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THE DETERMINANTS OF FOOD SECURITY

IN A GLOBALIZED WORLD:

EVALUATION OF THE EFFECTS OF TRADE LIBERALIZATION

WITH A SYNTHETIC CONTROL APPROACH

Settore disciplinare: AGR 01

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'Non ha colonne d'Ercole il pensiero.
La tua anima piccola,
diabolica pigrizia, se le crea.
Né Ulisse né Colombo sospettavano
le mille e mille isole in attesa.

Te aspettano interi continenti.
Dormono dentro il tuo cervello: osa!
Il mondo è da creare.'

MARIA LUISA SPAZIANI[1]

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[1] Poesia inedita, Roma, gennaio 2004.

Ai miei genitori

ABSTRACT

The food security issue is becoming more and more centre-stage in the political and social debate. Especially after the world food crisis of 2007-2008 and the consequent price spikes, it reached the top of the international agenda. The problems of accessibility, disposability and utilization of food, both in developing and poor countries, now draws the attention of policymakers and researchers. Of course, this dynamic and complex problem is influenced and determined by many 'macro' factors, analyzed with a case-study econometric approach. Among them, we can highlight education, infrastructure, the role of technological progress, public policies and trade reforms. Also in actuality, the process of markets globalization may represent one of the possible causes of food (in)security, while the very recent WTO agreement in Bali and the Indian Food Security Bill are notable too. These collectively represent how the matter of food, related to poverty and malnutrition, is becoming a global issue, taking into account the new emerging economies. The focus of this thesis is connected precisely to this causal factor. More specifically, the hypothesis is to test whether trade liberalization could have a role on the increasing, or decreasing, of the under five mortality rate (WDI, World Bank), used as a proxy for food security. The statistical sample considered is composed of 80 developing countries, 39 of which have experienced an episode of trade liberalization, between 1960 and 2010. The 41 residuals countries are included as a counterfactual in the econometric approach: the Synthetic Control Method (SCM). After a detailed revision of the literature about all the aspects related to food security, such as definitions, indicators and determinants, it was decided to adopt as outcome variable the rate of mortality in children younger than five years old. It was selected because of its comprehensive coverage both in terms of years and countries. Moreover, it is one of the three components of the Global Hunger Index (released by IFPRI), and it was suggested by many researchers, despite the fact that this variable can be influenced by multiple social factors. In fact, the problem of food security measurements and indicators, still remain a matter of contention inside the scientific community and the international agencies, like FAO or IFPRI. What was particularly challenging at the beginning of this investigation concerned the isolation of the effect of commercial liberalization on child mortality, and, as a consequence, on the level of food security in each country. To study this phenomenon, the indicator proposed in the literature is the one of Sachs and Warner (1995), revised by Wacziarg and Welch (2003; 2008). Note: it can assume the value of one, if the country considered is 'open' (which means that it has to be in compliance with all the five criteria assumed); zero, otherwise. From a theoretical point of view, it is possible to identify two different reasonings, in favor or against trade openness. On the one hand, a better availability of agricultural commodities could reduce poverty and encourage economic growth; on the other, there is a controversial debate regarding the effects that subsidies received by farmers of rich countries, can have on poor net importer countries. Nevertheless, an excess of markets integration may provoke a weakening of the economies of developing areas, inducing unemployment and, even, a higher level of poverty. As for the methodological approach, what was defined firstly were the covariates: the variables implemented for the synthetic control. They were chosen as a function of their influence on the outcome variable. Above all, we included the level of development and economic growth, the presence of wars or conflicts, the population growth, the percentage of rural population and food supply (measured as the amount of kilo calories available per capita). As already mentioned above with reference to the statistical and the econometric approach, it was developed by Abadie and Garzeabal (2003; 2010), and called SCM. This methodology, applied to the investigation of the impacts of economic openness on malnutrition, has been recently implemented as an estimation approach for comparative case studies. The underlying hypothesis is that it is possible to construct a weighted combination of potential control countries – the synthetic control – that approximate the most relevant characteristics of the country affected by the intervention (Billmeier and Nannicini, 2013). In our study, the 'treated' country is the one which experienced a trade reform – 'treatment'. The situation which happened after the treatment (economic openness) can be estimated by the SCM. The SCM is able to calculate a counterfactual circumstance of the 'treated' country, in the absence of trade liberalization. The consequential result of the 'treatment' can be verified by looking at the outcome trend of the synthetic control. More precisely, the synthetic control algorithm estimates the missing counterfactual as a weighted average of the outcomes of potential controls. The weights are chosen so that the pretreatment outcome and the covariates of the synthetic control are, on

average, very similar to those of the 'treated' country. The advantage and the power of this approach is the possibility to clearly verify the ex post effects of trade reforms on the outcome variable. Moreover, the SCM can be seen as a useful and innovative strategy, which completes and integrates the ex ante techniques of analysis, traditionally implemented in Social and Political Sciences - notably the partial or general equilibrium models. Although this methodology is more flexible and transparent than others, there is a limitation regarding the inferential techniques. This is mainly due to the fact that the number of observations in the control pool and the number of periods covered by the sample are usually quite small in comparative case studies, like this. This is why, following the suggestions of the inventors, we implemented the placebo tests, based on permutation techniques. This means that the synthetic algorithm was sequentially applied to every country in the pool of potential controls and then used to compare the placebo with the baseline results. To sum up, we evaluated the dynamic of the under five mortality rate in a 'treated' country (which experienced an episode of trade liberalization in the decades considered), with the situation in a sample of control (the synthetic control), composed by a group of very similar countries to the one 'treated', but in which there was not any trade reform. It is important to notice that the synthetic control is chosen taking into account the covariates mentioned above; besides, the weight of each country of the synthetic control is selected in order to minimize the difference with the 'treated' country, in the pre-treatment period. With respect to the results, we decided to select a pre-treatment period of twenty years, and a post-treatment period of ten years. This is mainly because after a decade from the openness to trade, the effect of this phenomenon of child mortality tend to be very difficult to isolate and identify. In fact, other reforms or social policies can occur which can mask the real influence of the occurrence of interest in the outcome variable. In summary, the approach highlights two different visual outcomes: tables and graphs. The first are less practical, but helpful to understand how the algorithm works; the second are more direct and intuitive. The preliminary results obtained, show that the impacts of trade liberalization on under five mortality rate is, on average, positive. Especially, in 25 countries, out of 39, this effect is clearly registered and the tendency over the years is child reduction. However, we are aware of the fact that more placebo tests are required to test the validity and the robustness of these evidences. Moreover, in a few developing countries political and economic reforms happened simultaneously; so that, this overlapping may not permit the correct identification of the real effect of commercial openness on the outcome variable. Another element that should be taken into more consideration is the role of government regime; in fact, the same treatment in a democratic or autocratic country, may cause different performs. In any case, the debate around the effects of trade liberalization on food security still remains open; moreover, its impacts continue to be ambiguous. However, this modern methodology can be considered very useful to verify parametric relationships. In particular, the precision and the accuracy of the estimations of the counterfactual are extremely good; the countries included in the synthetic control are selected by an algorithm, as a function of their similarity to the 'treated' country, relative to the chosen covariates. Lastly, the proposed statistical framework can deal with endogeneity from omitted variable bias by accounting for the presence of time-varying unobservable counter-founders.

Contents

1. Definition and evolution of Food Security's concept: an historical overview

"Today it is possible to see men trying to secure a sure food supply, cures for diseases, and steady employment. Politicians, researchers and international agencies are trying to eliminate every ill, to remove every obstacle which offends man's dignity. The imbalance grows with each passing day: while some nations produce a food surplus, other nations are in desperate need of food, or are unsure of their export market. Today no one can be unaware of the fact that on some continents, countless men and women are ravished by hunger and countless children are undernourished. Many children die at an early age; many more of them find their physical and mental growth retarded" (Populorum Progressio, 1967).

For the first time in the history of human kind, the right to food was highlighted during the United Nation (UN) General Assembly in 1966; then it was reaffirmed and elaborated by the World Food Conference in 1974, which adopted the "Universal Declaration on the Eradication of Hunger and Malnutrition" which proclaims: *"Every man, woman and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties"* (Campbell, 1991; Maxwell and Smith, 1993). As suggested in many occasions not only by researchers, but also by politicians, the human right to nutrition rightly figures among the first and fundamental rights, as an essential condition of the right to life. For this reason, it is mentioned and protected in many Constitutions, around the world. Food security has been promoted by the United Nations, (United Nations Development Programme [UNDP] 1994) economists and analysts of hunger and famine, like Amartya Sen, who declared that *"food security is the most basic human need"* (Jenkins and Scanlan, 2001).

The very initial definition of this complex and dynamic phenomenon came to prominence at the 1975 World Food Conference (Staatz *et al.,* 1990). Later in the mid- and late 1970s, discussions and debates around this topic and its interconnections with everyday life, were strongly influenced by two main factors: on the one hand, the shortfall in world food production and, secondly, the spike in prices early in that decade.

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[2]Epistole I, 2, 40.

Initially, the concept of food security regarded, almost exclusively, the guarantee of an adequate amount of foodstuffs, avoiding transitory shortfalls in the aggregate supply of food. However, by the early 1980s, the world food supply situation evolved, especially when the African famines took place (Staatz *et al.,* 1990; United Nations Development Programme [UNDP] 1994).

In the second half on the 1980s, food security became an important issue in development processes, promoting not only a large academic literature, but also a conceptual and organisational innovation by aid agencies, and, many regional, national and local programmes in developing countries, especially in Sub-Saharian Africa (Maxwell and Smith, 1993; Jenkins and Scanlan, 2001). Considering only the definitional issue alone, Smith *et al*. (2003) have assembled a bibliography of over 180 items, many of them derived from the period 1986-1991.

The very first definition was subsequently amplified by the Food and Agriculture Organization (FAO) to include the concept of nutritional value and food preferences (Barret, 2010; WHO, 2010). Food security represents *"a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"* (Declaration on world food security. World Food Summit, FAO, Rome, 1996).

In summary, Rosegrant and Cline (2003) identified five distinct stages in the evolution of thinking and practice of food security, over the past thirty years. The first stage was characterized by concentration on the inadequacy of food supplies at the global and national levels. The second stage revealed that, despite the substantial expansion in food supplies that had occurred in the two previous decades (1970-1980), by the mid-1980s severe food crises erupted, mainly in Africa. The third stage, represents the period when food supply was recognized as a basic element in determining nutritional security. This stage opened the way for related food security concerns, − such as environment, cultural practices, education, health status. The fourth stage mentioned both food and nutritional security as fundamental to address poor households survival. The fifth emphasized nutrition throughout the life-cycle of households (Rosegrant and Cline, 2003).

Despite the "green revolution" and the significant growth in international food aids and assistance, between 1970 and 1990 almost half of the world's less developed countries (LDCs) experienced a decline in aggregate food supply, and more than a quarter suffered from an increase in child hunger (Davis *et al.,* 2001; Jenkins and Scanlan, 2001). It was confirmed by the

estimates of FAO, which reported that the total number of chronically undernourished people in developing countries was 828 million, for the 1994-96 period. In Asia is registered the largest absolute numbers of undernourished people, while the largest proportion of the population (39%) is in sub-Saharan Africa (Davis *et al.,* 2001). Even today, child malnutrition is still persistent in many developing countries, although overall, the share of malnourished children is projected to decline from 31% in 1997 to 14% in 2050. Nevertheless, this represents a nearly 35-year delay in meeting the Millennium Development Goals (Jenkins and Scanlan, 2001; Rosegrant and Cline, 2003).

The main cause of increasing complexity during the analysis of food security's problem is a shift in the level of analysis: in the 1970s the attention was on national and international food security, defined in terms of the level and reliability of aggregate food supplies; but in the 1980s food security was focused on individual and household food security, with the emphasis on access, vulnerability and entitlement (Maxwell and Smith, 1993; Broca, 2002). Nowadays, the analysis of access and entitlement is central to food security, identifying the risks facing particular social groups and mapping their vulnerabilities (Maxwell and Wiebe, 1998). For instance, a typical problem in Sub-Saharan Africa is the dialectic issue between food policies and the productive resources allocation. In fact, the policies originally designed to alleviate national problems of food surpluses or shortages, can exacerbate regional entitlement disparities, particularly when markets are poorly integrated and regional income inequalities are evident (Staatz *et al.,* 1990; Campbell, 1991).

If we consider the recent researches, we have to take into account the strong link between land tenure and food security: the first is viewed as all attempts to monitor food security in famine areas, recognizing that access to productive land as one of the most important factors in determining household or individual food security (Maxwell and Wiebe, 1993).

In fact, Maxwell and Wiebe (1998) found that the risk of entitlement failure determines the level of vulnerability and food insecurity. Entitlements are defined as *"the set of all those commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which he or she live-shaving sufficient resources to obtain appropriate foods for a nutritious diet"*.

As Nobel Laureate, Amartya Sen, wrote: *"starvation is the characteristic of some people not having enough food to eat. It is not the characteristic of there being not enough food to eat. While the latter can be a cause of the former, it is but one of many possible causes"* (Barret,

2010). Sen's work focused the attention on the lack of access by households and individuals to food, mainly due to low incomes and scarce entitlements, as a cause of food insecurity. Others, such as Staatz *et al.* (1990) pointed out that the most common lack of access is chronic, not transitory.

In fact, it is possible to identify two different types of food insecurity:

- chronic means that a household runs a continually high risk of inability to meet the food needs of its members. It describes a long-term lack of access to sufficient food. Although the most severe situation of chronic food insecurity is typically associated with natural isasters (drought, floods, war, or earthquakes), most food insecurity is associated not with catastrophes, but rather with permanent and irreversible poverty (Staatz e*t al.,* 1990; Barret, 2010);

- transitory: occurs when a household faces a temporary decline in the security of its entitlement, and the risk of failure to meet food needs is of short duration. Transitory food insecurity both describes periodic or seasonal food insecurity and focuses on intra and inter annual variations in household food access (Maxwell and Smith, 1993; Lorenzana and Sanjur, 1998; Pinstrup-Andersen, 2009).

The last FAO Summit in 1996 had already established that hunger and malnutrition are not phenomena of a merely natural or structural nature, affecting only certain geographic areas, but have to be seen as the consequence of a more complex situation of underdevelopment. Consequently, household food security was defined as *"secure and permanent access of households to foods, sufficient in kinds and amounts to enable all individuals to live a healthy, active and productive life"* (Lorenzana and Sanjur, 1998; World Bank, 2010).

Though there are disputes over the definitions of food security, and the exact numbers involved. The real challenge for researchers, politicians and the entire human community is to create the conditions to allow those who are poor today, to escape poverty (Broca, 2002). More than 1 billion people are estimated to lack sufficient dietary energy availability, suffer undernutrition due to insufficient intake of calories, protein or critical micronutrients − i.e. vitamin A, iodine and iron (Barret, 2003).

By the way, food security is becoming a growing concern worldwide (Barret, 2010). At the 1996 World Food Summit in Rome, 186 heads of state pledged to halve the number of

undernourished people in the world by 2015 (Broca, 2002; Rosegrant and Cline, 2003). During the decades, the 186 heads of state took several promises, which culminated in *"The Millennium Declaration"* issued at the 24th special session of the United Nations General Assembly in June 2000 (Broca, 2002; Pinstrup and Andersen, 2009). The aim was to reaffirm the will of halving the number of poor, and fight against hunger and malnutrition.

It is a truth universally acknowledged, that food security is becoming a more and more urgent and relevant problem, not only from an economic point of view, but also for its implications for people in developing countries. What is important to notice is that the major part of the scientific literature dates back to the 1980s or the 1990s, when many universities and international agencies started to pay more attention to the problems of poverty, hunger, malnutrition which are all closely related to food security. Only recently, a few researchers started to consider that the concepts of food security and food safety are dynamic and include many different determinants, such as cultural and social factors.

Food security is commonly conceptualized as based on three main and distinct pillars:

1. <u>Food availability</u>, which means sufficient quantities of food available on a consistent basis. Adequate availability is necessary, but does not ensure universal access to *"sufficient, safe and nutritious food"* (FAO, 1996; Barret, 2010) The question is not only whether food is available in a country, but whether it is available in the right place at the right time; there must be a mechanism for ensuring that food of the right quality is made available (Barret, 2010; WHO, 2010). Concerning this topic, it is a very recent news that the Indian's Supreme Court declared that the right to unadulterated and safe food is a constitutional right[3]. The literature concerning food security analyses the concept of availability in relation with the idea of *"enough food"*, which is presented in different and complex ways (for example, as a *"minimal level of food consumption"*, or as a *"target level"*). FAO (1983) used a distinct definition: "*basic food needed"* or as the food *"adequate to meet nutritional needs"* (Barraclough and Utting, 1987). In more descriptive formulation, Kracht (1981) refers to *"enough food for life, health and growth of the young and for productive effort"*; the World Bank (1986) to *"enough food for an active, healthy life"* (Maxwell and Smith, 1993).

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[3] www.foodsafetynews.com

2. <u>Food access</u> by individuals to adequate resources or entitlements to acquire appropriate foods, for a nutritious diet. These resources need not be exclusively monetary but may also include traditional rights, extremely important in rural areas of developing countries, where these rights are still very popular (Broca, 2002). Furthermore, access to food is determined by food entitlements, which are derived from human and physical capital, assets and stores, access to common property resources and a variety of social contracts at household, community and state level (Maxwell and Wiebe, 1998).

3. <u>Food utilization</u>: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation (Barret, 2003).

Historically, the concept of food security is referred to the national food supply's capacity to meet the population's energy and nutrient needs. However, worldwide shifted the point of view of interest and concern: from national to household level, especially where programs of food aids may have adverse effects on the poor (Lorenzana and Sanjur, 1998).

More specifically at national level, food security has often used a synonymous of self-sufficiency; it was seldom clear thereal meaning of it: whether all citizens had access to enough food to meet energy and nutritional requirements, or if it is only enough to meet the demand for food and the domestic production (Smith *et al.,* 2003). However, availability does not necessary assure access to food or enough calories, to ensure a healthy life (Maxwell and Smith, 1993).

The latest definition of food security (FAO, 1996) highlights the idea that food should be *"safe and nutritious"*, which emphasizes food safety and nutritional composition. On the other hand, the addition of *"food preferences"* changes the concept of food security from mere access to enough food, to access to the food preferred. This implies that people with equal access to food, but different food preferences, could show different levels of food security (Pinstrup-Andersen, 2009).

Furthermore, the concept of food security has been used extensively, at the household level, as a measure of welfare, implementation, and evaluation of specific programs. Usually, a household is considered food secure if *"it has the ability to acquire the food needed by its members to be food secure"* (Pinstrup-Andersen, 2009). However, household food security is necessary but not sufficient for adequate nutrition of all members. Although "coping strategies" vary with local conditions, it is true that the more the severity of food insecurity increases, the

more household responses become progressively serious and threatening to livelihoods (Maxwell and Smith, 1993). With this terminology, "coping strategies", we intend a behaviour, or, better, a process, that helps individuals (characterized by their own personal background, strengths and fragilities) to cope with a given situation. It is possible to identify three types of nutritional adaptations to reduce food intake or energy stress:

1. genetic adaptation is the make-up of the individual determines the extent to which physiological adaptations are possible. The capacity for physiological adaptations will influence the social adaptations that are necessary;

2. physiological adaptation usually is viewed as the reduction in body size, growth, metabolic rate and fertility;

3. behavioural responses means the reductions in energy expenditure both in adults and children (Rosegrant and Cline, 2003).

However, Pinstrup-Andersen (2009) distinguishes four ideas as important considerations, about the core concepts of food security:

1. availability of food − it is not just the quantity of food entitlement that matters, but also the quality of entitlement. In particular, the highest state of food security requires not just secure and stable access to a sufficient quantity of food, but also access to food that is nutritionally of adequate quality, culturally acceptable, procured without any loss of dignity and self-determination, and consistent with the realisation of other basic needs;

2. ability of the household to obtain food;

3. the desire of the household to obtain food;

4. intra-household distribution of food.

However, it is fundamental to distinguish between food security and **food safety**. In fact, the first time in which the Official Journal of the European Communities defined this concept, was in the *Regulation (EC) No 178/2002 of the European Parliament and of the Council, of 28 January 2002, laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety*. In this document, the legislator outlines the conceptualization of "**food law**". "*It means the laws,*

regulations and administrative provisions governing food in general, and food safety in particular, whether at Community or national level; it covers any stage of production, processing and distribution of food, and also of feed produced for, or fed to, food-producing animals".

In the chapter III of the same regulation, it was established the **European Food Safety Authority** (EFSA) whose mission was to *"provide scientific advice and scientific and technical support for the Community's legislation and policies in all fields which have a direct or indirect impact on food and feed safety. It shall provide independent information on all matters within these fields and communicate on risks".*

The food security literature is sometimes accused of being more concerned with the current state of food insecurity than with changes over time. In this context, the conventional concern can be emphasized including the consideration of local food habits and cultural acceptability; in particular the cultural importance of food as a vehicle for self-realisation, communication and the maintenance of social relations (Maxwell and Smith, 1993; Smith *et al.,* 2003).

Oshaug (1985) presented the dimension of *"human dignity and human rights"* as a further condition of food security, suggesting that it depends on "*self-respect, freedom of choice and action and mutually beneficial exchange"*. As already mentioned above, the topic has particular importance because of the its increasing implication as a determinant in conflicts, as a source of food productive resources (Messer, 1990; Jenkins and Scanlan, 2001). Moreover, there are sad situations, especially in African countries where people die of hunger because peace is not guaranteed. All of these considerations have transformed the problem of food security, from a uni-dimensional to a multi-dimensional matter and, as a consequence, problems of measurement also increased (Pinstrup-Andersen, 2009).

Potential consequences of food insecurity include hunger, malnutrition and, either directly or indirectly, negative effects on health and quality of life, but much of the academic debate is about the definition of hunger (Campbell, 1991). Hunger, then, becomes a potential although not necessary consequence of food insecurity, and it can be referred to the physical discomfort caused by a lack of food and can only be properly gathered at the individual level (Bratton and Cho, 2006).

Also the concept of household itself is problematic, and individual members of the household will experience different food security risks and follow different food security

strategies. Consequently, food security shocks, such as work, output, food, assets, will affect different kinds of households and members of individual household in different ways (Staatz *et al.,* 1990; Maxwell and Smith, 1993).

In any case, undernutrition reflects insufficient dietary energy or caloric intake, according to internationally agreed standards (Maxwell and Smith, 1993). On the other hand, malnutrition refers to undernutrition, obesity, and micronutrient (mineral and vitamin) deficiencies and it can be defined as *"a vicious circle that begins before birth, gets transmitted during reproductive stages of life and lasts into old age"* (International Food Policy Research Institute [IFPRI]).

Campell (1991) identified two sets of potential consequences of food insecurity which include physiological symptoms of suboptimal nutritional status, which is considered to be the classic measures of malnutrition and health and quality of life outcomes. In delineating the links between food insecurity and health, the consequences of food insecurity must be distinguished from those of its common correlates, such as poverty, highly constrained environments, that would be included as risk factors for a poor diet; for instance, it was suggested that food insecurity contributes to family disintegration.

2. Food Security Indicators

2.1. Importance and complexity of food security measurements

"Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture we would know much of the economics of being poor."

T.W. SCHULTZ (1979)

Food security is a concept that has evolved considerably over time and there is much literature on potential household food security (HFS) indicators (Hoddinott, 1999). There is currently no general agreement about how to best incorporate all these different aspects: food safety, dietary quality, food availability (Keenan *et al.,* 2000; Barret, 2010). The need to measure food insecurity accurately was recognized in the *"1993 Ten Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program"* (NNMRRP), which blamed the US Department of Agriculture (USDA) and National Center for Health Statistics to *"Recommend a standardized mechanism and instrument(s) for defining and obtaining data on the prevalence of food insecurity or food insufficiency in the USA and methodologies that can be used across the NNMRRP and at state and local levels"* (Kendall *et al.,* 1995).

Over the past quarter century, Sen's core thesis − that food access accounts for most food insecurity − has focused increased attention on individual-specific hunger and underweight data. They naturally reinforce the strategies based on poverty reduction, food price, and social protection policies (Barret, 2010). In fact, before Sen's most important publication, *"Poverty and Famines: An Essay on Entitlements and Deprivation"* (1981), the main focus of debate on food insecurity was food supply (Coates *et al.,* 2006; Webb *et al.,* 2006). After Sen, the debate shifted from macro supply and micro physiological concerns to household-level issues, relating to food access; that is, the ability of households to obtain food in the marketplace or from other sources, such as transfers or gifts (Barret, 2010).

Households experience food insecurity when their resources are inadequate simply to obtain "enough food" to meet basic needs. This is the condition which may result in hunger for household members. Keenan *et al.* (2001) found that, despite a broader understanding of the complexity of food insecurity problem, policy makers still look for clear and understandable

indicators (i.e. measures of regional or national food supply) which should help them in designing efficient programs. Recently, however, many have begun to question the validity of commonly used indicators of food security measured at the national level as representative of indicators of access to food at the household level (Maxwell and Frankenberger, 1992). Food availability and stable access are both critical issues for households food security; however, vulnerability is a local condition also like food entitlements (Frankenberg, 2003).

Maxwell and Frankenberger (1992), listed approximately 450 indicators of food security, but only 25 of them, are the most important. On the contrary, Riely *et al.* (1995) listed 73 measures, but more disaggregated than those previously found by Maxwell and Frankenberger (1992). Consequently, the first methodological problem for researchers is how to determine which indicators are the most appropriate, given the aim proposed (Hoddinott, 1999). In the discussion about the identification and selection of adequate indicators, numerous aspects need to be taken into consideration. Among the others, the most significant are certainly: measurability, sensitivity, reliability, efficiency and the cost-effectiveness.

Additional attention requires their ease of interpretation, level of disaggregation, credibility, political and cultural acceptability. This process of choice highly depends on the level of investigation, whether it is global, national, regional, community, household or individual (Reinhard and Wijayaratne, 2002).

Measurement is necessary at the beginning of any development project to identify and characterize the nature and the level of food insecurity (i.e. seasonal versus chronic) to assess the severity of the level of malnutrition (Hoddinott, 1999). Then, also the process of monitoring is fundamental firstly to ensure that development projects positively impact on the beneficiaries, then to monitor trends, to determine priorities, evaluate the effectiveness of intervention programmes (Shetty, 2003; Sibrian, 2009). Once such instruments are tested, they can be used to evaluate the effectiveness of nutrition education programs in improving the nutritional quality of diets (Keenan *et al.,* 2001; Pheley *et al.,* 2002). Current research on food security indicators includes measurements of individual food insecurity, hunger duration and frequency, not only at the individual level but also in population subgroups (Radimer, 2002).

It is important to notice that analysts need to choice among indicators; it necessarily involves a trade-off between the object of the programs and the availability of the information described by each indicator, for example household surveys, coping strategies, dietary diversity (Coates *et al.,* 2006; Frongillo and Nanama, 2006). FAO relies the most widely cited indicator,

"undernourishment", derived from national-level food balance sheets. Alternative measures, are those reported by the U.S. Department of Agriculture (USDA), generated by simulation models based on prices and national accounts and production equations. They are often radically different from FAO estimates (Hoddinott and Yoannes, 2002; Naiken, 2003).

In fact, the USDA food security measure is based on household self-declarations, differentiates between diverse levels of food security, and more focused on the household-level resource constraints (Lorenzana and Sanjur, 1998; Pinstrup-Andersen, 2009). However, it is preferable for the description of the well-being of households (Lorenzana and Sanjur, 1998; Pinstrup-Andersen, 2009).

But the real challenge is how should household or individual food security be estimated? Consumption surveys would tell us what was consumed in terms of access to food, and allocation behaviour. Another methodology is the combined evaluation of individual anthropometric estimates in children and the household behaviour; it provides a powerful input into the design and implementation of policies and programs to improve nutrition (Sarlio-Lähteenkorva and Lahelma, 2001). Another important contribution to the debate regarding the food security measurements, is the paper presented by Webb *et al*. (2006). It illustrates a two main conceptual ideas, also described in Verpoorten *et al.* (2012):

1) a shift from using measures of food availability and utilization to measuring ''inadequate access'';
2) a shift from a focus on objective to subjective measures (i.e. indicators of self-reported food insecurity).

In this context, Pradhan and Ravallion (2000) argued that approaches to measuring poverty became polarized during the 1990s between what they call *''objective-quantitative schools''* and *''subjective-qualitative schools''*. The former continued to refine measures based on poverty lines, expressed as a monetary measure of individual economic welfare. This approach was criticized because of its theoretical framework too theoretical, and focused on monetary imputation of values (Webb *et al.,* 2006). However, large-scale studies on the experience of poverty (such as the World Bank's *Voices of the Poor Project*) led to the development of the other alternative schools, whose characteristic is the focus on less tangible

factors that emerge from the words people use to describe their everyday lives (Pradhan and Ravallion 2000; Webb *et al.,* 2006).

As noted by Maxwell and Slater (2003), the definition and measurement of food insecurity have evolved rapidly, from objective to more subjective indicators of food shortage, which represents a major shift in thinking about food security. This approach often starts with qualitative data collection methods usually derived from the studies of anthropologists describing how people express their idea of hunger. Then the approach evolves into a more rapid techniques using focus groups or peer assessments of food insecurity status (Webb *et al.,* 2006).

It is also important to notice that the greatest advances in the measurement of food insecurity will mainly come from a global network of sentinel sites, using a standardized core survey protocol for regular, repeated household and individual level monitoring. It would enable the researchers and policy makers to track the co-evolution of multiple food security indicators across continents and to rigorously monitor and evaluate their impacts. In fact, if all the stakeholders engaged in this process knew better the *a priori* accuracy of different indicators, they could design better social programs, local and global (Barret, 2010).

2.1.1. Different types of indicators

As already mentioned, a great number of different indicators can be used to understand and delineate the level of household, or individual, food security. One of the first classifications was made by Maxwell and Frankenberger (1992), who proposed two different categories:

1. process indicators: they mainly describe food supply and food access, including inputs and measures of agricultural production (such as the agro-meteorological data), access to natural resources, institutional development, market infrastructure, exposure to regional conflict. This orientation focused on production data and nutritional status that are easier to obtain. On the other hand, indicators that reflect food access are the various means or strategies used by households to meet their needs. Thus, they vary across regions, communities, social classes, ethnic groups, households, gender, and season. This is why they can be considered location specific (Maxwell and Frankenberger, 1992; Frankenberger, 2003).

2. <u>outcome indicators</u> are proxies of food consumption and they can be grouped as follows:

    a. <u>direct indicators</u>: they include those that are closest to actual food consumption rather than marketing channel information or medical status; one of these is the Household consumption surveys;

    b. <u>indirect indicators</u>: applied when direct indicators are either unavailable or too costly to collect, in terms of time or money.

Webb *et al.* (2006) suggested a further division, based on the methodology of data collection:

1. <u>fundamental indicator</u>: which presupposes no others measurements;

2. <u>derived indicators</u>: are a calculation that assumes a well-known empirical relationship with given measure. For instance, in developing countries derived indicators are more appropriate because they are proxies for food consumption, income, assets, that presumably related determinants, or consequences, of the phenomenon. One of the problems with derived measures is that, even if the phenomenon itself is fixed or universal, relying on correlates is risky because causes and consequences may differ in the strength of their association to food insecurity, depending on the context.

2.1.2. *Regional versus Individual Food Security*

A critical question is at what degree of precision indicators should be used; precisely, which is the most significant level of aggregation: national or regional. In this two cases, FAO (1983) suggests the indicator of food supply, measured in terms of kcal/capita/day (Staatz *et al.,* 1990; Reinhard and Wijayaratne, 2002). For example, the restrictions on private marketing of grain imposed in many of the Sahelian countries, until the 1980s, helped to ensure national self-sufficiency, on the one hand; on the other, they were not translated into an adequate regional food supplies. It implies that using only the indicators of frequency of meals or dietary diversity, they would not have been able to completely understand the nutritional status of the children in the household (Sarlio-Lähteenkorva and Lahelma, 2001; Hoddinott and Yoannes, 2002).

Hence, measurements of regional food security may be poor guides to interventions to help malnutrition. This can pose three challenges for policy makers:

1. the development of more accurate, country-specific indicators to monitor more precisely individual and household poverty and insecurity situations;
2. sustain the instability of local agricultural production through political reforms and infrastructure improvements, which intended to increase the ability of traders to move food at low cost, among countries and villages.
3. understand better how diseases, intra-household food distribution, and nutrition education mediate the relationship between household food availability and individual food security (Staatz *et al.,* 1990).

In terms of regional comparisons Shapouri and Rosen (1999) analysed the intensity of the current malnutrition problems among Africa, Asia, Latin America and Carribean (LAC) and the New Independent States (NIS)[4]. Sub-Saharan Africa was classified as the most food insecure region, mainly because of the high population pressure on food supplies; then, extremely significant is also the political instability in the North African region. In contrast, many of the Asian countries analysed, have registered an increasing in food availability over the past three decades. On the other hand, in LAC, the most problematic dimension of the food system is the distribution within each country.

Anthropometric data, however, do not necessarily reflect food consumption or energy adequacy *per se* because they can be influenced by other environmental determinants of nutritional status, such as infections and diseases. One of the advantages of this type of measurement is its simplicity and reliability, two characteristics very helpful in national surveys projections of trends and long-term forecasts of food needs. On the contrary, a possible disadvantage is that , anthropometric data in adults are not currently available on a global or regional basis; this is a problematic aspect, because they could be useful to compile representative databases, unlike the data currently in FAOSTAT (Shetty, 2003; Sibrian, 2009).

