LISBON SCHOOL OF ECONOMICS & MANAGEMENT
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MASTER'S DEGREE

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DISSERTATION

POVERTY TRAPS IN SOUTHERN RURAL MOZAMBIQUE: A STRUCTURAL EQUATIONS MODELLING APPROACH

BERNARDO CALDAROLA

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SUPERVISION:

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MESTRADO EM
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DISSERTAÇÃO

ARMADILHAS DA POBREZA NO SUL DE MOÇAMBIQUE: UM ESTUDO DE CASO COM EQUAÇÕES ESTRUTURAIS

BERNARDO CALDAROLA

ORIENTAÇÃO:

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The pages that follow, regardless their (arguable) theoretical, empirical and academic value, represent only one step in a 2 years long walk, and a tiny part of a journey that has just started and for which I would like to say

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Obrigado,
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Merci,
Grazie,

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Darfo Boario Terme, October, 16th 2016

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ACRONYMS

AfDB – African Development Bank Group

CD – Coefficient of Determination

FDI – Forward Direct Investments

AEO – African Economic Outlook

CFA – Confirmatory Factorial Analysis

FDI – Forward Direct Investiments

GOF – Goodness-of-fit Index

HDI – Human Development Index

IMF – International Monetary Fund

INE – Mozambique's Statistical Institute

MINAGMoz – Mozambique Agricultural Ministry

OECD – Organisation for Economic Co-Operation and Development

OMR – *Observatorio do Meio Rural*

PCA – Principal Component Analysis

SEM – Structural Equation Model

TIA – *Trabalho de Inquérito Agricola* (Agricultural Survey)

WB – World Bank

UNDP – United Nation Development Programme

UNRCO – United Nation Resident Coordinator Office

ABSTRACT

This article analyses the rural economy of three districts in southern Mozambique, proving the existence of a lock-in device that keeps small-scale farmers and their households into poverty. All variables taken into account result from an original survey-based dataset which includes socio-economic information about rural livelihoods and the agricultural sector. A Structural Equation Modelling approach is adopted to detect non-linearity in wealth creation – in particular by analysing health, market/institutional environment and food security in relation to an asset-based measure of wealth. Drawing upon the concepts of complexity, multidimensionality and cumulative causation, this work proves the existence of a poverty trap by analysing the varying dynamics related to the relationship that exists between food security and wealth. The methodology adopted in this work represents an alternative to the traditional tests usually applied for the detection of poverty traps, including a wider number of factors in the study of persistent poverty; finally, it provides some useful policy recommendations regarding the struggle against poverty in this area.

Keywords: poverty trap, Mozambique, rural economy, food security, Structural Equation Model

RESUMO

Este trabalho visa analisar o contexto de economia rural em três distritos da região Sul de Mozambique, para demonstrar a existência de mecanismos "aprisionadores" que detêm as famílias camponesas numa condição de pobreza. Todas as variáveis tomadas em conta para o estudo resultam de uma base de dados autoproduzida que inclui informação sobre a subsistência no contexto rural e o sector agrícola. Este trabalho utiliza a abordagem dos modelos de equações estruturais (SEM) para detectar as possíveis não-linearidades no processo de criação de riqueza, em particular a través da análise da saúde, do contexto institucional e de mercado, e da segurança alimentar em relação à riqueza das famílias. Recorrendo aos conceitos de complexidade, multidimensionalidade e causação cumulativa, procura-se demonstrar a existência de uma "armadilha da pobreza" a partir da análise das diversas dinâmicas relacionadas com a relação que existe entre segurança alimentar e bem-estar das famílias inquiridas. A metodologia adotada neste trabalho constitui uma alternativa aos testes tradicionalmente utilizados na investigação sobre as armadilhas da pobreza, pois inclui um numero maior de factores na analise da pobreza persistente. Em conclusão, os resultados da estimação do modelo fornecem algumas recomendações em termos de politicas de combate contra a pobreza, de acordo com as características especificas da zona.

Palavras-chave: armadilhas da pobreza, Moçambique, economia rural, segurança alimentar, modelos de equações estruturais

1. INTRODUCTION

This Master's thesis consists of an exploratory research in the field of rural development, with particular attention to poverty dynamics circumscribed to three relatively poor rural districts in the south of Mozambique. Although Mozambique experienced a remarkable post-war economic growth, it is still considered a poor country, with a considerable share of the population living in poor rural areas and striving for self-subsistence. Despite the huge presence of international donors and several international financial programs promoted by public and private entities, the problem of poverty endures, imposing to researchers and policy makers a reflection over policy effectiveness in the struggle against poverty. In this framework, this work integrates the economic literature committed to the study of persistent poverty, contributing to the theoretical formulation of the so-called "poverty trap", that is, a lock-in device that hampers wealth accumulation, sinking whole communities into poverty.

The questions that this work attempts to answer to are: what makes poverty persistent? Which factors should be considered in the observation of poverty dynamics? To do so, it has initially been considered a wide range of neo-classical authors who share as a common ground the theoretical formulation of the poverty trap mechanism as a non-linear process influenced by the interference of a factor that hampers accumulation. Empirical evidence suggests that considering a unique factor as the only cause of poverty restricts the scope of the analysis, often producing outcomes that are not fully able to explain poverty, and to correct it by forecasting its future evolutions. For this reason, the traditional formalisation of poverty traps is integrated in this work with concepts as

complexity and cumulative causation, in an attempt to widen the spectrum of the analysis of poverty by drawing upon a number of factors that interact continuously following non-linear paths. This integrated theoretical framework is applied to the study of poverty traps through the use of a family of multivariate statistical techniques: the Structural Equation Models (SEM). This set of techniques allows for a simultaneous analysis of correlated phenomena, providing a powerful tool capable to analyse structural relationships and correlations that involve several factors at the same time. Data for this study have been collected during a three-months fieldwork across the rural districts of Chóckwe, Guijá and Kamavotha, in southern Mozambique. Thanks to the essential support of the *Observatorio do Meio Rural,* a Maputo-based research centre directed by professor João Mosca, and of its research team, several farmer and peasant households have been surveyed in order to collect information about their livelihoods (in particular regarding health, market, institutions, food security and wealth); the information gathered was included in a database, whose contents provide the "raw material" that inspired the present work. This research comes under the project of Applied Advanced Studies in Development, and benefitted from the support of the Gubelkian foundation and OMR.

This work is organized in 8 sections, of which this introduction is the first one. The second section illustrates the contextual setting of Mozambique, with particular attention to poverty and to the agricultural sector; then the third section goes through the existing literature over poverty traps, drawing upon the neoclassical tradition as well as including more heterodox concepts, as complexity and cumulative causation, that integrate the theoretical formulation of poverty trap adopted in this work. The fourth section reviews

the existing scientific literature over health, market / institutional environment and food security as possible causes of persistent poverty due to their correlation to wealth; the following section is then dedicated to the formulation of a theory that explains the existence of a poverty trap, caused by the interaction of the variables chosen and described in section 4. The sixth section aims to test through a multivariate statistical methodology the theory enounced in section 5, whose results will be shown and discussed in section 7. Finally, the last section will include some conclusions and policy implications, proposing also possible improvements in the approach and methodology adopted, recognising the unavoidable necessity to further enhance both data quality and methodology.

2. CONTEXTUAL SETTING

The general context in which this work unfolds requires a deep understanding of the economic feature of Mozambique, in particular of its southern region, Gaza – the one taken in exam. Among its contradictions and inconsistencies, Mozambique shows at the same time great economic potentialities, due to the huge availability of natural resources and abundant land, along with sharp inequalities and unexplored possibilities. In the first paragraph, an overview of the relationship that exists between agriculture and poverty will be provided, in order to set the boundaries wherein this work sets his analysis. The second paragraph includes information about the rural sector in the country, to provide details over the economic and productive features that characterise the rural sector.

2.1 Poverty and agriculture in Mozambique

Despite the skyrocketing economic growth that Mozambique experienced after the end of the civil war – with an average of 7,2% GDP growth in the last decade – since 2010 this trend slackened sharply; some of the reasons can be found into the volatile FDI inflows (mainly related to the exploitation of natural resources), as well as into the decrease of exports over the last 5 years (also linked to monetary depreciation) and into the appraisal of escalating political violence and uncertainty[1] (AEO, 2015). Furthermore, despite the increase of per-capita GDP in the last years, severe poverty is still a problem

[1] The English reporter Joseph Hanlon, among the most important European journalist active in Mozambique, reported through his online newsletter "Mozambique news, reports & clippings" a new appraisal of political conflict between the two most important parties (FRELIMO, the governing party, and RENAMO, the opposition) with thousands of refugees fleeing the country due to the unsuccessful negotiation process for peace after the civil war ended in early 90s. More detailed information about the political situation can be found here http://www.open.ac.uk/technology/mozambique/news-reports-2016-0

in Mozambique: according to the Human Development Report (2015), Mozambique is ranked 180th out of 188 countries included in the HDI, with the 44,1 % of the population still living in multidimensional poverty, and another 14,8% situated close to the poverty line; moreover, in recent times Mozambique has been among the largest recipients of food aid flows (Abdulai *et al*., 2004).

Besides this general picture, official data also show a failure in the struggle against poverty, with a large share of the population depending only on their own production (Cunguara and Hanlon, 2010); in addition, the policies promoted by the Bretton Woods' Institutions as PARPA (*Plano de Acção para a Redução da Pobreza Absoluta*), despite their purpose, failed in achieving the goal of poverty reduction by supporting, among the others, the agricultural sector (Cunguara,, 2011). In this framework, the reduction of food exports and the stagnation of productivity reported by national data from the TIA (MINAGMoz, 2012) are likely to compound the conditions of those households that depend mostly on what they produce. For instance, several institutions and scholars in recent times advocated for more rural-centred policies in the country (Mosca, 2015 and Castel-Branco, 2008) due to the marginalisation of small-scale farmers in the policy framework.

Consequently, the agricultural sector's weight shrunk noticeably over the last five years (from 27,6% of the real GDP in 2010 to the 23,9% in 2014, according to the AEO 2015). More importantly, the 99,8% of the farms in Mozambique are family-run, with the 98,6% owning less than 10 hectares of cultivable land: this makes family-run farming responsible for 99,7% of the food supply in the country (Uaiene, 2015). Better said, small-

scale farmers are responsible alone for almost the totality of the food security of more than 25 million of people, a number doomed to increase in the next years, if we watch to the most recent demographic trends.

2.2 Characteristics of the rural sector

Despite land abundancy, the agricultural sector in Mozambique shows an extremely low degree of modernization, along with low productivity; moreover, land availability is often invalidated by land-grabs and resettlements imposed by multinational companies with strong economic interests in the region (Locke, 2014). For instance, the average land worked per farmer decreased to 1,4 ha in 2012, showing a 22% loss since 2005 (MINAGMoz, 2012)[2]. Furthermore, most of the cultivated land is rain-fed, while irrigation is concentrated in the southern region with 60% of the irrigated land allocated to sugarcane plantations. On the production side, farmers only use basic inputs, as non-augmented seed, making little use of fertilisers; the low level of mechanisation obliges the farmers to hire seasonal workers, or to rely on the mutual help offered by other farmers from the same association they belong to[3]. The most common agricultural products grown by the small-scale farmers are corn (37% of the total cultivated land in the country), beans, but also rice, cassava and fresh vegetables (MINAGMoz, 2012). However, for this research I will not consider the totality of the national cultivations; the analysis is

[2] I will henceforth may refer to small family-run cultivations with the Swahili term "*machamba",* widely used in the whole country.

