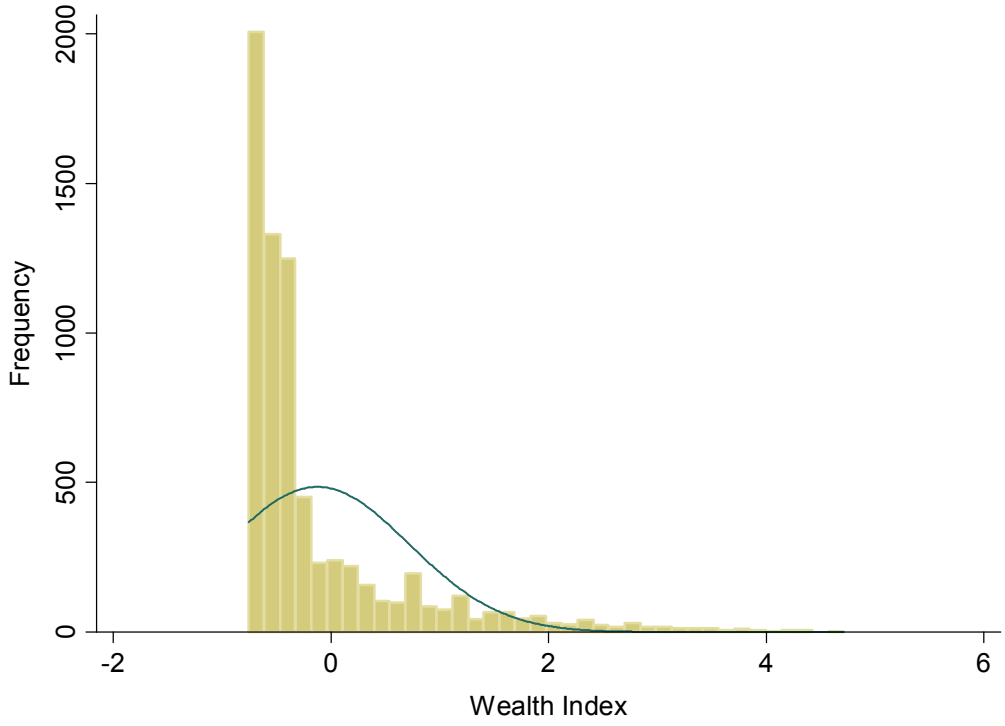
Accessinfo = 4.5 if radio = 1, TV = 1, and newspaper = 1

Accessinfo = 2.7 if radio = 0, TV = 1, and newspaper = 1

ANNEX 7. Distribution of the Wealth Index

Figure A-5 displays the distribution of the wealth index among the households with children below five of age. As outlined by the normal density plot, such a distribution is not well fit by a normal distribution. The mean is much larger than the median and the mode; the result is that the distribution is clearly skewed to the right. This means that there is large wealth inequality and that the highest proportion of the household population is (relatively) poor.

Figure A-5. Wealth Index distribution



Another important point concerns the absolute value of the wealth index. As stated in section 6.5.4 this variable was constructed applying a principal components technique on the whole household population, followed by a normalization of the final values. Since the mean is lower than zero (-0.125), on average, the sample of households with children in the age-group 0-5 at the time of the DHS survey is poorer than the total household sample.

ANNEX 8. First-Stage in 2SLS Regression (from Table 10)

Robust regression for endogenous Access to Information [108]

Dependent variable: *Accessinfo*	Coef.	Std. Err.	P-value
Constant	0.212	0.600	0.724
Cluster Radio Availability [107]	**2.044**	**0.745**	**0.006**
Child's Age	0.000	0.000	0.402
Child's sex (female=1)	0.023	0.033	0.486
Mother's Age	-0.004	0.002	0.092
Mother's Age at 1st birth	-0.005	0.005	0.293
Mother is currently married	0.437	0.055	0.000
Mother's Incomplete Primary Education	0.196	0.040	0.000
Mother's Complete Primary Education	0.040	0.110	0.716
Mother's Incomplete Secondary Education	0.015	0.133	0.911
Mother's Complete Sec. Education or Higher	-0.636	0.203	0.002
Mother's HAZ	0.020	0.017	0.240
Mother's BMI	0.005	0.005	0.346
Father's years of schooling	0.047	0.006	0.000
Household size	0.001	0.005	0.806
Household members < 5	-0.378	0.151	0.012
Household Permanent Income	0.667	0.034	0.000
Availability of Electricity	0.099	0.419	0.812
Availability of Toilet Facilities	-0.428	0.544	0.432
Children Mortality Rate	0.586	0.294	0.047
Mothers' literacy rate	0.105	0.138	0.445
Rural Area	-0.080	0.060	0.184