However, taking into account the individual food surveys, it is possible to say that food intake surveys generally refer to the direct assessment of quantities of food consumed by

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[4] The countries that until 1991 were constituent republics of the USSR, including Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan. The term can also include Russia and sometimes Estonia, Latvia, and Lithuania (The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company).

individual household members. This contrasts with the household expenditure method, that estimates average food quantities at the household level from data on food expenditures and prices; although some of these surveys do also ask about weights of foods. Food intake surveys also pay more attention to food composition and therefore are able to provide information on intakes of nutrients as well as dietary energy (Clay, 2002; Mason, 2003). Such methods aim to give more precise measurements of intake and sometimes attempt to measure requirements, including energy expenditure, although these are quite difficult and expensive to estimate.

But, the attempt to always find different categories, changes over until in the report of FAO, the State of Food Insecurity (SOFI, 2001) was noted that *"… attempts to seek one simple cause for either good or bad performance are not very useful. The power of just a few variables to explain changes in highly diverse, and indeed unique national situations is limited"* (FAO, 2002: 7).

2.1.3. *Household versus Individual Food Security*

Focusing on a deeper level of investigation, researchers claimed that reschool children or pregnant and lactating women – the most nutritionally vulnerable members of the households – could be penalized by poor health and sanitation. Also, inappropriate child feeding practices may prevent to reach adequate levels of individual and household food consumption (Sarlio-Lähteenkorva and Lahelma, 2001).

National food availability surveys are only partially available not really representative. A recent branch of the literature reconsiders the value of survey data, able to capture objective dietary, economic, and health information combined with socio-cultural acceptability (Barret, 2010). On the other hand, Chung *et al.* (1997) found a non-significant correlation between a very large set of process indicators and measures of food security outcomes. The development agencies reach the same conclusion: there is only a little correlation between food production and household food security.

Now, several authors suggested seven ways to measure household and individual food security, briefly summarized below (Hoddinott, 1999; Coates *et al.,* 2006; Frongillo and Nanama, 2006). The list move from very accurate but time and skill-intensive, to those that can be implemented quickly (Hoddinott and Yoannes, 2002).

1)   Individual Food Intake Data

This is a measure of the amount of calories, or nutrients, that an individual in a given time period (24 hours) usually assumes and consumes. These data are derived by two approaches:

- observational: an expert decides to remain in a selected household during an entire day, measuring the amount of food served to each person. The amount of food prepared, but not consumed, is also measured, exactly as food consumed outside the household – snacks. This method has two principal advantages: firstly, the indications provided are very accurate; so that, it guarantees the possibility for the researchers to define a nutritional status for each member of the household. Secondly, because the data is collected on an individual basis, it is possible to determine whether food security status differs within the household. Indeed, it may be the case that sufficient calories are being consumed at the household level, but inequalities within the household result in some members consuming in excess of their requirements while others do not obtain sufficient food to eat. The disadvantages mainly consist in the impossibility to constantly repeat the analysis, in order to verify day-to-day variations in nutrient intake. Furthermore, it requires highly skilled experts, who can observe and measure quantities quickly and accurately (Hoddinott, 1999).

- recall: it is based on individual interview until when they have established the exact composition of every meal and snack for each member of the household. This method generates an enormous amount of data that needs to be checked, and aggregated before being usable. Recently, it was implemented in Western Honduras, Northern Mali, and Central Malawi, where the implementation proved infeasible survey conditions. Consequently, despite its clear advantages in terms of accuracy, it is unlikely to be an indicator that can be easily collected (Hoddinott, 1999).

2) Household Caloric Acquisition

The household caloric acquisition method consists is the annotation of the number of calories, nutrients, available for consumption by household member, during a defined period of time. The expert should ask the principal information about how much food is prepared to the person

responsible for preparing meals. After that, it would be converted into a measure of the calories available for consumption in the household. This measure produces a specific estimation of the number of calories available in the household. Because the questions are retrospective, rather than prospective, the possibility that individuals will change their behaviour as a consequence of being observed should be taken into more consideration. An important observation is that the level of skill required by the expert is lower than in the previous approach. On average, the survey lasts around 30 minutes per household, less than time required to obtain information about individual intakes (Hoddinott, 1999).

But, this method generates a large quantity of numerical data that needs to be carefully checked; moreover, it neither captures accurately any food eaten outside of the household or incorporate considerations of wastage, nor differential allocations of food among household members (Hoddinott, 1999).

3)   Self-Reported Food Insecurity

People's own perception of food needs is an important aspect of HFS. Many households experience seasonal food shortages on a regular basis, and are forced to make behavioural adjustments to compensate for these shortfall. Even when people have access to food that can meet their nutritional requirements, the food may not be culturally preferred (Frankenberg, 2003).

One of the main critiques relates to this method is that it is not based on actual measurement but on simulations. One of the drawbacks of the simulation-based studies is that their country coverage may be limited and sometimes not representative. Verpoorten *et al*. (2012) have analysed data on self-reported food insecurity of more than 50,000 individuals in 18 sub-Saharan African countries over the period 2005 to 2008, when global food prices increased dramatically.

The average level of self-reported food insecurity hides large heterogeneity, both within countries and across countries. The results are heterogeneous: self-reported food security improved on average in rural households, while it worsened in urban households. Improvements in food security were positively correlated with net food exports and GDP per capita growth. One shortcoming of this approach is that households may deliberately distort their response in order to gain development assistance (Frankenberg, 2003; Verpoorten *et al.,* 2012).

4) Dietary Diversity

Dietary Diversity (DD) is defined as *"the number of different foods or food groups consumed over a given reference period"*, and it is usually measured by summing the number of foods or food groups consumed over a reference period. Despite the well-recognized importance of DD, there is still a lack of consensus about what dietary diversity represents. There is also a lack of uniformity in methods to measure dietary diversity and in approaches to develop and validate indicators; this makes comparisons among studies not very significant. Evidences from a multi-country analysis suggest that per capita income and energy availability inside the household is correlated with the level of food (in)security; so that, DD could be a useful indicator of food security (Hoddinott and Yoannes, 2002; Ruel, 2003).

In developing countries the simplest methodology to measure DD is to count single food or food group. The analysis of Ruel (2002, 2003) confirms the consistent pattern of a positive association between diversity measures and nutrient adequacy. In previous studies, in fact, greater DD was associated with an increase in energy, fat, protein, carbohydrates, vitamins and minerals. The studies that have looked at the nutrient density of the diet, however, show inconsistent results: this may be explained by the specific nature of DD which among geographical context and age groups.

A few studies have specifically addressed the strong association between DD and household socioeconomic characteristics and/or food security. It confirms the necessity to control for socioeconomic factors when assessing the relationship between DD, child nutrition and health outcomes. The use of this method derives from the observations that as individuals become better nourished when they consume a wider variety of foods. What was unusual in surveys about DD, is the different answer, for the same household, during different seasons. In fact, DD is higher just after harvest time and lowest during the hungry season (Hoddinott, 1999; Naiken, 2003; Barret, 2010).

DD is clearly a promising measurement tool, but additional research is required to improve and harmonize measurement approaches and indicators; validation studies are also needed to test the usefulness of DD indicators for various purposes and in different contexts. Future research should specifically test whether increased diversity is associated with both higher dietary quantity (energy) and quality (essential nutrients) in different contexts and among different population groups (Ruel, 2002; Ruel, 2003).

5) Indexes of Household Copying Strategies

This is an index based on the capacity of the households to adapt its behaviour during periods of food shortages. In the nutrition literature, this type of index first appeared in Olson *et al.* (1997), and then in Campbell (1990). Coping strategies themselves are discussed in Maxwell and Frankenberger (1992) but it was Maxwell (1996) who proposed a method for taking consumption-related strategies and constructing a numerical index (Hoddinott, 1999; Mohd *et al.,* 2008; Barret, 2010). The person within the household who has primary responsibility for preparing and serving meals is asked a series of questions regarding how households are responding to food shortages. An important aspect captures with this approach is culture: fundamental for understanding and predicting individuals' responses to food insecurity (Coates *et al.,* 2006).

There are three advantages regarding this approach:

1. it is easy to implement (less than three minutes per household);
2. it directly captures the level of households' vulnerability;
3. the questions asked are easy to understand both by respondents and by analysts and project designers.

There are also a few disadvantages, because it is considered a subjective measure; different people might have different ideas about the concepts expressed in the questions. So that, comparison across households or localities could be problematic (Hoddinott, 1999; Barret, 2010).

6) Anthropometric data

Ideally, estimates of food security and undernutrition would be based on combined health and nutritional assessments, including anthropometry, across populations, stratified to ensure adequate representation of each social group (Clay, 2002; Frongillo and Nanama, 2006). Furthermore, anthropometric measures are likely to be more appropriate than food security estimates, to target policies and programs to improve both adult and child nutrition (Pinstrup-Andersen, 2009). Nutritional anthropometry indicators are defined as *"measurements of the*

variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition" (Jelliffe, 1966).

The measures are typically indirect, based on FBS, national income distribution and consumer expenditure data. The line of reasoning linking hunger and undernutrition with inadequate food intake allows the measurement of food insecurity in terms of the availability and apparent consumption of staple foods or energy intake (Mason, 2003). There are two main types of anthropometric measurements: growth and body composition (Shetty, 2003; Sibrian, 2009).

Body Mass Index (BMI) is considered to be the most suitable, objective anthropometric indicator of nutritional adult status. BMI was chosen because it derived from measures of weight and height of individuals of both sexes; it is consistently and highly correlated with body weight and is relatively independent of the height of the adult (Matheson *et al.,* 2002; Thomas and Frankenberg, 2002). BMI is thus a simple but objective anthropometric indicator of the nutritional status of the adult population and is closely related to food consumption and the prevalence of inadequacy of food in the community.

Data on BMI is relatively easy to collect and inexpensive to analyse (Matheson *et al.,* 2002; Thomas and Frankenberg, 2002). BMI can be used for the purpose of nutritional surveillance and for monitoring the effectiveness of intervention programmes, and it also allows for interregional and inter-country comparisons over seasons, years or decades (Shetty, 2003; Sibrian, 2009).

Nutritional anthropometry has several advantages (Gibson *et al.,* 2011), which can be summarized as follow:

- methods are precise and accurate provided standardized techniques are used;
- procedures use simple, safe and non-invasive techniques; then equipment required is inexpensive, portable and durable, and can be made or purchased locally;
- relatively unskilled personnel can perform measurement procedures;
- methods can be used to quantify the degree of undernutrition and provide a continuum of assessment from under to over nutrition
- methods are suitable for large sample sizes such as representative population samples and can be used to monitor and evaluate changes in nutritional status over time, seasons, and generations;

- methods can be adopted to develop screening tests in situations such as nutrition emergencies to identify those at high risk (Shetty, 2003; Sibrian, 2009).

However, there are also several limitations that should be mentioned:

- the relative insensitivity to detect changes in nutritional status following inadequacy of food over short periods of time;
- the inability both to distinguish the effect of specific nutrient deficiencies that affect growth in children and the inability to identify the principal causality of undernutrition;
- the relative higher costs and organization required to obtain representative and quality data for the purpose of estimating numbers of undernourished (Shetty, 2003; Sibrian, 2009).

7)   Diet quantity and diet quality

The studies of Smith *et al.* (2006) and Smith and Wiessman (2007) implemented two dimensions of *diet quantity* – defined as the inability to access sufficient food − the prevalence of food energy deficiency and the prevalence of severe food energy deficiency. It also employs two indicators of *diet quality* – it indicates the lack of access to nutritious food. The results point out that Sub-Saharan Africa suffer with more severe problem.

2.2. Quantitative and qualitative methods

Qualitative and quantitative measures of food insecurity are still new and have largely been developed for application in North America, initially relating to safety net programmes, like food stamps (Mason, 2003). The main concern of this type of analysis is to develop an abbreviated qualitative-quantitative method based two measures: food sources of household energy availability (the quantitative part) and a self-perceived HFS scale (the qualitative) (Lorenzana and Sanjur, 1999; Pradhan and Ravallion, 2000).

- *National Household Surveys (NHS)*: focus on household consumption or acquisition of food and non-food items. NHS usually covers single countries for one year. In

particular, both quantity and monetary data collected in the NHS are useful to estimate average food prices, for different products for different groups of household (Hoddinott, 1999; Sibrian *et al.,* 2008). In addition, NHS provides data about household income and expenditure level, as well as a number of other socio-economic and demographic characteristics.

- *Food Security Statistics Module (FSSM)*: it is the software developed by FAO Statistics Division to help NSOs to estimate food consumption statistics derived from food consumption data collected in NHS. The FSSM software consists in a set of programs developed to process food consumption, income and other relevant data, implement statistical procedures for estimating food security statistics, integrate results in standard tables and prepare charts and graphs ready for publication (Naiken, 2003; Melgar-Quinonez *et al.,* 2006). One of the uses of these statistics is the assessment and monitoring of the national and sub-national food security situation in the context of the World Food Summit and Millennium Development Goals targets on hunger reduction.

- *The Household Food Security Survey Module (US HFSSM):* USDA developed this set of questions based on the overall food insecurity experience that can be administered in a survey and reported as either a continuous score of the severity of the phenomenon or as a categorical indicator of food security status. Recent research in the United States has confirmed that the US HFSSM is a valid and useful method for measuring household food insecurity (Melgar-Quinonez *et al.,* 2006).

- *The Food Balance Sheets (FBS):* estimates food for human consumption from agricultural and industrial production and trade data as well as country total food consumption (Hoddinott, 1999).

- *Access to food:* is expressed in terms of an inequality index, like the Gini's coefficient (Hoddinott, 1999).

- *Food deprivation:* it refers to the condition of people whose food consumption is continuously below body dietary energy needs. FAO's measure of food deprivation is

based on the distribution of food consumption expressed in terms of dietary energy (Hoddinott, 1999).

- ***Diet composition***: it refers to the consumption patterns of macronutrients by food commodity groups at national and sub national levels and for socio-economic population groups (Hoddinott, 1999).

2.3. Global Hunger Index (GHI), FAO and IFPRI approaches

2.3.1. Global Hunger Index (GHI)

The GHI, developed by IFPRI, captures three dimensions of hunger: insufficient availability of food, shortfalls in the nutritional status of children, and child mortality (Wiesmann, 2006). Accordingly, the index includes three equally weighted indicators: the proportion of people who are food energy deficient as estimated by the FAO, the prevalence of underweight in children under the age of five as compiled by the World Health Organization (WHO), and the under-five mortality rate as reported by the United Nations Children's Fund (UNICEF). The GHI has been calculated for 1981, 1992, 1997, and, most recently, for 2003. The latest round ranks 97 developing countries and 22 countries in transition (Wiesmann, 2006).

Moreover, the GHI combines the percentage of people from the entire population who are food-energy deficient with the two indicators that deal with children under five (Wiesmann, 2006; Appendix 2, 2007). This ensures that both the situation of the population as a whole and that of children, a particularly physiologically vulnerable subsection of the population, are captured (Wiesmann, 2006).

The calculation of GHI scores is restricted to developing countries, and countries in transition for which measuring hunger is considered most relevant. Developed countries are not included, because hunger has been largely overcome in these countries (Wiesmann, 2006).

The Global Hunger Index is calculated as follows:

$$[GHI \ = \ (PUN \ + CUW \ + CM) \ / \ 3]$$

where:

PUN = proportion of the population undernourished (in percentage);

CUW = prevalence of underweight in children under five (in percentage);

CM = proportion of children dying before age five (in percentage) (Wiesmann, 2006).

All three index components are expressed in percentages. The GHI varies between a minimum of 0 and a maximum of 100. This index provides a series of advantages, like the ability to integrate different aspects of a multifaceted phenomenon or the capacity to guarantee a quick overview of the situation, facilitating the use of statistics for policymakers.

The most commonly used measure of hunger is the FAO indicator of the proportion of undernourished in the population, based on three parameters: dietary energy supply per capita, the variation of dietary energy intakes across households, and minimum dietary energy requirements (Wiesmann, 2006).

However, there are concerns about measuring other aspects of hunger. In fact, many economists make objection that the reliability of all three parameters FAO uses to estimate the proportion of undernourished are not precise enough to guarantee adequate measurements.

2.3.2. *FAO and IFPRI: parametric versus non-parametric approach*

The FAO approach estimates the average food consumption parameter from national food balances such as those from the FBS compiled and prepared by FAO on yearly basis. The FBS is the only data source for global monitoring. Furthermore, FAO has been traditionally estimating the prevalence of undernourishment in the total population using a parametric approach in the sense that it is based on the parameters of the distribution of dietary energy consumption (DEC) and the dietary energy requirement (DER) (Mason, 2003). Recently, researchers from IFPRI have proposed a non-parametric approach as an alternative to the FAO approach, based on the direct comparison of the DEC of each sampled household in a NHS with the summation of the DER of all members in the corresponding household (Sibrian *et al.,* 2009).

However, some criticism can be found, about this method:

1) the prevalence of undernourishment in the population is derived by comparing the DEC of each household in the sample with the DER obtained as an aggregation of the DER calculated for each of the individuals in the household, the result of the comparison

between DEC of each household in the sample with the DER, may be affected by the biases and errors inherent to the individual household level data from the NHS;

2) the estimation of DER is incorrectly based on the median of the distribution of acceptable body-weights for a given sex and age group (Sibrian *et al.,* 2009).

The above approach is claimed by the IFPRI researchers to be an improvement as compared to the FAO approach in the sense that the prevalence of undernourishment in the population is derived by aggregating inferences regarding food inadequacy made at the level of the individual households rather than a single inference made at the population level (Sibrian *et al.,* 2009).

3. Food Security determinants

"No society can surely be flourishing and happy,
if the greater part of the members
are poor and miserable"

ADAM SMITH

The challenge of feeding 9 billion people in forty years' time is becoming a fundamental research topic and political issue, for more than one reason. Not only does the incredible population growth compete for land, water and energy, but also the effects of climate change or conflicts may affect the human ability to produce food (Godfray *et al.,* 2010b). These elements mentioned above are only a few of those which affect food security, but they have profound implications for the capacity of agriculture to meet this century's demand for food, doing so in ways that are socially and environmentally sustainable (Gregory *et al.,* 2005; Fedoroff *et al.,* 2010; Godfray *et al.,* 2010).

If we start to analyze which are the main factors, affecting food security, we have to remark that making substantial and determinant progress in improving food security is not only really difficult, but it also is a real challenge (Rosegrant and Cline, 2003). Indeed, there is more than one element which can influence household food consumption, like the availability of safe drinking water, the access to primary health care and education, the lack of roads and infrastructure or low family's incomes (Badolo and Kinda, 2010).

In fact, as we can read in the World Bank publications (1986), some of the causes which affect food insecurity, should be summarized as follows: *'the major sources of transitory food insecurity are year-to-year variations in international food prices, foreign exchange earnings, domestic food production and household incomes. These factors are often related with temporary sharp reductions in a population's ability to produce or purchase food and other essentials, undermine long term development and cause loss of human capital from which it takes years to recover'.*

Furthermore, we can make a list of the main food security, or insecurity, determinants which will be further analyzed in specific paragraphs. Badolo and Kinda (2010) suggest a classification in two different macro-clusters:

1. <u>microeconomic determinants</u> of food insecurity − related with environment health, inadequate access to food, low rates of agricultural production, infrastructure and local markets;

2. <u>macroeconomic causes</u> − representing the factors expressed at the country level.

It is also possible to report that conflicts affect many assets of agricultural production, like fields and infrastructures; in addition, they could have not only acute short-term but also persisting long-term negative impact (Clay, 2002). Then, innovation became more and more urgent in the last few decades. In fact, both innovations in agro-ecological approaches and genetic engineering, such as crop breeding, have brought important and documented successes. But, these are only a few examples of how modern technologies improve food security (Rosegrant and Cline, 2003).

Moreover, the health environment of households is really crucial in explaining the intensity and incidence of food insecurity. Really, households are more exposed to infectious diseases and health problems related to malnutrition, when they do not have any assurance of safe water sources, good sanitation or other health facilities (Badolo and Kinda, 2010). It is no accident that the highest level of infection of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) was detected exactly in these areas, and it is still very predominant.

Another important point regards the role of policies and investments, on multiple fronts: in agricultural research, water and transport infrastructures, natural resources management and human resources. All of them should improve the worldwide food security situation, especially in developing countries. Besides, progressive policy reforms could not only increase agricultural production, but also encourage poverty reduction in rural areas, which are the most populous, with a consequent improvement in income levels. In fact, it is very well known that increasing the rank of investments in human capital is essential to accelerate food security improvements (Rosegrant and Cline, 2003).

Closely related to this previous point, there is the idea of economic environment, which is represented by an efficient financial system that facilitates access to credit and a good transport and communication infrastructure. As for the first, it is extremely important to ensure low food prices, access to food supplies, and efficient food markets, which means that they can quickly respond to changes in demand. Moreover, access to credit is fundamental for the reduction of the

obstacles in investing and innovating in the agricultural sector, especially where the infrastructure are scarce (Badolo and Kinda, 2010).

But, investments in infrastructures can increase agricultural production on one side reducing the costs of transporting food storage and inputs; on the other consolidating the links between rural and urban areas, or agricultural and nonagricultural activities. Actually, new lands can be brought into cultivation and new techniques can be used to intensify the tillage of the existing land; so, roads and other means of transport give farmers access to new technologies. Indeed, infrastructures contribute to the sharing of information between producers and markets (Rosegrant and Cline, 2003; Badolo and Kinda, 2010).

One of the latest fields of research is about the role that education can play especially in poor agricultural areas. In fact, it was demonstrated that education intensifies the ability of farmers to adopt more advanced crop-management techniques and technologies. Furthermore, enhancing the household's education level, it encourages movement into more remunerative nonfarm work, increasing the total household income. In addition, it is demonstrated that girls and women's education is extremely important in every dimension of development (Rosegrant and Cline, 2003).

With regard to the macroeconomic causes, four major factors can be identified: political regime, population growth, economic performance, and income inequality. In fact, it was demonstrated by Sen (1999) that starvation and malnutrition had never occurred in a democratic country. This idea highlights the modern concept that the observance of civil and political rights may afford the protection of economic and social rights, including the right to food. Besides, other researchers, such as Wiessman (2006) which could be the link between the level of malnutrition in the countries, and the presence of armed conflicts. His studies demonstrated that political and social conflicts have a complex, but direct, impact on food security in two major ways. Firstly, they provoke the limitation of food availability, caused by the collapse of agricultural production; then, they induce an insufficient access to food supplies, raising unemployment and poverty, and changing the relative prices (Badolo and Kinda, 2010). To sum up, it is clear that food security is directly influenced by the political context.

With regard to population growth, it is influenced by the national and global conomic performance, but, according to Malthus (1798), it can also increase the pressure on agricultural resources (Allouche, 2011). In this case, both agricultural productivity and consequently food production, could be penalized. However, other researchers like Boserup (1965) suggested that

just technical progress and agricultural productivity could be favored by the population growth, which constitutes a source of *"creative pressure"*. On the other hand, as suggested by Badolo and Kinda (2010) a high degree of inequality at national level, results in constraints on food access for the households, promotes poverty and increases of food insecurity.

However, in other researchers' opinion, the determinants of food security can be divided into three sets:

1. factors which affect food demand and food consumption: changes in consumption patterns , the effects of urbanization on the food system, population growth and the different levels of income among the countries;
2. future trends in food supply;
3. exogenous factors which affect the food system: for example, competition for water, energy and land and climate change (Brown and Funk, 2008; Godfray *et al.,* 2010).

Two of the most important conclusions that emerge from these recent scientific researchers are, on the one hand, the importance of investing in research to improve agricultural production and to enable the food system to deal with future challenges. On the other hand, the interest in sustainable food production should be reached through the application of current technologies. In the end, science will be having a prevalent role in feeding the world in the coming decades, but to tackle the huge and complex problem of food (in)security a multi-disciplinary approach is required which should involve economics, social sciences, policy makers, and international agencies (Godfray *et al.,* 2010).

3.1.   Food, water and climate: emergencies and challenges

From the literature point of view, there are two major theoretical predictions about the implications of changes in agricultural production, due to climate change. Firstly, food supply at both global and local levels is affected by food production; so that, the increase in the frequency and severity of extreme events impacts on crops yields. Secondly, climatic conditions could have strong effects on the possibility of getting to food and the rural poor, who are mainly farmers, may have their welfare and safety compromised (FAO, 2008). Particularly in tropical areas, farmers are both producers and consumers of their own agricultural products, or they sell them in

local markets. This situation exposes these people to climate instability because when the yields are extremely low, due to an extraordinary climatic event, their income goes down. So, production costs go up and they are unable to maintain a basic consumption (Brown and Funk, 2008).

Indeed, the paper of Badolo and Kinda (2010) studied the effect of climatic shocks on food security for 77 developing countries over the period 1960-2008. Using the level of malnutrition and food production as indicators of food security and a panel data, they demonstrated that the instability of rainfalls is one of the main factors of food insecurity in poor countries. Furthermore, the change in climatic conditions will increase water scarcity in the coming decades (Lobell *et al.,* 2008; Fedoroff *et al.,* 2010).

Nevertheless, in Clay's opinion (2002) there is not clear evidences, neither for Africa nor for the other continents, that climatic variability has increased significantly in the last few years. But, he admitted that global models suggest that some changes in climatic conditions are happening; in fact, a lot of estimations have been developed in recent years in order to predict the increase in frequency and intensity of droughts and floods; thus, the poorest regions of developing countries, already characterized by the highest levels of chronic malnutrition and undernourishment, may become areas with the highest degree of instability in food production (Rosegrant and Cline, 2003; Godfray *et al.,* 2010). So that, the progressive increase in people affected by new diseases, or with a deterioration in their health status, could make populations more vulnerable to extreme shocks.

In order to highlight the role that water plays in agricultural production, it is essential to highlight that 70% of global freshwater is used exactly for agricultural purposes. In Sub-Saharan Africa, where there is the largest concentration of malnourished or undernourished populations, the slogan "Water is for food" has become recurrent during the latest debates about climate change and poverty reduction (Brown and Funk, 2008; Godfray *et al.,* 2010).

The Intergovernmental Panel on Climate Change (IPCC) assesses that nearly five hundred million people around the world currently live in areas where there is no water, or its supply is chronically short. So that, the IPCC predicts that the number of people who will live without secure access to water will increase dramatically. In this context, water resources are becoming more and more vulnerable to climate change, with severe consequences for human and food security.

The relationship between water and food security was deeply analyzed by Collier (1999) and Allouche (2011). As for the work of Collier and the US State Failure Task Force, it suggests that there could be a correlation between food insecurity and civil wars. Indeed, the author demonstrated that there was a strong relationship between the most important indicators of food deprivation − low per capita income, high income inequality or low food production per capita, civil wars (Collier, 1999). Nevertheless, other analysts think that other reasons should be taken into account in describing the problem of food insecurity, such as ethnic and political rivalry (Paalberg, 1999). Even so, most specialists would agree that hunger and structural or country-specific conditions could become the main causes of conflicts.

On the other hand, the goal of Allouche (2011) was to examine how water and food systems could react to different levels of shocks and stresses: conflicts, global trade and climate change. The main points of the article revolve around four main concepts, which can be summarized as follows:

- firstly, the scarcity of resources might be considered a cause of regional and national conflicts;
- secondly, the lack of security about water and food resources could be explained not only by political power, but also by gender and social relations;
- thirdly, the role of global trades was found to be fundamental for national water and food supply. But, recently, the spike of food prices is threatening these supplies, increasing the phenomenon of land 'grabbing' and other food sovereignty movements;
- lastly, it is possible to notice that in some decades food and water security will have to cope with new challenges under the threat of climate change.

If we consider the impacts of climate change on different aspects of food security we can propose the recent researches of Schmidhuber and Tubiello (2007) who analyzed how climate change could impact on different aspects of food security: production, availability, access, supply, utilization and the food system, including food distribution side. The differences among these dimensions are dissimilar across regions and over time, depending on the structural socio-economic situation of a specific country. For example, variability in climatic conditions has an effect on the stability of food supplies; the increase in extreme events can bring higher risks of erosion damage. In fact, in rural areas where agriculture is the most important part of the local

food supply, changes in frequency of rainfall aggravate the precariousness of local food systems (FAO, 2008).

The effect of climatic variability on food production and availability is double. On the one hand, Schmidhuber and Tubiello, (2007) think that the pasture productivity of some humid and temperate grasslands may be increased by moderate incremental warming. On the contrary, climatic models explain that the most dangerous disruption to agriculture is the drying of the central parts of continents, like America and Europe, which now constitute the world's main breadbaskets (Ehrlich *et al.,* 1993; Lobell *et al.,* 2008). As a result, what are now the most productive and fertile regions may become areas unsuitable for cropping, and also the tropical grasslands may become increasingly arid (Fedoroff *et al.,* 2010).

It is also true that, if temperature rises over the current average levels, there will be an expansion of many agricultural pests, and their ability to survive the winter (Schmidhuber and Tubiello, 2007; Hanjra and Qureshi, 2010). So that, it is possible to say that food production is both directly affected by climatic variability especially in changes in agro-ecological conditions, and indirectly influencing growth and income's distribution. Consequently, these elements are related to the demand for agricultural foodstuffs (Badolo and Kinda, 2010).

On the other hand, climate impacts can influence the possibility to buy food in a double way: affecting the income-earning chances and making certain foodstuffs unaffordable, for very indigent individuals, because of high prices. Moreover, alterations of the seasonal demand for agricultural workers, due to different climatic conditions, may mutate production techniques, with an increase, or decrease in mechanization (Badolo and Kinda, 2010). So, climate variability should be considered the primary cause of unstable access to food. The people who could be at risk of losing their access to food are usually landless agricultural workers, who depend on agricultural wages, and have a small amount of savings, especially in regions of erratic rainfall (Schmidhuber and Tubiello, 2007).

If we start to analyze the impacts of climate change on food utilization, it is possible to say that climatic variability affects people's capacity to use food effectively, starting a vicious circle in which malnutrition makes the populations more susceptible to food-borne and infectious diseases. Likewise, the major impacts of flooding will be felt strongly in extremely poor areas, where sanitation and hygiene infrastructures lack. As a result, there may be a double effect: in the beginning there may be a great amount of people exposed to water-borne diseases, like

cholera, and then, a considerable decline in labor productivity as well as an increase in poverty and mortality (Schmidhuber and Tubiello, 2007).

However, some analyses highlighted the fact that food consumption is related to nutritional aspects of food consumption, in particular micronutrients, which are obtained from plants. The problem is that changing the yields of fundamental crops, or influencing decisions to grow crops of different nutritional value, could directly affect individual diet composition (Badolo and Kinda, 2010). But also, the difference in countries' socio-economic characteristics are critical for the ability to cope with problems of food instability, caused by climate (Schmidhuber and Tubiello, 2007).

To end with a positive modern concept, Lobell *et al.* (2008) suggest that populations should learn to deal with the increasing climate instability, for example, by cultivating sorghum, instead of maize, whose requirements in term of water are lower. Gregory *et al.* (2005) noticed that the capacity of different food systems to decrease their vulnerability to climate change is not identical, because of the complex and numerous socio-economic factors affecting both food systems and, hence, food security.

In point of fact, both declining productivity of agricultural soils and their degradation are serious threats in many areas of the world (FAO, 2004). Besides, low agricultural production could be considered a real problem for international food supplies, and, consequently, for the prices of food stuff on food markets. It is possible to say that climate change affects agriculture and food security through altering the temporal and spatial distribution of rainfalls and the accessibility to land and water (Hanjra and Qureshi, 2010). It may affect food systems in multiple ways; for example, through direct effects on crop yields, consequent changes in markets, supply chain infrastructure and, eventually, on food prices. In relation to the climate change-food security link, many researchers found that the first has a strong negative impact on crop productivity, increasing the risk of hunger. This is particularly true of African countries, especially those in the Sub-Saharan region (Gregory *et al.,* 2005). Lobell *et al.* (2008) indicated that, mainly Southern Africa, but also South Asia are the two regions where there is the largest amount of food-insecure populations.

In conclusion, the key messages of this paragraph can be summarized as follows:

1. climate change can increase the number of people at risk of hunger, malnutrition and food or water-borne diseases;

2. Sub-Saharan Africa is becoming the most food-insecure region;

3. rainfall volatility has effects on the economic systems, food production and availability;

4. the adverse impact of climate change will fall disproportionately on the poor;

5. climate instability increases the dependency of developing countries on imports. In this case, national revenues are affected by rainfall, which restrains the possibility for poor countries to purchase foodstuffs on the international market (Brown and Funk, 2008).

3.2. The influence of migration on food and nutrition security

Another main factor affecting malnutrition and undernourishment is migration, a very heterogeneous and composite concept. In fact, the possibility to create a link between migration and food and nutrition security has fundamental implications for policy-makers. But in the development economics literature there has been little attention about this topic, even though it was demonstrated the influence of nutrition on human health, through different channels (Zezza *et al.,* 2011). In any case, the effect of migration on food security is extremely complex to understand, firstly because it is a country-specific situation, then because it involves either the whole family, or only some members. In fact, the primary effect of migration depends on the migrants' characteristics, their family and the socio-economic context (Nguyen and Winters, 2011).