[3] For a more comprehensive work on the farmers' associations in Mozambique, please see Júnior *et al.* (2015)

circumscribed to only three southern districts that can be considered representative of the different characteristics of the rural sector across the country:

i. *Chockwe*, in the southern province of Gaza, is traditionally acknowledged as an historical agricultural productive hub, with a high presence of agricultural inputs, with prevailing medium and large exploitations;

ii. *Guija*, again in the South, is an area whose agricultural production is mostly addressed to food markets, with a low presence of agricultural inputs. Exploitations' size varies between 0,5 ha / 2 ha;

iii. *Kamavotha*, or the Maputo surroundings (*Cintura de Maputo)*, is the closest rural area to the capital city. It is a district whereby the production is almost only addressed to internal markets, and is characterised by the intense use of productive inputs, and by the proximity of producers to the intermediate input market. Nevertheless, land is exploited only in small scale.

The three areas considered for this study are geographically displayed in Figure 1. The differences in consumption, production and land distribution of these three districts enrich the study of rural poverty in an area that, especially in the colonial period, represented the most important staple food productive hub in the country (Mosca, 2005), today facing severe conditions of persistent poverty and food insecurity.

3. THEORETICAL FRAMEWORK

This section consists of an overview of the theoretical framework that underpins the hypothesis tested in this work, that is, the existence of a trapping mechanism that forces three southern rural districts of Mozambique into persistent poverty. For instance, we will review the literature pertaining to the "block" of political economy, to define the concept of poverty trap; likewise, we will consider the stream of authors that attempted to formalise mathematically the concept of poverty trap in a more rigorous way. Therefore, we will consider poverty as a multidimensional phenomenon, making the existing formalisation of poverty traps – that is often considered the result of a too reduced set of factors – much wider and inclusive.

The first paragraph of this section illustrates the mainstream formalisation of the concept of poverty traps, providing the basic tools to understand this theoretical formulation and its empirical implications into the reality; the second paragraph proposes a wider and more heterodox view of poverty traps, drawing upon the concepts of complexity and multidimensionality. The third and last paragraph goes through the existing tests to detect poverty traps, and proposes a new approach based on a wider panoramic of this phenomenon.

3.1 The neoclassical concept of poverty trap

In political economy, the concepts of coordination and cooperation are part of the basic elements of the earliest development economics (Nurkse, 1953; Leibenstein, 1957; Myrdal, 1957; Hirschman, 1958). They have been introduced by the first "structuralist" thinkers, as Rosenstein-Rodan (1943) who explained the existence of inefficient equilibria that trapped countries in underdevelopment, adducing as a cause of such inefficiency the presence of inter-sectoral spill-overs. This highlights the importance of coordination between different sectors in the promotion of developmental policies. With the paradigmatic shift that took place in the late 70s with the

advent of the Washington Consensus (Williamson, 1993), these concepts were eclipsed by the blind (and strictly neoliberal) faith in the total deliverance of the market forces; according to this approach, the market should be left to work alone as the only engine for a more efficient economy, denying the need of a coordinating agent (Krueger, 1990; Lal, 1985). Almost a decade later, with the first undeniable failures of the IMF and WB driven policies, coordination and cooperation were reconsidered and deepened in their theoretical formulation, first by the adepts of institutional economics, to mention one among the others the founder of this new vague Douglass North, who focused on the role of institutions in promoting development through policies and State intervention (North, 1991), and later by other authors who highlighted how bad institutions and social norms could trap people into poverty (Sindzingre, 2007).

If we aim to define briefly this concept, a poverty trap can be seen as a self-enforcing mechanism whereby countries – or households and individuals – start poor and remain poor; in few words, a poverty trap occurs when it is present poverty to beget future poverty itself (Azariadis & Stachurski, 2005). Therefore, a poverty trap is a mechanism that can bring about a condition of persistent or chronic poverty. Often in the literature, these mechanisms are categorised according to weather they are characterised by single or multiple inefficient economic equilibria; in both cases, starting conditions and the structural features of a country/household are very important in the determination of a poverty trap, as well as the concept of threshold (Barret & Carter, 2013). The most widely used concept in the neoclassical economic literature is the multiple equilibria poverty trap (Acemoglu *et al.,* 2001; Banerjee & Duflo, 2011; Dasgupta, 1997; Dasgupta & Ray, 1986; Moser & Barrett, 2006; Murphy, Schleifer & Vishny, 1989; Rosenstain-Rodan, 1943) whose graphical formalisation can be represented as in Figure 2. The S-shaped red curve describes a situation affected to a poverty trap, compared to another (the blue traditional neoclassical production function) which is free from obstacles undermining the accumulation

dynamics. On the left side of the intersection between the 45º axis and the S-shaped curve, that is, before the threshold point of wealth below which households experience a poverty trap, the curve has a negative first derivative; this situation corresponds to diminishing returns, a concept which is deemed particularly relevant in the analysis of farms' production (Samuelson, 2001). The formalisation obtained through the phase diagram in Figure 2 describes a situation in which, to a given level of wealth in the moment *t,* corresponds an even lower level of wealth in the moment *t+1* due to a factor that generates a non-convexity in the accumulation dynamics (Mas-Colell, 1987); better said, it generates a poverty trap. Authors that are opting for this formulation to describe persistent poverty often rely on a single factor causing poverty traps, that can be identified in insufficient savings, food insecurity, market failures, etc. (Kraay & McKenzie, 2014). Furthermore, this formulation often justifies one-time interventions as needed actions to lift the poor above the threshold detected (Sachs, 2005), which often proved to be rather ineffective (Barret & Carter, 2015).

3.2 A deeper look into poverty traps: complexity and multidimensionality

Despite its elegant and smooth formalisation, the concept of poverty trap often falls short in taking in consideration the wide number of factors that could be at the base of a non-linearity in wealth accumulation, especially at the micro level. According to Arthur (1989; 1994) the economy, as well as households' wealth trajectories, can get locked into inefficient paths due to positive feedbacks and increasing returns, that might cause multiple equilibria in the same economic context. These phenomena are caused by random and relatively small events that, under specific conditions, will end up pushing the economy towards one or more inefficient equilibria, bringing about a self-enforcing mechanism that prevents the economy to shake free from the stochastic consequences of a random small event. Following the hints emerging from the conclusions of an empirical review by Kraay and McKenzie (2014), this elaboration suggests that

it is meaningless to ascribe to a single factor or variable the origin of a trapping mechanism: the path follows a certain trajectory pushed by forces that are often difficult to detect and to be formally defined; even if they begin from the same starting point, different economies can end up in completely different stationary states, covering divergent paths (Pritchett, 1997).

Therefore, the formulation proposed in this work considers the trapping process as a complex outcome of cumulative causation between more than one or two factors, in a number that varies according to each situation; the aim is to expand the neoclassical formalisation providing empirical evidence of the fact that several factors could be relevant in bringing about a lock-in device such as a poverty trap is. For instance, the characterisation of the nature of the poverty trap, and the identification of its causing factors are fundamental to set up an exit strategy (Kraay & McKenzie, 2014), revealing the insufficiency of one-time interventions and justifying a more specific intervention to tackle persistent poverty more effectively. For this reason, both intervention and theoretical formulation require a multidimensional approach to poverty, entailing the deprivation of capabilities (*e.g.* stemming from bad health) and the external environment (*e.g.* institutions and markets) as constitutive and non-excludable elements of the analysis of persistent poverty (Sindzingre, 2005).

3.3 Testing for poverty traps: seeking for an alternative

Besides the problematic theoretical formulations, poverty traps also present challenges when testing[4] for them on empirical data. Most of the problems are related to one of their basic features, that is, the presence of multiple equilibria; they are not always detectable, and a negative test does not automatically imply that we are not in front of a multiple equilibria poverty trap (Barret and

[4] Most common tests for poverty traps can be found in the works of Antman and McKenzie (2007), Loshkin and Ravallion (2004), McKenzie and Woodruff (2006), Van Campenhout and Dercon (2009).

Carter, 2013). On the other hand, the patterns in data that could bear a multiple equilibria hypothesis can be consistent also with other hypotheses, making the detection of a poverty trap much more difficult (Rodriguez, 2008). In this framework, this work proposes an alternative to general testing of poverty traps, contemplating the notions of complexity and multidimensionality. By considering a complex system, we will not seek for an economic equilibrium condition before attempting to detect a poverty trap; given the stochastic and dynamic nature of the economic paths (Arthur, 1989), the notion of equilibrium becomes irrelevant, giving scope for a more meaningful non-equilibrium analysis. Instead of assuming that the economy tends toward a steady state, we assume that its path is dynamic and continuously evolving, reacting to several factors, and that under some specific conditions it can be "trap" people into poverty. The innovative feature of this kind of tests is to consider a complex system with a set of elements adapting or reacting to the pattern created by the elements themselves (Arthur, 2013). As a final remark, it is worth mentioning that since the original database used for this study is cross-sectional and not longitudinal, we will accomplish the task of testing for the presence of a poverty trap by describing a set of conditions that can be at the base of a poverty trap, as a picture in a given moment rather than considering a trend over time.

4. LITERATURE REVIEW

Before proceeding to the statistical test, following the principles mentioned in the last paragraph of the former section, it is necessary to select a number of factors capable to explain the mechanisms leading to the creation of a self-enforcing mechanism, like a poverty trap. Since the multivariate technique chosen for testing (SEM) relies on the relationship between latent variables[5], we will treat the factors as such, each factor stemming from a different set of observed variables. The observed independent variables, properly grouped, result into a latent variable, that is, a common latent factor capable to explain at the same time the whole set of independent variables chosen in the model (Borsboom, 2008). This section is divided in 4 paragraphs, one dedicated to each factor: health, market/institutional environment, food security and wealth; the section goes through the existing literature drawing upon previous research regarding the above-mentioned factors and their relationship with persistent poverty. Although we will mention each factor separately in the following paragraphs, the methodology adopted for this research work takes all the latent variables in account simultaneously. Detailed information about the variables and descriptive statistics can be found in Table I. The four factors have been chosen according to their relevance for the rural livelihoods in rural southern Mozambique (Mosca, 2015), as well as to their observability.

4.1 Health

Intuitively, poor health is likely to translate into poor livelihoods; if we look at insightful previous research, it appears undeniable the existence of a strong relationship between health and poverty, with very bad health conditions as a possible cause of trapping mechanisms (Sachs, 2001; Nyakato & Pelupessy, 2011). Due to the limits imposed by data availability on health conditions,

[5] The terms "latent variable", "construct" and "factor" are used interchangeably in this work.

and to the low reliability of some of them (like AIDS, sexual diseases and recurring children diseases) only data about malaria have been used to define this latent construct. Malaria is a rather good proxy measure for health in contexts like poor rural Mozambique; many authors consider it a "poverty disease" (Gallup & Sachs, 2001), with causality between poverty and malaria working in both ways (Teklehaimanot & Meija, 2008). The set of explicative variables making up this construct are: rate of usage of mosquito nets, rate of the incidence of malaria (in this case I considered the percentage of people that did not contract malaria) and rate of repellents' usage. The explicative variables chosen are expected to be positively correlated to the latent factor. Furthermore, they are consistent with the usage of an asset based poverty measurement (that will be described in the last paragraph of this section), although self-reported health data might result not fully reliable (Somi *et al.*, 2008).