[107] Instrumental variable for *Accessinfo*.
[108] Provincial variables omitted.

ANNEX 9. First-Stage in 2SLS Regression (from Table 11)

Robust regression for endogenous Access to Information [109]

Dependent variable: *Accessinfo*	Coef.	Std. Err.	P-value
Constant	0.573	0.443	0.196
Cluster TV Availability [110]	**-0.927**	**0.458**	**0.043**
Cluster radio availability [31]	**1.090**	**0.566**	**0.054**
Child's Age	0.000	0.000	0.535
Child's sex (female=1)	0.016	0.022	0.459
Mother's age	0.002	0.001	0.200
Mother's age at 1st birth	-0.015	0.003	0.000
Mother is currently married	0.143	0.032	0.000
Mother's incomplete primary education	-1.181	0.028	0.000
Mother's complete primary education	-0.133	0.020	0.000
Mother's incomplete secondary education	0.069	0.026	0.007
Mother's complete sec. education or higher	-0.027	0.036	0.442
Mother's HAZ	0.016	0.011	0.152
Mother's BMI	-0.001	0.003	0.611
Father's years of schooling	0.021	0.004	0.000
Household size	0.004	0.003	0.239
Household members < 5	-0.116	0.101	0.248
Household permanent income	0.144	0.020	0.000
Availability of electricity	-0.080	0.279	0.773
Availability of toilet facilities	0.602	0.393	0.126
Children mortality rate	0.151	0.192	0.432
Mothers' literacy rate	-0.027	0.080	0.733
Rural area	-0.040	0.037	0.287
Interaction Incompl. Secondary – HH wealth	-0.114	0.017	0.000
Interaction Incompl. Primary – Accessinfo	0.950	0.003	0.000

[109] Provincial variables omitted.
[110] Instrumental variables for *Accessinfo*.

ANNEX 10. Post-Estimation tests on final model

The model presented in table 11 meets all the basic statistical requirements. This section reports the results of post-estimation tests on the final OLS model with interactions (column 4 of table 11).

a) Homoskedasticity

The initial results were affected by heteroskedasticity; both the White test and the Breusch-Pagan/Cook-Weisberg test rejected the null hypothesis of homoskedasticity (p-value = 0.000). The addition of the 'robust' option of Stata allowed to include heteroskedasticity-robust standard errors.

b) Lack of Multicollinearity

On the full model the Variance Inflation Factor (VIF) test was run. The result is:
VIF = 4.57 and 1/VIF = 0.218 for the variable 'Mother's literacy rate'. The value of VIF is much below 10, the usually adopted critical value, thus there is no multicollinearity.

c) Joint significance of regressors

The F-statistics is: F (33, 7087) = 49.89, prob > F = 0.000. The variables are jointly significant.

d) Linearity

Linearity is tested using the Ramsey RESET test (option *ovtest* in Stata): the null hypothesis is non-linearity. F(3, 7084) = 1.67 Prob > F = 0.170. Non-linearity is rejected at 0.1 level.

e) Model specification

The model is said to be well specified if there are no omitted variables. This is verified through the *linktest*.

Dependent variable: child HAZ	Coef.	Std. Err.	P-value
Constant	0.007	0.084	0.929
_hat	1.010	0.104	0.000
_hatsq	0.003	0.031	0.915

The coefficient associated to the fitted values (_hat) is statistically significant and the coefficient associated to the squared fitted values (_hatsq) is not significant: the model is well specified.