A schematic graphic (Figure 1) explains the five main ways through which migration influences the different aspects of household food security:

1. income and remittances;

2. effects on household composition and decision-making: a possible example may be the difference between female and male headship;

3. insurance and consumption smoothing effects: they improve the household ability to guarantee stable access to food seasonally or at a time of crisis;

4. effects on improved knowledge of health and care practices;

5. effects on time allocation (Azzarri and Zezza, 2011).
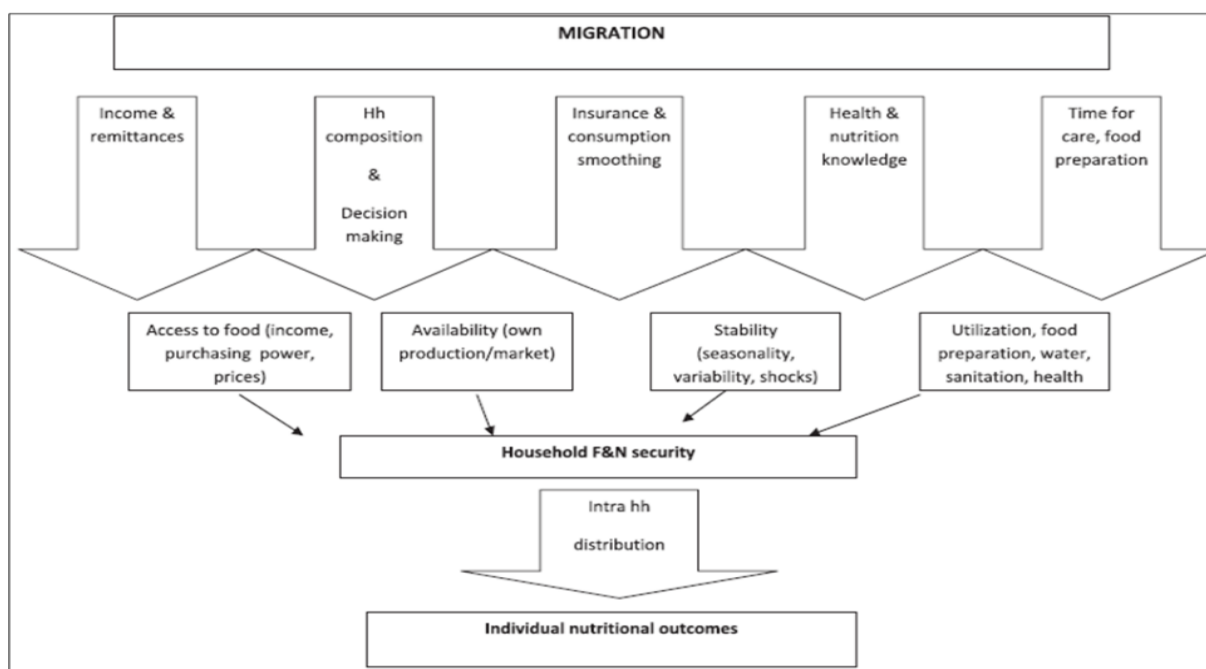
Figure 1: The conceptual framework of migration and food nutrition security.
(Source: Azzarri and Zezza, 2011)

As suggested by Banerjee and Duflo (2007) migration can be viewed as a movement from the home country to other countries, or from the rural context, to the suburban quarters. This is the case, reported by de Brauw and Mu (2011), of the rapid economic growth in China, which coexists with a large scale rural-to-urban migration, even if a great number of kids were left in rural areas. Examining these children, the researchers found that migration stimulates two different nutritional outcomes: on the one hand, children whose average age is 10 are more likely to be underweight; on the other, younger kids tend to be overweight, because they grow up without the care of their parents.

It is extremely important to notice that migration affects the level of food security of a family through changes in time allocation of household members. From one point of view, if one or more individuals decide to depart, their relatives have to take up the tasks that migrants used to carry out, especially in the agricultural sector (Mu and Van de Walle, 2009). From another, migrants spend less time cooking or monitoring the eating habits of their children. For this reason, it was demonstrated that the older children of migrant households' are less cared after and spend more time on household chores, than kids remaining at home. In the same analysis, it was found that the remaining adult household members usually do not spend a lot of time preparing meals or breastfeeding their babies (de Brauw and Mu, 2011). Indeed, when a family

migrates to a new city, the mothers' time may become more constrained, leaving less time for child care in general, as found in the case study of Mexico by Hildebrandt and McKenzie (2005).

However, it is also possible to identify two key types of migrants: international versus domestic migrants and short-term versus long-term migrants. It is important to make these two distinctions because people who decide to move away from their homes are characterized by different considerations (Zezza *et al.,* 2011). On the one hand, people who leave their home towns for "seasonally migration" to obtain a supplement income, or to respond to some unexpected shock. In fact, the migrant could earn more money than in agriculture, remaining close to his original social network, carrying on economic interactions with his own households and communities, left behind (de Brauw and Mu, 2011). On the other hand, a long-term migrant is permanent and the field of analysis should be focused on the relationship that these people maintain with their households, which represents almost the only source of insurance available (Munshi and Rosenzweig, 2004; Zezza *et al.,* 2011). In Vietnam, it was observed that long-term migrants are not married and have fewer local ties; specifically, girls and women who emigrate to find a better job tend to be younger than males, and not married; on the contrary, adult men are better educated and have higher migration propensities.

A very interesting case of study is the analysis of the Tajikistan context, made by Azzarri and Zezza (2011). This country suffers from high levels of child malnutrition, even if it has the largest share of remittances to GDP in the world. The paper mentioned above, investigates the relationship between international migration and child malnutrition, using data from household survey. The results indicate that migration appears to have a positive role in enhancing child growth, but also a negative effect, increasing the obesity rate among migrant children, compared to those who did not migrate.

Another meaningful field of research related to migration, is the role that the remittances have on household characteristics. Generally speaking, a direct income effect is documented, enabling households to improve their expenditure level in education, small business investments and food and health related products or services (Karamba *et al.,* 2011). Indirectly, the money earned by migrants, has a positive effect on production and investment decisions through the relaxing of binding liquidity and insurance constraints (Nguyen and Winters, 2011; Zezza *et al.,* 2011).

However, the main difficulty in this case is to distinguish between the effects of income from remittances and information from migrants, even if both of them would be expected to

enhance nutrition situations. Karamba *et al.* (2011) found that migration encourages the sharing of additional information among people of different tribes or regions. Furthermore, it generates habits which increase the household's knowledge of methods and experiences improving nutrition, health, and productive skills. In fact, Gibson *et al.* (2011) think that migrants can have the opportunity to learn about different topics, such as health practices, which they have met in the destination countries. This knowledge could lead people who remain to use health inputs more efficiently, or to adopt new norms about diet and health behaviors to reduce obesity and increase nutrient intakes.

As for the analysis of the income's effect, Lucas (1987) lighted upon the result of migration in South Africa on cropping and livestock management: they were thanks to the investments in productive resources due to the remittances. Similar effects are documented in Mali by Findley and Sow (1998) and in Somaliland by Ahmed (2000). It is true also for productive assets, like lands or machines, in Kenya, remittances facilitated households in improving their labor capacity. But, Zezza *et al.* (2011) think that migration may also impact on the allocation of household labor not only as far as productive activities are concerned, but also regarding reproductive activities, including child care. In addition, migration should be considered one of the mechanisms of coping strategies adopted by poor people to deal with shocks (Karamba *et al.,* 2011).

More specifically, Karamba *et al.* (2011) found that food expenditure per capita increases as a result of migration, in particular for some specific categories of food, like meat and fish, as well as nuts and oils. This would suggest that migration reduces the level of undernourishment, providing more calories and increasing diet diversity (Nguyen and Winters, 2011). But a closer examinations led to the conclusion that in the destination countries, the exposure to different dietary habits, which may be not necessarily better, can lead to a worsening in the composition of diets.

After all, the availability of different types of foodstuffs may provoke shifts to higher energy and fat intakes, as well as a higher consumption of processed food (de Brauw and Mu, 2011). In fact, there may be a shift towards foods containing higher levels of fats and sugar, or lower levels of vegetables and fresh fruit. For this reason in areas characterized by high density of emigrants, where the incidence of being overweight and obesity is extremely high, nutrition education programs are organized (Zezza *et al.,* 2011). As demonstrated by de Brauw and Mu

(2011) there is an increase in weight-for-age in kids remaining in their country of birth, and the total caloric consumption in children rises when one or both parents emigrate.

Besides, migration affects nutritional habits in long-term migrants through the exposition to different types of diets, and health practices in destination countries. These factors may have both positive and negative effects on the quantity and quality of household food consumption as well as other nutritionally-relevant behaviors (Zezza *et al.,* 2011). Nguyen and Winters (2011) using panel data from Vietnam Household Living Standards Surveys have discovered that short-term migration has a positive effect on per capita food expenditures, calories consumption and food diversity. On the contrary, if people decide to migrate for a long period, this appears to be positively related to food consumption; in fact, rural areas are characterized by less economic growth and lower level of food security.

Although difficult to measure, migration leads not only to important psychological problems, such as separated families or missing parents, but even to social problems like the abandoning of the native villages; all of these factors have negative effects on the global level of nutrition (Zezza *et al.,* 2011). Furthermore, as a consequence of migration movements, children could be separated from their parents, become depressed, weaken and lose weight. This is the situation in Tonga, where the changes in diet seem to play a predominant role in the divergences in child health. In fact, for children who migrate with their family, a major level of income guarantees them an increase in milk and meat consumption, which should boost their height-for-age and weight-for-age. This idea is reinforced by the results obtained by Gibson *et al.* (2011) who suggested that the consequences of migration on food security and child health depend on whether children themselves migrate with their parents, or whether they remain in their original place. The estimation suggests that children who migrate experience improvements, while diets worsen for children who remain.

Moreover, children's health and food security status in their first years of life, is extremely important for cognitive development and can have direct implications on lifetime earning potential, school performance and labor productivity (Nguyen and Winters, 2011). WHO (2002) concludes that malnourished children are exposed to a higher risk of mortality, due to infectious illness such as diarrhea and pneumonia (de Brauw and Mu, 2011).

Another effect that migration may cause is a demographic shift both within the household and at the community level: that is a prevalence of female headship and a lower productive activity due to the departure of the active members, who are usually men (Zezza *et al.,* 2011).

Women may remain without their husbands and exercise a direct control over the household cash resources, deciding to allocate them differently. For example, they could choose to increase the fraction devoted to purchasing more and higher quality food, or other inputs into child health and nutrition.

Nevertheless, the potential harmful effect of workers' displacement on nutrition should be taken into consideration. Particularly, it could be extremely dangerous if the migrant's departure is long, because it can reduce the household's level of productivity or household care taking (Karamba *et al.,* 2011). But, the departure of a household member may be advantageous because a reduction of the total amount of household's food consumption could be registered, by reason of the smaller number of mouths to feed (Gibson *et al.,* 2011).

Another recent approach to study the impact of migration on nutrition security is the one developed by de Brauw (2011) who studies how the young in migrant households cope with shocks, like the latest worldwide food price crisis which occurred in 2007 and 2008, compared with kids in non-migrant households. In particular, the focus was the state of El Salvador, where the crisis reduced relative household income so that food became more expensive, compared to other goods of the household budget. The results suggest that the presence of a migrant overseas implies smaller declines in height-for-age scores among young children. As for the policy implications, non-migrant households should be targeted for additional cash transfers at times of crisis.

In this way, children should not suffer because migration is associated with higher kids' nutritional and health status, during the period of rising food prices. So, this study has demonstrated that there is a positive correlation between households that send migrants to the United States, and child height-for-age, during a period of rapidly increasing food prices (de Brauw, 2011). Moreover, children are guaranteed their level of food intake more in migrant households than non-migrant households, whereas, it appears that non-migrants reduce the total amount of calories consumed, or at least they try to maintain it constant, changing their nutritional habits.

Last, food security may be affected by migration because it promotes human capital accumulation, improving the level of education of the young; in fact, people who decide to emigrate are not only the poorest, but they are often well educated, young-to-middle-aged household members, who would like to find better jobs outside their community. For this reason, Nguyen and Winters (2011) observed that individual characteristics and household size are

extremely important during the evaluation of the pros and cons of migration; specifically, age, level of education and educational background.

Another example on the same issue regards the situation in El Salvador, Guatemala and The Philippines, where it was suggested that remittances have a certain and beneficial impact on school retention and investments in education (Yang, 2004; Adams, 2006). As for a better education, it is effectively associated with improved nutritional outcomes. In Mexico, this is confirmed by evidence-which demonstrates that nutrition and health education of mothers could be effectively influenced by migration (McKenzie, 2006). From another point of view, some information should be gained from the literature that looks at human capital outcomes of migration, which are similar to nutritional outcomes, or they can be seen as diverse channels through which household and individual food and nutrition security situations can be improved (Azzarri and Zezza, 2011).

To sum up, these studies and their results demonstrate that:

- parental migration is positively correlated with underweight status among children, especially if they are older than 10;
- adult members of migrant households have a different household time allocation, spending less time cooking and buying food.

3.3.   Education and cultural habits: the key to food security

All over the world approximately 800 million people live in conditions of illiteracy and food insecurity (Burchi and De Muro, 2007). Notably, it is very well known that the education level is negatively correlated with malnutrition and food insecurity just as educational deprivation contributes to a high level of hunger (Lutz *et al.,* 2004; Godfray *et al.,* 2010). This suggests that civil society, international organizations and governments should fight food insecurity investing more in the education sector, especially primary education for rural people. FAO (2005) declared that education on food security is *"one of the most powerful engines for reducing hunger and poverty"* clarifying that *"lack of education undermines productivity, employability and earning capacity, leading directly to poverty and hunger"*.

The matter of nutrition and undernourishment attracts policy-makers and the international agencies' attention because of some puzzling failures. For example, in India and Egypt malnutrition is extremely high compared to their economic growth; in the first country,

simultaneously incremented the income per capita, more than fourfold between 1990 and 2010, the number of underweight children fell only by 25 % (The Economist).

Paradoxically, a low level of nutrition can cause obesity, not only in children, but also later in adult life. In fact, during the first period of pregnancy the baby's body stores up fats, as an energy reserve and it never loses its acquired metabolism. In part, this tries to explain the high obesity rates in countries where, in some decades, there was a switch from poor to middle income status. Taking the case of Mexico, for example, where in 1980 obesity was almost an unknown phenomenon, now 30 % of Mexican adults are clinically obese and 70 % are overweight. The good news is that improving the educational level is a good investment, − with a potential restraining vector − for the present and the future generations, especially regarding micro-nutrient deficiencies or breastfeeding (The Economist).
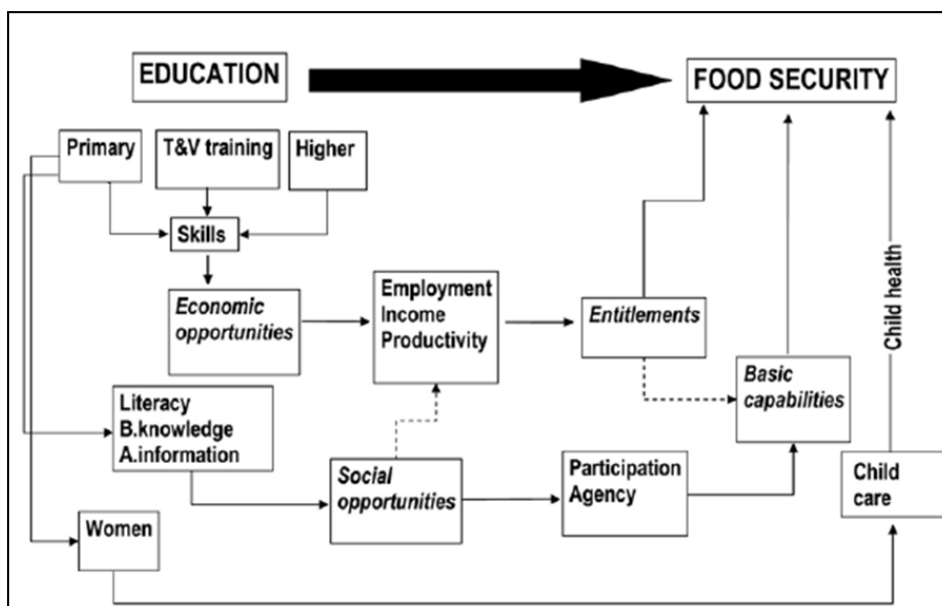
Figure 2: Contributions of education to food security.
(Source: De Muro and Burchi, 2007)

However, figure 2 suggests that education could have a double indirect effect on nutrition security: the first is through the progress of economic production; the second is through social and institutional change, like the human capital framework (De Muro and Burchi, 2007). As for the last, in Mukundi's opinion (2003) education *"can open the mind of people"*, so that, it guarantees access to public information concerning health, nutrition, and hygiene (Kamiya, 2010). Indeed, acquiring knowledge about food or water-borne-diseases is essential to know how to diversify diets, or how to avoid children's illnesses, in order to build a stronger immune system and diminish infant morbidity and mortality.

The immense and pervasive power of the new-age internet communication medium facilitates as never before the ready access to fundamental and advanced education and now possesses the intrinsic, readily accessible facility to upgrade individual, household and community self-enhancing determination and self-help mechanisms, rapidly capable of spawning new initiatives and driving micro- and macro- planning adjustments. Another benefit of education to food security is obtained through an improvement in social relations and social capital, seen as the social networks where a person can find assistance in emergency situations (De Muro and Burchi, 2007). In many African states, the role that the community plays is impressive (Woolcock and Narayan, 2000). Finally, education represents a psychological contribution to food security; in fact, thanks to a high education level, people can become food secured and they seem to be more ambitious and self-confident (De Muro and Burchi, 2007).

Education influences food security through the economic performances of a country. In rural areas, this is usually manifested by increasing agricultural productivity and efficiency, specifically the amount of output per unit of input, or the allocation of the inputs of production. Moreover, it is to be noted that education is extremely important to promote the ability of rural poor to avoid hunger and poverty, with their own means. Actually, well-educated people are likely to find a better job and, in addition, they use the available productive resources more rationally. Besides, informed people generally select more valuable objectives in their life; for example, having stable access to food for their household (Burchi, 2006). It is also true that nutritional status varies within households; in fact, during the period of crisis, mothers leave more food for their children, becoming themselves ill or underweight.

After all, there is another hidden contribution of education to food security: the non-farm income which can reduce household's vulnerability and recover more rapidly from emergencies like in case of natural disasters (De Muro and Burchi, 2007). Thus, the main theoretical foundation of the latest analyses is the idea that being educated improves the capacity to diversify people's activities, increases their income and agricultural production, improves access to information on topics like health or sanitation, strengthens social participation and cohesion (Burchi, 2006).

A crucial element which should be taken into serious consideration is the cultural background (The Economist; Smith and Haddad, 1999). Take rural Bangladesh, for instance, the family meals' composition is not determined by mothers but by mothers-in-law, and this is something to which specific policies should be addressed (FAO, 2001). But, in many countries

there is the problem of "hidden hunger", which can be explained as a situation in which everyone in a village is malnourished, so, poor nutrition becomes the norm and it becomes socially accepted. From one point of view education should be viewed as a way to change people's behaviors to a better, even if more expensive, diet. On the contrary, in rich countries people consume vast quantities of junk food knowing only too well that it is bad for them (The Economist).

For this specific reason, the raising of women's human capital should be considered the most effective way to reduce poverty and malnutrition; this is very well demonstrated by studies in Egypt and Mozambique where it was shown that mothers' education is the key determinant for future socio-economic politics, because it contributes for more than 50 % to the reduction of child malnutrition and infant diseases (Frongillo *et al.,* 1997; IFPRI, 2000).

Banerjee and Duflo (2007) reveal that people who are extremely poor do not have enough money to provide a good education for their kids; generally the level of expenditure is around 2% of household budgets. This fraction does not change comparing the poor to the extremely poor, or rural areas to urban areas. In any case, education is considered to be a key to food security for poor populations, in particular for the majority of people who live in rural places of developing countries and represent the largest proportion of the world's undernourished. Indeed, they are traditionally more disadvantaged by any national educational policy. All these elements reflect the essential factors to ensure food security in the long run (Burchi and De Muro, 2007).

Besides, the main finding of Burchi and De Muro (2007) is that the association between primary education[5] and food insecurity is very high; on the contrary, it progressively decreases with secondary, and tertiary education. Then, it is important to outline that primary education is a key determinant to reduce food insecurity in rural areas by approximately 20%, even if compared to different factors such as health, access to water and sanitation (Subbarao and Raney, 1992). T

Another key determinant of children's nutrition is their mothers' level of schooling; in fact, it is important to outline that kids, whose mothers have completed primary education are better nourished than kids whose mothers have lower or no educational attainments. Moreover, both the mother's general knowledge and nutrition knowledge are improved by primary education. On the other hand, the mother's secondary schooling indirectly contributes only to the household wealth and no substantial difference was found in the benefits of the mother's education comparing urban or rural areas (Subbarao and Raney, 1992; Burchi, 2006).

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[5] For primary education we intend the first stage of compulsory education, followed by secondary school.

Furthermore, it is very important to take into consideration the gender aspect for ensuring long term food security, particularly, the specific consequence that women's education has on household security (Nazli and Hamid, 1999). In point of fact, girls and young women attend school to obtain the basic skills useful to teach right health and hygienic practices to their children, once they become mothers (FAO, 2001). This means that female education should be improved because it reflects the direct effect on nutritional households' status (Burchi, 2006). Quoting Sen (1999), *"female literacy is found to have an unambiguous and statistically significant reducing impact on under five mortality, even after controlling for male literacy"*. In addition, if women assume a more active role inside their families, they can contribute to a drastic reduction in infant mortality, which in rural areas or developing countries, is mainly due to malnutrition (Burchi, 2006).

As suggested by IFPRI (2000), the person's gender has many implications for the property rights, which influence land care, and the rights to manage and use land resources (Nazli and Hamid, 1999). For example, in Sub-Saharan Africa women generally do not have access to education, labor, fertilizers and other inputs; but, when they obtain the same level of education or acquire some agricultural experience, they are able to increase the fields' yields of the main crops by 22% (Alderman *et al.,* 1995; Quisumbing, 1995). FAO (2001) reports that when women dispose of their income, this is primarily spent on food and children's needs. Women should be considered the key to food security for their households, because they are responsible for food selection, preparation and for the care and feeding of children. Besides, it was demonstrated that if poor households are headed by women, they usually provide more nutritional food for their children then those headed by men, who lack knowledge about food preparation and they are not able to translate food availability into nutritional security for their households. This observation confirms the importance of gender-based knowledge and its role regarding food security.

3.3.1. *Food for education programs (FFE) and Food for work programs (FFW)*

Adelman *et al.* (2008) analyze the impact that food for education programs has on school attendance and on the development of cognitive skills in children. This topic has received a renewed attention as a policy instrument for realizing one of the Millennium Development

Goals: to achieve universal primary education. Though this idea, is likely to realize another important objective: to eradicate extreme poverty and hunger (von Braun *et al.,* 2004).

So that, FFE are taught to serve meals in schools and provide take-home rations, in order to attract children, in exchange for school participation. The powerful attraction of these programs is that they try to improve both school participation and learning outcomes, increasing the amount of food consumption of malnourished children (Barrett *et al.,* 2002). FFE programs were experimented with great success in many developing countries, like Argentina, Colombia, Nicaragua, but probably the most famous is the case of Mexico, where they were called PROGRESA/Oportunidades. When this program was launched in 1998 it was revolutionary in two ways. Firstly, it aimed to integrate interventions in health, education, and nutrition simultaneously, because researchers understood that, on the one hand, all of these dimensions of human welfare are interdependent; on the other, education, nutrition and poor health are both causes and consequences of the conditions of extreme poverty in which millions of people live (Skoufias, 2005). Secondly, PROGRESA was implemented to be continually evaluated and improved, in order to become more and more effective, improving the social and nutritional situation of Mexico's poorest people. This is why IFPRI started to collaborate with Mexican organizations, evaluating the project for the entire period (Skoufias, 2005).

As a result, in-school meals programs could be considered a good idea to improve primary school attendance in areas where the initial level of attendance was low. On the contrary, the potential impact on school enrollment of children who were not previously enrolled in school was not investigated. Moreover, there is evidence that school meals improve performance in math and literacy tests, anthropometry, iron status and cognitive development, which depends on the type of food provided, the size of the food rations and the program duration (Barrett, 2002; Adelman *et al.*, 2008; Mwaniki, 2011).
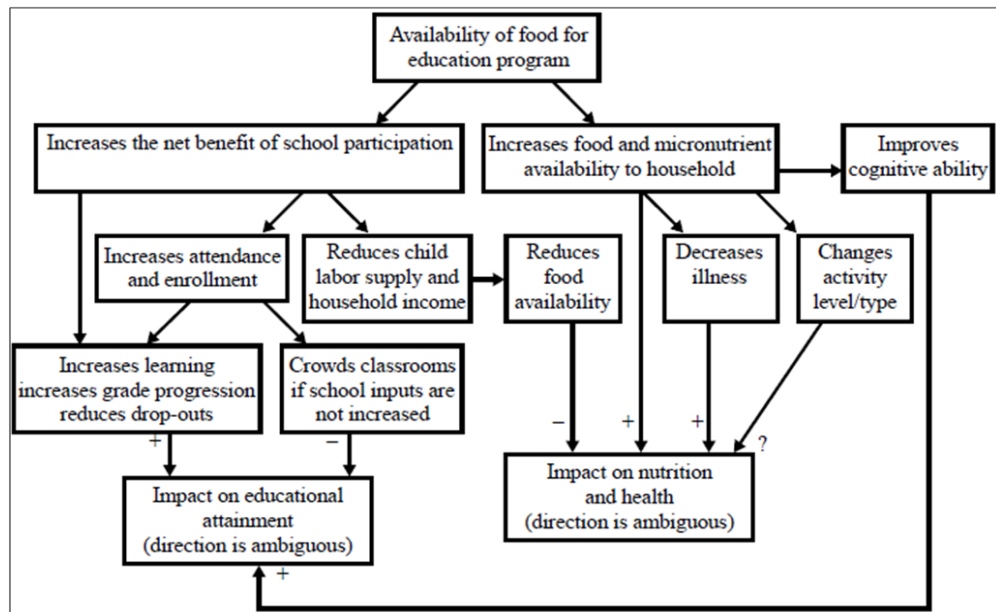
Figure 3: potential benefits of food for education programs.
(Source: Adelman et al., 2008)

The framework through which FFE programs may affect the participants' education and nutrition results is illustrated in figure 3. It is clear that school participation is increased by FFE programs, which may improve educational, learning achievement and associated gains in cognitive function (Adelman *et al.*, 2008). In fact, if kids are not given the recommended quantity of food in school age, this can cause great damage to children. Specifically, food insecurity can reduce school enrolment or attendance, limit the capacity to concentrate and perform in school (De Muro and Burchi, 2007). Moreover, these specific programs advanced even the health status of the whole household increasing food availability.

However, FFE programs are the target of one main point of criticism: they are extremely expensive in terms of nutrition benefits, which tend to be relatively small, if compared to those from nutrition programs targeting younger children. As a result, governments and donors are debating the future of FFE programs (Adelman *et al.*, 2008).

Another type of programs are those called food-for-work (FFW) programs which have been widely proclaimed as a means of providing transfers to a specific range of the population. In particular, FFW programs are widely promoted for their capacity to target poor populations effectively through a reliable safety net that reduces vulnerability and stimulates productivity (Barrett *et al.,* 2002). But, about the FFW's efficacy two distinct clarifications are needed: FFW programs represent a valid instrument to help people who suffer transitory income shocks. On the other hand, they can be viewed as a mechanism for development, because they improve

livelihoods and accelerate recovery from shocks. To sum up, FFW programs provide participants with the minimum essential quantity of food necessary to maintain a good level of nutrition; they require that the individual should work in exchange for this benefit (Barrett *et al.*, 2002).

3.4.   Diseases and Infections

The proportion of people affected by illnesses has rapidly increased and one of the recognized factors of infections is exactly the presence of diseases linked with high levels of malnutrition, restricted food intake and nutrient mal-absorption (Loevinsohn and Gillespie, 2003). But in general, infections and diseases, like malaria, tuberculosis and HIV/AIDS, which reduce the hours available to agricultural work and the time for household food acquisition, are a dramatic plague in the African continent (Mwaniki, 2011). Moreover, it was discovered that people who live in marginalized groups or areas are more vulnerable to be infected, because of limited access to coping mechanisms like social networks (von Braun *et al.*, 2004).

From another point of view even the presence of tuberculosis is associated with malnutrition and poverty; indeed, individuals who do not have appropriate diets and access to essential micronutrients, such as zinc, vitamin D and iron, are more likely to contract TB and die soon. On the contrary, in the case of malaria the link can be found between income level and diet quality (von Braun *et al.*, 2004).

Besides, food insecurity can worsen the effectiveness of medical treatments, impairing the immune system. Another problem for many HIV affected is the limitation to access to food, the decrease in labor availability and income, the savings' erosion and the increase in health care (Gregory *et al.*, 2005; FANTA, 2008). Furthermore, if people live without proper food and nutrition, they could easily transit from HIV to AIDS making the general health status worse?; this is why individuals with HIV require 50% more proteins and 15% more calories than healthy people. In the same way, mothers during the period of pregnancy can easily infect their babies, who will rapidly become food insecure (Mwaniki, 2011).

Moreover, HIV/AIDS affects active adults economically, contributing to widespread food insecurity and undermining the households' capacity to produce or buy food. In particular in Sub-Saharan Africa, AIDS is the major cause of adult mortality and morbidity. FAO calculates that by 2020 the epidemics will have spread to around 20% or more of people who live and work in fields, in many Southern African countries. The most serious problem is that more than 30% of the population of the 25 most affected countries resides in rural areas; this affects not only

agricultural production but also farm and domestic labor supplies (Mwaniki, 2011). In this case, a vicious circle settles in the family, increasing the number of children with little or no care and orphans (Badolo and Kinda, 2010).

3.5.   Conflicts and inequalities

Another determinant aspect that seems to receive limited attention, not only from international institutions, but also from the scientific community, is the relation between the presence of conflicts and food security (United Nations, 2010). Thus, food and also water security should be considered a political problem which should be addressed primarily through political changes and a reduction in generalized violence; in fact, the problem of inequality and allocation is the most important variable in explaining food insecurity (Lundberg and Squire, 2003). This is particularly true of conflicts and international wars, which are often linked with resource scarcity and economic crisis; on the contrary, water and food contentions are much more local, but they are able to aggravate the level of malnutrition of the population hit, not just in the short term but also in the long run (Collier, 1999; Allouche, 2011).

The concept of water wars is a dominant topic in the NGOs and media, more than food wars. Indeed, in 2007 the UN Secretary General Ban Ki-moon declared that *"water scarcity threatens economic and social gains and is a potent fuel for wars and conflict"* (Lewis, 2007). Naturally, the idea of food security or water conflicts is used for intensifying international and national key policy priorities. But, analyzing the problem on a sub-national scale the link between scarcity and conflict, hunger and food insecurity is more complex; in fact, water scarcity and food insecurity may lead to local political instability and sometimes violent forms of conflict (Allouche, 2011).

In addition, conflicts exercise both a direct and an indirect effect on food security through various channels. To start with the first type of effects, it includes: the disruption of farm land and machinery, the diffusion of bombs, and the killing of livestock, which blocks the access of both consumers and producers to local and international markets. In addition, wars and violence tend to discourage investment in agricultural modernization, deteriorating the environment for the utilization of food (United Nations, 2010).

On the other hand, conflicts usually go beyond the geographic borders of states being an important indirect effect on local societies, which is primarily manifested in refugee migration and then in a deterioration of regional investments. So, it is possible to use food insecurity as an

indicator of access to basic resources, but its interaction with conflicts is bi-directional: food instability is a source but even a result of local conflicts. Historically, riots and fights occur as a consequence of food shortages. The evidence suggests that there is an empirical foundation between resource scarcity and the outbreak of conflicts, especially in rural areas, where many battle fields are located, and where rural populations constitute a major source of recruitment of fighters (United Nations, 2010).

Jenkins and Scalan (2001) highlight that among the several policies which might contribute to improving the level of food security, the most important is the reduction in internal violence, which means restrictions on international arms trade and promotion of political democratization (Poleman 1997; de Soysa and Gleditsch 1999). In fact, they found that genocide, civil wars, arms imports and any other form of political discrimination which targets ethnic groups, is central to child hunger. Another main evidence is that political democratization is a key source of diminishing child and adult malnutrition rates. Moreover, the structural modernization of the educational system, improving the investments in human and physical capital, expands the possibility of a shift towards political democratization of least developed countries.

Furthermore, the major barrier for food security is inequality, which is related not only to international trade but also to political systems; in fact, food supply can be increased through international trade, but this is not sufficient in itself to reduce hunger. Moreover, in poor and undernourished societies, restrictions on political freedoms could be considered more crucial than increasing the food supply. Specifically, Sorensen (1991) and Wickrama and Mulford (1996) found that political democracy is positively related with improved physical quality of life and lower income inequality. What is more, the combination of political democratization and domestic investments are both decisive factors in ensuring food security (Jenkins and Scanlan, 2001; Olper, 2007).

In a very innovative way, Olper (2007) presented an empirical investigation of how the political regime, and the related government ideology (right-wing vs. left-wing) may influence agricultural land ownership. In particular, the inequality of the distribution between the two types of governments was taken into account. What was demonstrated was the deep ambiguity of this link, which could have been also affected by the pressure of specific groups of power, or if the model was the median voter approach. Generally speaking, it was shown that protection tend to decrease in land inequality, and with left-wing government orientation, but not following a linear

pattern. Specifically, left-wing governments tend to support agriculture in more unequal societies.

3.6.   Trade and trade policies

Godfray *et al.* (2010) observe that through global trade there was an overall increase in terms of food security between 1970 and 1990; but, the greatest improvements were registered in North Africa and the Middle East, limited changes occurred in Asia and Oceania and Latin America and Sub-Saharan Africa underwent a decline. In any case, food security was pushed to the top of the global policy agenda, after the recent spikes in food prices, which occurred between 2007and 2008 (Swinnen and Squicciarini, 2012).

Price levels and their variability affect agricultural production and food consumption. Generally speaking, trade policies have often been utilized to reduce the volatility of commodities, which are mainly influenced by global macroeconomic and trade issues. Therefore, these trends should not be analyzed individually, but they have to be considered in the wide context of the behaviors of the prices of all commodities (Diaz-Bonilla and Ron, 2010; Hanjra and Qureshi, 2010). Moreover, these situations suggest that there is a more complex relationship between food prices and other exogenous factors, which play a determinant role in it, like the energy market. Recently, there has been competition between food and energy not only for productive or transport costs, but also for biofuels, which exploit some food crops, like maize (Ivanic and Martin, 2008, Ruel *et al.,* 2010).