4.2 Market and Institutional Environment

A market-based poverty trap is described in an insightful theoretical paper from Barret and Carter (2013), in which the authors demonstrate that a poverty trap may be originated by multiple financial market failures; likewise, exclusionary political institutions can be the at the base of persistent poverty, since they can settle permanently inefficient dynamics and social norms (Bowles, 2006). These two elements are considered simultaneously as a part of the same latent variable; for instance, we assume that high transactional costs are a result of market inefficiencies, or failures, and that at the same time the weak state support contributes to increase the fixed costs for the small producers, contributing to the exclusion and marginalisation of the rural population. As environmental factors, market and institutions – if not properly working – can become the cause of a mechanism that can trap entire regions into poverty. In order to measure this construct, we will consider: the level of state support (calculated as a summated scale of the number of sectors in which rural households receive governmental support), the difficulty to create a

commercialisation network (measured by the distance to which the producers manage to sell their products) and the degree of market development (calculated as a summated scale of a number of different factors related to the efficiency of the market, explained in detail in Table I).

4.3 Food security

The concept of food security plays a pivotal role in the formation of the general theory to be tested in this work, since it is assumed as an *ex-ante* status with respect to health as well as markets must complement with governments in creating a food secure environment (Barrett, 2005). It is also considered strictly correlated to the wealth of rural households, since almost the totality of the households surveyed are tightly depending on their own food production, regardless weather they produce enough to sell the exceeding production or not. Therefore, a low level of wealth for food insecure smallholders' households is expected. As to Barret (2005), food security can be defined as the "access by all people at all time to enough and appropriate food to provide the energy and nutrients needed to maintain an active and healthy life". It is therefore an *ex-ante* status, with respect to a set of conditions in each moment of time, according to which we can define an individual, household or country vulnerable for a lack of food security; this way of conceiving food security as a "static" factor is suitable both for the latent-variable approach adopted in this work, and for the use of cross-sectional data, since they do not enable the observation of data over time. Moreover, the use of disaggregated data about food security helps to provide a deeper insight on each household or group, as highlighted by Popkin (1981) and McLean (1987). Therefore, poverty is treated as an *ex-post* outcome of food security, also directly correlated to wealth – as in the theoretical model that we will test ahead. In conclusion, food insecurity (*ex-ante)* causes poverty (*ex-post)*. In synthesis, poorer households will be less food secure, and then even poorer, further reducing food security, and so on, bringing about a loop that corresponds to the condition of persistent poverty.

Considering also the level of self-sufficiency as a determinant of food security, we chose the following observed variables to build this third construct are: total land owned, diversification in consumption, diversification in production, availability of food over the year, and finally, wealth – measured as an "asset index", and to which is dedicated the next paragraph.

4.4 Wealth

Differently from the three previous constructs, the concept of "Wealth" is represented by an observed variable, working as a dependent endogenous variable in the theory that will be tested. Wealth is quantified by an asset-based index, that is, a non-money-metric measure (Carter & Barret, 2006) that allows to circumvent any problem stemming from the arduous disclosure of income-related information. This kind of measure has already been used to study welfare dynamics in Mozambique (Giesbert and Schindler, 2012), with quite satisfactory results; this observed dependent variable – that we will call also "Asset Index" – has been built weighting and summating both domestic and productive goods, as indicated in Table I and Table II; the summated scale of the weighted number of goods owned for each category corresponds to the asset index. The parameter applied to weight the ownership of the goods included into the index have been calculated with a multivariate technique called Principal Component Analysis (PCA)[6] (Filmer & Pritchett, 2001; UNDESA, 2005); according to the methodology adopted in the literature considered for this work, the parameters reflect the relevance of each good in the determination of the final value of the index[7]. PCA is a widespread technique, often adopted to create asset indexes from continuous variables (Booysen *et al.*, 2005), as in the case of the data

[6] Details about the methodology applied to obtain the asset index are enclosed in appendix B. PCA results are included in the same appendix, in Table II.

[7] For a more comprehensive discussion about the various techniques that can be adopted for the creation of an asset index, and especially about the advantages of PCA, please refer to Wall and Johnston (2008:146) or Gordon *et al.* (2012)

used in the variables that measure the concept of "Wealth" in this work. The assent index is therefore used as a proxy of households' well-being, providing a more accurate measure if we compare it to consumption and income data, which are often biased by several environmental and exogenous factors (Sahn & Stiefel, 2000). The higher the value of the index, the better the wealth conditions of the household which the value refers to. As a dependent variable in the model, the asset index is the key point of the relationship that exists between the latent variables, from which we mean to obtain information about non-equilibrium wealth dynamics, as we will see in the following section. By measuring the intensity of the relationship between the asset index and the three latent variables (Health, Market & Institutional Environment and Food Security), and then analysing the variations occurring in this complex relationship for different levels of wealth, we can provide some useful information to describe the non-linarites in which could be found the roots of persistent poverty. In conclusion, the purpose of the theory exposed in the following chapter is to statistically validate the multifactorial nature of poverty in this area, and then to validate the same structure for different levels of wealth, with the purpose of detecting any possible difference in the mechanism that leads to the creation of wealth.

5. THEORY AND HYPOTHESES

After having defined both the latent constructs considered to test for poverty traps, with their respective explicative observed variables, the following step is to set up the statistical test to validate the theory by which we presume the existence of a poverty trap in the three rural districts of Chóckwe, Guijá and Kamavotha. Before going more into the methodology adopted, it is necessary to establish a set of theoretical hypotheses that, if confirmed, would reveal the possibility of the existence of a poverty trap. If all the following hypotheses hold after being tested, the general theory (that is, the existence of a poverty trap in the context taken in exam) will be verified. The hypotheses that make up this theory are categorised in two groups: the first group, the set of structural hypotheses, aims to test the multifactorial structure of poverty through a Confirmatory Factor Analysis (CFA), which is a specific configuration of SEM techniques; the last hypothesis, that alone represents the second group, involves the validation of the multifactorial structure of poverty tested by the first group of hypotheses, and aims to detect the supposed non-linearity of wealth creation by analysing the variations in the parameters that describe the relationships involving the measurement of wealth.

5.1. *Structural hypotheses*

H1: Health (*Health*) is positively and significantly correlated to Market and Institutional Environment (*Mkt_Inst*);

H2: Health (*Health*) is positively and significantly correlated to Food Security (*Food_sec*);

H3: Market and Institutional Environment (*Mkt_Inst*) is positively and significantly correlated to Food Security (*Food_Sec*);

Testing this group of hypotheses represents the first step of theory validation. We assume that the three of the factors considered by the theory co-variate altogether; if this assumption is confirmed

and if it is found statistically significant, the model can be considered coherent, since the latent variables will be proved able to explain enough of the variability of the data on which we have run our statistical technique, the Confirmatory Factorial Analysis (CFA) (Hair *et al.*, 2014). These hypotheses are consistent with the notion of complexity mentioned in the theoretical framework: they implicitly assume that all the latent variables are correlated to each other, involving more than one factor in the examination of poverty causation, and verifying the consistency and the statistical soundness of a multidimensional idea of poverty. If the poverty trap will be detected (after the verification of the next group of hypotheses), all the factors considered in the model will be involved in the mechanism that locks the economy into poverty, overtaking the "mainstream" theory according to which poverty traps are originated by a unique factor, as described in section 3.1. A graphical formulation of this hypothesis is displayed in Figure 3. If these hypotheses hold, proving to be statistically significant, the terrain to test for non-linearity will be ready.

5.2. *Non-linearity hypothesis*

H4: Food security (*Food_sec*) has a different effect on Wealth (*Index*) according to the different levels of income observed in the sample.

Since in this work we propose an innovative testing process that does not involve the research of a steady state, opting for a non-equilibrium detection of persistent poverty, we consider non-linearity as an outcome of the conditions characterising each household. More precisely, with the structural hypotheses verified, the same multivariate technique can be run over two different partitions of the data available (the poorest quartile and the three richest quartiles) in order to observe a difference in the relationship among the variables, *i.e.*, if there is a discrepancy in the intensity of the correlation between the latent variable (*Food_sec*) that explains the dependent observed variable which is the object of our analysis (*Index*), we can conclude that there is a scope

for the detection of a mechanism that might be locking the economy into an inefficient path, preventing the take-off of the economy. This last step will also serve as a validation of the whole model. Figure 3 provides the general overview of these two groups of hypotheses, forming the general theory to be tested in the following two sections.

6. METHODOLOGY

This section will focus on the methodology adopted to test the theory described in the former sections of this work; for this purpose, the first part of the section will be consecrated to the description of the original database that allows to empirically test the underpinning theory of this work, whereas the second part will briefly describe the multivariate analysis technique used to analyse the relation between the variables chosen for the study: the Structural Equation Model.

6.1 Data

The data used in this work consists of the outcome of a survey made up of closed questions, submitted to *machamba*-owning families in three southern districts of Mozambique; inquiry and survey[8] submission have been carried out in 2015, between July and September. Surveys have been validated basing on the clarity of the given responses; hesitant and uncertain responses have not been considered. Furthermore, observation with incomplete answers where not deleted from the database; the missing data have been imputed following the all-available approach, or *pairwise*[9] approach (Hair *et al.*, 2014). Considering all the limitations imposed by this kind of fieldwork, as well as the low quality of official population data, we obtained the sample using a random and not systematic method, applying a post-sampling methodology that will be explained in detail ahead in this section. For each of the areas taken in exam, more than 400 individuals have been surveyed, in representation of their own household – the unit of analysis of this research. This process resulted in a database made of 1200 valid observations, amid the totality of households surveyed. Nevertheless, before the estimation, all the observations for each variable have been weighted using as a sample weight variable the masculinity rate inside each household,

[8] Survey can be found in appendix A

[9] Hair *et al.* (2014) recommend this approach for cases in which missing data do not exceed the 10% of the whole data available.

compared to the regional population gender rate (population data from INE, 2015). This operation allows to attribute a loading to all the values in the dataset, in order to make the sample more representative of the whole regional population, leading to a much more reliable and accurate result (Hahs-Vaughn & Lomax, 2006). Furthermore, a stratification variable based on the original district of each household is adopted, creating mutually exclusive and internally homogeneous subgroups, that allow for a lower standard error in the estimation. Both stratification and weighting are applied through the survey data option made available by the statistical package.