On the other hand, food security at the household level requires the focus on volatility in the domestic market. In fact, it is very well known that global food prices are transmitted to the national level, but their effects on poor people is determined by the level of integration between the local market and the national food markets (Kanbur, 1998; Deaton, 2010). Besides, for many developing countries a distinction should be made between urban consumers, who are more integrated with the national markets and rural consumers and producers who are characterized by lower levels of integration (Diaz-Bonilla and Ron, 2010; Naylor and Falcon, 2010; Torero, 2011).

Swinnen and Squicciarini (2012) found that the rise in prices has a mixed effect on poverty and hunger: it increases the cost of food for consumers but also increases incomes of farmers, who represent the major part of the world's poor. Moreover, a combined effect of price

changes, market imperfections, economic growth, and policy interventions may result in more than one effect on food security. For instance, in Asia the increase in average wages and remittances has been stronger than the rise in food prices. So, starting from the 2008 food crisis, there are a few functions which policy-makers should address: firstly, how to increase investments in agriculture, reassuring the global food supply; secondly, how to revise the link between fuel and food prices; thirdly, the food security system should become more sustainable as national safety nets, only if it is market-based (Christiaensen, 2009).

According to the World Bank (2009) during the last price spike nearly three quarters of developing countries adopted some policy measures to prevent local prices from reflecting international prices. Indeed, governments can reduce the transmission of price volatility from international to domestic markets, enforcing different types of instruments, such as domestic and fiscal policies or duties. But, even infrastructures, which can increase transportation costs, marketing structures and logistics can heavily influence local price instability (Diaz-Bonilla *et al.,* 2000; Tiwari and Zaman, 2010). Furthermore, the review of Ruel *et al.* (2010) highlights that urban and rural poor are both affected by any type of crisis, but the latter most of all because they are landless and net buyers.

In order to understand what are the effects of changes in price trends and price volatility on food security, it is essential to point out that, in the short run, high food prices benefit food producers, while low food prices help consumers. The crisis management constitutes a policy dilemma that each government has dealt with over the years in different ways: comparing high food prices that benefit food producers, and poor consumers who are helped by low food prices. In general, rich and industrialized countries used transfers from taxpayers, through subsidies, and consumers, through border protection to maintain high prices for producers; on the other hand, many developing countries followed policies of low agricultural or food prices to help urban populations and further the process of industrialization. But, any political approach which has to cope with this issue, should maintain a reasonably neutral system of prices and incentives, promoting and generating investments in rural areas and employment opportunities for the poor (Diaz-Bonilla and Ron, 2010).

However, many economists emphasize the need for free international trade, so that it is possible to improve global food security, enabling food demand and supply to strike a balance throughout the world. So that, FAO (2008) suggests that global trade could be a solution to the equality and food insecurity problem; but, it has been widely acknowledged that free markets

tend to penalize the poorest people, who do not have the opportunity to influence the structure or the rules of global markets (Aksoy and Beghin, 2005; Anderson, 2010). It is important to outline that even if global trade and technological innovation can be considered the key drivers in providing stability of global food systems. The most destabilizing threat is the increase in food prices and, consequently, in the number of malnourished people. What is more, recent debates about global food security do not take into adequate consideration the political dimension of resource scarcity, which is linked with politics of inequality, gender and power (Allouche, 2011).

Analyzing the role that markets play in defining the level of vulnerability, it is possible to discover that poverty and price instability are closely interrelated, due to the fact that poor people are more exposed because they spend a large proportion of their resources either purchasing or producing food, diminishing their capacity to cope with perturbations (Gregory *et al.,* 2005; Cervantes-Godoy and Dewbre, 2010).

But, the main question to which researches try to find an answer is what could be the links between trade, trade policies and food and nutrition security. Figure 4 displays the numerous interactions between trade and food security (Diaz-Bonilla and Ron, 2010).
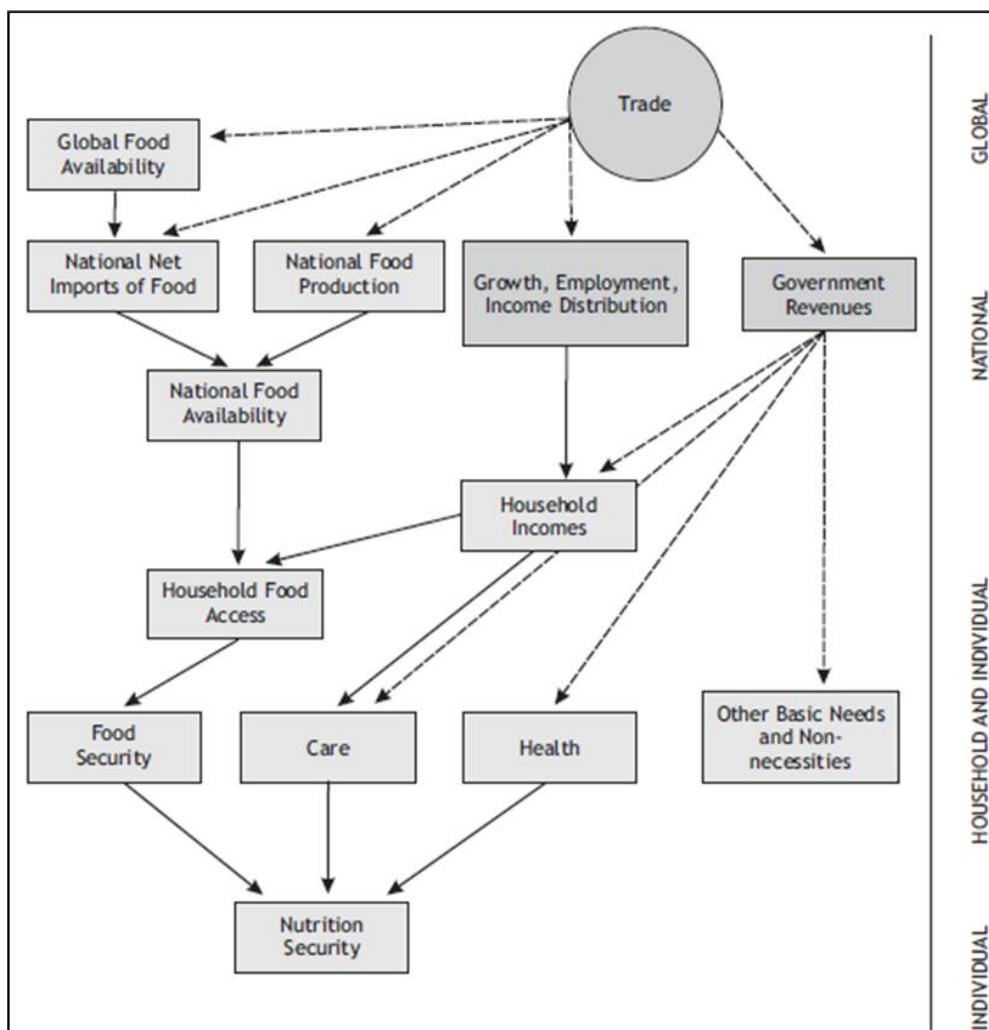
Figure 4: conceptual framework for food security and trade.
(Source: Diaz-Bonilla and Ron, 2010)

Thus, trade policies are able to influence:

- world food availability, production and food imports;

- profits for food producers and the food costs for consumers: from the consumer's point of view, there can be a consequent impact on wages, maintenance and accumulation of human capital;

- the decisions to invest in agriculture and to adopt new technologies, which can generate dynamic effects that are more important than the short term impacts of any policy;

- the economic performances of different countries, meant as growth, stability and income distribution patterns;

- the government revenues: that are the direct collection of trade taxes, and the indirect impact of the rate and variability of growth on general tax collection. The total amount of money available for the government affects a few aspects of the social and economic life of people, first of all, the possibility of investing in infrastructure, technology and services that support food and agricultural production. Then, implementing transfer policies, such as food subsidies, cash transfers, or other poverty-oriented programs; finally, financing public services and investments in education and health. In conclusion, all these factors have a crucial role both for food and nutrition security.

To sum up, trade policies and trade can have multiple impacts on the determinants of food and nutrition security: food availability, food costs, public services and investments, incomes and employment and government transfers and subsidies. Considering the variety of types of influence, it could be extremely difficult to identify unequivocally the impact, be it positive or negative, of specific trade policy intervention. This argument should be kept in mind during the evaluation of the worldwide food security situation (Diaz-Bonilla and Ron, 2010).

3.6.1. Land Grabbing

Land grabbing is an interesting example of how both investors and governments of some developing countries, mainly the Gulf States, China, South Korea or Brazil, are buying or leasing land in other countries to support food security (Mackenzie, 2008). The IFPRI calculates that about 15–20 million hectares of farmland have been subject to transactions in the last few years. More specifically, 2.5 million of these hectares are located in just five African countries: Ethiopia, Ghana, Madagascar, Mali and Sudan (Cotula *et al.,* 2009). Indeed, this extremely recent phenomenon concerns agricultural deficiencies, like water shortages, or the total dependency on food imports, which are not able to meet the rapidly growing domestic demands (Allouche, 2011). The main driver of this business is the will of becoming food secured at country level, considering the higher and higher level of price foodstuffs, but also energy security, meant as biofuels production. Thus, the land is considered a new safe investment opportunity (Kugelman and Levenstein, 2009; De Castro, 2012).

Research on land tenure, like the one of Platteau (1992) suggested that the most apparent qualitative linkage between land tenure and food security, is one of the key point in tenure

security. In fact, the increased security of tenure in productive resources enables more efficient and profitable agricultural production, and hence, greater access to food via both own production and trade. There is also the presence of secondary linkages include access to common property resources for livestock production and non-agricultural livelihoods, fuel wood and other forest products (Maxwell and Wiebe, 1998).

Numerous researchers, who have written separately on both land tenure and food security or famine, have not specifically outlined direct positive linkages beyond the suggestion that improved access to land or increased security of tenure leads to enhanced agricultural productivity (Platteau, 1992). The implied policy question at the root of the land tenure/food security nexus concerns the positive linkage, that is, the extent to which increased access to land or tenure security will lead to increased access to food and increased food security (Maxwell and Wiebe, 1998). In any case, the conceptual understanding of food insecurity has gradually evolved over the past fifteen years to include, not only transitory problems of inadequate supply at the national level, but also, chronic problems of inadequate access and unequal distribution at the household level (Staatz *et al.,* 1990; Barret, 2010).

3.7.   Technology and Biotechnology

Technology and biotechnology are portrayed as the ideal solutions for reducing food scarcity; in fact they are evoked as a means with a double function: ensuring resource abundance and influencing environmental, social and health costs (Fedoroff *et al.,* 2010). This is an interest challenge: the recent explosive growth of biotechnology, because it has opened up enormous potential in the key areas of genomics, bioinformatics, transformation, molecular breeding, diagnostics and vaccine technology (Rosegrant and Cline, 2003).

Some authors like Mehta *et al.* (2007) hope for a new "blue revolution", namely, greater irrigation capacity in Africa on the one hand, and crop biotechnology on the other (Serageldin, 1999; Ejecta, 2010). Many experts think that modern biotechnology can offer a significant contribution to avoid the problem of food insecurity (Davis *et al.,* 2001; Tester and Langridge, 2010). Despite the fact that there is a widespread interest in alternative technologies, it is also possible to speak of crisis of innovation concerning extremely recent technologies or investments, which simply do not work as promised (Gleick, 2003; Thompson *et al.,* 2007).

Biotechnological research and development must result in improved yield potential and increased productivity. The FAO has recognized in its recent "Statement of Biotechnology"[6] (2000) (Northoff, 2000) that genetic engineering has the potential to increase production and productivity in agriculture, forestry and fisheries (BCFN, 2011). It could also lead to higher yields on marginal lands in countries that today cannot grow enough food to feed their people. Biotechnology has been suggested as a potential solution to the food security problems of developing countries (Davis *et al.,* 2001). However, IFPRI estimates that effective food demand can be met in the future with very slowly declining international prices if adequate investments in research and development, and irrigation are undertaken by national, international, private and public organizations. On the contrary, most experts expect modern biotechnology to offer significant contributions to the problem of food insecurity.

3.8.   Other determinants

3.8.1. *Population growth*

In estimating the trends of future food demands, The United Nations (2004) suggest some projections of the forthcoming population growth, with the 'medium fertility' assumption. Although they argue that the result of 1.8 children per adult female overestimates fertility in China which is more likely to be 1.5, global population growth is predicted to reach 9 billion in 2050 (Godfray *et al.,* 2010). But, there are some regional differences: for example, the European population is forecast to decline, but African's will double, China will peak in about 2030 and be overtaken by India around 2020. Thus, rapid population growth may also affect food security status in more than one way: firstly, it reduces per capita land availability and per capita food availability; secondly, it affects environmental degradation reducing agricultural productivity; then, it impacts also on the spread of diseases influencing labor productivity and incomes (Shapouri and Rosen, 1999; Maxwell and Slater, 2003; United Nations, 2010).

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[6]The statement was published in March 2000 on the occasion of the "Codex Alimentarius Ad Hoc Intergovernmental Task Force on Foods Derived from Biotechnology" meeting in Japan.

3.8.2. *Property rights and access to credit*

In many African countries, the problem of land tenure involved changes in property rights in order to induce better land conservation practices and higher productivity. Under these circumstances, there was a gradual and endogenous process of individualization of land which had been communal, and the appearance of new land markets where people can buy and sell land in a tenure system, that previously prohibited land alienation (Maxwell and Wiebe, 1998). This phenomenon is known as the commercialization of agriculture and it is supported by the theory in land economics which suggests that the increase in tenure security stimulates productivity, greater access to and demand for credit and investment, conflicts' reduction over ownership (Barrows and Roth 1990; Platteau, 1992).

But, Migot-Adholla *et al.* (1991) in a study that included Ghana, Kenya, and Rwanda, noted that where the land under customary tenure is usually neither registered nor tradable, there is no relationship between cross-sectional variations in land rights and productivity. This is the case of SSA countries where the ownership of land is not sufficient to increase access to formal credit. So that, the suggested linkage relationship between the security of land tenure and food security also involves access to credit and increased investment.

As for this latest issue, cash transfer schemes have gained popularity throughout Latin America, but in many African countries are just emerging, like in Malawi, where Miller *et al.* (2011) conducted a deep analysis. Specifically, the Malawi Social Cash Transfer Scheme was launched in 2006 to directly improve the level of food security providing cash transfers to the country's most indigent households. But, if in Latin American countries there is evidence that these types of programs have a benefit impact on food security indicators, there is no clear result from African poor countries.

On the other hand, Diagne (1998) took into consideration the estimated marginal effects of the amount of money which a member of a credit program receives, as a measure of the impact of access to credit on household welfare. So, the main finding is that access to formal credit improves the household annual income, by enabling the family members to reduce their loans from informal sources. Nevertheless, this influence is extremely small and it does not influence per capita incomes or nutritional status of credit program members. In fact, in this specific situation, the major constraints are the land scarcity and the unfavorable terms of trade for the smallholders' farm products. The first way through which these populations could escape

from the situation of hunger and malnourishment should be a more free access to credit for poor rural households, engaging them in more profitable farm and nonfarm activities.

3.8.3. *Mass Media*

Policy agenda and people's opinions are extremely influenced by mass media, because they communicate events or shocks, transmitting emotions, invoking public responses and inducing policy-makers and governments to act. Indeed, during the 2008 dramatic crisis, the presence of mass media offered challenges and opportunities for NGOs and experts, to capture public opinion, signaling the situation of social distress in which many people in developing countries live (Swinnen and Squicciarini, 2012).

However, the impact of all these factors on households' food security status should be deeper analyzed in order to better understand the possible pathways through which to cope with shocks and crisis. In fact, drastic changes in the socio-economic and natural environment, such as periods of drought or conflicts, can alter the production strategies with potential consequences on food household access. But, the main problem of how to comprehend the relative importance of any of these pathways varies significantly across households, locations, and over time (Riely *et al.,* 1999). This issue is known as external validity and it assumes great importance especially in case of surveys and questionnaires about the households' food security level. In conclusion, there is the need for a clear debate about the complex and dynamic problem of food (in)security, considering global developments, policies affecting food security and socio-economic changes among the rich and the poor (Swinnen and Squicciarini, 2012).

4. Empirical approach: the Synthetic Control Method (SCM)

In the analysis of the possible impact of the food security determinants on the level of malnutrition, we analyzed different approaches, suggested from the literature. A few of them, point to a relationship, both among the trade liberalization and the process of democratization, and the state of food insecurity in a country (Matthews, 2011; 2012). But, it is extremely challenging to prove empirically these results. In fact, a considerable complication lies in the well-known statistical endogeneity between the causal factors of undernourishment and growth. In this context, Rutten *et al.* (2013) carried out a series of simulations in the interest of stylizing the effects of different types of trade barriers on the global level of food security. Among the very impressive results, their political recommendations clearly show that poor net importing countries, which usually are located in Africa, can take advantages from a decrease of the import tariff barriers. Moreover, a WTO-led general forum should be convened with the aim of diminishing the use of trade policy measures as a response to the rise of world food prices.

Recent empirical results examined by researchers conclude that the standard OLS regression lacks of sufficient precision, for a variety of reasons. This is why, borrowing the method developed by Abadie and Gardeazabal (2003) we intend to use a new approach to study the possible impact of economic and political liberalizations on country food insecurity and malnutrition. In particular, we apply a recent econometric technique, the synthetic control methods (SCM), which allows us to compare different case studies. As suggested by Billmeier and Nannicini (2013), it can be viewed as a 'third way' between the hardly generalizable analysis of individual country situations, and the standard cross-country regressions. One of the first empirical implementation of the SCM methods proposed by Abadie and Gardeazabal (2003), is the one that investigated the effect of California's tobacco control program of Abadie *et al.* (2010). These authors demonstrated that, after the introduction of a restrictive law called Proposition 99, the tobacco consumption precipitated in the analyzed American states, rather than the relative synthetic control region.

As a matter of fact, the investigation of case studies is usually developed when a political or social intervention need to be enquired, item by item. In fact, the reason why this technique is often requested, is its feasibility to detect the impacts of a policy measure on a specific outcome of interest. It can be adopted only when it is possible to compare units which had been treated and units which had not been exposed to be intervention considered. This systematic framework

allows the SCM to be used in comparative case studies, examining more precisely quantitative inference in small-comparative studies, but without excluding the implementation of qualitative approaches (Abadie *et al.,* 2012).

The first application of this methodology in the field of food security, has been presented by d'Agostino *et al.* (2013), but it was mainly focused on social protection programs in Sub-Saharan Africa. Especially, what was explored was the linkages between food security and cash transfer programs, introduced in 22 countries, starting from the beginning of the nineties, for ten years. The donor pool was made up of 26 countries. The SCM was applied to measure with comparisons the trajectory of the index of food security after the intervention. Results and comments will be more closely analyzed at the end of this chapter, in order to better enlighten the advantages of the SCM applied to malnutrition dynamics.

4.1.   The theory of SCM

The central idea underlying the SCM lies in the fact that a country, characterized by an event like the trade openness, can be compared with similar states which, on the contrary, have remained less accessible from a commercial point of view. The first study that implemented this new approach, was the one of Abadie and Gardeazabal (2003), in which they investigated if a conflict, such as the one occurred in the Basque Country, had affected the economic performances of that area. In fact, even if the evidences provided by the literature are not completely satisfactory, it is very well known that political instability tends to favor negative effects on economic welfare (Barro, 1991; Mauro, 1995; Alesina *et al.,* 1996).

Abadie *et al.* (2012) describe very precisely how a synthetic comparison unit has to be built. Firstly, hypothesize that the object of the study is a sample of $J + 1$ aggregate units, such as countries, indexed by j, and that, among them, it is possible to identify the unit $j = 1$ as the case of interest. So that, the $j = 1$ can be named as the "**treated unit**", the one exposed to the event or the intervention of interest. On the other hand, units from $j = 2$ to $j = J + 1$ are the potential units of comparison and constitute the "**donor pool**", that is, a reservoir of potential comparison units. Motivated by these considerations, the pool used as a comparison, need to approximate the counterfactual of the case of study, but without the intervention. What is extremely important is that the control units must show outcomes that are thought to be driven

by the same structural process, as the unit representing the case of intervention, but that were not subject to structural shocks to the outcome variable during the sample period.

Saia (2012) implemented the effect of the adoption of a unique currency in the Euro area; specifically, he investigated the UK's decision not to join the Euro on trade, and highlighted the crucial importance of the choice of the counterfactual, using the SCM, which was designed to build up a counterfactual in absence of the treatment. In this way, the technique of the selection of the comparison units is fundamental, in order to remove ambiguity during this process. Likewise, the SCM takes into consideration the existence of time-varying unobserved factors. Just to briefly sum up all the aspects which were already treated in the previous studies, we should mention that the SCM was documented as a robust and powerful tool in comparative studies, where the unit of interest were regions, like in the case of terrorism in the Basque Countries (Abadie and Gardeazabal, 2003) or countries, such as in the other paper of Abadie *et al.* 2010, which analyzed the anti-tobacco policy. Besides, Lee (2011) studied the inflation targeting using the SCM, whereas Nannicini and Billmeier (2010) analyzed the economic liberalization (Billmeier and Nannicini, 2013; Saia, 2012).

One of the reasons why the synthetic method was developed, is that most of the empirical literature deals with the analysis on economic indicators of political instability. But, the dilemma of these studies is the possible endogenenity between political conflicts, which can determine governmental instability, and economic indicators, among different countries. This problematic condition, that could be interpreted both as a cause and an effect of fluctuation in economic outcomes, can be corrected using the instrumental variable techniques. All the same, the validity of this approach could be often questioned (Abadie and Gardeazabal, 2003). Besides, other weakness of the strategy mentioned above, is the possible heterogeneity which characterized the country-specific situations.

Particularly, the interpretation of the obtained results can be really difficult and does not have a general validity. In addition, it was exactly to deal with the barrier of these procedures that a new inferential method was required, and it is worthwhile to point out that its main advantage lies in the ability to verify the significance of the estimates; in fact, it can be applied to situations where the traditional regression methods cannot be implemented.

They usually include policy and social interventions which take place at macro or aggregate level, but affecting a small number of units and individuals (Abadie *et al.,* 2010). To estimate the supposed impacts of these scenarios, comparative case studies are often applied,

taking into account some specific variables, like the mortality rates, the changing in per capita income etc., both for the unit affected by the intervention of interest and for the unaffected units. The central feature of these types of studies is that the units of analysis are usually aggregate entities, like countries or regions, for which appropriate and specific comparisons often do not exist.

The theory underlying the SCM is based on the observation that, if the individual's objects of the examination are only a few and can be considered as aggregate entities, a combination of comparison units can be more useful than any single comparison unit alone, in order to uniquely segment the characteristics of the units representing the case of interest. For this reason, the unit of comparison adopted, usually is a (convex) weighted average of all potential comparison units that best resembles the characteristics of the case of interest.

Motivated by these considerations, it is possible to distinguish the advantages of the SCM not only towards regression and comparative case studies, but also in respect of their use for statistical inference. Relatively to the first technique, the use of control units as a comparison precludes the type of extrapolation typical of regression results. From another point of view, it is possible to study the regression estimator as a weighted average of the outcomes of comparison units, whose sum is equal to one. As well as in comparative studies and in contrast with the regression analysis, the SCM implies that the contribution of each comparison unit to the counterfactual of interest is explicated. This allows the utilization of both quantitative and qualitative techniques to investigate the similarities and differences between the units representing the case of interest, and the synthetic control. On the other hand, in large sample regression-based studies, a more focused description is allowed and consequently the analysis of the similarities and differences between the case of interest and the comparison unit, helps avoid extrapolation biases (Abadie *et al.,* 2012).

It may be considered that, constructing a synthetic comparison, as a linear combination of the untreated units with coefficients that sum to one, may appear unusual. Nevertheless, the regression-based approach also uses the same methodology. Differently from the SCM, the regression approach does not limit the coefficients of the linear combination that define the comparison unit to be between zero and one, therefore allowing extrapolation outside the support of the data. Despite that, regression weights are unrestricted and may assume negative or values greater than one. As a result, estimates of counterfactuals, based on linear regression, may extrapolate beyond the support of comparison units. Even if the characteristics of the case of

interest cannot be approximated using a weighted average of the characteristics of the potential controls, the regression weights are extrapolated to produce a perfect fit (Abadie *et al.,* 2012).

Another point that can be criticized is the role of statistical inference. In fact, in comparative case studies it is difficult to implement it, for more than one reason: firstly, because of the small sample nature of the data, followed by , the absence of randomization and lastly because probabilistic sampling is not employed to select sample units. These limitations restrict the possibilities of application of traditional approaches to statistical inference.

However, by arranging the process of estimating the counterfactual of interest, the SCM allows researchers to carry on a wide array of "**placebo studies**", that provide the building blocks for an alternative mode of qualitative and quantitative inference. This alternative strategy is based on the hypothesis that the confidence that a particular synthetic control estimate reflects the impact of the intervention of interest, would be absolutely undermined if the obtained estimated effects of similar, or even greater, magnitudes occurred in cases where the treatment did not take place.

It is possible to identify two ways in which the "placebo tests" can be conducted:

1. the first strategy about how to approach the placebo studies is to reassign the intervention to units like case countries, not directly exposed to the intervention. Here, the assumption is: the confidence that a sizeable synthetic control estimate reflects the effect of the intervention can be neutralized in similar or larger estimates. This result would arise when the treatment is artificially reassigned in the dataset to units, not directly exposed to the intervention. A example of this idea consists in applying the SCM to estimate placebo effects for every potential control unit in the donor pool, in order to create a distribution of placebo effects, against which it is possible to evaluate the effect estimated for the unit that represents the case of interest. The supposition that a large synthetic control estimate reflects the effect of the treatment, would be severely weakened if the magnitude of the estimated effect fell well inside the distribution of placebo effects. As well as, borrowing the strategy of the traditional statistical inference, it is possible to compare the quantitative distribution of placebo effects and the synthetic control estimate, using the *p-values*. In fact, it can be helpful in estimating the effect of the intervention for each unit of the sample.

2.   Then, the "**in-time placebos**", which can be described as a type of falsification exercises. Suppose, for example, that the SCM estimates a sizeable effect of a certain intervention of interest, and that the validity of its result would completely disappear if the SCM also estimates large effects, and when applied to periods in which the intervention did not occur. The feasibility of these experiments is robust especially when the availability of the data is sufficient in terms of number of time periods, when no structural shocks to the variable of interest occurred (Abadie and Gardeazabal, 2003; Abadie *et al*., 2010).

To illustrate the main characteristics and the goals of the SCM, Abadie *et al*. (2012) proposed an application regarding the economic impact of the 1990 German reunification on per capita GDP in West Germany. So, to better explain the mechanism of creation of the placebo tests analyzed in this paragraph, it can be constructive to follow the same approach. Specifically, their sample covers the period starting from 1960, providing a pre-intervention period of 30 years, before the year of the reunification. Generally speaking, this event can be considered one of the most significant political events in post-war European history. As reported by Abadie et al. (2012), Lipschitz and McDonald (1990) estimated that the effect per capita GDP in West Germany was about three times higher than in East Germany, at the time of the reunion. This consistent income disparity of these two separated states, called for political and economic adjustments of unprecedented complexity and scale. Thus, this event provides an excellent case study to examine the economic consequences of political integration.

In this context, it was necessary to construct a 'synthetic' West Germany as a convex combination of other advanced industrialized economies, chosen to resemble the values of economic growth predictors for West Germany, prior to the intervention, which in the present case correspond to the reunification. The intention of this 'synthetic' West Germany is to reproduce the (counterfactual) per capita GDP trend, that the 'real' West Germany would have experienced in the absence of the 1990 reunification. The counterfactual is constructed as a weighted average of potential control countries in the donor pool, which is represented by a sample of 16 OECD member countries, that are commonly used in the comparative political economy literature about advanced industrialized countries. To sum up, the estimation of the effect of the reunification was achieved by matching the actual (with reunification) and counterfactual (without reunification) trends, in per capita GDP for West Germany.

Besides, this enables to test whether the SCM can show large estimated effects when applied to time periods earlier than the reunification; on the contrary, if the estimated effects are found to have similar, or even larger, magnitude than the one estimated for the 1990 reunification, the confidence that the effect estimated for the 1990 reunification is attributable to reunification itself, would greatly diminish. This would mainly be influenced by the fact that in the 1960-1990 period, Germany did not experience any structural economic shock, of such a magnitude that could have potentially matched the reunion of East and West Germany.

In this particular case, the "in-time" placebo tests would suggest that the synthetic controls do not supply a good predictor of the trajectory of the outcome in West Germany, in periods when the reunification did not occur. Conversely, the effective outcome found by the application of Abadie *et al.* (2012) demonstrated that the 1990 German reunification had a very large effect, but no effect at all when they artificially reassign the reunification period in the data to a time period before the year of reunion.

Abadie *et al.* (2012) explained the construction of a synthetic version of West Germany in detail. Especially, the synthetic 'country' was designed with weights (v_m) selected in order to reproduce in the best way possible the predictors of per capita GDP in West Germany in the pre-reunification period. Then, the cross-validation technique was implemented to choose v_m. For this reason, the years from 1971-80 were divided and denominated training period, and the period from 1981-90, became the validation period; overall, the time from the beginning of the seventies to the late eighties, is called pre-treatment time. Subsequently, using predictors measured in the training period, the v_m weights were selected so that the resulting synthetic control can attenuate the root mean square prediction error (RMSPE) over the validation period. Moreover, the set of v_m weights, measured in 1981-90, was adopted to estimate a synthetic control for West Germany. This technique, intuitively, allows to choose the weights in order to reduce the out-of-sample prediction errors.

Therefore, one main goal of this approach is to try to evaluate the influence and the effect of the German reunification on per capita GDP, in West Germany; it is calculated as the difference in per capita GDP levels between West Germany and its synthetic counterpart in the years following the reunification. Ultimately, a series of robustness checks and placebo studies were implemented. On the other hand, the synthetic control method contributes to develop a quantitative tool, to select or validate comparison units. The difference between the actual West

Germany and its synthetic version, provides the effect of the German reunification on per capita GDP in West Germany.

Regarding the placebo studies, they occupied a specific role to figure out the credibility of the obtained results. During this step what is called the event of interest is the German reunification, which is reassigned in the data set to a year different than 1990 and countries different than West Germany. Firstly, the reunification effect for West Germany was compared to a placebo effect, obtained after reassigning in the data the German reunification, 15 years earlier the period when the reunification actually occurred, which was established as the middle of the pre-treatment period in the year 1975. As a consequence, the evolution of the level of per capita GDP between 1960-1975 in the actual West Germany, was approximately reproduced by the synthetic West Germany. Besides, its trajectories both in West Germany and in its synthetic counterpart do not diverge considerably, from 1975 to 1990. However, the 1975 placebo reunification had no observable effect, contrary to the actual 1990 German reunification.

On the other hand, it is possible to proceed along a different way. The placebo tests can be also conducted, artificially reassigning in the dataset the event of interest to a comparison unit; in the present case, is the German reunification. Hence, it is possible to obtain synthetic control estimates also for that country in which the event of interest was not observed; in this way, it is possible to apply this approach to each country in the donor pool. This permitted to compare the estimated effect of the German reunification on West Germany, to the distribution of placebo effects obtained for other countries (Abadie *et al.,* 2012).

In spite of a long series of benefits, this type of research is frequently restricted by two principal complications, so that its empirical implication is extremely difficult.

1. Firstly, the identification of the comparison units is typically ambiguous, mainly due to the fact that they are selected on the basis of subjective measures of affinity between treated and untreated units.
2. Secondly, comparative case study usually makes use of disaggregated data; accordingly, the traditional inferential techniques are implemented to estimate the level of uncertainty about the aggregate values of an entire population. Besides, this procedure tends to shorten the researchers' discretion in the selection of the characteristics of the comparison control units, which must be very similar to affected and unaffected individuals. In addition, the implementation of the method allows researchers to make a

decision about the study design, without distinguishing in advance, the way in which those purposes will influence the outcomes of the analysis (Abadie *et al.,* 2010).

What is more, it was illustrated by Abadie *et al.* (2012) that the main concern about quantitative inference in comparative studies, does not derive from the small-sample nature of the data, but from the absence of an explicit mechanism that determines how comparison units are selected. In contrast, the SCM carefully specifies how the units of observation are selected, for the comparison group.

But, there is another reason why the SCM is considered a valid alternative to the other approaches mentioned above. In fact, it is easier to observe a combination of units or individuals, which can better explain the comparison, than an analysis focused only on single treated or untreated unit (Abadie *et al.,* 2010). Similarly as with the matching estimators, the SCM forces the researcher to demonstrate the correspondence between the region exposed to the policy of interest and its synthetic counterpart; it is the weighted average of regions chosen from the donor pool which is relied on.

4.2.   Methodology of SCM

It is notable that another meaningful characteristic of the method which is being analyzed, is the transparency and the clearness of the results. To be more precise, the total weights of the predictors must be restricted to be positive and equal to one; thus, the SCM guarantees the conclusions' precision (Abadie *et al.,* 2010). For that purpose the specific contribution of each control component on the counterfactual of interest, can be identified. Moreover, the element of similarity between the treated and untreated units can be extracted and highlighted, especially considering the pretreatment outcomes and the expected post-treatment outcomes.

Briefly, the main difficulty in the empirical implementation of comparative case studies is the inferential challenge and the ambiguity about the choice of valid control groups. For this reason, the method developed by Abadie and Gardeazabal (2003) can been seen as a way to combine both the quantitative and the qualitative aspects of the comparative politics. The present model can be described as an extension of the traditional linear panel data method; but, as already mentioned above, the SCM allows to observe the variation with time of the significance

of unobserved variables, on the final results. The first time in which Abadie and Gardeazabal (2003) proposed the implementation of the novel approach, they followed a two steps strategy.

1. Firstly, it was necessary to identify other Spanish regions, which could be used as a component of the 'synthetic' control region. They should have reflected the most significant economic characteristics of the Basque Country, before the onset of the terroristic rebellion, in the late 1960's. The approach allows to compare the consequent evolution of the so called 'counterfactual' Basque Country characterized by the absence of the terroristic attacks, to the real economic situation in the same territories. In this specific context, it was found that the income per capita documented after the beginning of the instability, decremented about 10%, confronted with the counterfactual. To be more precise, an analytic discussion about the first step of the method is inevitable; so that, it can be helpful to divide it into two parts:

    - above all, it was conceptualized - the 'synthetic' Basque Country, weighting the average of other similar Spanish regions, - was characterized by the absence of terrorist attacks; then, it was used as a basis for a comparability analysis, versus the situation in the considered territory. The aim was to estimate which would have been the per capita GDP in the Basque Country if the rebellion would not have been occurred. This counterfactual indicator is calculated as the per capita GDP of the synthetic Basque Country. Broadly speaking, the impact that the civil war had on the economy can be carried out by examining the relationship, on the one side between the synthetic indicator of growth and the real one, and the difference of the two of them, and the frequency of terroristic activity in the same period. In addition, it was clearly demonstrated that, at the peak of the rebellion, the value of the indicator of economic performances decreased considerably. In fact, variation in the per capita GDP gap are related to a relative intensification of the aggressions.

    - At this point of the research, the question was to understand if, the difference of 10% between the synthetic and the real GDP per capita was really generated by the effects of the civil war, or it was due to some weakness of the methodology.

To address this doubt, a 'placebo study' was required. To this end was chosen a region, Catalonia, with no terroristic activity, and it was compared to the economic evolution of the 'synthetic' sample. The decision to take into consideration the Catalonia area was established because it was the region with the largest weight in the synthetic control. In this way, it could be easily found if the differences in growth, observed in the Basque Country, might have been induced by factors other than the riots. The obtained results suggested an underestimation of the economic performances of the Basque Country, during the last decade of the twentieth century. More precisely, there are no evidences in the literature that the entrepreneurs registered a diminution of their profits, as a result of the conflicts. But, it is also true that, the beginning of the war may have redirected investments and transactions to other Spanish territories, generating an expansion of the gap.

2. The second step, points out the fact that the unilateral truce which was proclaimed by ETA in September 1998, can stand for a natural experiment to evaluate the adverse effects of the conflict, in particular, to measure the potential impacts of the civil war on the market value of a sample of Basque-firms and foreign firms. The application in the paper of Abadie and Gardeazabal (2003) verified that, immediately after the truce became credible, the stocks of non-Basque enterprises were more penalized than the Basque enterprises. However, at the end of the cease-fire, the latest data revealed a negative performance comparatively to the non-Basque.

A critique that can be advanced is that the synthetic control unit is not perfectly able to recreate the characteristics of the Spanish region objectively by the analysis, before the onset of the terroristic events. Thus, the GDP difference may have been caused by differences in growth predictors between the Basque Country and the synthetic unit before terrorism, or by other factors, not captured by the data used by Abadie and Gardeazabal (2003).

Although this methodology is more flexible and transparent than others, there is a limitation regarding the inferential techniques. This is mainly due to the fact that the number of observations in the control pool and the number of periods covered by the sample are usually quite small in comparative case studies, like this. This is why, following the suggestions of

Abadie and Garzeabal (2003; 2010), we implemented the placebo tests, based on permutation techniques. This means that the synthetic algorithm was sequentially applied to every country in the pool of potential controls and then used to compare the placebo with the baseline results. So that, the second part of the present chapter is focused on a more detailed analysis about the episodes of trade liberalization; in fact, the aim of the placebo tests is to test the robustness of the obtained results. Specifically, the placebo tests can be extremely important for those countries where the effects of a trade openness appear to be more evident.

This type of analysis is very useful especially when, after the estimations of the U5MR, the results revealed a significant impact of trade openness. For these countries the placebo tests tend to confirm and ensure the accuracy and the robustness of the estimations. On the contrary, in the other geographical areas the research highlighted the statistical fragility of the results.

4.3.   The implementation of the model

Abadie *et al.* (2010) proposed a model which can be used to better explain the SCM, implemented in comparative case study analysis. The assumption is that it is necessary to observe $J + 1$ regions and that only the first region is exposed to the intervention of interest, like a specific policy, then we have J remaining regions as potential controls. This essential approach was adopted from the statistical matching literature, so that it is possible to refer to the set of potential controls as the "donor pool". Furthermore, without loss of generality and in order to simplify the notation, the first region examined is assumed to be uninterruptedly exposed to the policy of interest, after some initial intervention period.

Let Y_{it}^N be the outcome that would be observed for region *i* at time *t*, in the absence of the policy intervention, for units $I = 1, ..., J+1$ and time periods $t = 1, ..., T$. Let T_0 be the number of pre-intervention periods, with $1 \leq T_0 < T$. Let Y_{it}^I be the outcome that would be observed for unit *i* at time *t*, if unit *i* is exposed to the intervention, in periods $T_0 + 1$ to T. The assumption is that the treatment has no effect on the outcome, before the implementation period; so for $t \in \{1, ..., T_0\}$ and all $i \in \{1, ..., N\}$, it can be obtained $Y_{it}^I = Y_{it}^N$. In practice, interventions may have an impact prior to their implementation. In those cases, T_0 could be redefined to be the first period in which the outcome may possibly influence the intervention. Thus, it is possible to hypothesize that outcomes of the untreated units are not affected by the intervention implemented in the treated unit. Let $\alpha_{it} = Y_{it}^I - Y_{it}^N$ be the effect of the intervention for unit *i* at

time t, and let D_{it} be a dummy indicator that is equal to one, if i is treated at time t, and valued zero otherwise.

The observed outcome for unit i at time t is: $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$. The object of the estimation is $\alpha_{1\,T_0+1}, \ldots, \alpha_{1T}$; for $t > T_0$, α_{1t} can be calculated as follow: $Y_{it}^I - Y_{it}^N = Y_{1t} - Y_{it}^N$. It is necessary to clarify that Y_{it}^I is known; so, to estimate α_{1T}, only Y_{it}^N needs to be estimated. So that, we can rewrite the model as:

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it}.$$

In this context, it is possible to identified: δ_t as an unknown common factor, constant across units; Z_i is a (r x 1) vector of observed covariates, which are not influenced by the policy intervention; θ_t and λ_t are vectors of unknown parameters the first, and of unobserved common factors, the second. Lastly, μ_i is a vector of unknown factor loadings, and ε_{it} are unobserved transitory shocks at the region level. Furthermore, the SCM requires a vector of weights, called W, equal to $(w_2, \ldots, w_{J+1})'$; thus, $w_j \geq 0$ for $j = 2, \ldots, J+1$ and $w_2 + \cdots + w_{J+1} = 1$. It is important to underline that, each single value undertaken by the vector W represents a potential synthetic control, that is, a particular weighted average of control regions.

Besides, the value of the outcome variable for each synthetic control determined by the vector of weights, W, is:

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt}$$

W is observed for T periods, $t = 1, \ldots, T$ for the region affected by the intervention, Y_{1t}, and the unaffected regions, Y_{jt}, where $j = 2, \ldots, J+1$. Moreover, the vector $K = (k_1, \ldots, k_{T_0})'$ define a linear combination of pre-intervention outcomes: $Y_i^K = \sum_{s=1}^{T_0} k_s Y_{is}$.

As for the inference aspect of the model, it is appropriate to note that, using the comparative case techniques, the measure of the standard errors commonly reported in this type of regression, estimate uncertainty about aggregate data. In particular, if aggregate data are used for estimation, in most cases there will still remain a certain level of uncertainty referred to the value of the parameters of interest. This is due to the fact that some incertitude about the value of

the estimated parameters, comes from lack of knowledge of aggregate data. To be more precise, it can be derived from ignorance about the ability of the control group to reproduce the situation in which the treated unit would have evolved in the absence of the treatment.

The SC estimator of the effect of the treatment is calculated as the result of the comparison of post-intervention outcomes, between the treated unit, which is exposed to the intervention, and the synthetic control, which is, obviously, not exposed to the intervention. Thus, for a post-intervention period $t \ (with \ t \ \geq \ T_0)$, the SC estimator of the effect of the treatment is given by the comparison between the outcome of the treated unit and the outcome of the SC at that period:

$$Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}$$

The matching variables in X_0 and X_1 represent the predictors of post-intervention outcomes, which are themselves not affected by the intervention. A few critics could point out that one limitation of the method can be situated in the presence of unmeasured and unknown factors, affecting the outcome variables, as well as heterogeneity, in the effect of observed and unobserved factors. In spite of that, Abadie *et al.* (2010) demonstrated that, a solution to this problem can be found if the number of pre-intervention periods in the data is large; in this case, matching on pre-intervention outcomes helps controlling for the unobserved factors affecting the outcome of interest as well as for the heterogeneity of the effect of the observed and unobserved factors on the outcome of interest.

The intuition, which lies at the base of this method, is that only units that are similar to observed and unobserved determinants of the outcome variable, as well as in the effect of those determinants on the outcome variable, should produce similar trajectories of the outcome variable over extended periods of time. The central idea is that, at the moment in which it has been established that the treated unit representing the case of interest, and the SC unit have similar behavior over extended periods of time prior to the intervention, it can be inferred that the discrepancy in the outcome variable, following the intervention, can be interpreted as a result of the intervention itself.

To sum up, the advantages obtaining from the implementation of the SCM, derive from the overall consensus among political methodologists regarding the necessity to integrate and harmonize both qualitative and quantitative tools, for empirical research in political science (Abadie *et al.,* 2012). In fact, this methodology falls exactly between the two main approaches,

providing a very powerful tool. On the contrary, the SCM provides an efficient and structured way to select comparison units in quantitative comparative case studies, combining them together and the careful selection of cases that is done in qualitative analysis. Nevertheless, the method presented above, allows to guide the selection of comparison units in qualitative studies; moreover, by explicitly specifying the set of units that are used for comparison, it facilitates detailed qualitative analysis and comparison, between the case of interest and the set of comparison units selected by the method.

In conclusion, the underlying idea of the SC group approach is established on the notion that the construction of a composite or artificial control group is more similar to the treatment group in the pre-treatment period, than any single component of the control group would be on its own. This procedure offers a remarkable way of control groups selection for the study of the effects of interventions, happening at an aggregate level and modifying aggregate countries or geographical regions. Just as an example, Abadie and Gardeazabal (2003), in studying the economic impact of terrorism in the Basque Country, used a combination of two Spanish regions which can be comparable to them and mimic their economic growth, in the absence of terrorism. Likewise, Abadie *et al.* (2010) experimented with the method described above, in order to study the effect of the large-scale tobacco control program implemented in the American state of California, in 1988 (Lee, 2011).

4.4.   An application of the SCM on Social Programs in Sub-Saharan Africa

The almost unique application of the method described until now, on food security, is the one conducted by d'Agostino *et al.* (2013). Their research explored the linkages between food security and social protection in 48 Sub-Saharan African countries; specifically, the aim was focused on the evaluation of the impact of cash transfer programs introduced during the 1990s and 2000s, on the one hand, in obtaining adequate level of food security, on the other, by reducing the vulnerability of the poorest part of the population. This type of policy usually considers two different points of view: the first, called 'short-term' poverty, can be improved by providing guaranteed extra money to poor people; however, the cash transfer can be considered as a way to contribute to the reduction of 'long-term' poverty, providing a form of insurance against risks and allowing indigent individuals to invest in productive sectors. For example, most

of this money is normally devoted to improve the level of education, health and nutrition, thereby weakening the intergenerational transmission of poverty.

The originality of this investigation is the application of the SCM, to consider the trajectory of post-intervention food security index of economies modified by this program, versus countries which were not under the cash transfer programs. The results obtained at the end of this project of research, underline the fact that there are combined synergisms between cash transfer programs and the level of food security. Moreover in detail, it was discovered that if the cash transfer programs are associated with specific and definite nutrition goals, an improvement in the design of social protection interventions can be achieved. This analysis also recommends, from a political point of view, a more accurate coordination among these types of programs, which usually cope with short-term poverty by affording guaranteed extra money, and the national development strategies.

As for the characterization of the methodology and the data, it is possible to postulate with the definition of the independent variable, the prevalence of undernourishment, which can be defined as the proportion of the population who live in a condition of chronic poverty and undernutrition. This variable sums up different types of information related, on one side, to the distribution of calories in different countries, on the other to dietary energy supply, which mimics the measure of availability and access to food security. But, concerning the independent variables implemented as controls, the researchers highlighted the underlying importance of the access to improved water sources and sanitation facilities, the cereal import dependency ratio and the political stability or the absence of violence/terrorism.

So, given the parameters mentioned above, the object of the application was to examine a sample of countries which had experienced these kinds of policies, compared with the others, that were not treated. As mentioned previously, the main difficulty of the SCM is to find similar countries to the ones exposed to the intervention. So, the synthetic control, which can be defined as the weighted combination of potential control countries, was constructed, in order to approximate the fundamental features linked to food security of the treated country. In this way, it is possible to compare the outcome trend of the synthetic control: the situation in a country where the introduction of the cash transfer took place, is compared to a counterfactual situation in the absence of the treatment.

In the present case study, the criteria that were followed to choose the donor pool were twofold: the first is that the countries should have not experienced the cash transfer policies, and

secondly, it should have not experienced other types of policies that might have had direct effects on the level of food insecurity. Briefly analyzing the results, it emerges that two distinct types of cash transfer programs can be recognized in the Sub-Saharan Africa region. In particular, very similar programs have been implemented by the upper-middle income countries; on the contrary, the group of fragile and low-income states share policies with similarly parallel characteristics. Moreover, the explanation of these heterogeneous results can be found in the fact that, in high income countries, the cash transfer policies are viewed as an important part of a social security scheme; so that, the same countries can implement other policies which could affect the impact of cash transfer on food security.

5. Data

In the present study, the dataset covers a worldwide panel of 192 developed and developing economies, over the period 1960-2010. The aim is double: on the one hand, we tried to estimate the effect of trade openness, intended as trade liberalization, on food security; on the other, the effectiveness of a process of democratization, on the total level of starvation. We called these two reform episodes as "economic (or trade) liberalization" and as "political liberalization", respectively. As for the indicator of trade liberalization, use was made of the one firstly proposed by Sachs and Warner (1995), afterwards updated and revisited by Wacziarg and Welch (2003, 2008). Furthermore, the dataset comprehends numerous variables, such as socio-economic characteristics of a country, its level of productivity in agriculture, the per capita income, among the others. Clearly, there is a difference between the entire dataset and the one performed with the SCM. In point of fact, the selection of the nations was subjected to the variables availability in different years, for the different countries.

As a measure of food (in)security we decide to use the **under-five mortality rate** (per 1,000 live births), which means the probability – per 1,000 – that a newborn baby will die before reaching age five, if subject to current age-specific mortality rates. Hereafter, it will be named 'U5MR' for brevity. The variable summaries the estimation developed by the UN Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UN DESA Population Division) at www.childmortality.org. The database is extracted from the Catalog Sources World Development Indicators, of World Bank[7]. U5MR will represent the output variable of interest (or the dependent variable) in the following econometric exercise.

Starting from the revision of the literature already cited in the previous chapters, we have selected the main determinants of food (in)security. Obviously, their coverage was the main limitation and obstacle for their implementation in the empirical analysis. In fact, other important factors such as the access to potable water, or the level of AIDS infection, are not applicable neither to long period of time, nor to all the countries included in our dataset.[8] So that, what follows is a list of the most fundamental control variables, also called covariates:

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[7] World Development Indicators (World Bank).
[8] For that reason our identification strategy should be robust to the standard problem of omitted (unobservable) variables bias.

- the **Gross Domestic Product** (GDP) per capita, extracted from Alan Heston, Robert Summers and Bettina Aten (2012). Penn World Table (PWT) Version 7.1. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania URL, Nov 2012[9]. As for this variable, we draw out both the GDP in level and in growth, to include all of the changes in market prices that have occurred during the considered years, due to inflation or deflation. The PWT are one of the most famous source for real national accounts data (expressed in a common currency - U.S. dollars), Robert Summers and Alan Heston of the University of Pennsylvania, closely in collaboration with Irving Kravis organized these incredible amount of data. They currently cover the valuation of the real GDP, capital, productivity, employment and population of 167 countries from 1950 to 2011, which allows researchers to have free accessibility to a larger amount of information compared to other databases, i.e. World Bank's World Development Indicators.

- The **polity 2** (polity2) indicator, which was extracted from the Polity IV Project: Political Regime Characteristics and Transitions, 1800-2012. This is an annual, cross-national, time-series and polity-case formats which codes democratic and autocratic "patterns of authority" and regime changes in all independent countries with total population greater than 500,000, in 2012. The countries covered were 167 in 2012[10]. The goal of this project is the *"research of coding the authority characteristics of states in the world system for purposes of comparative, quantitative analysis"*. The approach follows the theoretical hypothesis of examining, complementary, elements of both democratic and autocratic regimes, in governing institutions, rather than discreet and mutually exclusive forms of governance. This scheme provides a wide spectrum of regimes, from the so called, *fully institutionalized autocracies* − mixed, or *incoherent, authority regimes* − to *fully institutionalized democracies*. The polity 2 indicator, specifically, captures these variations through a 21-point scale: from the minimum level of -10 (hereditary monarchy) to the higher score of +10 (consolidated democracy). Another advantage of this indicator is its flexibility in being converted to three categories:

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[9] (http://pwt.econ.upenn.edu/).

[10] *Polity IV Project: Political Regime Characteristics and Transitions, 1800-2002*. Version. College Park, MD: Center for International Development and Conflict Management, University of Maryland. URL: http://www.cidcm.umd.edu/inscr/polity/index.htm.

1. autocracy: from -10 to -6;

2. anocracy (an unusual political term to explain a regime where public power is not empowered in public institutions, but spread among elite groups. These continue to have a status of competition with each one to another, for political influence): from -5 to +5;

3. democracy: from +6 to +10.

- As a measure of **economic liberalization** (openness_ww), following the research of Billmeier and Nannicini (2013), we use the binary indicator developed firstly by Sachs and Warner (1995), later extended by Wacziarg and Welch (2003; 2008). As mentioned in all these previous researches, a country can be classified as 'closed' or 'opened' (as reported in table 1 of the Appendix). Wacziarg and Welch (2003) support the notion that any other elemental indicator would be too simplistic to capture the complexities of trade policy. In fact, the dates of trade liberalization are able to catch and describe different aspects: episodes of discrete shifts in trade policy, the estimation of the within-country response of growth, investment and openness events.

- Extracted from the FAOSTAT database are the three variables: **food supply** – total – (kcal/per capita/day), **percentage of agricultural area** and **ratio of rural population over total population**, expressed as a percentage. What this division of the Food and Agricultural Organization provides is both time-series and cross sectional data, related to food and agriculture for at least 245 countries. The aim is the improvement and the dissemination of relevant and global information, available both for the researchers and the general public, to fight against global hunger and malnutrition. The data are free available, from 1961 to the latest update; nevertheless, there are series of previsions about the possible trends and tendencies of popular, among the others. The main domains where we selected the information are: 'Population' 'Resources' and 'Food Supply'.

- The level of **education**[11] is also a very important determinant of food (in)security. Specifically, we extract these type of material from the Barro, R. and Lee, J. W. April 2010. A New Data Set of Educational Attainment in the World, 1950-2010. NBER Working Paper No. 15902. As perfectly well explained in the presentation of the website, the total amount of data in available for 146 countries, disaggregated by sex and in 5-year

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[11] http://www.barrolee.com/

intervals from 1950 to 2010. The database also provides information regarding the adult population (which includes two groups of individuals: over age 15 and over age 25) by sex at seven levels of schooling— no formal education, incomplete primary, complete primary, lower secondary, upper secondary, incomplete tertiary, and complete tertiary. Other useful information available are the estimations of the average years of schooling at all levels – primary, secondary, and tertiary – for each country and for regions in the world. They are based on census/survey observations from consistent census data, disaggregated by age group.

6. Food security and Trade Liberalization

The role that trade may play in the evolution of the malnutrition level was firstly taken into account at the conference of Bretton Woods (1945), where it was proposed to set up an International Trade Organization. Consequent to this idea, the GATT was established (in 1947) with the mission to oversee the gradual lowering of many tariffs on imports of manufactured goods, by governments of developed countries. However, distortionary subsidies still remain high, and trade policies continue to influence agricultural and services markets of both developed and developing countries; this interferes with the efficient resource allocation, the economic growth of countries and poverty alleviation. The GATT was absorbed into the World Trade Organization (WTO) on 1 January 1995, but it was during the Uruguay Round (1986-1994) of multilateral trade negotiations that agreements about some trade liberalization plans were signed, stretching over the subsequent ten years. The complexity of the trade liberalization process reflects the involvement of least developing countries (LDCs), that started to introduce structural adjustment programs. As a consequence, the major part of the trade regimes of the countries mentioned above, now demonstrate more openness and they can be compared to the open trade regimes of high-income OECD countries (Bernini Carri, 2009; Paarlberg, 2010).

But, in the 1996 World Food Summit was set the goal of reduction by half the number of people who suffer from hunger and poverty, by 2015. This issue was also better specified during the WTO Doha Conference, held in November 2001, whose goal was the promotion of a new round of multilateral trade negotiations. As for the agricultural sector, Ministers agreed to grant a special and differential treatment for poor countries, in order to *"enable (them) to effectively take account of their development needs, including food security"* (FAO, 2003).

A two-component strategy to achieve national food security was suggested:

1. <u>food self-sufficiency</u> means the satisfaction of needs primarily through domestic supplies;
2. <u>food self-reliance</u> denotes the idea of maintaining a certain level of domestic production, in combination with the import of food stuffs, to reach the food needs of the population (Panagariya, 2002; FAO, 2003).

The very key point of the international debate revolves around the identification of the benefits and the risks of international trade to ensure food security. In any case, this debate is extremely ambiguous, because it is incredibly problematic to study the consequences of trade liberalization on the level of malnutrition. This situation is even more challenging if the analysis may be focused on single households or individuals (Bezuneh and Yijheyis, 2009).

As suggested by a large part of the literature, many developing countries decided to implement outward-oriented trade policy strategies, from the nineties. In fact, both World Bank and the International Monetary Fund promoted trade openness, because it was supposed to favor economic growth and development of poor economies. Specifically, poverty reduction and the increasing of food availability for local populations were supposed to raise. On the contrary, the conclusions of the econometric analysis of Bezuneh and Yijheyis (2009) revealed that, both in the medium and long run, food availability is not encouraged by policies of openness.

The process of liberalization, usually, is activated by a series of commercial measures, – i.e. the agreements among trade partners concerning the reduction or the gradual removal of tariffs, quotas, and other barriers (export subsidies and taxes or import and export licensing requirements). Typically, the main theoretical assertion in favor of trade openness is the one that claims that it obliges different countries to identify in which economic sectors they have a comparative advantage (Bezuneh and Yijheyis, 2009).

Generally speaking, free trade can be analyzed focusing on its impacts on the poverty issue, given that there are strict connections between poverty and under nutrition problems. At national level, the temptation of almost every national government is to intervene in markets, despite the fact that economic and social benefits were evidenced in reducing government subsidies and opening the economies. These actions, inevitably, provoke distortions in international commerce, which can be particularly harmful to the standard of living of the poorest people.

From a theoretical point of view, many economists have identified three main approaches in trade-development relationships:

1. the **"optimistic"** vision, that takes into account the fact that commerce has a favorable influence on growth rates, higher demand of goods, more efficient allocation in resources, economies of scale and agglomeration;

2. the main point of the **"pessimistic"** vision is that, strong asymmetries impact on very poor people. Specifically, the reduction of trade share for primary commodities has more severe effects on countries that produce these types of goods; generally, they are the developing countries. This "immisering trade theory" was very popular especially during the fifties and the sixties, when an intense debate began. It was mainly due to the way in which trade gains were distributed between developed countries, considered the "center" of the world economy, and developing countries, the "periphery";

3. the third theory, called **"intermediate"** suggests that markets may demonstrate both global net benefits but also consistent asymmetric spread effects (UNCTAD 2002; 2003; 2004). Generally speaking, a country as a whole may benefit from more free trade; however, it does not clarify the situation of winner and loser, within a country. So that, it means that this approach has some difficulty to evaluate whether and how much the different groups of people take advantage or are penalized from trade. Moreover, it is true that trade relations can not only play a determinant role on both the distribution of income, on different economic or social groups within a country, but also the gains between trading countries (Bernini Carri, 2009).

It is also possible to distinguish three main categories of a narrow range of gains of free trade, on the countries' economies, depending on with aspect is emphasized:

- trade can increase the total amount of goods and services available to the national population (<u>increased consumption argument</u>);
- trade makes available different goods and services, to the population (<u>diversification argument</u>);
- trade eases the stability in the supply and prices of goods and services (<u>stability argument</u>) (FAO, 2000; 2001).

6.1.   Openness to trade, growth and food security

A number of empirical economics studies support the thesis that openness to trade facilitates economic growth, which is also positive for food security and poverty reduction. Although pros and cons to more free international trade can be found, it also true that it is very difficult for a

country to experience a long period of fast and stable growth in a context of lack of trade openness and integration. On the contrary, not all 'open' countries are characterized by a successful level of GDP per capita (Magrini *et al.,* 2013).

In this context the World Bank released a series of Reports (2000; 2002; 2002a) that evidenced the central issue of whether or not globalization of markets reinforces poverty reduction; moreover, they confirm the hypothesis that this phenomenon has a double effect. One the one hand, a positive effect is observed where countries experienced a new form of market integration into the world economy; on the other hand, it can happen also that some countries can be more marginalized. However, all the documents and the studies agree on the fact that international trade and trade openness is vital for poverty minimization, in most of the developing countries. In spite of the fact that this link is neither simple nor automatic to identify and demonstrate, the results infer that the indispensable condition for reducing poverty levels is a positive export growth rate, even if it must not have to be seen as a guarantee of that (Bernini Carri, 2009).

One of the facts that can encourage the increment of the opportunities of access for underdeveloped countries to export goods to rich countries' markets, is the elimination of trade barriers. At the same time, this decision may damage the poorest countries, net food importers, as a result of higher prices of import agricultural commodities. Besides, this policy of tariffs suppression might induce a phenomenon of competition among developing countries as a consequence of different trade preferential treatment systems. What is more, if the increasing of these commodities has passes onto the domestic market, the major part of these impoverished populations could benefit from it. In fact, they usually live in rural areas and depend on food selling. They can be considered net sellers of food. Even in the case in which malnourished people are net food buyers, they could be favored by increasing prices, because the labor demand for them, also rises.

If we analyze more in detail the impacts of countries' trade openness on malnutrition levels, we should take into consideration their degree of vulnerability. In point of fact, if a country is characterized by a high rate of political vulnerability and under-nutrition, even a limited increase in the international commodities price level could have catastrophic consequences. Moreover, removing tariffs distortions, might show an adverse reaction: on one side, the income of rural household could be reduced, but on the other, urban families can take

advantage from lower food prices. So that, a few economists support the theory that agricultural trade liberalization is bad for poor households.

However, Runge *et al.* (2003) argued that another possible way to try to eradicate hunger and under-nutrition is to introduce innovative technologies in the agricultural sector, such as newly developed varieties of staple crops. Nevertheless, reports like FAO (2003) agree that recent quantitative simulations, which are based on econometric and statistical models, encourage the belief that tariff and agricultural subsidies can be viewed as the most important obstacle for the progress of the developing economies and, as a clear consequence, for the fight against poverty and malnutrition. What seems to be extremely very well-known is the fact that different trade policies have different implications on food security levels; this can distinctly recognized through the link between distribution of incomes and expenditures. This is the reason why, the legislation should comprehensively examine the potential effects of any change in the trade regime and its direct or indirect effect on: rural and urban incomes, employment, government revenues, commodity price volatility in the international market (Ayouz *et al.,* 2004).

Another interesting issue that Valdes and McCalla (1999) proposed and Panagariya (2002) studied was related to this research question: if we accept the idea that the world, globally speaking, wants to reach a sufficient level of food security, we have also to find how agricultural trade liberalization impacts developing countries' economic growth. Usually, the economic theory considers the search for benefits of simultaneous liberalization in several sectors, implementing a general-equilibrium model, even if extremely complex. This is the main reason why, the author of this scientific paper opted for a simpler model: the partial-equilibrium framework. The assumptions underlying this model are double: firstly, no liberalized sectors can be substituted to others. This implies that a numeraire good, not subject to any policy distortion, was applied in all the possible substitution processes. Secondly, developing countries are supposed not to have any power to influence the market. After this clarification, the study was divided into two main sections: the trade liberalization policies in OECD countries, and then in developing countries (Valdes and McCalla, 1999; Rodriguez and Rodrik; 1999; Panagariya, 2002).

1. OECD Economies

To begin with the first issue, three fundamental instruments were identified:

    a) domestic support measures;
    b) export subsidies;
    c) tariffs.

But, the critical issue that should be deeply investigated is whether or not economic growth in different countries increases or is reduced by the removal of the support. In fact, if the OECD countries would propose a tariffs reduction, it might globally increase the price of the commodity, subject to the contraction (Panagariya, 2002). This fact, could favor exporters, but hurt net food importers, leading to ambiguous effects on both the sides of the market. However, trade preferences confound the findings of the theoretical analysis; usually, the beneficiary countries of the tariff cuts expand their preference margin, but the profitability of their exports diminishes drastically. Although, the consequences of these instruments of trade policy should be considered one at a time, in the European agriculture policy they were applied simultaneously. Specifically, countries that are net importers of both food and agriculture may be damaged by advanced economies trade liberalization of both food and agriculture, because of price rises. On the contrary, USA, Southern America and Asian countries may benefit. Above all, there are assertions of multilateral institutions that argue that a more open market in rich countries, does not surely impact negatively on developing countries (Panagariya, 2002).

Notwithstanding, that the reduction or the removal of both agricultural protection measures and export subsidies may impact on the level of the efficiency of the agricultural sector, net gains for the least developed countries still remains questionable (Winters *et al.,* 2004). As mentioned above, starting from the post-war period, a progressive and gradual process of tariff reduction was launched. Especially the Kennedy Round of 1967 concluded with a general agreement about this topic. Simultaneously, the commercial growth of geographical areas less developed quickly increased (Romalis, 2006; Bouet, 2006; 2007).

Matthews (2011; 2012) in his research papers figured out that it was during the Uruguay Round Agreement on Agriculture (AoA), this was the first time when specific measures related to agricultural trade and distorting subsidies entered into force. It was in 1995 there were

negotiations for all the WTO member countries (Winters *et al.,* 2004). In consideration of this accord, a collective debate commenced, mainly related to the suitability of these trade measures to stimulate agricultural production and, thereby, food security (Anderson and Martin, 2005; Diaz-Bonilla and Ron, 2010; De Schutter, 2011).

Then, in 2001 the Doha Round Declaration at paragraph 3 asserts that one of its principal tasks was: *"committed to addressing the marginalization of least-developed countries in international trade"*. More recently, in 2004 the WTO General Council Decision declared that the undernourished Members of the organization *"must be able to pursue agricultural policies that are supportive of their development goals, poverty reduction strategies, food security and livelihood concerns"*. Ivanic and Martin (2006; 2008) highlighted a few bases 'development-focused politics' which should be employed by developing countries; their role is to ameliorate infrastructures, the education level, both property rights and the introduction of technology and innovation, for poverty alleviation (Matthews, 2011; 2012).

2.   Developing Countries

The type of countries, whose individual size can be considered 'small', usually benefit from their own liberalization, even if the adjustment costs may be slower than richer economies, because they primarily depend on the agricultural sector. Exactly for this reason, in the short-run a very few districts have the ability to absorb workers released by the new openness trade policy. From another point of view, poor countries tend to adopt fixed restrictions on export goods; but, as long as they are small, they do not improve the national welfare (Winters *et al.,* 2004). In this case, the policymakers should investigate which are the most significant sources of income of poor households, and enquire in which way trade openness would influence or impact both on them and on their real wage (Panagariya, 2002).

Another enchanting research – which deals with the potential trade restrictions that local governments may bring into play, to prevent volatility of international markets to impact on national food prices – is the one proposed by Magrini *et al.,* (2013). Especially during the last food price spikes national barriers were adopted with a twofold purpose. On the one hand, to contain the level of prices and their volatility; on the other, their impact on consumer's well-being and individual level of malnutrition. This last aspect is the one less studied; that is why the applied research of Magrini and colleagues, focused mainly on it. In fact, a broad review of the

literature in this topic enlightens the strong interrelation between trade policy reforms, poverty and vulnerability (Anderson *et al.,* 2013). Specifically, they implemented the Generalized Propensity Score Matching approach to test the inter connections between global distortions on agricultural trade on food security. To measure the level of price distortion they included the annual Nominal Rate of Assistance (NRA) by commodity; it was derived from a World Bank dataset, organized by Anderson and Nelgen (2012). As for the food security indicator, they followed the paper of Cafiero (2013) and decided to choose the food supply – expressed as kcal/day/pc – from the FAOSTAT database. As a result, the preliminary findings described in the draft of the paper demonstrate an unexpected but strong correlation between the NRA and food availability; more precisely, countries which tend to protect their home economies, perform worse than the others, with respect to food availability (Magrini *et al.,* 2013).

It is necessary to notice that a considerable body of the literature started to pay more attention to the study of the determinants of agricultural protectionism, from a political economy perspective (Olper, 2001; Anderson, 2010). In particular, it was demonstrated that agri-food importers countries usually register higher level of trade barriers, than poor countries. The former allocate less income per capita to foodstuffs; moreover, the farmers are a limited proportion of the population, very well organized to lobby for collective action in their favor. On the contrary, in the latter the industrial exerts a strong power in the policy making decision process. In this context, agriculture is taxed, and neither protected of subsidized as in OECD countries (Anderson, 2010). The usual measure of the level of the protectionism in agriculture is the Agricultural Nominal Rate of Assistance (NRA), derived from the World Bank dataset "Agricultural Distortions Database" (Anderson and Valenzuela, 2008). The Encyclopedia of World Economy defines the NRA as *"the simplest indicator of distortions to agricultural, calculated as the percentage by which a country's government policies have raised (or lowered if it is negative) gross returns to producers above (below) what they would be without the government's intervention"*.