Surveys have been randomly submitted directly in the *machambas*, with the support of some representatives of the most important Mozambican farmers' association, the UNAC (*União Nacional dos Agricultores e Camponeses* – National Union of Peasants and Farmers*)*, that joins together a considerable number of smaller farmers' associations. Altogether, the research group that conducted the fieldwork beneficiated from the support of a team of five surveyors provided by the OMR; local surveyors were also recruited in each district, in a number decided on a weekly base according to the number of people to be inquired foreseen for each day of work. Nonetheless, the influence of measurement error merely due to the data gathering method must be taken in account. The collection of data obeyed to the criteria of the highest relevance of the variables considered for the study of poverty; the surveys have been submitted to farmers (in representation of the whole household) in the three southern districts, as mentioned in paragraph 2.2 of this work. The database resulting of the above-mentioned data-gathering process contains the rough information that, properly elaborated, enables the identification of the nature and strength of the relationship among latent variables, providing information about the mechanism that is supposed to be at the origin of persistent poverty in these rural areas. The cross-sectional database thus obtained, despite the several limitations imposed by this kind of data, allows the researcher to take a snapshot of the situation at a given moment in time. Although it does not allow to make

inference basing on the evolution of observed data over time, cross-sectional data allow to make an *ex-ante* assessment, providing a picture of the state of a conjoint of variables in a specific moment of time (Chaudhuri *et al.,* 2002). Variables regarding demographic, social, and economic features of the rural livelihoods entail all the aspects relevant for the analysis of persistent poverty. The variables observed will be properly grouped, forming the latent variables that represent the three constructs described in chapter The three latent variables are directly unobservable, but at the same time they are determined by the data available in the dataset. Therefore, the correlation relationship between the latent variables, as well as the way in which they interact, represents the backbone for the testing strategy implemented through the SEM technique.

6.2 The Structural Equation Model (SEM): an implementation through Confirmatory Factor Analysis (CFA)

According to Hair *et al.* (2014), Structural Equation Modelling (SEM) is a family of statistical models that aims to explain the relationships among multiple variables. SEM is increasingly gaining popularity in a wide range of research disciplines, mostly because of its capability to analyse complex relationships among latent variables (Grace, 2006). In the specific case of poverty, SEM provides insightful information regarding the several determinants and dimensions of poverty (Ningaye *et al.*, 2013), not measuring poverty with a unique indicator – regardless the dimension or set of dimensions it might refer to – but measuring the intensity and describing the nature of the relationship between the factors that create a situation of chronic poverty. One of the reasons of the increasing adoption of SEM in empirical research is the fact that, like other multivariate techniques, it reduces the number of observed variables grouping them into latent constructs, the interaction among which represents the general model. Furthermore, comparing to other techniques that do basically the same, SEM allows for a much smaller measurement error (Voth-Gaeddert and Oerther, 2014); with SEM it is up to the researcher to decide which constructs

represent which independent observed values, and not the statistical tool, as occurs for example with Exploratory Factor Analysis (Walker *et al.,* 2009). On the other hand, this advantage translates into the necessity of a strong theory behind the statistical model; the face validity of each construct requires each latent variable to be underpinned by several strong theoretical assumptions already proved by previous research (Hair *et al.*, 2014). However, since the model relies on the use of latent variables, it is obviously not immune from further measurement error; in fact, inference conducted with latent variables has a much lower degree of certainty than any estimation run on observed data (Borsboom, 2008); moreover, a construct can be theoretically inconsistent or weak, so that the related observed variables might be not fully able to explain the construct, originating a biased or non-explicative latent variable.

The SEM configuration that fits the best to the data and to the theory to be tested is represented by Confirmatory Factor Analysis (CFA); this technique allows to assess the validity of a set of constructs, set up by the researcher before the data gathering. In CFA, all the latent variables chosen by the researcher work as measurement components, and are supposed to covariate saturating the model[10] (although it is important to remark that covariation does not correspond to causation). The measurement model thus obtained undergoes goodness-of-fit tests, as we will see in the next section. If the result of this assessment is satisfactory,

Therefore, this approach involves on hand the assessment of both the validity and the reliability of the latent variables; on the other, it is an analysis of the accuracy and the significance of the covariation relationships existing between the constructs. By analysing the parameters estimated both for the relationship that exist between the observed and latent variable, and those estimated

[10] For "model saturation" it is meant that all the constructs covariate among them, reaching the maximum number of degrees of freedom, that is, of parameters estimated; this aspect is particularly relevant in order to achieve the model identification.

for the correlation between latent variables, the model provides information about the multidimensional structure of poverty, resulting from the interpretation of the parameters estimated through CFA. This first part of the model estimation will be used to test the first three hypotheses of the theory articulated in chapter 5.

The second step of the estimation process is carried out by running the same CFA model (keeping unchanged the paths and relationships showed in Figure 3) upon two different partitions of the dataset, more specifically on two sub-samples corresponding to the poorest quartile and to the three richest quartiles. If these two new estimations are capable to keep the explanatory capability of the previous estimation, the model will be validated. But more importantly, any potential differences in the standardised parameters resulting from the new estimation over the two sub-samples can provide useful information about the dynamics of poverty in the model, especially detecting non-linarities in the creation of wealth, as we will see in the next section.

Despite the limits resulting from the use of cross-sectional data, that often are not sufficient to go beyond the mere description of a phenomenon (Dasgupta, 2009), SEM allows also to explain the nature of the phenomenon analysed estimating the magnitude of the relationship between latent constructs, providing us with a powerful theory-testing tool. The theory tested through the CFA approach is said reflective (it is always the latent variables to explain the observed ones), while the model arrangement is congeneric, that means that each independent variable is associated to only one latent variable (absence of cross-loadings of the same observed variables explained by more than one latent variable). Furthermore, a cogeneric model foresees that the error terms related to the observed variables from the same construct are not correlated to each other, neither they are correlated with error terms of variables that refer to another construct: this arrangement reduces the likelihood of yielding a biased estimation. Finally, the estimation method

chosen is the Maximum Likelihood with Missing Values (MLMV)[11] (Enders & Peugh, 2004), widely used for Structural Equation Models; this involves a powerful tool that provides an unbiased estimation compared to other techniques, particularly concerning non-normality issues (Olsson *et al.,* 2000) and provides acceptable estimations also in presence of missing values in the observations, if they less than the 10% of the complete data available (Savalei, 2008). Confidence interval has been set at 95%.

[11] All CFA and SEM estimations have been run with the software Stata 13.1.

7. RESULTS AND DISCUSSION

After passing through the methodology adopted to test our theory, we finally discuss the results of the CFA estimations, to validate the two sets of hypotheses that make up the theory that undergoes the statistical test performed by CFA. The main goal of the estimations is firstly to affirm the coherence of the measurement components; the outcome of the estimation entails relevant information about the nature of poverty in rural poverty, especially regarding the relationship between food security (*Food_Sec*) and wealth, in a dynamic system in which all the aspects of rural life related are correlated to each other. All the parameters and covariance values in the following paragraphs will be shown in their standardised values, in order to ease comparability.

7.1 Confirmatory Factor Analysis: results

The descriptive statistics of the observed variables can be consulted in Table I, whereas the results of the CFA estimation are graphically shown in Figure 4, and displayed more in detail in Table III. The measurement model describes the relationships between the latent variables and their respective observed variables, as well as the correlations supposed to exist between the three latent constructs (Von-Gaeddert & Oerther, 2014); since the survey data option adopted by the statistical package does not allow for the use of more classical and widespread absolute goodness-of-fit (GoF) indexes, as the Chi-square (χ^2) absolute GoF Index (Bollen *et al.,* 2013), the only class of indexes that can be used to assess the overall quality and explicative power of the model are those based on the residuals of the estimation. For instance, Stata 13 permits to estimate the Multivariate Coefficient of Determination (CD), an index whose characteristics can be compared to the classical coefficient of determination (R^2) often used to assess linear regressions' goodness-of-fit; the CD evaluates the proportion of generalized variance in a set of latent variables explained by a group of observed variables (Edwards, 2001). Since the CD value calculated for this first

CFA estimation is close to 1 (0.986), we can consider the measurement model's overall fit and variance explained rather satisfactory.

With respect to the individual parameters estimated through CFA corresponding to the regression coefficient between the observed variable and the latent construct, normally the loadings are considered acceptable only if their standardised values range between -1 and 1, with p-value[12]<0.05; it is often recommended to re-specify the model if some of the parameters associated to any latent-observed variable relationship has a value lower than 0.7, as it happens only three of the independent variables of our model (*Comm_network,* 0.65; *State_supp,* 0.54; *Rate_rep*, 0.50). However, since these values are still higher than 0.5 they can be considered still statistically relevant (Hair *et al.,* 2014). Furthermore, they are in line with the reality examined: for instance, if we consider the context of a "traditional" economy characterised by informality – not necessarily corresponding to a non-market economy as it is shown by Sindzingre (2004) – we can expect a reduced influence of formal commercialisation networks in the creation of wealth, since the largest part of the production is addressed to self-subsistence rather than to the markets. Regarding the role of the support from the State, its low relevance can be imputed to the flawed governmental policy inefficiencies, in what concerns the struggle against poverty as well as the assistance addressed to rural land smallholders and farmers' associations in general. Overall, loadings that determine the latent variables chosen show satisfactory values, the strongest pertaining to food security that appears as the best-explained latent variable in the model. On the other hand, also the parameters that indicate the degree of correlation between the latent variables (curved double-headed arrows in Figure 4) are proved to be statistically significant, with values that suggest the consistency of the relationship between the constructs that represent Health,

[12] P-values are determined by the confidence interval, that in this case has been set at 95%; consequently, the result delivered by the significance test must be 0.05 or lower.

Market & Institutional Environment and Food Security. However, the presence of these correlations does not imply the idea of causation between the constructs, but it exclusively counts for the mutual influence that exist between the three latent variables, demonstrating that the three factors must be considered simultaneously in the analysis of poverty and wealth creation.

In conclusion, the estimation of the measurement model by CFA confirms the set of structural hypotheses, that is, it validates the internal consistency of each latent variable given the significance of the parameters that link the latent variable with the respective observed variable (conceptual coherence has already been theoretically verified by relying of previous research to make up the constructs), and above all, it confirms the correlation that exist between the three latent variables, that validates the three-dimensional nature of poverty in the context analysed.