However, Bezuneh and Yiheyis (2009) have collected a series of documents – such as the report of FAO (2003) – in which they classified two antithetic points of view. The arguments which sustain the issue that trade liberalization boosts food security are:

- the positive impact of economic growth on poverty reduction; as a consequence of this phenomenon, also the level of availability (and accessibility) of food may change, supporting the nutritional requirements;
- a potential fall of domestic food prices, due to the higher quantity of food available;
- a gradual stabilization of the variability of food supply; in fact, at national level, it might be compensated by the international supply of commodities;
- the earnings from the expansion of foreign export rate may activate augmentation in domestic food production.

On the other hand, a series of contradictory reasons were listed, as follow:

- the policymakers should take into account the readjustment of income distribution (normally, against the poor) which may occur due to the modification in the structure of production. Thus, the situation of food availability for low income families, can become worse and even more precarious;
- even the availability of staple commodities at cheaper prices, may provoke a loss of revenues for rural households, where the production of raw foodstuffs may be the only way of sustenance. This point was one of the essential components of the food policies strategies, requested by developing countries. In fact, the guarantee and the preservation of an adequate agricultural production is seen as the most vulnerable situation for rural households. Besides, lowering the protection in this economic sector, might negatively impact the poorest part of the populations, where both the highest rate of poverty is agglomerated, and employment alternatives are extremely restricted (Matthews, 2011).
- the globalization of markets and their liberalization could increase the variability of the availability of staples, for net importer countries;
- in food importer countries, a process of liberalization might negatively influence food imports, due to a higher import debt.

The interconnection among market access, openness and economic growth was deeply investigated by Romalis (2006) in his paper. The aim of the research was to try to identify if there would be a causal effect on better economic outcomes of trade openness. In particular, the hypothesis object of investigation is that when a 'large' country – trading partner of poor

countries – decides for a trade openness, also its partners might accelerate both economic growth rate and their trade flows.

To follow through on this assumption, the trade openness was evaluated using the Sachs and Warner (1995) database, revised by Wacziarg and Welch (2003; 2008). Besides, the measures of countries' international integration are derived from the US Most Favored Nation (MFN) tariff rates, which expresses the level of access of developing countries' national markets. A provocative matter enlightened by Romalis (2006) is: which are the determinants factors of the liberalization process. To answer to this question there is a double perspective: on the one hand, the process of trade openness may be determined by internal policy modifications; on the other hand, the liberalization policy of 'rich' developed countries – which usually are the trading partners of poor states – may affect developing countries trade regimes. So that, the national decision of trade liberalization in rich countries is not a consequence of poor nations, and it is less susceptible of endogeneity issues. This is why, it could be adopted as a valid instrument to measure the economic growth of developing societies, where a policy of trade liberalization took place.

The MFN tariffs of rich countries are thus used as an instrument of developing countries openness and trade liberalization. The conclusion is that, it does: the decline of international trade barriers, especially in developed countries, intensify the economic growth of their trading partners, in particular, poor countries.

6.2. Economic liberalization, GDP per capita and food security: the SCM

The most recent theoretical application about the investigation of the consequences of a process of economic liberalization on real GDP per capita, was conducted by Billmeier and Nannicini (2013). On this occasion, they applied the new methodological approach (already presented in the previous chapters of the present dissertation), the SCM. With the support of this scheme, the aim was to compare the situation of a country post the liberalization process, measured with the binary indicator developed by Sachs and Warner (1995) and updated by Wacziarg and Welch (2003; 2008). In agreement with it, the countries in the sample are classified as 'closed' if at least one of the five conditions expressed in the configuration of the index:

1. average tariffs exceed 40%;
2. non-tariff barriers cover more than 40% of their imports;

3. they have a socialist economic system;

4. the black market premium on the exchange rate exceeds 20%;

5. many of its exports are controlled by a state monopoly.

But, Rodriguez and Rodrik (1999) explained that in the majority of the developing countries, the meaning of the openness index should be interpreted in a more general way. In fact, if trade policies are the main component of the binary index indicated above, it is also correct to notice that more market-oriented instruments, usually followed from a policy of economic liberalization.

As for the set of covariates involved in this research, the GDP per capita before and after the treatment, investment as a share of GDP, population growth, secondary school enrollment, the average inflation rate, and a democracy dummy, were included. It is necessary to underline the fact that from a theoretical point of view, the affirmative link between economic liberalization and the increasing in income level, it very difficult to verify. The originality of the present study, was the possibility to compare the economic performances of the same country, before and after the liberalization year, using the SCM. More specifically, they used a panel of 80 economies from 1963 to 2005; the research question was to find if a country − which has followed a process of liberalization at time T − has conducted a higher economic growth, at time $T + i$. The powerful strategy of the SCM is also the fact that the country object of investigation was compared to countries (with very similar characteristics, i.e. economics, political, education level…) which have not switched up to a more open trade economy. This is what in theory in called the synthetic control: the *"transparent estimation of the counterfactual outcome of the treated country, namely, a linear combination of untreated countries"* (Billmeier and Nannicini, 2013).

The evaluation of the countries selected as a sample − that opened their economic sectors in a given year − necessitating an adequate quantity of other nations − whose economies are still close − to compare with them. The key strength of this approach is the transparency in the selection procedure, and the serious awareness whether there are enough similar countries, (to the one treated), in the same geographical area. The SCM is very potent in finding the weighted combination of the potential control countries, namely the counterfactual of the observed country, in the absence of a change of trade policies, by examining the outcomes of the synthetic control group. Regardless of this, one of the critical points of this methodology is the lack of the

possibility of evaluation, using the official standardized inferential techniques. More precisely, the researchers usually compare more numerous samples, but with the SCM the donor pool consists of a smaller number of observations.

As for the placebo tests, Billmeier and Nannicini (2013) acted in accordance with Abadie *et al.* (2010). Following their procedure they applied the permutation technique, extremely useful to make inference: so that, the cross-sectional placebo tests were performed. This means that, to each specific country of the donor pool, was assigned a specific synthetic algorithm, and then the process of comparison took place between them and the baseline findings. In other words, the two authors of the paper confronted them with the real economic trends of the countries treated.

To briefly sum up the outcomes of the application, divided for the different geographical areas, it is possible to illustrate that:

- in the Asian continent the countries where the episode of trade liberalization is most significant, are: Indonesia (1970), Philippines (1988) and Nepal (1991). In the first one, the process went particularly well because the term of comparison of average income before the year of openness, was identical to the countries of the synthetic control. On the other hand, it was extremely divergent after 1970, when the Indonesian indicator of wellness started to be boosted, until the level of 76% more in ten year time. As for the other two nations the outcomes are not so clear and even unambiguous. In Nepal for example, the placebo tests are neither robust or the interpretation of the unexpected raising of the income level was due to the liberalization. Indeed, it started a few years before the moment indicated in the annex table of Wacziarg and Welch (2003; 2008) tables.

- In the Latin America area, Barbados (1966), Colombia, Costa Rica and Mexico (all the three of them liberalized in1986) were the most distinguished and decisive cases of the good process of the elimination of tariff barriers. Analyzing the situation after ten years, the same indicator of GDP per capita, was 57% more in Barbados, 23% in Colombia, and respectively 26% and 21% in Costa Rica and Mexico. With reference to the placebo tests, they confirm the robustness and the significance of the deductions.

- In Africa there occurred sixteen liberalization episodes from 1968 in Mauritius, to 1994 in Ivory Coast and Niger. Botswana (1979) belongs to the group of treated countries whose income per capita, in a ten year timeframe, was five times higher than the

estimation of the SC. The placebo tests agree with this conclusion. Nations which seems not to have taken advantages from the liberalization process are identified as: Cameroon, Zambia, South Africa, Gambia, Kenya and Niger. In these situations, what was observed was a decline or at least a stagnation of the level of income.

- In the MENA (Middle East and North Africa) region the interpretation of the results is very heterogeneous. In fact, the main observation was the small difference between the level of richness before and after the liberalization period. Only in Morocco (1984) the circumstances are slightly better, even if the placebo tests are not so indicative. The SC shows that Tunisia (1989), Mauritania (1995) and Egypt (1995) performed worse – both in five and in ten year timeframes.

The overall conclusions derived from the paper formerly mentioned can be summarized in a few main points. The first one, is that some countries experienced a better economic situation, after the trade liberalization, than others, where the ambiguity and the heterogeneity of the results is not so clear to interpret. With respect to the African countries – whose period of openness by and large started in 1990 they do not obtain the same benefits from trade liberalization as similar states, whose economy regime is still 'closed'. Some explanation can be reached in the paper of Giavazzi and Tabellini (2005) as well as Wood (1997). They suggested that where the process of democratization started before the liberalization policies, the level of the GDP per capita was higher, than in countries that follow a different, or even opposite, pattern. Also the role of institutions is extremely relevant to activate the process of economic growth and trade agreement with diverse trading partners; this is mainly due to the fact that *"good institutions will leads to good policies"* (Anderson *et al.,* 2001; Billmeier and Nannicini, 2013).

To sum up, the SCM compares a treated (liberalized) country, with a counterfactual (still closed), which represents a linear (convex) combination of comparison units. They have the attribute to be similar to the treated economy. Generally speaking, a progressive openness of trade barriers reports a positive (even non negative) effect on the income level, at national level. Especially in two African regions (the sub-Saharan and the MENA) the benefits of the new economic arrangement seem to be more remarkable.

6.3. Future challenges and possible solutions of problem of food security

As a general conclusion, we can say that malnutrition remains the major barrier to economic and social development, all over the world. In fact, it leaves entire populations unable to live neither a normal lives nor a economically and socially productive activities. Jenkins and Scanlan (2001) among the others, assumed that increased food supply is the key to reduce hunger and poverty.

Another interesting challenge with which politicians and researchers have to cope with is the increasingly of globalization phenomenon, that has generated intense scholarly debates, heated polemics, public demonstrations and street protests. Central to the debate also is how to conduct theoretical and empirical analyses and measurements of the impact of globalization on poverty. In part due to the forces of globalization, many developed countries have reaped the benefits of faster economic growth, cheaper imports, new technologies, and increased foreign competition (Davis *et al.,* 2001). Davis *et al.* (2001) found that globalization has had three fundamental impacts on food security. First, it has changed the regulation of agricultural trade; in fact, regulatory changes are pushing the global economy away from the special arrangements, protected markets, subsidized production, and national regulation, which currently characterize food and agricultural trade, to a more open, deregulated, rules-based, liberal trading regime, under the auspices of the WTO. Agriculture remains the largest employment sector in most developing countries and international agriculture agreements are crucial to a country's food security (WHO, 2010).

Second, a wider array of policies must be formulated to address education, making information available to households about the nutritional values of food. However, the picture just given would be incomplete if one failed to add to the economic and social indices of underdevelopment other indices which are equally negative and indeed even more disturbing, beginning with the cultural level. These are illiteracy, the difficulty or impossibility of obtaining higher education, the inability to share in the building of one's own nation, the various forms of exploitation and of economic, social, political and even religious oppression of the individual and his or her rights, discrimination of every type. If some of these scourges are noted with regret in areas of the more developed North, they are undoubtedly more frequent, more lasting and more difficult to root out in the developing and less advanced countries.

It is also possible to say that economic growth is dependent on social progress, the goal to which it aspires; and that basic education is the first objective for any nation seeking to develop

itself. Lack of education is as serious as lack of food; the illiterate is a starved spirit. When someone learns how to read and write, he is equipped to do a job and to shoulder a profession, to develop self-confidence and realize that he can progress along with others. In addition, literacy is the first and most basic tool for personal enrichment and social integration; and it is society's most valuable tool for furthering development and economic progress. Policies must also address issues such as community access to sanitation, clean water supply, health facilities, and stemming cultural habits and practices, especially those that impact food preferences and food preparation (Rosegrant and Cline, 2003).

Achieving food security needs policy and investment reforms on multiple fronts, including human resources, agricultural research, rural infrastructure, water resources, and farm and community based agricultural and natural resources management. Another point is that progressive policy action must not only increase agricultural production, but also boost incomes and reduce poverty in rural areas where most of the poor live. Increased investment in people is essential to accelerate food security improvements in particular in agricultural areas, where education works directly to enhance the ability of farmers to adopt more advanced technologies and crop-management techniques and to achieve higher rates of return on land (Rosegrant and Cline, 2003). Rural roads increase agricultural production by bringing new land into cultivation and by intensifying existing land use, as well as consolidating the links between agricultural and non-agricultural activities within rural areas and between rural and urban areas.

Based on trends in population growth, urbanization, income growth and associated lifestyle and food preference changes, some economics model projects that between 1995 and 2020, the demand for cereal will increase by 39%, meat by 58%, and roots and tubers by 37%. It also projects that the increase in global population will be heavily concentrated in the developing countries (Rosegrant and Cline, 2003). Food output is already increasing faster in the developing world, and by 2020 it is projected that it will be providing 59% of the world's cereal output, and 61% of meat output.

In conclusion, it is true that in the light of the current theories and the empirical evidences, the relationship food security / malnutrition (and health) and trade liberalization still remains ambiguous.

7. Results

In this section, the results of the applications obtained with the SCM will be presented and discussed. As already mentioned in the previous chapters, the statistical and the econometric approach was applied to the investigation of the impacts of trade liberalization reforms on under five mortality rate.

The underlying hypothesis is that it is possible to construct a weighted combination of potential control countries – the synthetic control – that approximate the most relevant characteristics of the country affected by the intervention (Billmeier and Nannicini, 2013). In selecting the counterfactual we decided to use a pre-treatment period of twenty years. Differently, the post-treatment results are displayed on a ten years period. This is mainly because after a decade from the openness to trade, the effect of this phenomenon of child mortality tends to be very difficult to isolate and identify from other possible shocks. In fact, other reforms or social policies can occur, and they can mask the real influence of the occurrence of the subject matter of interest in the outcome variable.

The output of the SCM can be represented using two different tools: tables and graphs. The first shown are less practical, but helpful to understand how the algorithm works; the second are more direct and intuitive. Overall, the results obtained con be summarize as follow. The impacts of trade liberalization on under five mortality rate is, on average, positive. Specifically, in 25 countries, out of 39, this effect is clearly registered and the tendency over the years is to conclude a reduction of child morality after a trade liberalization episode. These positive effect of trade liberalization on food security, in the majority of the cases is confirmed by the placebo tests. Differently, in six countries – Cameroon (1993), Zambia (1993), Cote d'Ivore (1994), Niger (1994), Burkina Faso (1998) and Burundi (1999) – trade liberalization seems to work in a different direction, namely child mortality increased after liberalization, and, thereby, the level of food security worsened. However, as the reported placebo test will show, whatever we detect an increase in U5MR after a trade liberalization episode, this effect tends to be hardly significant. Finally, for other countries such as – Botswana (1979), Morocco (1984), Tunisia (1989), Cape Verde (1991) and Mauritania (1995) – the influence of a more globalized market is demonstrated to be null.

The chapter is organized as follows: in the first sections the proposed results are divided into geographical regions – Latin America, Asia, Africa, Middle East and North Africa – in order

to better and more clearly explain each situation. The numerical values in the tables are referred to the output variable (under-five mortality rate – U5MR) between the 'treated' country and the synthetic control. The estimated measures are observed five years (T_0+5) and ten years (T_0+10) after the episode of trade liberalization.

7.1. Economic Liberalization Episodes: table design

All the tables have the same structure. For both the "treated" and the "synthetic control" each table reports the value of the covariates used to select the synthetic control: wars and conflicts normalized; the log of GDP per capita; GDP growth; the % of rural population; the amount of food available per capita in kcal; population growth. Moreover, we report also the values of U5MR in the pre-reform period used to select the counterfactual, and the same U5MR values in the post-reform period at T_0+5 and T_0+10, thus five and ten years after the treatment.

Lastly, the error term is specified as the Root Mean Square Error Term (RMSPE): it indicates the goodness of the estimation, measuring the magnitude of the gap in the outcome variable of interest (U5MR) between the treated country and its synthetic counterpart, evaluated in the pre-reform period., A large pre-intervention RMSPE is not indicative of a goodness of fit, meaning that the synthetic control does not closely reproduce the outcome of interest of the treaded country before the liberalization episode. Thus RMSPE too high are indicative of a general difficult to select a satisfactory synthetic control, and thus the results have to be taken with cautions.

7.1.1. Latin America

In our consideration to divide the analysis into geographical areas, the first situation analyzed are the eleven Latin American countries (from table 1 to table 4). Below the tables, are reported for each analysis the countries used to build the synthetic control and their relative weights. On average, there is no large difference between the 'treated' and the synthetic country in the pre-treatment period for all the covariates considered and, in particular, the values of the U5MR. This consideration is clearly confirmed by the low value of the RMSPE, never higher than 9 and in many case lower then 1. This means that the SCM have done a good job in selecting the synthetic control, and thus that the results reported below are credible.

In all the twelve Latin American countries analyzed, the U5MR of the treated country measured at T_0+5 and T_0+10, is always lower than that of the respective synthetic control. This suggests that trade liberalization clearly appear to *reduce* child mortality or, put differently, it improves food security. However, for some countries like Colombia and Venezuela the reform effect appear to be quite weak.

Table 1: covariates and output means for Chile (1976), Colombia (1986) and Mexico (1986).

CHILE 1976	Treated	Synthetic
war	0.00	0.09
lnrgdpch	8.32	7.95
gdp_growth	0.00	0.04
%_rur_pop	0.26	0.55
kcal_tot	2630.40	2659.24
pop_growth	0.02	0.03
U5MR1960	157.30	141.86
U5MR1968	85.80	93.51
U5MR1976	57.10	61.90
U5MR at T_0+5	30.00	48.09
U5MR at T_0+10	22.10	37.39
RMSPE		8.71

COLOMBIA 1986	Treated	Synthetic
war	0.00	0.06
lnrgdpch	8.41	8.12
gdp_growth	0.02	0.05
%_rur_pop	0.40	0.39
kcal_tot	2205.31	2698.09
pop_growth	0.02	0.02
U5MR1970	96.70	96.61
U5MR1978	65.10	65.22
U5MR1986	40.40	40.48
U5MR at T_0+5	34.10	35.76
U5MR at T_0+10	28.90	33.26
RMSPE		0.68

MEXICO 1986	Treated	Synthetic
war	0.00	0.03
lnrgdpch	9.07	8.47
gdp_growth	0.02	0.05
%_rur_pop	0.36	0.33
kcal_tot	2891.75	2866.91
pop_growth	0.03	0.02
U5MR1970	107.40	107.41
U5MR1978	81.30	81.24
U5MR1986	56.20	56.11
U5MR at T_0+5	43.80	51.85
U5MR at T_0+10	32.70	48.18
RMSPE		0.70

Notes: countries and relative weight used to build each the synthetic control: **Chile**: Poland (0.317); Syrian Arab Rep (0.683); **Colombia**: China (0.219); Congo Rep (0.066); Algeria (0.084); Iran (0.104); Malta (0.494); Swaziland (0.033); **Mexico**: donor pool countries: Algeria (0.111); Liberia (0.115); Malta (0.599); Swaziland (0.115).

Table 2: covariates and output means for Guatemala (1988), Paraguay (1989) and Venezuela (1989).

GUATEMALA 1988	Treated	Synthetic
war	0.00	0.04
lnrgdpch	8.49	7.87
gdp_growth	0.01	0.03
%_rur_pop	0.63	0.62
kcal_tot	2128.06	2255.86
pop_growth	0.03	0.03
U5MR1970	173.30	173.15
U5MR1979	128.30	128.36
U5MR1988	88.40	88.40
U5MR at T_0+5	69.50	89.52
U5MR at T_0+10	55.10	101.28
RMSPE		2.12

PARAGUAY 1989	Treated	Synthetic
war	0.00	0.09
lnrgdpch	7.97	7.39
gdp_growth	0.03	0.04
%_rur_pop	0.59	0.47
kcal_tot	2499.84	2620.14
pop_growth	0.03	0.02
U5MR1970	77.00	77.48
U5MR1979	65.10	65.14
U5MR1989	47.20	46.70
U5MR at T_0+5	39.60	53.02
U5MR at T_0+10	33.80	57.21
RMSPE		1.83

VENEZUELA 1989	Treated	Synthetic
war	0.00	0.01
lnrgdpch	9.17	8.54
gdp_growth	0.00	0.05
%_rur_pop	0.22	0.23
kcal_tot	2541.53	2910.55
pop_growth	0.03	0.02
U5MR1970	62.60	62.71
U5MR1979	45.80	45.73
U5MR1989	30.60	30.88
U5MR at T_0+5	26.70	30.52
U5MR at T_0+10	22.10	30.62
RMSPE		0.48

Notes: countries and relative weight used to build each the synthetic control: **Guatemala**: Congo Rep (0.372); Algeria (0.076); Haiti (0.118); Iran (0.088); Nigeria (0.017); Swaziland (0.259); **Paraguay**: Central African Rep (0.016); China (0.094); Congo Rep (0.042); Malta (0.439); Zimbabwe (0.409); **Venezuela:** Congo Rep (0.173); Algeria (0.029); Malta (0.696); Syrian Arab Rep (0.101).

Table 3: covariates and output means for Brazil (1991), Honduras (1991), Nicaragua (1991).

BRAZIL 1991	Treated	Synthetic
war	0.00	0.01
lnrgdpch	8.67	8.35
gdp_growth	0.03	0.03
%_rur_pop	0.35	0.37
kcal_tot	2589.05	2635.10
pop_growth	0.02	0.02
U5MR1970	130.90	131.01
U5MR1980	94.40	94.27
U5MR1991	59.20	59.19
U5MR at T_0+5	44.20	56.77
U5MR at T_0+10	30.80	50.44
RMSPE		4.38

HONDURAS 1991	Treated	Synthetic
war	0.00	0.04
lnrgdpch	8.00	7.53
gdp_growth	0.01	0.03
%_rur_pop	0.65	0.61
kcal_tot	2112.76	2393.10
pop_growth	0.03	0.03
U5MR1970	145.60	145.73
U5MR1980	94.70	94.72
U5MR1991	56.20	56.53
U5MR at T_0+5	45.10	55.00
U5MR at T_0+10	36.30	51.80
RMSPE		4.83

NICARAGUA 1991	Treated	Synthetic
war	0.38	0.25
lnrgdpch	8.06	8.02
gdp_growth	-0.03	0.01
%_rur_pop	0.50	0.54
kcal_tot	2059.14	2487.22
pop_growth	0.03	0.03
U5MR1970	171.50	171.70
U5MR1980	107.00	106.84
U5MR1991	63.30	63.46
U5MR at T_0+5	49.70	63.29
U5MR at T_0+10	38.10	59.48
RMSPE		3.59

Notes: countries and relative weight used to build each the synthetic control: **Brazil:** Congo Rep (0.257); Algeria (0.248); Iran (0.025); Liberia (0.062); Malta (0.408); **Honduras**: China (0.285); Congo Rep (0.195); Algeria (0.223); Iran (0.004); Syrian Arab Rep (0.293); **Nicaragua:** Congo Rep (0.058); Algeria (0.118); Iran (0.408); Malta (0.13); Chad (0.05); Zimbabwe (0.235).

Table 4: covariates and output means for Perù (1991), Dominican Republic (1992).

PERU' 1991	Treated	Synthetic
war	0.38	0.07
lnrgdpch	8.51	8.05
gdp_growth	-0.01	0.03
%_rur_pop	0.36	0.47
kcal_tot	2142.52	2477.22
pop_growth	0.03	0.02
U5MR1970	161.10	162.49
U5MR1980	123.40	122.67
U5MR1991	74.90	75.63
U5MR at T_0+5	53.60	72.15
U5MR at T_0+10	37.00	66.58
RMSPE		8.47

DOMINICAN REP 1992	Treated	Synthetic
war	0.00	0.04
lnrgdpch	8.35	7.81
gdp_growth	0.03	0.04
%_rur_pop	0.50	0.47
kcal_tot	2183.36	2500.08
pop_growth	0.02	0.02
U5MR1970	120.50	121.47
U5MR1981	84.60	84.19
U5MR1992	55.00	55.86
U5MR at T_0+5	44.70	60.80
U5MR at T_0+10	37.30	58.86
RMSPE		6.54

Notes: countries and relative weight used to build each the synthetic control: **Perù:** Congo Rep (0.065); Algeria (0.336); Iran (0.011); Malta (0.325); Chad (0.219); Zimbabwe (0.044); **Dominican Rep**: China (0.067); Congo Rep (0.23); Algeria (0.213); Malta (0.298); Zimbabwe (0.191).

To sum up, in Latin America there are no significant examples of states where the openness to trade represented a disadvantage for the food security level.

7.1.2. Asia

Considering Asian countries, the results tend to go in the same direction, although for some countries, the selection of the synthetic control appear a little bit more problematic. More specifically, while for Sri Lanka the RMSPE is very low and close to 1, for Philippines and Bangladesh tend to be significantly higher and around 6, suggesting a non perfect fit between the treated and the synthetic control in the pre-treatment period. However, it is important to know that values lower than 10 for the RMSPE can be consider more than acceptable in this kind of approach (see Bellmeier and Nannicini, 2013). As can be seen by the values of the U5MR at T_0+5 and T_0+10, for all the three Asian countries trade liberalization significantly reduce child mortality.

Table 5: covariates and output means for Sri Lanka (1977), Philippines (1988) and Bangladesh (1996).

SRI LANKA 1977	Treated	Synthetic
war	0.06	0.02
lnrgdpch	6.68	8.31
gdp_growth	0.04	0.03
%_rur_pop	0.79	0.75
kcal_tot	2198.44	2307.21
pop_growth	0.02	0.02
U5MR1960	97.00	96.87
U5MR1968	74.70	74.59
U5MR1977	59.30	59.28
U5MR at T_0+5	42.10	50.88
U5MR at T_0+10	24.40	42.61
RMSPE		1.27

PHILIPPINES 1988	Treated	Synthetic
war	0.44	0.11
lnrgdpch	7.68	7.49
gdp_growth	0.01	0.04
%_rur_pop	0.62	0.46
kcal_tot	2088.00	2609.43
pop_growth	0.03	0.02
U5MR1970	83.30	92.27
U5MR1979	82.10	81.79
U5MR1988	65.60	63.67
U5MR at T_0+5	49.90	65.95
U5MR at T_0+10	42.10	69.64
RMSPE		5.04

BANGLADESH 1996	Treated	Synthetic
war	0.00	0.06
lnrgdpch	6.55	6.77
gdp_growth	0.01	0.01
%_rur_pop	0.85	0.80
kcal_tot	2083.62	2023.78
pop_growth	0.02	0.02
U5MR1970	220.60	233.68
U5MR1983	183.70	175.71
U5MR1996	108.10	117.06
U5MR at T_0+5	83.60	98.63
U5MR at T_0+10	63.40	83.10
RMSPE		6.41

Notes: countries and relative weight used to build each the synthetic control: **Sri Lanka:** Lesotho (0.007); Panama (0.171); Philippines (0.13); Syrian Arab Rep (0.117); Trinidad and Tobago (0.496); Zimbabwe (0.078); **Philippines:** Malta (0.489); Chad (0.147); Zimbabwe(0.364); **Bangladesh:** Malta (0.109); Nepal (0.591); Chad (0.255); Zimbabwe (0.045).

7.1.3. Africa

The geopolitical situation in the areas of the African continent is more complex to enquire. In fact, in the first wave of trade liberalization demonstrated better advantages in comparison to the latest. The sixteen economic liberalization episodes observed in Africa happened between 1979 (Botswana) and 1999 (Burundi), as specified from table 6 to table 11.

In this subsample it is possible to focus on two main points: firstly, after the last decade of the nineteen century, only a few positive or discernible effects are registered. However, there are six cases of reported negative effects of trade liberalization on U5MR; particularly, in Cameroon (1993), Zambia (1993), Cote d'Ivore (1994), Niger (1994), Burkina Faso (1998) and Burundi (1999). Moreover, there are also two states in which the trend of the outcome variable – the U5MR – either for the 'treated' country and for the counterfactual, is very similar. So that, it is possible to say that in Botswana (1979) and Cape Verde (1991) the liberalization has no apparent impact on the levels of child mortality.

Generally speaking, only in Sub-Saharan Africa where trade liberalization happen before the ninety display a clear positive impact of trade reform on food security outcomes. Another possible explanation regarding the zero findings in this specific area, can be attributed to a gradual process of reform strategies; so that, this can be a reasonable explanation for the attenuation bias in the obtained results.

Table 6: covariates and output means for Botswana (1979), Ghana (1985) and Gambia (1985).

BOTSWANA 1979	Treated	Synthetic	GHANA 1985	Treated	Synthetic	GAMBIA 1985	Treated	Synthetic
war	0.00	0.06	war	0.00	0.05	war	0.00	0.01
lnrgdpch	7.21	7.84	lnrgdpch	7.22	7.20	lnrgdpch	7.17	7.08
gdp_growth	0.08	0.05	gdp_growth	-0.01	0.00	gdp_growth	0.00	0.02
%_rur_pop	0.92	0.56	%_rur_pop	0.69	0.71	%_rur_pop	0.74	0.76
kcal_tot	1988.61	2390.74	kcal_tot	1816.27	1999.65	kcal_tot	1947.00	2055.09
pop_growth	0.03	0.03	pop_growth	0.03	0.03	pop_growth	0.03	0.03
U5MR1960	168.20	168.31	U5MR1970	200.40	200.53	U5MR1970	300.80	300.49
U5MR1970	120.00	119.65	U5MR1978	172.70	172.78	U5MR1978	249.60	249.34
U5MR1979	76.60	78.03	U5MR1985	154.70	154.75	U5MR1985	203.30	203.13
U5MR at T_0+5	58.30	59.78	U5MR at T_0+5	128.10	146.02	U5MR at T_0+5	169.70	187.28
U5MR at T_0+10	48.20	47.32	U5MR at T_0+10	113.30	141.54	U5MR at T_0+10	141.00	181.14
RMSPE		0.51	RMSPE		2.08	RMSPE		3.61

Notes: countries and relative weight used to build each the synthetic control: **Botswana:** Malta (0.139); Nicaragua (0.195); Swaziland (0.179); Syrian Arab Rep (0.487); **Ghana:** Congo Rep (0.212); Madagascar (0.093); Nigeria (0.105); Panama (0.091); Chad (0.192); Togo (0.307); **Gambia:** Burkina Faso (0.207); Algeria (0.243); Malawi (0.131); Nigeria (0.092); Sierra Leone (0.326).

Table 7: covariates and output means for Guinea (1986), Mali (1988) and Uganda (1988).

GUINEA 1986	Treated	Synthetic
war	0.00	0.00
lnrgdpch	6.60	6.70
gdp_growth	-0.01	0.02
%_rur_pop	0.79	0.73
kcal_tot	2292.88	2122.56
pop_growth	0.01	0.02
U5MR1970	323.40	325.74
U5MR1978	295.90	290.92
U5MR1986	259.60	262.71
U5MR at T_0+5	235.30	252.32
U5MR at T_0+10	201.50	244.10
RMSPE		3.59

MALI 1988	Treated	Synthetic
war	0.00	0.00
lnrgdpch	6.26	6.72
gdp_growth	0.02	0.02
%_rur_pop	0.82	0.72
kcal_tot	1701.22	2109.50
pop_growth	0.02	0.02
U5MR1970	392.00	329.30
U5MR1979	328.60	288.40
U5MR1988	263.90	261.40
U5MR at T_0+5	243.40	251.90
U5MR at T_0+10	232.10	240.60
RMSPE		44.54

UGANDA 1988	Treated	Synthetic
war	0.39	0.18
lnrgdpch	6.46	6.46
gdp_growth	-0.03	0.00
%_rur_pop	0.92	0.84
kcal_tot	2244.61	1921.41
pop_growth	0.03	0.03
U5MR1970	181.00	217.62
U5MR1979	210.30	204.58
U5MR1988	180.40	167.98
U5MR at T_0+5	169.60	171.06
U5MR at T_0+10	157.40	180.44
RMSPE		20.81

Notes: countries and relative weight used to build each the synthetic control: **Guinea**: Rwanda (0.031); Sierra Leone (0.969); **Mali:** Sierra Leone (1); **Uganda**: Rwanda (0.205); Chad (0.566); Zimbabwe (0.229).

Table 8: covariates and output means for Benin (1990), Cape Verde (1991), Cameroon (1993).

BENIN 1990	Treated	Synthetic
war	0.00	0.01
lnrgdpch	6.83	6.90
gdp_growth	0.01	0.01
%_rur_pop	0.74	0.75
kcal_tot	1926.90	1964.64
pop_growth	0.03	0.03
U5MR1970	265.10	265.20
U5MR1980	213.60	213.67
U5MR1990	180.70	180.75
U5MR at T_0+5	158.20	169.04
U5MR at T_0+10	147.40	153.75
RMSPE		3.26

CAPE VERDE 1991	Treated	Synthetic
war	0.00	0.23
lnrgdpch	7.11	7.59
gdp_growth	0.02	0.02
%_rur_pop	0.73	0.67
kcal_tot	2093.19	2351.37
pop_growth	0.01	0.02
U5MR1970	178.20	176.28
U5MR1980	93.70	94.29
U5MR1991	59.10	59.66
U5MR at T_0+5	47.50	55.04
U5MR at T_0+10	35.50	51.22
RMSPE		2.35

CAMEROON 1993	Treated	Synthetic
war	0.00	0.11
lnrgdpch	7.56	7.33
gdp_growth	0.00	0.01
%_rur_pop	0.68	0.67
kcal_tot	2140.17	2125.21
pop_growth	0.03	0.02
U5MR1970	209.10	210.21
U5MR1982	168.40	167.65
U5MR1993	143.50	143.99
U5MR at T_0+5	155.10	134.05
U5MR at T_0+10	134.60	118.01
RMSPE		8.15

Notes: countries and relative weight used to build each the synthetic control: **Benin**: Central African Rep (0.031); Congo Rep (0.121); Nigeria (0.198); Nepal (0.262); Senegal (0.018); Sierra Leone (0.25); Togo (0.12); **Cape Verde**: China (0.463); Algeria (0.023); Iran (0.438); Nepal (0.076); **Cameroon**: Congo Rep (0.083); Algeria (0.08); Haiti (0.012); Liberia (0.082); Malta (0.124); Swaziland (0.132); Chad (0.487).

Table 9: covariates and output means for Zambia (1993), Cote d'Ivore (1994), Niger (1994).

ZAMBIA 1993	Treated	Synthetic
war	0.00	0.05
lnrgdpch	7.06	6.99
gdp_growth	-0.03	-0.02
%_rur_pop	0.63	0.60
kcal_tot	2213.70	2456.49
pop_growth	0.03	0.02
U5MR1970	179.30	197.36
U5MR1982	161.60	165.81
U5MR1993	192.40	167.74
U5MR at T_0+5	179.10	145.64
U5MR at T_0+10	143.30	109.28
RMSPE		19.22

COTE d'IVORE 1994	Treated	Synthetic
war	0.00	0.08
lnrgdpch	7.34	7.40
gdp_growth	0.00	0.00
%_rur_pop	0.64	0.65
kcal_tot	2627.88	2375.12
pop_growth	0.04	0.03
U5MR1970	241.70	240.44
U5MR1982	158.60	159.05
U5MR1994	152.30	147.07
U5MR at T_0+5	147.40	125.15
U5MR at T_0+10	134.50	87.03
RMSPE		18.75

NIGER 1994	Treated	Synthetic
war	0.00	0.00
lnrgdpch	6.57	6.40
gdp_growth	-0.02	0.01
%_rur_pop	0.87	0.91
kcal_tot	2006.75	2175.54
pop_growth	0.03	0.03
U5MR1970	318.70	339.30
U5MR1982	316.40	247.00
U5MR1994	291.60	219.40
U5MR at T_0+5	235.60	184.20
U5MR at T_0+10	184.90	129.20
RMSPE		62.18

Notes: countries and relative weight used to build each the synthetic control: **Zambia**: Liberia (0.592); Malta (0.145); Zimbabwe (0.263); **Cote d'Ivore**: Iran (0.157); Malta (0.053); Rwanda (0.217); Senegal (0.525); Syrian Arab Rep (0.047); **Niger**: Malawi (1).

Table 10: covariates and output means for Tanzania (1995), Ethiopia (1996), Madagascar (1996).

TANZANIA 1995	Treated	Synthetic
war	0.00	0.13
lnrgdpch	6.47	6.46
gdp_growth	0.01	0.00
%_rur_pop	0.85	0.84
kcal_tot	2108.68	1968.93
pop_growth	0.03	0.03
U5MR1970	212.10	213.17
U5MR1982	175.40	175.01
U5MR1995	159.60	159.95
U5MR at T_0+5	131.50	137.81
U5MR at T_0+10	90.10	112.26
RMSPE		12.28

ETHIOPIA 1996	Treated	Synthetic
war	0.62	0.17
lnrgdpch	6.06	6.57
gdp_growth	-0.01	0.00
%_rur_pop	0.89	0.83
kcal_tot	1610.73	1759.01
pop_growth	0.02	0.03
U5MR1970	237.00	257.66
U5MR1983	230.30	217.45
U5MR1996	167.70	182.59
U5MR at T_0+5	139.70	171.36
U5MR at T_0+10	101.90	157.77
RMSPE		10.31

MADAGASCAR 1996	Treated	Synthetic
war	0.00	0.15
lnrgdpch	6.87	6.93
gdp_growth	-0.01	0.01
%_rur_pop	0.80	0.68
kcal_tot	2408.62	2065.02
pop_growth	0.03	0.02
U5MR1970	162.30	189.23
U5MR1983	178.60	160.83
U5MR1996	131.80	143.83
U5MR at T_0+5	102.60	133.24
U5MR at T_0+10	76.70	124.04
RMSPE		16.79

Notes: countries and relative weight used to build each the synthetic control: **Tanzania**: Malawi (0.49); Nepal (0.141); Rwanda (0.133); Swaziland (0.04); Chad (0.349); Zimbabwe (0.288); **Ethiopia**: Nepal (0.128); Chad (0.8.38); Zimbabwe (0.034); **Madagascar**: Malta (0.18); Chad (0.619); Zimbabwe (0.2).

Table 11: covariates and output means for Burkina Faso (1998), Burundi (1999).

BURKINA FASO 1998	Treated	Synthetic
war	0.00	0.02
lnrgdpch	6.44	6.52
gdp_growth	0.01	0.00
%_rur_pop	0.89	0.88
kcal_tot	1926.57	2158.30
pop_growth	0.02	0.03
U5MR1970	315.90	312.49
U5MR1984	222.30	223.83
U5MR1998	191.40	189.23
U5MR at T_0+5	174.00	133.04
U5MR at T_0+10	131.60	88.35
RMSPE		8.88

BURUNDI 1999	Treated	Synthetic
war	0.00	0.07
lnrgdpch	6.22	6.53
gdp_growth	0.01	0.00
%_rur_pop	0.95	0.91
kcal_tot	1939.55	1968.28
pop_growth	0.02	0.02
U5MR1970	245.00	245.86
U5MR1984	183.60	182.95
U5MR1999	151.30	151.32
U5MR at T_0+5	138.50	109.06
U5MR at T_0+10	115.80	79.51
RMSPE		10.31

Notes: countries and relative weight used to build each the synthetic control: **Burkina Faso**: Algeria (0.055); Malawi (0.765); Rwanda (0.158); Senegal (0.021); **Burundi**: China (0.004); Nepal (0.407); Rwanda (0.396); Chad (0.164).

7.1.4. Middle East and North Africa

From the analysis of the Middle East subsample, three states out of five did not show a positive neither negative trends. Besides, Morocco (1984), Tunisia (1989) and Mauritania (1995) displayed a trend that coincides between the 'treated' and the donor pool. However, the other two countries enquired – Turkey (1989) and Egypt (1995) – revealed a positive trend of the episodes of trade liberalization on the outcome variable.

Table 12: representation of the numeric results in Morocco (1984), Tunisia (1989) and Turkey (1989).

MOROCCO 1984	Treated	Synthetic
war	0.14	0.14
lnrgdpch	7.49	7.48
gdp_growth	0.02	0.02
%_rur_pop	0.61	0.60
kcal_tot	2631.71	2561.33
pop_growth	0.03	0.03
U5MR1970	187.30	187.17
U5MR1977	152.30	152.18
U5MR1984	108.40	108.27
U5MR at T_0+5	83.80	85.45
U5MR at T_0+10	66.40	77.49
RMSPE		0.41

TUNISIA 1989	Treated	Synthetic
war	0.00	0.26
lnrgdpch	8.15	8.28
gdp_growth	0.02	0.02
%_rur_pop	0.50	0.52
kcal_tot	2762.53	2537.05
pop_growth	0.02	0.03
U5MR1970	177.10	176.09
U5MR1979	99.90	100.55
U5MR1989	53.90	53.99
U5MR at T_0+5	41.40	46.98
U5MR at T_0+10	31.50	43.16
RMSPE		1.57

TURKEY 1989	Treated	Synthetic
war	0.05	0.07
lnrgdpch	8.57	8.28
gdp_growth	0.02	0.02
%_rur_pop	0.55	0.49
kcal_tot	3359.79	2555.36
pop_growth	0.02	0.02
U5MR1970	186.20	185.94
U5MR1979	133.00	132.95
U5MR1989	78.10	78.01
U5MR at T_0+5	58.00	73.27
U5MR at T_0+10	40.60	65.38
RMSPE		4.22

Notes: countries and relative weight used to build each the synthetic control: **Morocco**: Egypt (0.394); Iran (0.186); Madagascar (0.118); Malta (0.078); Rwanda (0.055); Swaziland (0.001); Syrian Arab Rep (0.043); Zimbabwe

(0.124); **Tunisia**: China (0.212); Algeria (0.116); Iran (0.481); Malta (0.148); Senegal (0.43); **Turkey**: Algeria (0.319); Haiti (0.141); Iran (0.142); Liberia (0.054); Malta (0.28); Malawi (0.063).

Table 13: representation of the numeric results in Egypt (1995) and Mauritania (1995).

EGYPT 1995			MAURITANIA 1995		
	Treated	Synthetic		Treated	Synthetic
war	0.04	0.02	war	0.00	0.09
lnrgdpch	7.44	7.79	lnrgdpch	7.37	7.29
gdp_growth	0.04	0.01	gdp_growth	0.01	0.01
%_rur_pop	0.57	0.63	%_rur_pop	0.70	0.69
kcal_tot	2834.12	2367.21	kcal_tot	2299.00	2221.78
pop_growth	0.02	0.03	pop_growth	0.03	0.02
U5MR1970	237.30	237.93	U5MR1970	193.50	195.04
U5MR1982	145.30	143.29	U5MR1982	152.40	151.68
U5MR1995	64.20	71.56	U5MR1995	118.60	119.85
U5MR at T_0+5	45.10	58.27	U5MR at T_0+5	110.50	113.52
U5MR at T_0+10	31.20	43.02	U5MR at T_0+10	101.70	102.51
RMSPE		3.61	RMSPE		1.68

Notes: countries and relative weight used to build each the synthetic control: **Egypt**: Algeria (0.547); Malta (0.063); Nepal (0.264); Senegal (0.126); **Mauritania**: Liberia (0.027); Malta (0.138); Nepal (0.151); Swaziland (0.137); Chad (0.397).

7.2.   Economic Liberalization Episodes: chart processing

7.2.1. Latin America

The figures in the following paragraphs graphically represent the trends of the under-five mortality rate of both the 'treated' country and the synthetic control, up to ten years after trade openness. Specifically, in Central and Southern America economic liberalization episodes took place rather early, in temporal terms, as also suggested by Billmeier and Nannicini (2013). In fact, Chile, which liberalized in 1976, is the first country considered 'open', in our sample; on the contrary, the latest episodes of trade reforms happened in 1986, in Colombia and Mexico.

However, in the entire continent is registered a decrease of child mortality and malnutrition, except for Colombia (1986) and Cape Verde (1991), where the 'treated' and the synthetic control follow, on average, the same pattern. What is important to notice is that the goodness of the estimations obtained, is confirmed by the trend of dot line (synthetic) and the continue line ('treated') in the graph. More precisely, it means that the countries selected on the

basis of the covariates, as the 'synthetic' among the states of the donor pool, correctly recreate the situation in the analyzed country before the treatment.

As reported in figure 5, the only country where the SCM algorithm shows some difficulty in finding a suitable counterfactual is Chile. Billmeier and Nannicini (2013) suggest that one possible explanation can be found in the socio-economic and politic situation in the pretreatment years: the Pinochet coup – occurred in 1973. For this reason, a compatible counterfactual was arduous to be identified; so that, the inferential estimations obtained are weaken, because of a not adequate sample in the pretreatment period.

In particular, this country can be a valid example of country specific analysis. In fact, it is true that the effects of an episode of trade liberalization can be observed from a 'macro' point of view – such as at world or continent level – but also from a 'micro' or more local prospective. What is more, it is possible to make this observation: during the Unidad Popular Government (which took the power during the triennium 1970–1973), the state assumed a dominating role in the economy in more than one way. Firstly, by controlling prices, interest rates, credit, but also capital movements.

After the takeover of 1973 the abolition of the price control system generated a huge hike of inflation rates, a wage-price spiral, until the end of 1976, and an increase in the unemployment rate, up to the 18%. During the year of trade liberalization (1976) Chile began a second surge of reforms, including trade, the rationalization of the import duty system, and the reduction of non trade tariff barriers. All these economic instruments instigated an increase in the income level, in comparison to other countries of the synthetic control.

As it is clearly understandable in the same figure 5, Mexico (1986), Guatemala (1988), Paraguay (1989), Venezuela (1989) show a positive impact of economic liberalization on the reduction of child mortality. However, in figure 6 Brazil (1991), Honduras (1991) and Nicaragua (1991) denote the same pattern as the previous liberalized states. On the contrary, Perù (1991) and Dominican Republic (1991) reveal a positive decreasing of the dependent variable, but the synthetic control does not perfectly fit in the pretreatment period. So the static significant of these observations are not very robust.

Moreover, the trajectories related to Colombia (1986) and Honduras (1991) in post-treatment period are very approximate between the case of interest and their counterfactuals. One possible explanation may be found out in the fact that the diminishing in the level of the U5MR

is not due to the effects of trade openness. But, there could be a shared factor which had affected both the 'treated' countries and the synthetic controls.

Generally speaking, in Latin American countries, where the main episodes of trade reforms happened between 1976 up to 1991, the effects of commerce openness support the hypothesis that this can be positive for child malnutrition and, as a consequent, for the food security national level.
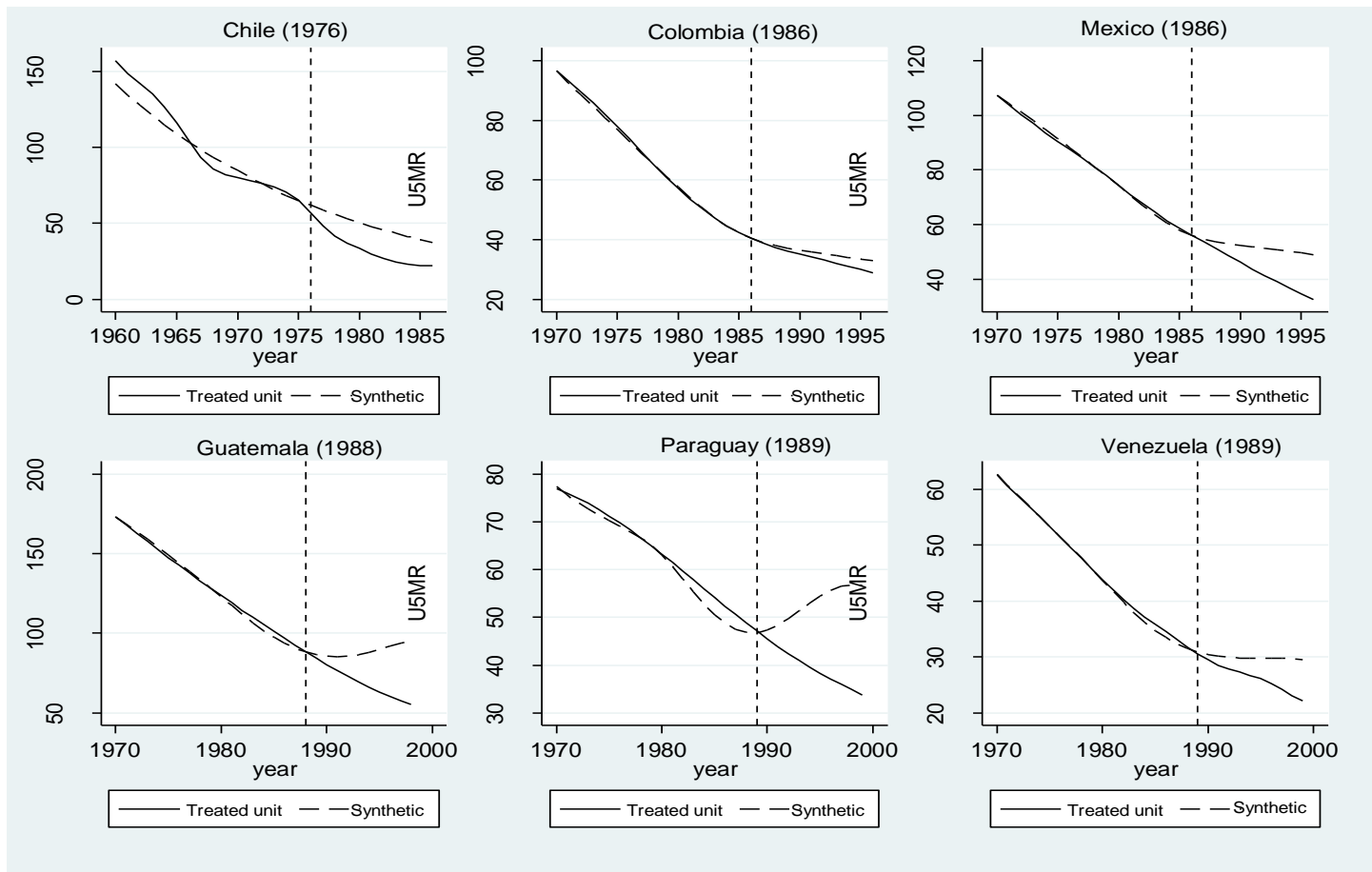
Figure 5: trend of U5MR in Latin America from 1976 to 1989 (treated country vs synthetic unit).
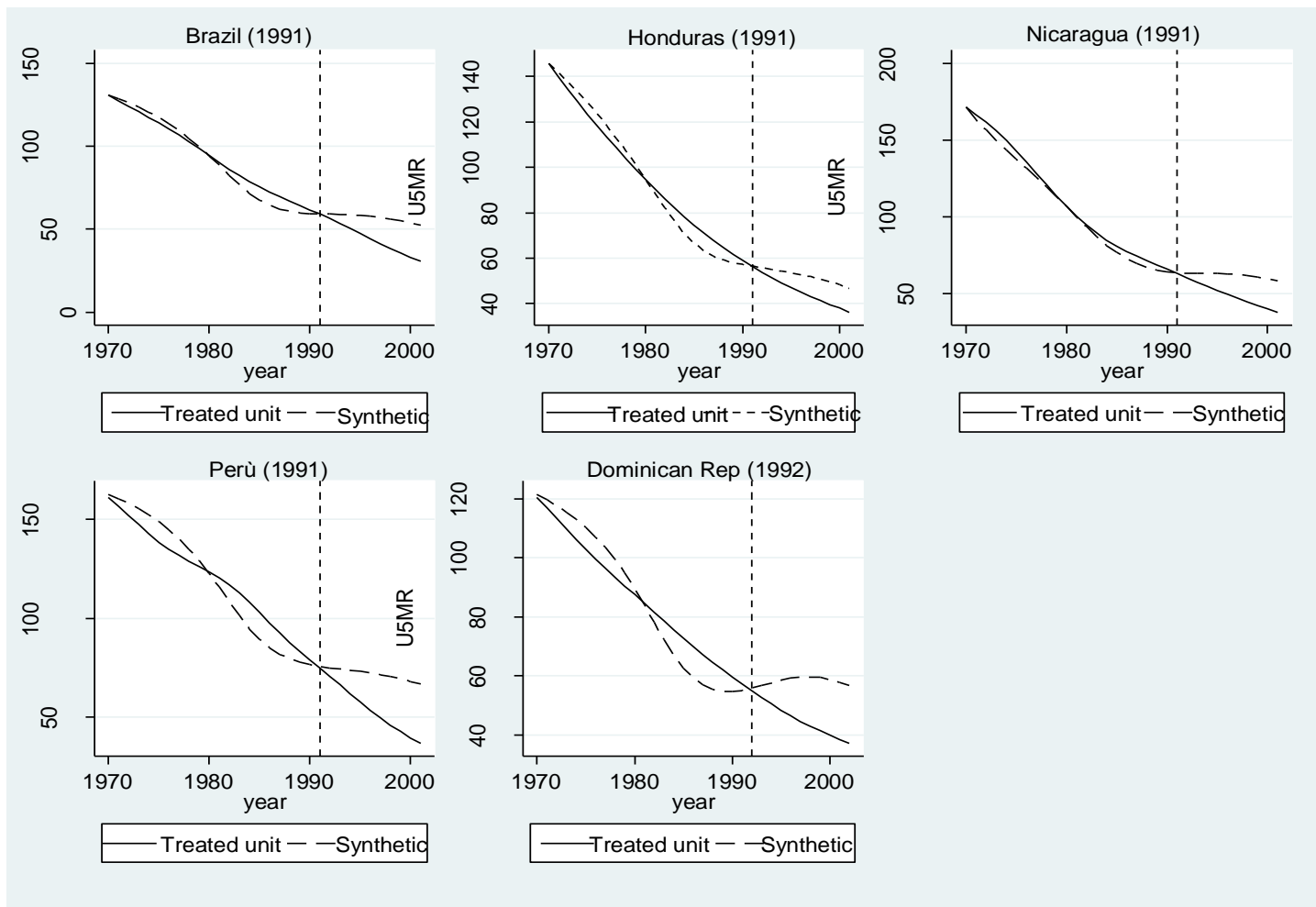
Figure 6: trend of U5MR in Latin America from 1991 to 1992 (treated country vs synthetic unit).

7.2.2. Asia

The results for this continent are presented in the next figure 7. The first sovereign state - experienced an example of economic liberalization, considered in our sample is Sri Lanka (1977); then, the same situation occurred in Philippines (1988) and Bangladesh (1995). In the first and latest case, the U5MR trends are almost identical in the pretreatment period, between the 'treated' country and the synthetic control. As for Sri Lanka, it consists of: Lesotho (0.007); Panama (0.171); Philippines (0.13); Syrian Arab Rep (0.117); Trinidad and Tobago (0.496); Zimbabwe (0.078), indicated with their relative weights; with respect to Bangladesh, the synthetic pool of states includes Malta (0.109); Nepal (0.591); Chad (0.255); Zimbabwe (0.045).

On the contrary, Philippines show a non perfect counterfactual from 1968 to 1988, even if, after the treatment year, the outcome variable diminishes in the next ten-years. Even if not considered in the present study, the case of Nepal (1991) and, on the other hand, Philippines (1988) do not lead to a significantly better trajectory than in the estimated counterfactual. Moreover, it is not very clear whether the effects of more open economy on child mortality reduction - after ten years - can be attributable to the economic reforms; in fact, the 'treated' line and the synthetic one started to diverge a few years before 1988. In any case, observing the estimates of the RMSPE for all the three countries involved here, it assumes, on average, very low numeric values: from 1.27 for Sri Lanka, to 6.41 for Bangladesh.
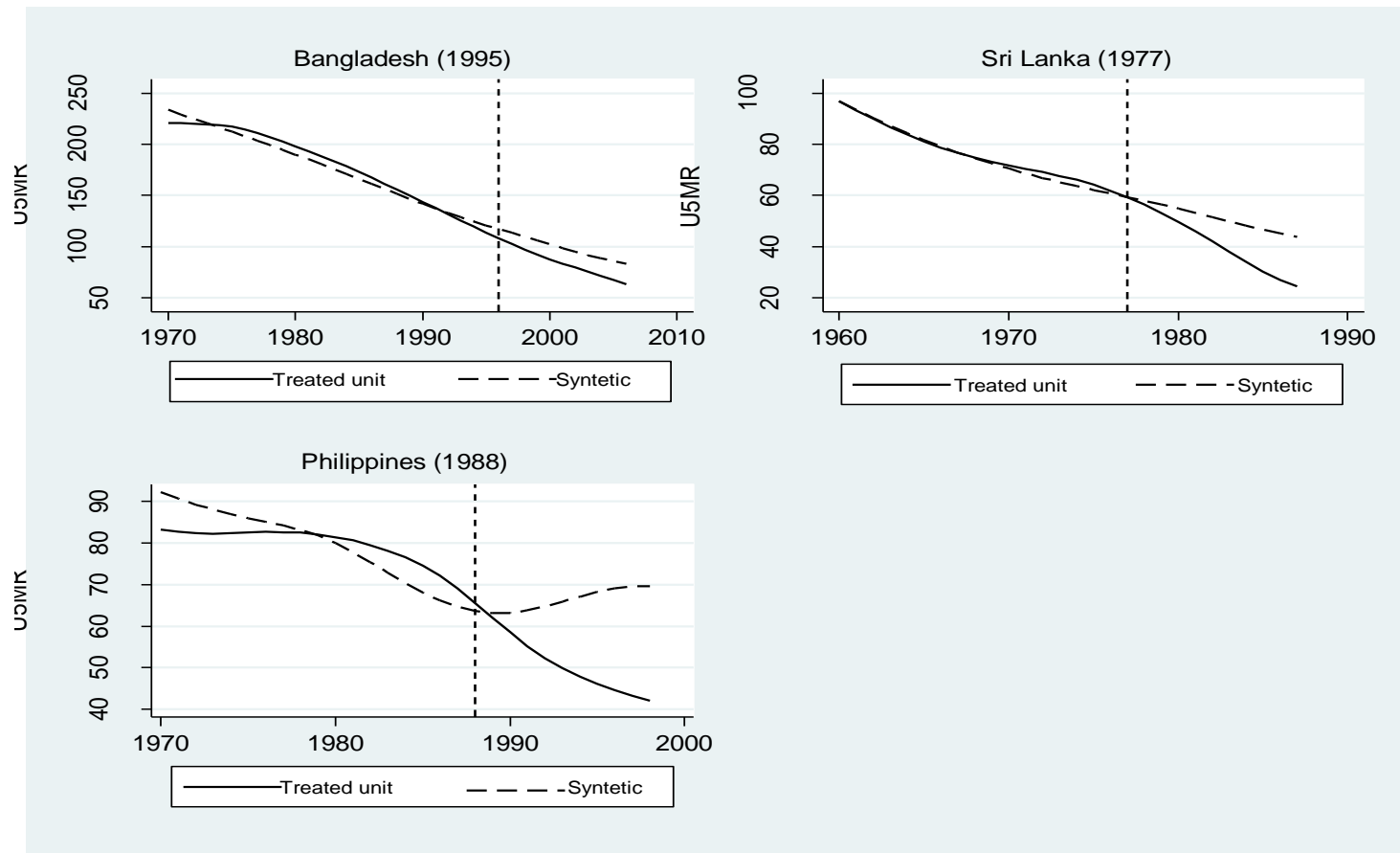
Figure 7: trend of U5MR in Asia from 1977 to 1995 (treated country vs synthetic unit).

7.2.3. Africa

In Africa the sixteen episodes of trade openness, analyzed under the SCM framework, occurred between 1979 in Botswana to 1999 in Burundi. The graphs reported in figures 8, 9 and 10 can help us to draw a few conclusions.

To start with the first figure 8, Botswana (with RMPSE is equal to 0.51) is the only country where the 'treated' and the synthetic control unit have exactly the same trends after the treatment. However, both Botswana (1979), Ghana (1985), Gambia (1985), Guinea (1986), show identical patterns in the pre-treatment period, between 'treated' and synthetic; on the other hand, the latest three countries mentioned above illustrate that after the year of openness the level of the U5MR diminished over the ten years.

All the same, in Mali (1988) and Uganda (1988) the pre-treatment trends are not very coincident; so that, the estimations obtained cannot be considered robust and statistically meaningful. It is true that most of the successfully episodes of trade openness in this continent happened before 1991, as it is clearly enlightened in both figure 9 and 10. In these countries, the main measures and instruments included in the trade reforms process were: the elimination of the import license requirements for certain types of goods, imported from specific countries and tariff revision.

A group of countries where the level of child mortality in the 'treated' unit has remained higher than in the synthetic control is composed by four example reported in figure 9 - Cameroon (1993) and Zambia (1993), Cote d'Ivore and Niger which liberalized in 1994 – but also Burkina Faso (1998) and Burundi (1999), as described in Figure 10. None of these examples seems to have gained or take some benefit from economic reforms and trade liberalizations: the numeric value of the outcome variable recorded in the real situation is above the threshold of the dot line – which represents the pattern of the synthetic unit.

To sum up, what is verified is that the positive evidences of the effects of trade reforms on child morality are concentrated in the first part of our sample; specifically, in countries where this phenomenon happened until the beginning of last decade of the nineteen century. Nevertheless, the influence of trade openness in the African continent after that period, seems to have neither discernible or clear effectiveness. Ever since, the level of child mortality – used as a proxy of food security in the present study – either remained higher in the 'treated' than in the

counterfactual, or the precision of the estimations are not be able to guarantee any significant conclusion.

It is also possible to conclude that the early episodes of liberalization in Sub-Saharan countries, such as in Botswana, Ghana, Gambia, Guinea, Mali, Uganda and Benin (started in 1979 and finished in 1990), had a positive impact of the reduction of the number of children dead before the age of five. While, almost all of the late attempts (among 1993 in Cameroon, and 1999 in Burundi) did not benefit from the effects of a more integrated economy. This is also confirmed by the placebo tests described in figure 14.

The explanation suggested by some researchers is that in these geographical areas trade reforms occurred after a process of gradual reforms and strategies; this can lead to an attenuation bias in the results obtained.
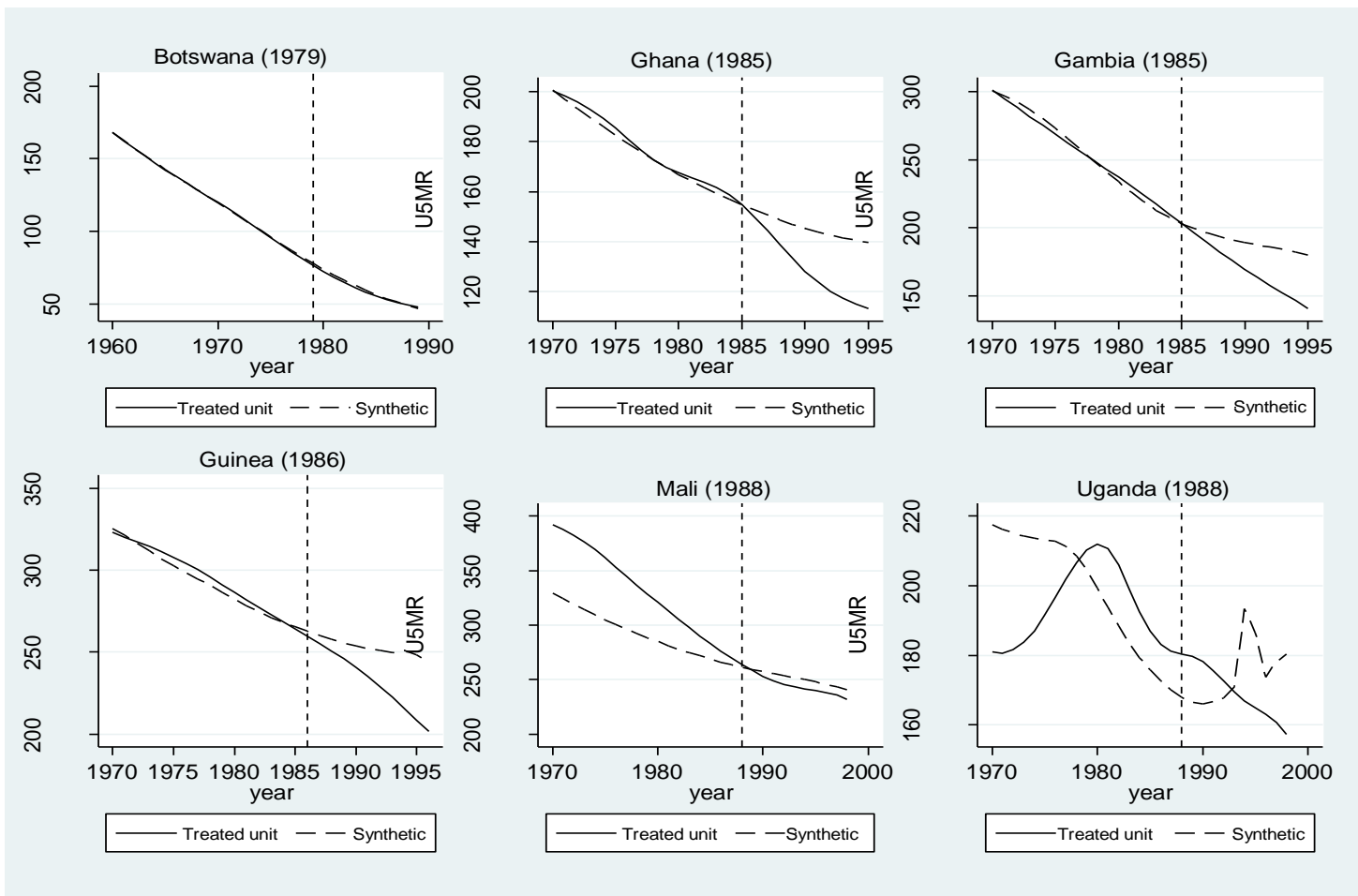
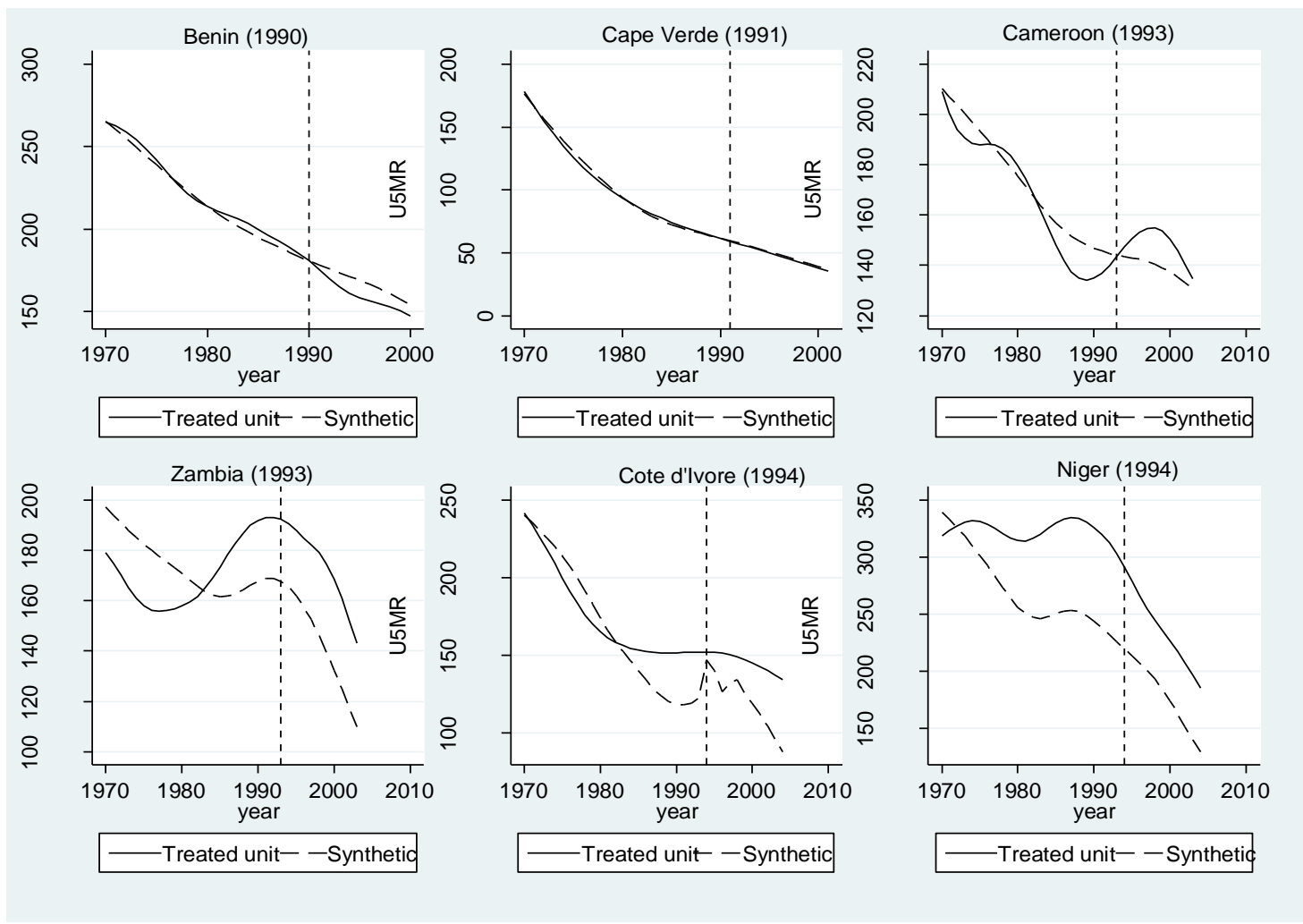**Figure 8.**: trend of U5MR in Africa from 1979 to 1988 (treated country vs synthetic unit).