7.2 Sub-sample estimation: results

By estimating the measurement model in the former paragraph, it has been confirmed the relationship between the latent variables, as well as the soundness of the coefficient attributed to the relationship between each construct and the respective observed variables, thus validating the first set of structural hypotheses enounced in section 5. However, to provide a more insightful overview about poverty dynamics, and to be enabled to make any kind of supposition over the possible causes of persistent poverty among the small-scale farmers' households in the rural areas analysed, we must validate also the last hypothesis (H4) that supposes the presence of non-linearity in the process of wealth creation, that is, a poverty trap. To this aim, the same CFA estimation needs to be conducted over two different sub-samples, in order to appreciate potential changes according to the level of wealth (or poverty) of each household. To do so, the sample has been split into quartiles, basing on the variable *Index*; the lowest quartile (households with an asset index below the value corresponding to the first quartile, corresponding to the value 0.4143) forms the first sub-sample of those living in the hardest relative poverty, while the second part

includes all the observations that belong to the remaining three quartiles of relatively less poor households. This operation has been realised by creating two fictitious dichotomous variables (*poor_1quart* and *rich_234quart*, Table I), so that the statistical package is able to estimate the model only for those households belonging to the first poorest quartile, or to the remaining three richest ones. The results of these two sub-sample estimations are described in Table IV and Table V. Starting from the absolute GoF Index, the values of the two CD are again fully acceptable[13]. From a comparison between these two new estimations with the one performed in the previous paragraph, several major and minor changes can be found. Firstly, it appears clear that the set of observed variables linked to the latent variable *Food_sec* has a stronger correlation with the latent variable: in particular, the amount of land owned (*Land_owned*) has a stronger effect on Food Security for the lowest quartile (0.91) against 0.82 in the CFA estimation and 0.79 for the richest quartiles. This result is coherent with the observed reality, since poor farmers count much more on the quantity of land available, rather than on costly productive inputs as seeds and fertilizers. Secondly, drawing the attention towards the latent variable *Mkt_inst,* it appears evident how the importance of a commercialisation network (*Comm_network*) is much higher for those who are able to sell part of their production, mostly in the richest quartiles of the sample (0.72), decreasing dramatically for the poorest (0.36). But most importantly, the most remarkable result arising from this comparative estimation is to be ascribed to the relationship between wealth and food security (*Food_sec -> Index).* For instance, the spread between the values of the "poor" estimation (0.55) and the "richer" one (0.94) gives scope for relevant considerations over persistent poverty. Such a result reveals a different relationship between the latent variable that represents the concept of

[13] CD's value calculated for both estimations is 0.987, with a slight fluctuation if compared to the first estimation in which CD's value was 0.986.

"food security" and the dependent variable representing wealth conditions, according to the set of socio-economic conditions that characterise each household.

These results unveil a possible non-linearity in wealth accumulation, to be detected in the relationship between *Food_sec* and *Index,* as well as into the correlation of food security with health conditions and the market and institutional environment; the covariation of the latent variables is important to assess the complexity of the whole system analysed; therefore, the determination of the level of wealth cannot be imputed to a unique factor (*Food_sec)* since it varies altogether with the other two latent variables. More specifically the non-linearity shows up in the fact that richer people remarkably benefit from improvements in the variables linked to food security, while for the poorest, the same improvement does not produce the same result, frustrating any attempt to support them through food assistance or any other intervention addressed to improve food security. On the other hand, the discrepancy in the results stemming from the two sub-sample estimations gives a hint on the different strategies and livelihoods that are put in practice by people with different wealth conditions, above and below the relative poverty threshold.

8. CONLUSIONS AND POLICY IMPLICATIONS

If one might want to sum up the results of the estimations carried out in the previous section, we could say that, according to the specific situation considered in this study, the health conditions and the market / institutional environment are both correlated with the level of food security, which is in turn explains the level of wealth; the intensity of this relationship varies according to the degree of wellbeing of each household, with the rich ones benefitting more of an enhancement in food security than the poorer ones. If this statement holds, as I have tried to demonstrate all along this work, several considerations can issue from it.

On the theoretical side, this works suggests a new perspective for the study of poverty. Although multidimensionality is not a new feature in the study and measurement of poverty, the mathematical formalisation of the studies that aim to address the origin of persistent poverty are often flawed, since they consider a very reduced number of factors as possible causes of the so called "poverty trap", rather than taking in consideration a set of factors that continuously interact with each other, producing many different effects on various aspect of the rural livelihood. Likewise, the concept of high marginal returns of any external intervention on the poor, so dear to the neoclassical economic thought, is questioned by the results of this exploratory research: in fact, the estimation of the CFA model on two different subsamples indicates higher marginal effects to the relatively richer (but still poor) households, among the communities analysed. It is obvious that this consideration is not enough to deconstruct the whole economic theory that stems from the neoclassical assumption of the methodological individualism, and marginalism in general, but at least advocates for the necessity of considering the idea of complexity and cumulative effects for any empirical study that involves the observation of poverty dynamics, proving that an effect expected by theory (e.g., high marginal effect of an improvement in food

security for the poorest) could not occur under a set of given conditions, that in this case can be brought back to a poverty trap.

Nevertheless, the most evident limit of the approach chosen in this work lies in the use of a cross-sectional database, which does not allow for the study of evolution of wealth over time, making therefore more difficult the observation of poverty dynamics, or better said, of the trapping dynamics at the base of persistent and chronical poverty. The existence of these mechanisms is revealed by observing a situation in a specific moment, analysing the relationships involving the most important observable aspects of the rural life in the three districts of Chockwe, Guijá and Kamavotha, in southern Mozambique. In order to appreciate the variation over time of assets' accumulation, it is needed to reiterate the same observations several times and spaced in a given time interval. However, the explorative nature of this work lays the bases for a deeper study that might include longitudinal data that permit the study of accumulation paths, that surely would provide a much more insightful view over rural poverty. In addition to this, the application of the same methodology (CFA) and the use of the same latent variables and correlations on another dataset in another poor rural context could be a useful tool to validate the approach adopted in this work. Therefore, despite its innovative purposes, the use of Structural Equations Models (CFA) in the study of poverty traps requires a considerable "fine tuning", before attaining a more suitable arrangement for the study of complex phenomena such as those causing persistent poverty.

On the policy side, this work indirectly provides a recommendation for policy-makers and donors. Indeed, the study of complexity in poverty through the analysis of multidimensional relationships performed in this research empirically shows that it is rather meaningless to perform an anti-poverty intervention addressing only a reduced range of factors, and above all, it is misleading to consider the poor as a unique category, associated under the criteria of an absolute

feature, as poverty is if we consider it as a condition in common to those who live under a certain threshold of income. Among the poor, relatively poorer people are likely to live a completely different situation from those who are slightly richer: for instance, food assistance is proved to produce a modest outcome in improving wealth conditions for the poorest, due to their natural tendency to diversification induced by the necessity to cope with risks and threats simultaneously (Cunguara & Darnhofer, 2011), or to the presence of other factors (as in shown in this work, bad health, or exclusive markets and institutions). The most insightful finding of this work demonstrates that too narrow interventions alone can hardly trigger a positive mechanism as expected by the supporters of one-time and ultra-specific external interventions against poverty

. To conclude, also the concept of threshold requires then much more attention and thorough analysis: if a threshold is set relying on the interference of a single variable on the accumulation dynamic, it could be overlooking important phenomena that might be playing a role in detaining people into poverty.

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ANNEXES

Figure 1: Mozambique's geography

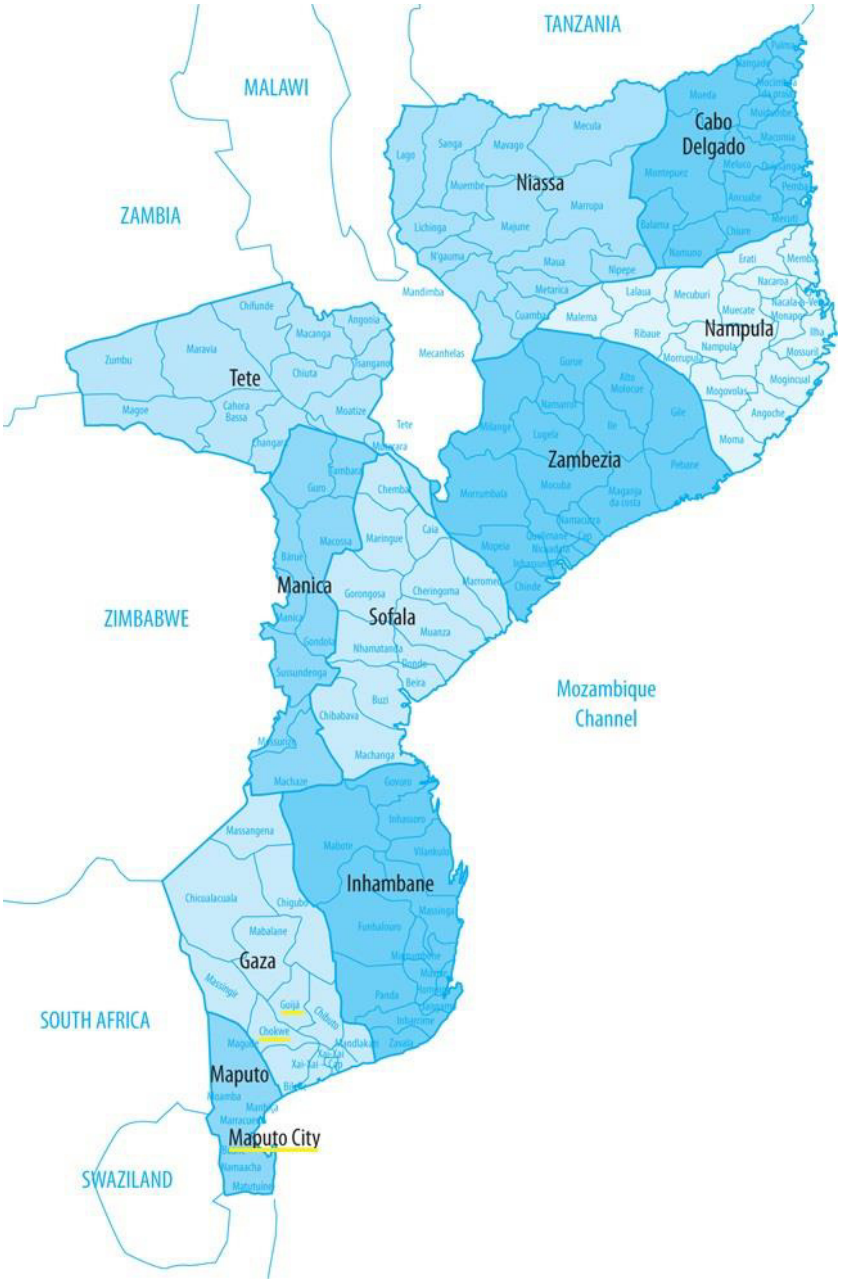

Figure 1- Source: UNICEF (www.unicef.org.mz/cpd/chapter_map.html)

Figure 2: Comparison between the normal accumulation dynamic with accumulation dynamic under a poverty trap

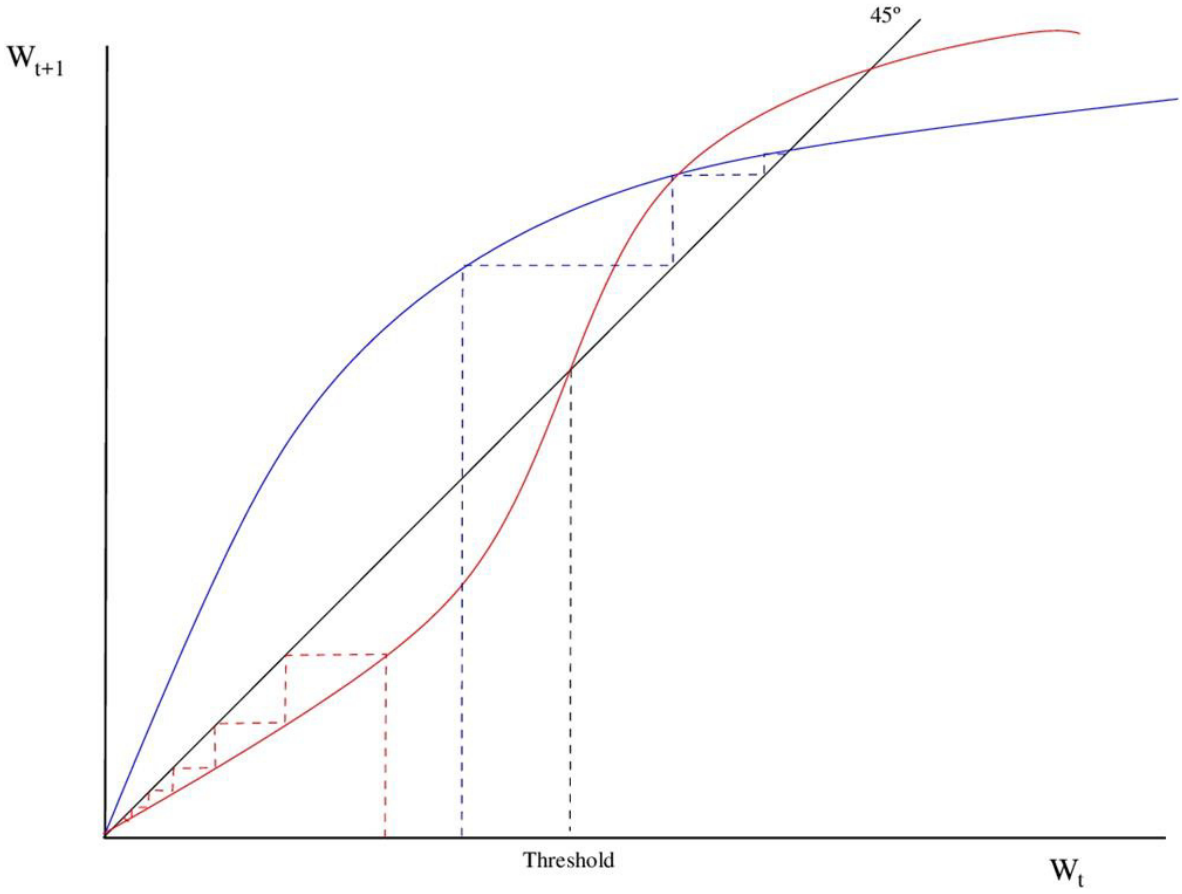

Figure 2 - Elaboration of the author based on the formulation of Banerjee & Duflo (2011)

Legend:

Normal accumulation dynamic (neoclassical function of production);
Accumulation dynamic under poverty trap (S-shaped curve

Figure 3: General theory

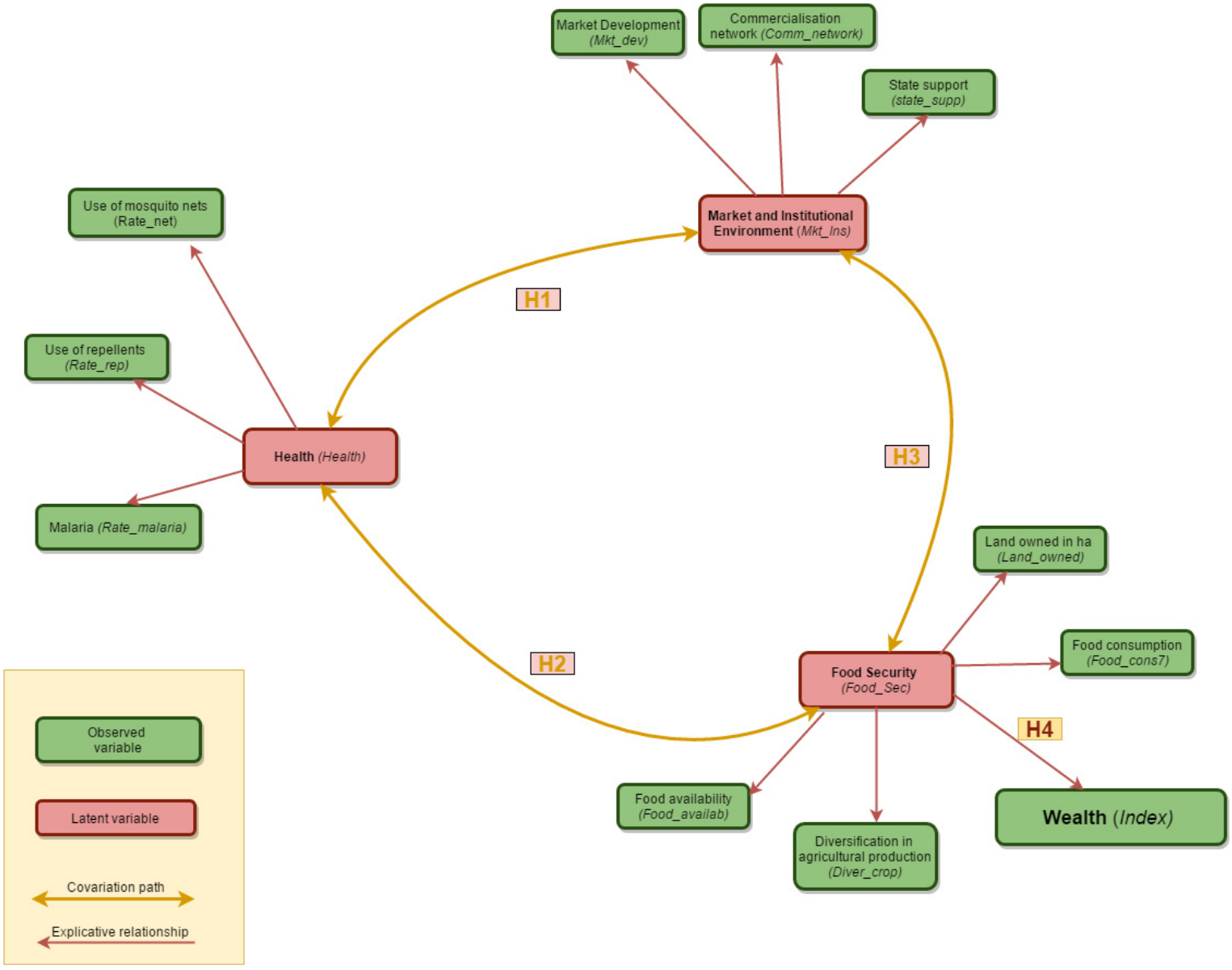

Figure 3 - Elaboration of the author

Figure 4: Estimation of the Structural Equation Model through CFA on Stata 13

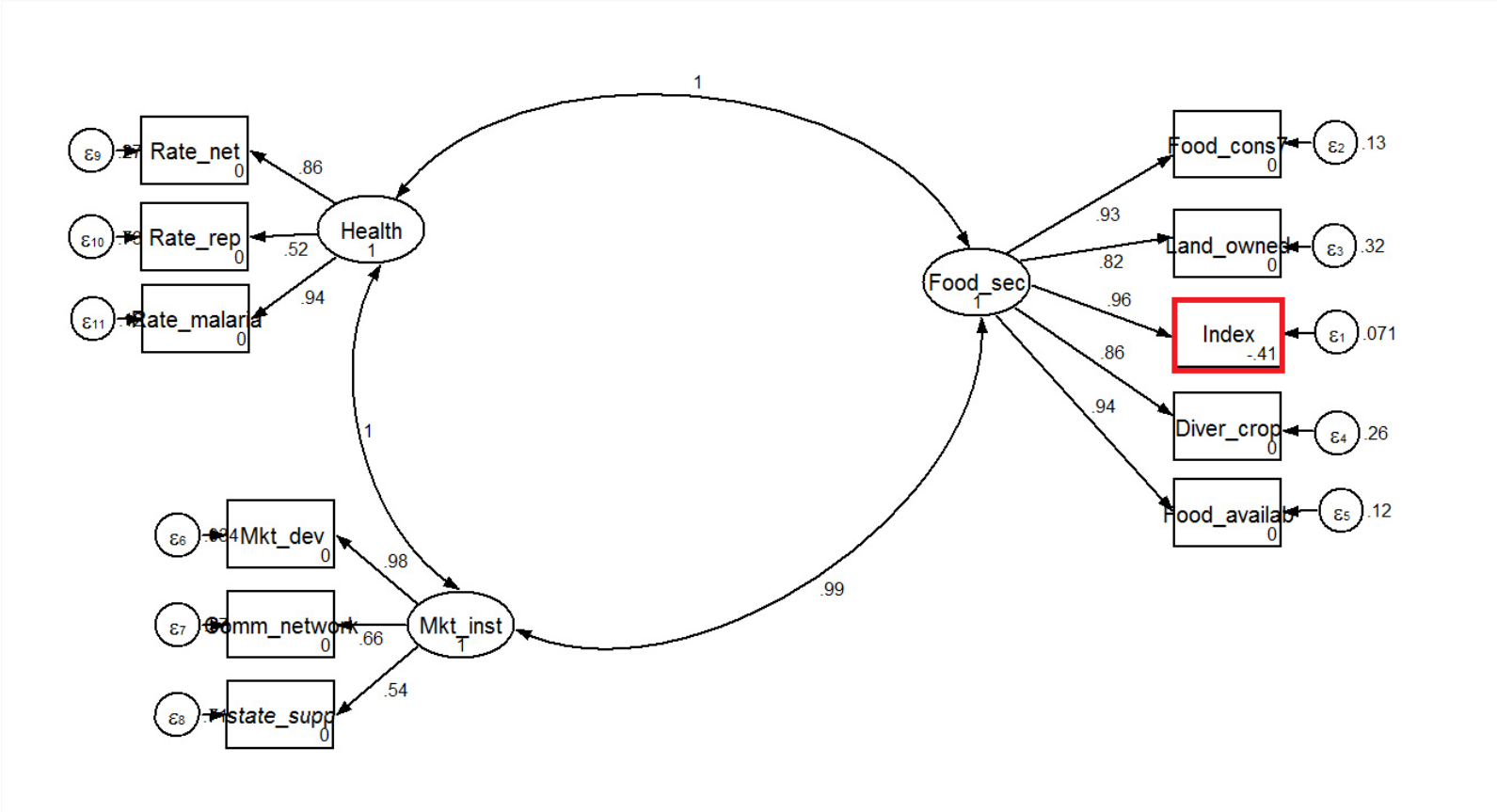

Figure 4 – Elaborated using the Stata 13 Path Drawer

Table I: List of variables and descriptive statistics

Observed variable	Label	Type	Obs.	Mean	Std. Deviation	Min. Value	Max. Value	Latent variable
Food_cons7	Weekly food consumption; different type of food consumed over the week (cereals, tubers, fresh vegetables, fruit, beans, red meat, chicken, fish, milk and derivates)	Ordinal	1200	4,178333	1,918228	0	11	*Food_Sec*
Land_owned	Total land owned by the household (in hectares)	Continuous	1200	0,955833	0,603478	~~0~~	5	
Diver_crop	Diversification of the agricultural production; number of different crops varieties cultivated (rice, corn, tomato, "buer" bean, sesame, caju, "manteiga" bean, other beans, sweet potato, vegetables, mapira, cassava, peanuts, sunflower, copra)	Ordinal	1200	2,170833	1,225929	0	8	
Food_availab	Number of months in which no difficulty in providing food was encountered	Ordinal	1200	9,110833	3,267892	0	12	
state_supp	Number of sector in which the State provides support (preparation, credit, technical support, fertilizers, tools, consumption, health, education)	Ordinal	1200	0,683333	1,076579	0	8	*Mkt_Inst*
Mkt_dev	Degree of market development based on difficulty to access credit, agricultural inputs, commercialisation nets, knowledge of market prices. Each element was evaluated by a likert scale from 1 to 5, with 5 the easiest and 1 the hardest).	Likert, summed scale	1200	11,597500	2,781236	0	20	
Comm_network	Number of commercial exits for the household's agricultural production (family, village, district, region, state)	Ordinal	1200	0,624167	0,795892	0	5	
Rate_net	Rate of people that are using a mosquito net in the household	Continuous, rate	1200	0,673106	0,407654	0	1	*Healh*
Rate_rep	Rate of people covered by the use of repellent in the household	Continuous, rate	1200	0,208465	0,392073	0	1	