Figure 9.: trend of U5MR in Africa from 1990 to 1995 (treated country vs synthetic unit)
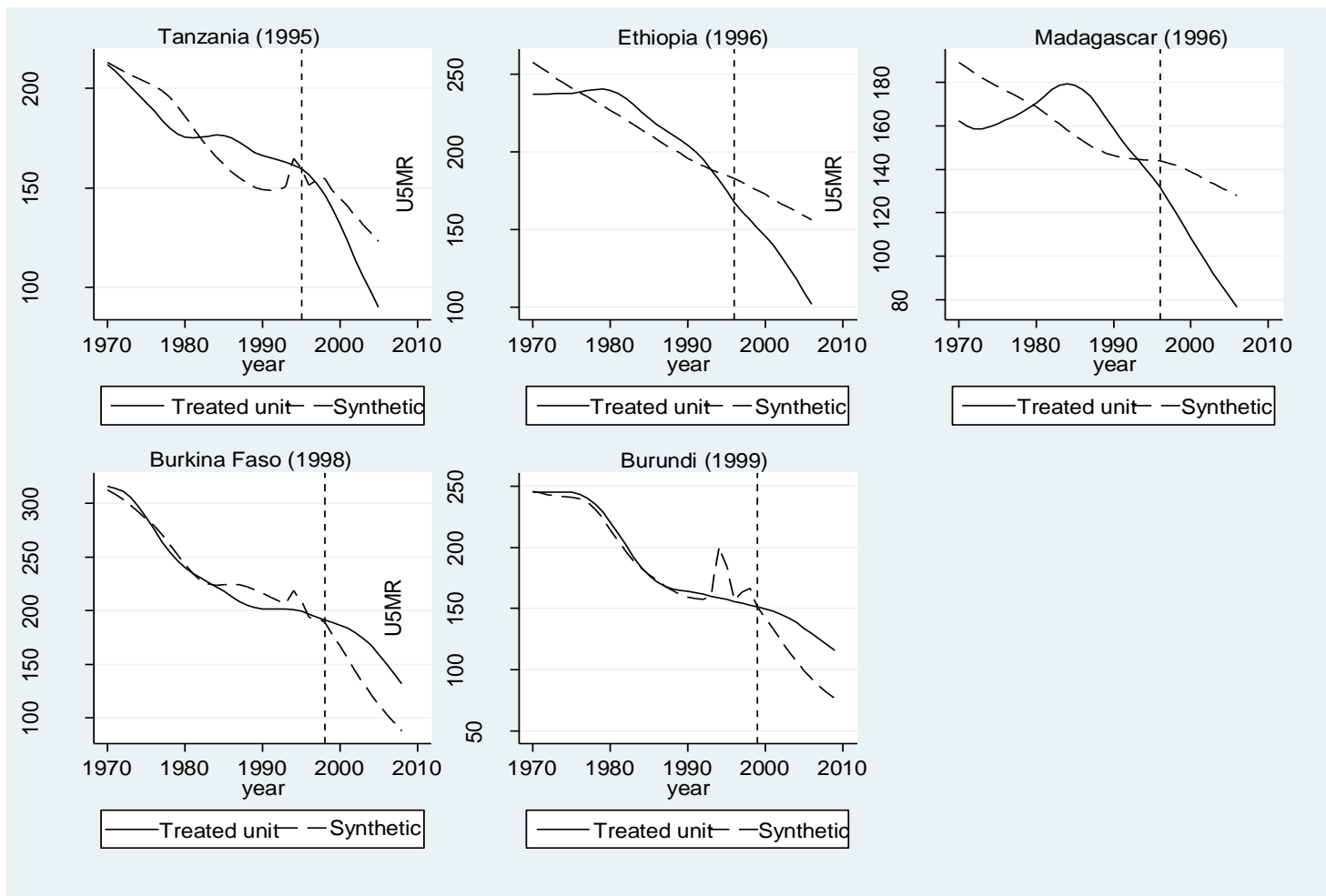
Figure 10: trend of U5MR in Africa from 1996 to 1999 (treated country vs synthetic unit).

7.2.4. Middle East and North Africa

The results for the Middle East and North Africa (MENA) region are graphically summarized in figure 11. Generally speaking, in this specific subsample, what is obtained is far from conclusive.

In Tunisia (1989) for example, the almost null effect is robust to placebo tests; as for Morocco – which had liberalized in 1984 – the political situation started to change since the late 1970s, when the country made good progress in reducing the balance-of-payments gap, by curtailing government spending and implementing tight incomes and credit policies. Moreover, the country also pursued a substantial trade and price liberalization.

In three cases – Morocco (1984), Tunisia (1989) and Mauritania (1995) – the difference in U5MR between the liberalizing economy and the synthetic control, is quite small at the time of treatment. In addition, where the process of liberalization took place rather late, the liberalizing country actually fares worse than the regional synthetic control both five and ten years after liberalization.
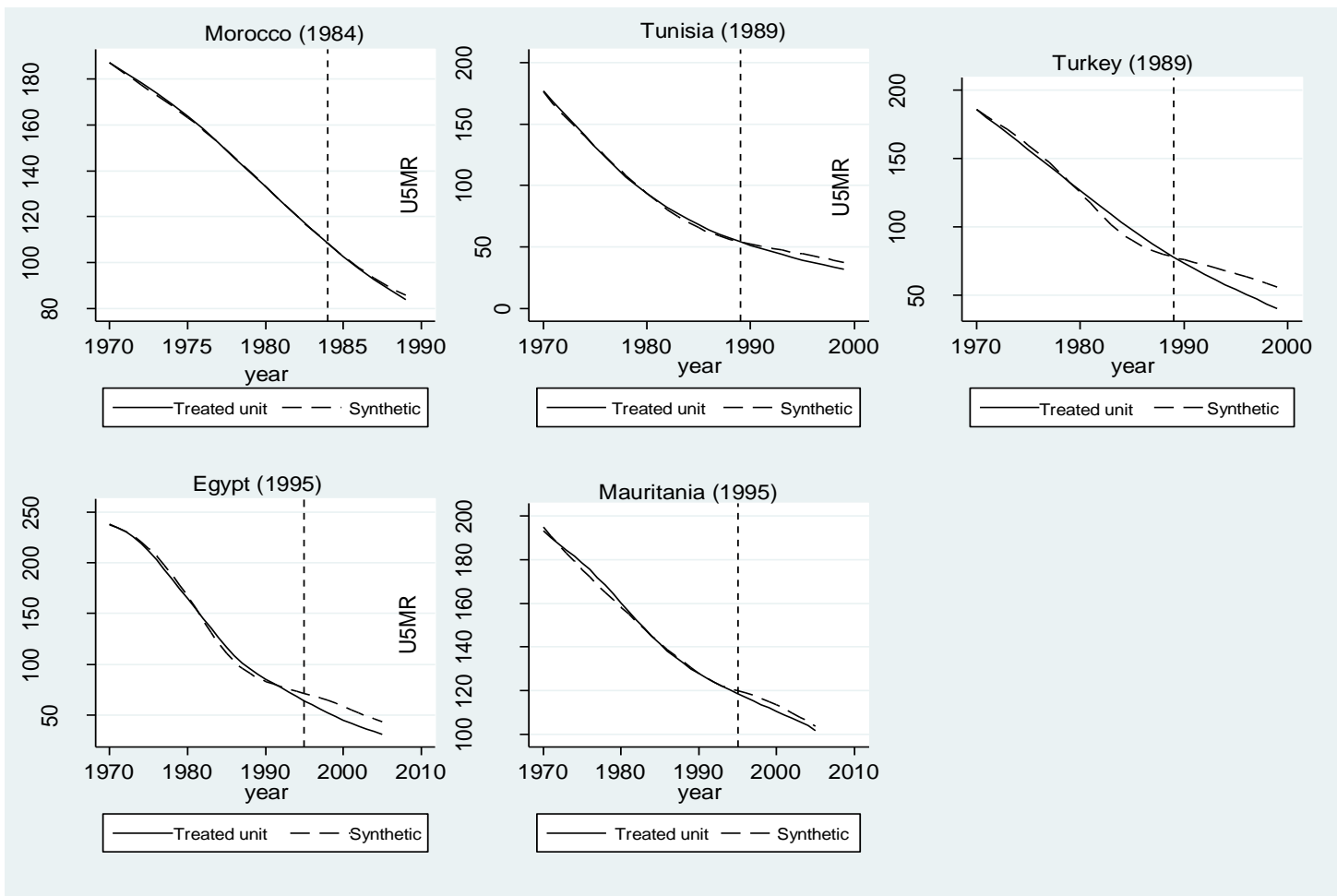
Figure 11: trend of U5MR in Middle East and North Africa from 1984 to 1995 (treated country vs synthetic unit).

7.3. Placebo Tests

However, we are aware of the fact that more placebo tests are required to test the validity and the robustness of these evidences. Moreover, in a few developing countries political and economic reforms happened simultaneously; so that, this overlapping may not permit the correct identification of the real effect of commercial openness on the outcome variable. Another element that should be taken into more consideration is the role of government regime; in fact, the same treatment in a democratic or autocratic country, may cause different performs.

In conclusion, the analysis in the previous paragraphs indicates that in some countries in different parts of the world, trade liberalization is associated with a remarkable positive effect on the reduction in child mortality rate. Nevertheless, either across the world and time, a lot of heterogeneity can be encountered.

In particular, the countries that are classified as 'open' after 1990, - among them many are located in Africa – did not gain the same benefits as the states which liberalized their economies before that year. This conclusion can be lead in terms of the percentage of under-five mortality rate.

In the research paper of Billmeier and Nannicini (2013) they speculate that one possible explanation can lie in a "*timing effect of economic liberalization*". In fact, Giavazzi and Tabellini (2005) has already documented that also the political regime is a fundamental factor in affecting the performances both of the economic growth and the under five mortality rate. These researches demonstrated that the states, whose market is more integrated before becoming democracies, usually follow a better tendency than those territories which perform the opposite pattern.

These considerations may be also applied to the variables examined in this study, but required more and deeper investigations. On the other hand, it was mentioned the 'timing effect' as another possible interpretation of the results: Wood (1997) indicated that there is an interaction between trade openness and wage inequality. In the current research this argument can be better focused relatively to developing economies.

More specifically, whether a poor state liberalizes its market, increasing the level of economic integration, it is inevitable to consider also the influence of globalization. In fact, in such a more competitive situation both the role of capital and labor are questioned. If the number of worldwide 'open' countries rises, there will be observed more specialization in labor-intensive

goods, produced in sectors agriculture and textile. Under these circumstances, the study of the potential benefits of a better and larger market openness on nutrition in general and on children mortality, specifically, needs to be meliorated.

However, the evidences draw out from the SC approach respect, on average, the socio-economic history of the sample considered. As far as the Asian continent, economies liberalized their markets earlier than in other part of the world: this allows it to obtain more substantial and greater economic and social benefits. Then, was the time of Southern and Central American governments, and only eventually, Africa. In these two circumstances the expected positive influence of more market integration on food security, through the measure of the percentage of child mortality.
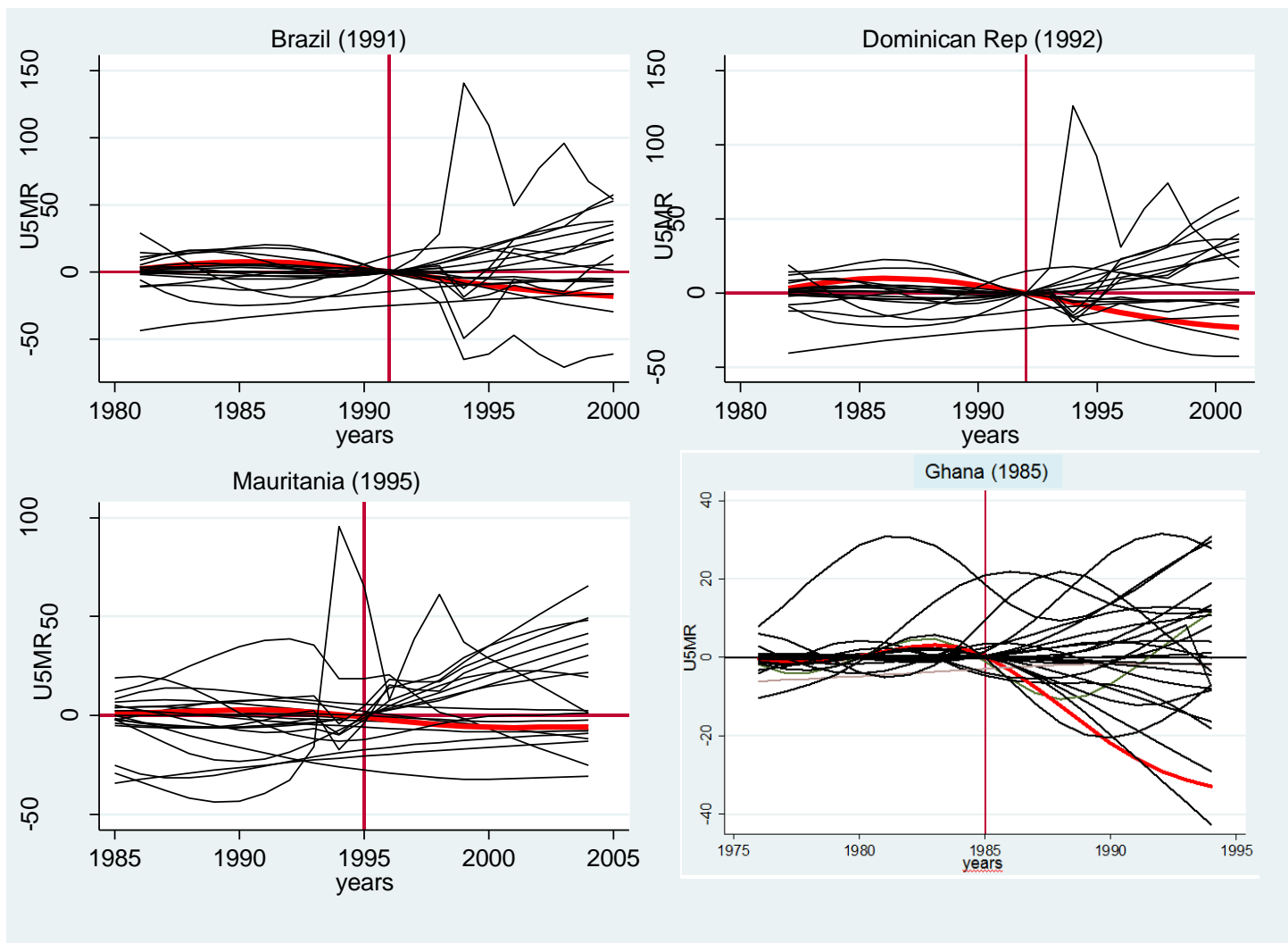
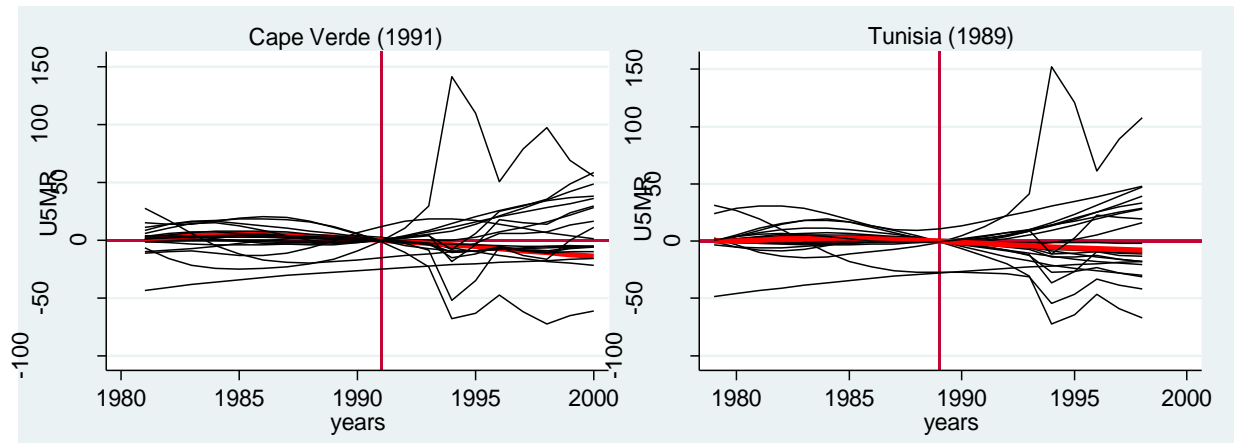**Figure 12:** Placebo tests in states with a significant impact of trade liberalization on U5MR.

Figure 13: Placebo tests in states with a null impact of trade liberalization on U5MR.
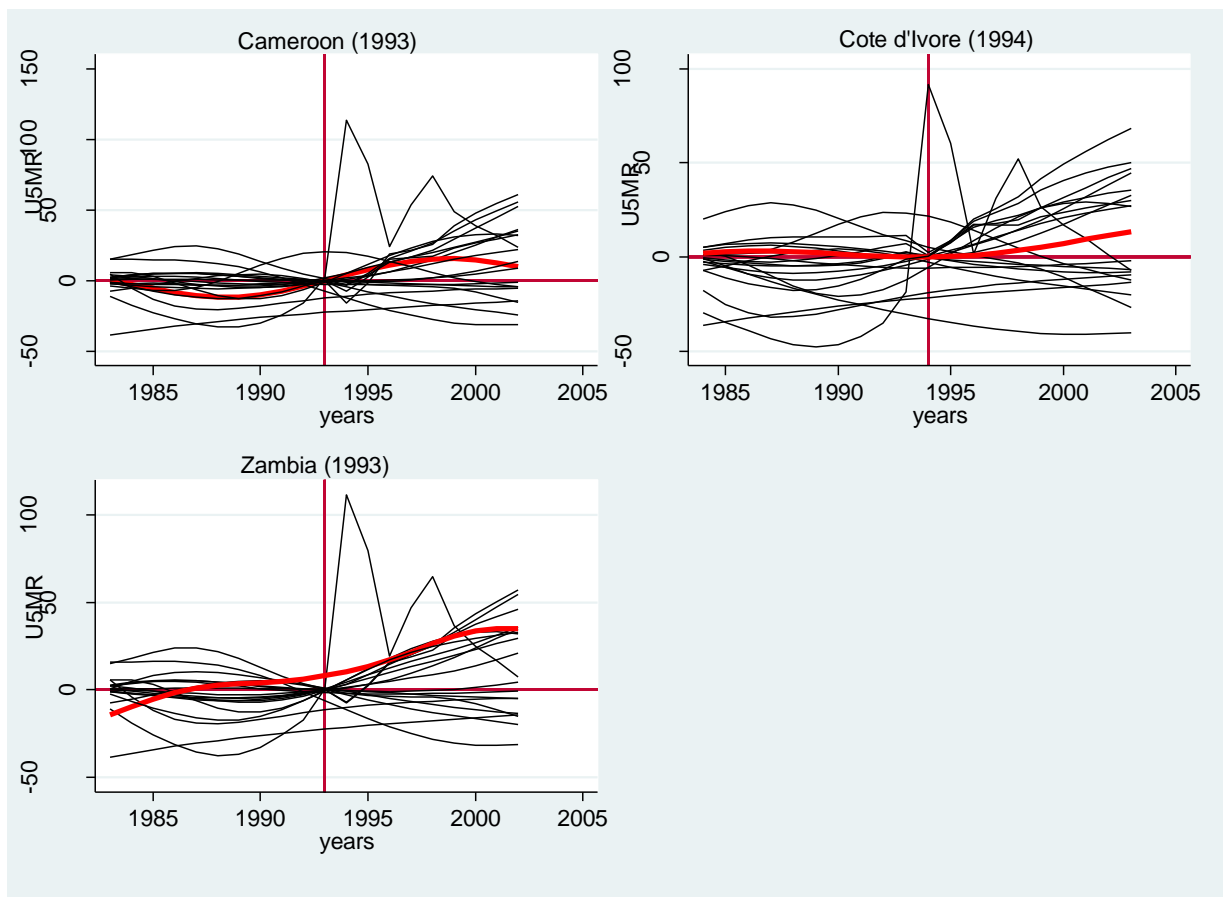
Figure 14: Placebo tests in states with a negative impact of trade liberalization on U5MR.

8. Conclusions

'It is intolerable that thousands of people continue to die every day from hunger, even though substantial quantities of food are available, and often simply wasted'.

POPE FRANCIS[12]

The food security issue is becoming more and more centre-stage in the political and social debate. Especially after the world food crisis of 2007-2008 and the consequent price spikes, it reached the top of the international agenda. The problems of accessibility, disposability and utilization of food, both in developing and poor countries, now draws the attention of policymakers and researchers.

The topic of food access and availability has always occupied a determinant role in the definition of the framework and structure of different populations around the world, particularly in poor continents, but nowadays also in the rich Europe. In fact, as recently highlighted not only in Reports (FAO and other international agencies) but also in the newspapers - like the Wall Street Journal in an interview with Bill Gates – it is claimed that stable and continuous food supplies, together with a good level of health and nutrition, are fundamental to improve the level of welfare in countries. What is more, it is crucial to consider also the socio-political implications of this: healthy young generations can attend school more frequently, increasing their human capital, contributing to their country's economy.

The above observations brings in focus the fact, thoroughly examined in the first three chapters of the present opus, that it is a complex and dynamic problem, influenced and determined by many 'macro' factors. From this examination, it is possible to say that to cope with this topic a multidisciplinary approach and vision is required. In point of fact, the very definition of what is commonly called food security is a matter of debate, not only at national but also at global level.

To start from the very beginning, the same definition of what FS means, is a concept in evolution. In fact, its explanation, has broadened since the term first came to prominence at the 1975 World Food Conference (Staatz *et al.,* 1990). Moreover, in the mid- and late 1970s, FS meant avoiding transitory shortfalls in the aggregate supply of food. Then, by the early 1980s,

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[12] Pope Francis' special address to the World Economic Forum's Annual Meeting in Davos (January, 2014).

the world food supply situation had evolved markedly, and, in the second half on the 1980s, FS became an important principle in development processes. It generated not only a large academic literature, but also a conceptual and organizational innovation by aid agencies, and, many regional, national and local programs in developing countries, especially in Sub-Saharan Africa (Maxwell and Smith, 1993; Jenkins and Scanlan, 2001; Smith *et al.,* 2003).

It was only during the nineties, that the concept of nutritional value and food preferences was included in the first definition (Barret, 2010). So that now, we can refer to FS as *"a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"* (Declaration on world food security. World Food Summit, FAO, Rome, 1996). In any case, FS is conceptualized as established on three main pillars: food availability, food utilization and food access.

Starting exactly from this point, this concept evolved over the years, to include the idea of food safety, food preferences – intended not only as nutritional, but also in terms of cultural acceptance – on the one side. On the other side, it is true that the availability of food commodities, the consequent level of nutritional security, and as a result, the percentage of children who died before the age of five, are linked with other factors: the sanitation system, infrastructures, the level of female instruction and education, only to mention a few.

Another engaging point that I have taken into consideration in my research, was to find which could be considered the optimal indicator(s) of this phenomenon. There is, in fact, an extensive corpus of scientific papers that have suggested different lists of possible indicators. Consequently, an important methodological problem is to determine which indicators can be chosen as appropriate, given our aim. Current research on FS indicators includes measurement of individual food insecurity, hunger duration and frequency, not only at the individual level but also in population subgroups (Radimer, 2002).

More precisely, we came to the conclusion that the most suitable reference (index) was the Global Hunger Index (GHI) developed by IFPRI, which includes a combination of three different dimensions, insufficient availability of food, shortfalls in the nutritional status of children, and child mortality, which is to a large extent attributable to undernutrition (Wiessman, 2006).

Then, trying to take into account all the determinants described at a 'macro' level, we identified that the best indicator to measure the level of food nutrition is the under five mortality

rate released annually by the UN Inter-agency Group for Child Mortality Estimation. It represents the output variable of interest in the present econometric application, and identifies the probability – per 1,000 – that a newborn baby will die before reaching age five. It is important to notice that, among a large number of different types of indicators, usually the analysts need to choose a trade-off between the availability of the information described by each indicator (both in terms of countries and years), and the object of the research.

The goals of my dissertation are multiple: firstly, analyze the complex and dynamic relationship between international trade and FS; then, provide an updated analysis, based on an empirical study of the relationship between trade and FS. Notably, FS has been used as frequent justification for agricultural protectionism policies in both high income countries and poor countries, where it is recently seen as a target that could be also achieved through the liberalization and globalization of international trade. The idea that trade liberalization can challenge FS is reflected in current bilateral and multilateral trade negotiations.

On the other hand, as a measure of economic liberalization, we use the binary indicator developed firstly by Sachs and Warner (1995), and later extended by Wacziarg and Welch (2003; 2008). From a theoretical point of view, it is possible to identify two different reasonings, in favor or against trade openness. On the one hand, a better availability of agricultural commodities could reduce poverty and encourage economic growth; on the other, there is a controversial debate regarding the effects that subsidies received by farmers of rich countries, can have on poor net importer countries. Nevertheless, an excess of markets integration may provoke a weakening of the economies of developing areas, inducing unemployment and, even, a higher level of poverty.

The empirical section of the thesis is mainly focused on study of the interaction and effects of market 'globalization' and its influence on the level of nutritional requirement in different states. The panel dataset considered is composed of 80 developing countries, 39 of which have experienced an episode of trade liberalization, between 1960 and 2010. The 41 residual countries are included as a counterfactual in the econometric approach: the Synthetic Control Method (SCM).

The most recent theoretical application about the investigation of the consequences of a process of economic liberalization on real GDP per capita, was conducted by Billmeier and Nannicini (2013) applying the SCM. Following this approach, we implemented the same

methodology, with the aim to compare the situation of food security in a country after the liberalization process.

This methodology, applied to the investigation of the impacts of economic openness on malnutrition, has been recently implemented as an estimation approach for comparative case studies. The underlying hypothesis is that it is possible to construct a weighted combination of potential control countries – the synthetic control – that approximate the most relevant characteristics of the country affected by the intervention (Billmeier and Nannicini, 2013).

In our study, the 'treated' country is the one which experienced a trade reform – 'treatment'. The situation which happened after the treatment (economic openness) can be estimated by the SCM. The SCM is able to calculate a counterfactual circumstance of the 'treated' country, in the absence of trade liberalization. The consequential result of the 'treatment' can be verified by looking at the outcome trend of the synthetic control.

More precisely, the synthetic control algorithm estimates the missing counterfactual as a weighted average of the outcomes of potential controls. The weights are chosen so that the pretreatment outcome and the covariates of the synthetic control are, on average, very similar to those of the 'treated' country. The advantage and the power of this approach is the possibility to clearly verify the ex post effects of trade reforms on the outcome variable. Moreover, the SCM can be seen as a useful and innovative strategy, which completes and integrates the ex ante techniques of analysis, traditionally implemented in Social and Political Sciences - notably the partial or general equilibrium models.

Although this methodology is more flexible and transparent than others, there is a limitation regarding the inferential techniques. This is mainly due to the fact that the number of observations in the control pool and the number of periods covered by the sample are usually quite small in comparative case studies, like this. This is why, following the suggestions of the inventors, we implemented the placebo tests, based on permutation techniques. Adopting this approach the synthetic algorithm was sequentially applied to every country in the pool of potential controls and then used to compare the placebo with the baseline results.

To sum up, we evaluated the dynamic of the under five mortality rate in a 'treated' country (which experienced an episode of trade liberalization in the decades considered), with the situation in a sample of control (the synthetic control), composed by a group of very similar countries to the one 'treated', but in which there was not any trade reform.

It is important to notice that the synthetic control is chosen taking into account the covariates mentioned above; besides, the weight of each country of the synthetic control is selected in order to minimize the difference with the 'treated' country, in the pre-treatment period. With respect to the results, we decided to select a pre-treatment period of twenty years, and a post-treatment period of ten years. This is mainly because after a decade from the openness to trade, the effect of this phenomenon of child mortality tends to be very difficult to isolate and identify. In fact, other reforms or social policies can occur which can mask the real influence of the occurrence of interest in the outcome variable.

The preliminary results obtained, show that the impacts of trade liberalization on under five mortality rate is, on average, positive. Especially, in 25 countries, out of 39, this effect is clearly registered and the tendency observed over the years is child mortality? reduction. Moreover, in a few developing countries political and economic reforms happened simultaneously; and so, due to the occurance of overlapping reforms this may preclude the correct identification of the real effect of commercial openness on the outcome variable.

In six countries – Cameroon (1993), Zambia (1993), Cote d'Ivore (1994), Niger (1994), Burkina Faso (1998) and Burundi (1999) – the openness of trade markets seems to have had a negative effects on child mortality, and, thereby, on the level of food security. However, in countries such as – Botswana (1979), Morocco (1984), Tunisia (1989), Cape Verde (1991) and Mauritania (1995) – the influence of a more globalized market is demonstrated to be null, with respect to the 'treated' and the synthetic control.

However, a possible observation regarding the African context is the following: the early episodes of liberalization in Sub-Saharan countries, such as in Botswana, Ghana, Gambia, Guinea, Mali, Uganda and Benin (started in 1979 and finished in 1990), had a positive impact of the reduction of the number of children dead before the age of five. While, almost all of the late attempts (among 1993 in Cameroon, and 1999 in Burundi) did not benefit from the effects of a more integrated economy. The explanation suggested by some researchers is that in these geographical areas trade reforms occurred after a process of gradual reforms and strategies; this can lead to an attenuation bias in the results obtained.

In summary, the empirical analysis emphasized the fact that trade liberalization has, on average, a positive influence on food security level, measured as the percentage of kids dead before the age of five. This specific determinant seems to perform a crucial role in the analysis of

nutrition determinants. Moreover, a robust and statistically significant link was discovered and identified between trade openness and food (in)security in the sample considered.

However, the theoretical ambiguity of the relationship between trade and food security, associated with the endogeneity of agricultural trade policy on food security, makes this analysis a real empirical challenge. Yet, understanding this relationship represents a fundamental step towards the design of better policies for food security.

In any case, the debate around the effects of trade liberalization on food security still remains open; moreover, its impacts continue to be ambiguous. However, this modern methodology can be considered very useful to verify parametric relationships. In particular, the precision and the accuracy of the estimations of the counterfactual are extremely good; the countries included in the synthetic control are selected by an algorithm, as a function of their similarity to the 'treated' country, relative to the chosen covariates (Abadie *et al.,* 2010; 2012). Lastly, the proposed statistical framework can deal with endogeneity from omitted variable bias by accounting for the presence of time-varying unobservable counter-founders (Billmeier and Nannicini, 2013).

From my personal point of view, if somebody asks me why it is so important to study food security in developing countries, I could answer that it is exactly its complexity that makes it fascinating and very challenging because of all the factors involved. What is more, the State of Food Insecurity released by FAO last year, enlightens us that the number of undernourished people still remains unbelievably high: 870 million people in the two-years period, 2010–2012, and the vast majority of them live in low income countries.

In any case, the study trends to confirm the fact that, generally speaking, more openness in trades and commerce can increase the level of food security in the analyzed countries. As an additional observation now at the end of my current targeted research, from my personal point of view, what should be taken more into consideration in the future is the role of education, aimed at providing 'the heart of the process of self-empowerment' targeting a firm deliverable creating over time a powerful support pillar for community-centered microfinance projects which can be ideal readily-managed progressive vehicles for international aid programs. In fact, where trade liberalization requires a shared effort at all levels – national, international, socio-political and institutional – to increase the local level of schooling, at least primary and secondary, the governments can create targeted projects.

In conclusion, during the development and the implementation of the present research, it was extremely attractive and stimulating to be engaged in the whole complexity of the matter of food and nutrition, food and its security, food and its relevance at social and cultural levels.

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