Rate_malaria	Rate of people who did not contract malaria in the household	Continuous, rate	1200	0,845511	0,251507	0	1	
Index	Index measuring the level of asset owned by the family, calculated as a weighted (PCA) summated scale of the following assets owned: pipe water, fridge, stove, radio, mobile phone, car, bicycle, hoe, water pump, plough, atomizer (Appendix B)	Continuous, rate	1200	1,092303	0,672117	0,0857	2,749	None
Weight	Weight variable based on masculinity ratio in the sample and in the population	Continuous, rate	1200	1	0,528602	0,443	5,426170	None
Strata2	Stratification on district of origin	Nominal	1200	2	0,816837	1	3	None
poor_1quart	Income below the average - according to Asset Index measure	Dichotomous	1200	0,561667	0,496390	0	1	None
rich_234quart	Income above the average - according to Asset Index measure	Dichotomous	1200	0,415	0,492928	0	1	None

Table II: Principal Component Analysis for the creation of an Asset Index – components' values

Variable		*Comp1*	*Comp2*	*Comp3*	*Comp4*	*Comp5*	*Comp6*	*Comp7*	*Comp8*	*Comp9*	*Comp10*	*Comp11*	*Variable Unexplained*
Water	a_1	.0742	.1131	.2934	.0327	.9344	-.0795	-.0459	-.0972	.0472	.0056	.0373	0
Cooker	a_2	.4389	-.2799	-.0905	-.1681	.0036	.0252	.1688	-.0490	.1995	.5732	.5410	0
Fridge	a_3	.4951	-.0797	.0270	-.0803	-.0053	-.1443	.1338	.0618	.0090	.2765	-.7889	0
Radio	a_4	.4390	.0056	.1853	.0221	-.0497	-.2425	.0442	.3717	-.6538	-.2807	.2545	0
Cellphone	a_5	.2544	.0032	.4282	-.0278	-.1048	.8068	-.2513	-.1254	-.0857	-.0401	-.0375	0
Car	a_6	.3096	.2664	-.1754	.0421	-.0949	-.2793	-.8119	-.1787	.1365	.0086	.0617	0
Bycicle	a_7	.1039	.3842	.5735	-.0133	-.3005	-.3098	.3152	-.3703	.2648	-.0995	.0987	0
Hoe	a_8	.0115	-.1369	.1844	.9109	-.0644	-.0269	-.0365	.2287	.1610	.1806	.0168	0
Agr_mach	a_9	.0265	.6497	-.0614	-.1214	.0136	.1808	.0723	.6536	.2661	.1434	.0448	0
Waterpump	a_{10}	.1299	.4785	-.4297	.3215	.0587	.1915	.2759	-.4264	-.3798	.1538	.0133	0
Sprayer	a_{11}	.4183	-.1184	-.3243	.1144	.0802	.1357	.2126	-.0093	.4398	-.6541	.0374	0

Table III: SEM / CFA Results

	Linearized					
Standardized	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
Measurement						
Index <- Food_sec	.9638492	.0070989	135.77	0.000.	9499214	.9777769
_cons	-.4067317	.0396555	-10.26	0.000	-.4845338	-.3289296
Food_cons7 <- Food_sec	.9337795	.0035003	266.77	0.000	.926912	.940647
_cons	0 (constrained)					
Land_owned <- Food_Sec	.8219451	.0145159	56.62	0.000	.7934657	.8504246
_cons	0 (constrained)					
Diver_crop <- Food_sec	.8614331	.0052496	164.09	0.000	.8511336	.8717326
_cons	0 (constrained)					
Food_availab <- Food_sec	.9361207	.0047621	196.58	0.000	.9267778	.9454637
_cons	0 (constrained)					
Mkt_dev <- Mkt_inst	.9830053	.0050476	194.75	0.000.000	.9731021	.99290840
_cons	0 (constrained)					
Comm_network <- Mkt_inst	.6577078	.0110127	59.72	0.000	.6361014	.6793142
_cons	0 (constrained)					
state_supp <- Mkt_inst	.5372565	.0141368	38.00	0.000	.5095207	.5649923
_cons	0 (constrained)					
Rate_net <- Health	.8553018	.0078706	108.67	0.000	.8398601	.8707435
_cons	0 (constrained)					
Rate_rep <- Health	.5195974	.0148076	35.09	0.000	.4905457	.5486491
_cons	0 (constrained)					
Rate_malaria <- Health	.9365772	.0056077	167.02	0.000	.9255753	.9475792
_cons	0 (constrained)					
var(e.Index)	.0709948	.0136846			.0486392	.1036254
var(e.Food_cons7)	.1280558	.0065371			.1158517	.1415455
var(e.Land_owned)	.3244062	.0238625			.2808106	.37477
var(e.Diver_crop)	.2579331	.0090444			.240785	.2763024
var(e.Food_availab)	.123678	.0089158			.1073664	.1424677
var(e.Mkt_dev)	.0337006	.0099237			.0189119	.0600539
var(e.Comm_network)	.5674205	.0144863			.5396991	.5965657
var(e.state_supp)	.7113555	.0151902			.6821687	.741791

var(e.Rate_net)	.2684588	.0134635			.2433021	.2962166
var(e.Rate_rep)	.7300185	.015388			.7004439	.7608419
var(e.Rate_malaria)	.1228231	.010504			.1038509	.1452613
var(Food_sec)	1	.			.	.
var(Mkt_inst)	1	.			.	.
var(Health)	1	.			.	.
cov(Food_sec,Mkt_inst)	.9920551	.0060698	163.44	0.000	.9801466	1.003964
cov(Food_sec,Health)	1.013.446	.0037681	268.95	0.000	1.006053	1.020838
cov(Mkt_inst,Health)	1.003.432	.0063477	158.08	0.000	.9909781	1.015886

Fit statistic	Value	Description
Size of residuals		
CD	.986	Coefficient of determination

Table IV: CFA Sub-sample estimation results (poorest quartile)

	Linearized					
Standardized	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Measurement						
Index <- Food_sec	.5519298	.2384611	2.31	0.021	.0840815	1.019778
_cons	2.09887	.7258205	2.89	0.004	.6748484	3.522892
Food_cons7 <- Food_sec	.9374373	.0051037	183.68	0.000	.9274242	.9474505
_cons	0 (constrained)					
Land_owned <- Food_Sec	.9096988	.0298988	30.43	0.000	.8510389	.9683587
_cons	0 (constrained)					
Diver_crop <- Food_sec	.9293624	.0068749	135.18	0.000	.9158743	.9428505
_cons	0 (constrained)					
Food_availab <- Food_sec	.9118064	.010835	84.15	0.000	.8905487	.933064
_cons	0 (constrained)					
Mkt_dev <- Mkt_inst	.9888841	.0093489	105.78	0.000	.970542	1.007226
_cons	0 (constrained)					
Comm_network <- Mkt_inst	.3642145	.0248219	14.67	0.000	.3155152	.4129138
_cons	0 (constrained)					
state_supp <- Mkt_inst	.7003743	.0254396	27.53	0.000	.6504631	.7502856

_cons	0 (constrained)					
Rate_net <- Health	.8072571	.0179575	44.95	0.000	.7720254	.8424887
_cons	0 (constrained)					
Rate_rep <- Health	.3148204	.0360973	8.72	0.000	.2439995	.3856414
_cons	0 (constrained)					
Rate_malaria <- Health	.9215151	.0117235	78.60	0.000	.8985142	.9445159
_cons	0 (constrained)					
var(e.Index)	.6953735	.2632276			.3308849	1.461367
var(e.Food_cons7)	.1212113	.0095688			.1038195	.1415166
var(e.Land_owned)	.1724481	.0543978			.092871	.3202116
var(e.Diver_crop)	.1362856	.0127785			.1133858	.1638104
var(e.Food_availab)	.1686091	.0197588			.133977	.2121934
var(e.Mkt_dev)	.0221082	.0184899			.0042849	.1140687
var(e.Comm_network)	.8673478	.018081			.8325895	.9035572
var(e.state_supp)	.5094758	.0356345			.4441476	.584413
var(e.Rate_net)	.348336	.0289926			.2958556	.4101258
var(e.Rate_rep)	.9008881	.01.0227283			.8573819	.94660195
var(e.Rate_malaria)	.15081	.0216067			.1138555	.1997589
var(Food_sec)	1	.			.	.
var(Mkt_inst)	1	.			.	.
var(Health)	1	.			.	.
cov(Food_sec,Mkt_inst)	.9921197	.0101941	97.32	0.000	.9721193	1.01212
cov(Food_sec,Health)	1.016.308	.0089993	112.93	0.000	.9986516	1.033964
cov(Mkt_inst,Health)	1.008.377	.0124361	81.08	0.000	.9839775	1.032776

Fit statistic	Value	Description
Size of residuals		
CD	.987	Coefficient of determination

Table V: CFA Sub-sample estimation results (richest quartiles)

	Linearized					
Standardized	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Measurement						
Index <- Food_sec	.944569	.0144128	65.54	0.000	.9162918	.9728462
_cons	.0000717	.1015993	0.00	0.999	-.1992608	.1994042
Food_cons7 <- Food_sec	.936603	.0041034	228.25	0.000	.9285523	.9446538
_cons	0 (constrained)					
Land_owned <- Food_Sec	.7960042	.016796	47.39	0.000	.7630513	.8289571
_cons	0 (constrained)					
Diver_crop <- Food_sec	.8492675	.0063987	132.72	0.000	.8367135	.8618215
_cons	0 (constrained)					
Food_availab <- Food_sec	.9426327	.0054223	173.84	0.000	.9319944	.9532711
_cons	0 (constrained)					
Mkt_dev <- Mkt_inst	.9841435	.0048093	204.63	0.000	.9747079	.9935791
_cons	0 (constrained)					
Comm_network <- Mkt_inst	.7239755	.0115993	62.42	0.000	.7012183	.7467327
_cons	0 (constrained)					
state_supp <- Mkt_inst	.4867995	.0161816	30.08	0.000	.455052	.518547
_cons	0 (constrained)					
Rate_net <- Health	.8737372	.008526	102.48	0.000	.8570097	.8904648
_cons	0 (constrained)					
Rate_rep <- Health	.5613631	.0165985	33.82	0.000	.5287977	.5939284
_cons	0 (constrained)					
Rate_malaria <- Health	.9451268	.0063228	149.48	0.000	.9327219	.9575318
_cons	0 (constrained)					
var(e.Index)	.1077894	.0272278			.0656664	.176933
var(e.Food_cons7)	.1227747	.0076866			.1085835	.1388207
var(e.Land_owned)	.3663773	.0267394			.3174989	.4227805
var(e.Diver_crop)	.2787447	.0108685			.2582165	.3009049
var(e.Food_availab)	.1114435	.0102225			.0930886	.1334176
var(e.Mkt_dev)	.0314616	.0094661			.0174347	.0567738
var(e.Comm_network)	.4758595	.0167952			.4440232	.5099785
var(e.state_supp)	.7630262	.0157544			.7327346	.7945702
var(e.Rate_net)	.2365832	.014899			.2090859	.2676968

var(e.Rate_rep)	.6848715	.0186355			.6492683	.722427
var(e.Rate_malaria)	.1067353	.0119517			.0856838	.132959
var(Food_sec)	1	.			.	.
var(Mkt_inst)	1	.			.	.
var(Health)	1	.			.	.
cov(Food_sec,Mkt_inst)	.9909815	.006111	162.16	0.000	.978992	1.002971
cov(Food_sec,Health)	1.010.861	.0039342	256.94	0.000	1.003142	1.018579
cov(Mkt_inst,Health)	.9973776	.0064209	155.33	0.000	.9847802	1.009975

Fit statistic	Value	Description
Size of residuals		
CD	.987	Coefficient of determination

APPENDIX A: Survey

1. IDENTIFICATION

1.1.	Survey number	
1.2.	Date of submission (DD/MM/AAAA):	_____/_____/_____
1.3.	Inquirer's name:	
1.4.	Administrative unit:	
1.5.	Name of the village/community:	
1.6.	Surveyed person's name (optional):	

2. HOUSEHOLD INFORMATION

ID	Name (optional):	Relation with the head of the family:	Gender 1 = Male 2 = Fem	Age (years)	Education level (please include last year of schooling concluded)	Occupation in the household **(code)** 1= permanently resident 2= Most of the time away from home
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

3. EDUCATION

3.1. Please indicate the level (year) of schooling currently attended by your family members:

Family member	1	2	3	4	5	6	7	8	9	10	11	12
Year currently attended												

4. HEALTH

4.1. Do you adopt any of the following preventive measures? Yes (1) or not (0)

	Family member											
Measure:	1	2	3	4	5	6	7	8	9	10	11	12
Use of anti-mosquito nets												
Use of repellent												
Preventative medical consultation												
Vaccines												
Deworming												
Pits' sanitization												
Food washing with sterilized water												
Other (indicate)												

4.2. Do you normally use condoms in your sexual relationships? Yes (1) or Not (0)_____

	Family member											
Illness/disease	1	2	3	4	5	6	7	8	9	10	11	12
Malaria												
AIDS/HIV												
Tuberculosis												
Worms/parasites												
Diarrhoea												
Other (indicate)												

4.3. How much is far away the closest hospital?_____(km)

4.4. Did you incur in any of the following illness/disease during last year? Indicate if Yes (1) or Not (0)

4.5. In case of occurrence of one of the above listed diseases, in the last year did you have access to any of the following cures? Indicate if Yes (1) or Not (0)

	Family member											
Treatments	1	2	3	4	5	6	7	8	9	10	11	12
Medical examination												
Pharmaceutical treatment												
Hospitalization												
Traditional medicine												
Other (please mention)												

5. LIFE STANDARDS AND COLLECTIVE/FAMILIAR ASSETS PROPERTY

5.1. Are these service available for your family?
Indicate if Yes (1) or Not (0))

a) **Water:** Potable _____ Pit _____ Fountains _____ Shares with neighbours ____ Other _____.

b) **Energy:** Power generator_____ Public electricity _____Solar _____Other_____

5.2. Goods ownership - Indicate if Yes (1) or Not (0)

Household	Total quantity owned	**Transports**	Total quantity owned	**Machamba**	Total quantity owned
Gus burners		Car/truck		Hoe	
Fridge		Motorbike		Plough	
Radio		Bicycle		Water pump	
TV		Cart		Atomizer	
DVD player		Other			
Mobile phone					
Sofa					
Sewing machine					

6. INCOME

6.1. Please indicate the net income for each of these economic sector (in Meticais):

Sector	Farming	Fishing	Livestock/cattle	Transport	Manufacture trading	Salary
Income						

6.2. Please indicate the partition of your income for each of the following headings:

	Alimentation	Clothes	Transport	Ceremonies	Education	Health	Free time	Savings	Other
Percentage									

7. SUPPORT AND ASSISTANCE FROM THE GOVERNMENT

	Yes (1) or Not (0)
a) Machinery for the preparation of land	
b) Credit	
c) Technical assistance	
d) Seeds	
e) Fertilizers	
f) Tools	
g) Food consumption	
h) Health	
i) Education	
j) Other (please specify)	

8. FOOD AVAILABILITY AND SECURITY

Food type	Consumed in the last 24 hours: Yes (1) or Not (0)	Consumed during the last week: Yes (1) or Not (0)
a) Staple cereals or derived: corn, rice, wheat, other local grains		
b) Potatoes, mandioca or other roots/tubers		
c) Vegetables		

d) Fruit		
e) Legumes or peanuts		
f) Any kind of meat a part from chicken		
g) Chicken		
h) Dry or fresh fish/seafood		
i) Milk or derivate		
j) Iodised salt		
k) Vitamin integrators		

8.1. Food availability during the year - Yes (1) or Not (0)

Month	Did you incur in food scarcity during the last 12 months?	In which of the following months did you observe an income below the average?	Did you harvest this month?
January	__	__	__
February	__	__	__
March	__	__	__
April	__	__	__
May	__	__	__
June	__	__	__
July	__	__	__
August	__	__	__
September	__	__	__
October	__	__	__
November	__	__	__
December	__	__	__

9. PRODUCTIVE FACTORS

Please indicate following a scale from 1 to 5, where 1 represents no difficulty, 2 some difficulty, 3 difficult, 4 very difficult and 5 impossible.

	Degree of difficulty				
a) Access to credit	1	2	3	4	5
b) Access to land	1	2	3	4	5
c) Access to subsidies	1	2	3	4	5
d) Access to agricultural inputs	1	2	3	4	5
e) Access to technical assistance for production	1	2	3	4	5
f) Create a commercialisation net	1	2	3	4	5
g) Access to irrigation	1	2	3	4	5
h) Employment of manpower	1	2	3	4	5
i) Storehouses/offices	1	2	3	4	5
j) Knowledge of market prices	1	2	3	4	5
k) Others	1	2	3	4	5

10. MARKET STRUCTURE

10.1. How far you sell your products? _____km.

10.2. Selling space of the products

	Where the majority of the products is sold	Please indicate the 3 main locals
a) Family		
b) Family and neighbours		
c) Association		
d) Village		
e) District		
f) Province		
g) Region		
h) National		
i) Exportation		

11. OWNINGS

11.1. Do you own cattle/livestock?

Animal	**Bovines**	**Poultry**	**Goats**	**Swine**	**Ovine**	**Other**
Total in number						

11.2. Land:

Irrigated surface (ha)	Dry farming surface (ha)

11.3. Where do you obtain the productive inputs?

	Village	Province (km)
a) Seeds		
b) Fertilisers		
c) Fuel (gas, oil or others)		
d) Extra-parts for tools/machinery		
e) Working tools		
f) Packages		

12. FARMING

12.1. Please indicate the main culture and production obtained with the Machamba:

Cultures	Machamba				
	Yes (1) or Not (0)	Quantity (kg)	Sold (Kg)	Consumption (Kg)	Price (Kg)
a) Rice					
b) Corn					
c) Tomato					

d) "Buer" beans					
e) Gergilim					
f) Cajú					
g) "Manteiga" bean					
h) Other beans					
i) Sweet potatoes					
j) Other vegetables					
k) Mapira					
l) Mandioca					
m) Peanuts					
n) Sunflower					
o) Copra (coconut?					
p) Outros					

12.2. For which of these activities do you normally hire employees?

	Land preparation	Seeds	Dibble	Harvest
Machamba				

13. TECHNICAL ASSISTANCE

13.1. How many visits from a technical expert have you received this year? _____.

13.2. Which are the topics you dealt with the expert?

	Topic discussed	Topic required
a) Technical info about culture		
• Land preparation		
• Seeding time		
• Type of seeds		
• Fertilization		
• Other		
b) Info over diseases and plagues		
• Vaccination		
• Alimentation		
• Livestock diseases		
• Plough type		
• Other		
c) Market price information		
d) Support to commercialization		
e) Support in supply chain		
f) Product conservation		
g) Building of silos		
h) Other		

APPENDIX B: Principal Component Analysis

In this work an Asset Index is created as a composite indicator that reflects households' ownership of domestic and productive goods and assets, following the methodology elaborated by Abeyasekera (2005). The asset index can be formalised as an indicator *A* which is a function of the underlying variables a_i observed for each household *j* and related to the assets taken in account for the construction of the index:

(1) $$A_j = f(a_{1j,}a_{2j,} \dots, a_{nm})$$

Therefore, the variables a_{ij} are combined to make up the index A_j as a linear combination of the assets considered in this specific case (indicated in Table II), and yielding a synthetic measure that can be used as a proxy of households' wealth. However, simple linear combination would not reflect the relative importance of all the variables, since each of those has a different relevance, or weight, in determining the households' wealth. Assigning a weight β_i to each component of the index, the linear combination the will result is:

(2) $$A_j = \beta_1 a_{1j} + \beta_2 a_{2j} + \cdots + \beta_n a_{nm}$$

In the research literature, several techniques are available to calculate the value of the coefficients β_i as indicated in the note 7 of this work, all of which are based on the variance and covariance of the variables $a_{i,}$ and identify common patterns in the data, that we will call components. In this case the technique adopted is Principal Component Analysis, that according to Gordon (2012) is a more general technique compared to others as Factor Analysis which is more suitable for computations over categorical variables. The first

column (*Comp1)* of Table II that includes the results of the PCA estimation represents the set of components, one for each variable, that better explain the variance and covariance. Consequently, the values included in the first column of values correspond to the weights to be applied to the variable $a_{ij.}$ Replacing in (2) the variables a_{ij} with the those listed in Table II, and the values of β_i with those pertaining to the *Comp1* set for the corresponding variable, the final formula for the computation of the Asset Index A that will result is:

(3) $$A_j = \text{Water}_j \times 0{,}0742 + \text{Cooker}_j \times 0.4389 + \text{Fridge}_j \times 0{,}4951 + \text{Radio}_j \times 0.4390 + \text{Cellphone}_j \times 0.2544 + \text{Car}_j \times 0.3096 + \text{Bycicle}_j \times 0.1039 + \text{Hoe}_j \times 0.0115 + \text{Agr\_mach}_j \times 0.0265 + \text{Waterpump}_j \times 0.1299 + \text{Sprayer}_j \times 0.4183$$

The values resulting from the calculation of the Asset Index *A* for each household *j* represent a new variable, *Index,* which has been included in the data set to be adopted as dependent variable in the Structural Equations Model.