Fighting poverty and child malnutrition: on the design of foreign aid policies

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Abstract

In this paper, we have developed a two-period overlapping-generation model featuring the effects of child nutrition in developing countries. The model gives rise to multiple equilibria including a poverty trap. It shows that child nutrition status may affect the development of human capital unfavorably and leads countries into poverty. Various exogenous foreign aid policies implemented by international organizations such as the World Food Programme (WFP) are considered. School feeding programs can solve social problems like child labor. However, they do not necessarily help countries to achieve economic development. On the contrary they can lead to poverty if the initial human capital is low. Only if the subsidies are large, can they prevent a country being trapped in poverty. If the WFP provides a fixed amount of food to households, then a quality/quantity trade-off takes place: Parents decrease the nutrition of their offspring and increase the number of children they have. Consequently, total nutrition decreases and the developing country gets locked into poverty whatever its level of human capital. At the end of the paper, we estimate the changes in human capital from a sample of 66 developing countries (almost half of which are African countries), and use the estimates to explore the quantitative effects of the model. The model is then calibrated under different production functions. The results confirm the theoretical predictions.

JEL classification: I10; O11; O40; I11.
Keywords: Child Nutrition; Foreign Aids; poverty traps; human capital; school meals.

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1 Introduction

Malnutrition constitutes a global "silent emergency", killing millions every year and sapping the long-term economic vitality of nations, according to the UN Children's Fund (UNICEF). In the state of the World's Children 1998, UNICEF advised governments and other international organizations to take measures against hunger and the violation of children's rights. The World Food Programme (WFP) estimates that there are about 925 million undernourished people in the world today. Hunger and malnutrition are a greater risk to worldwide health than AIDS, malaria, and tuberculosis combined. Consequently, hunger and malnutrition are top global priorities.

About 90 million people per year get food from the WFP, the largest humanitarian organization worldwide. According to the Food and Agriculture Organization (FAO), WFP delivered almost 50% of global food aid in 2004. WFP's mission is to improve the nutrition and quality of life of the most vulnerable people at critical times in their lives and to fight micronutrient deficiencies, reduce child mortality, improve maternal health, and combat disease, including HIV and AIDS. For instance, in 2009, WFP spent 6.7 million dollars supporting regions such as Uganda, Chad, Liberia, Sierra Leone, Ivory Coast and Guinea, offering school feeding programs, subsidizing nutrition prices, providing financial support to local farmers and providing food to households.

This paper explores the causal links between nutrition, education and human capital accumulation. It evaluates the efficiency of different WFP food aid programs aimed at improving child nutrition and pushing the developing countries away from deprivation. Several studies such as Arcand (2001), Wang *et al.* (2003) and more recently Curais *et al.* (2010) show that nutrition affects the health and economic development of nations. In particular, these researchers argue that poor nutrition leads developing countries to impoverishment. However they do not show how these countries can escape from the poverty trap. Galor and Mayers (2003) show that the link between health and education contributes to explaining the long term effects of nutrition and health on economic growth. They show that if policies financing education are implemented without addressing deficiencies in nutrition, poverty traps may persist.

In our benchmark model, we consider an overlapping generations model where agents live for two periods. Agents get their utility from consumption and the human capital of their surviving children. They choose how many children to have, their amount of schooling and their level of nutrition. It is assumed that parents decide how their children allocate their time between schooling and labor. Child labor, in fact may be crucial to their nutrition, since many children in developing countries are forced to work to provide a supplement to their parents income (see, for example, Hazan and Berugo, 2000; Adbus and Rangazas, 2010; Curais *et al.*, 2010 and Moav, 2005).

In our model, if children spend less time in education and more in work, the human capital accumulation of children will have a negative impact on future human capital and thus on the income of the country. In this framework, we assume that there is no bargaining between parents and children regarding the allocation of the family's income (see for instance Udry, 2003). Moreover, a key ingredient of our setting is that the children's survival probability depends on their nutrition status (see Strulik and Weisdorf, 2010; Gloom and Palumo, 1999). This allows us to investigate the effects of health on human capital through changes in mortality (see Chakraborty and Das, 2005) not only in the benchmark model but also in the extension model where we include aid in the survival probability of children (see Huff and Jimenez, 2003).

Our model emphasizes the importance of the relationship between health and learning capacity (Curais *et al.*, 2010). Here, nutrition has dynamic and synergistic effects on economic growth, through the channel of education. For instance, Neumann, *et al.* (2007) used a randomized school feeding study that was conducted in the rural Embu District of Kenya to test for a causal link between animal-source food intake and changes in micronutrients, growth, cognitive, and behavioral outcomes. They showed that meat supplementation improves growth, cognitive and behavioral outcomes in children. Simeon (1998) showed that providing school meals can be beneficial for learning because it relieves immediate short-term hunger. Children who are not hungry are more attentive and have higher cognitive abilities.

To capture this complementarity, we assume that the determinants of human capital includes education, parental human capital (see de la Croix and Doepke, 2003) and the nutrition status of the children (see Curais *et al.*, 2010). Our benchmark model gives rise to multiple equilibria (development regimes) and initial conditions matter. Some countries may be caught in a poverty trap. Possible strategies (such as foreign food aid) will be identified and evaluated to see if they allow developing countries to escape from poverty.

Recently a number of studies have focused on the relationship between foreign aid and economic growth. Empirical studies, such as Hansen and Tarp (2001) and Economides *et al.* (2008), have found that aggregate foreign aid has, on average, a positive effect on growth in a country. However, they have not focused on specific policies such as food assistance. Other studies (see, for instance, Easterly *et al.*, 2004; Roodman, 2007) have argued that the recipient country's characteristics determine the success or failure of foreign aid. Of these, the most substantial are the timing of the distribution of aid during a negative trade shock (Collier and Dehn, 2001) and the geographic/tropical location of the recipient nation (Daalgard *et al.*, 2004).

Our paper is closely related to those by Azarnert (2008) and Neanidis (2010). Azarnert explored the influence of humanitarian aid on population growth and human capital accumulation. In his model, fertility decisions are based on a quantity/quality trade-off for children, as originally proposed by Becker (1960). This trade-off arises because parents' utility depends on both the number and the quality of their children. Azarnert (2008) shows that aid increases fertility by reducing the cost of having more children. As a result, parents invest less in the education of their offspring, which leads to a fall in human capital. However Azarnert ignores the potentially beneficial impact of foreign aid on the survival probability of children, which has been extensively documented (see Huff and Jimenez, 2003; Neanidis, 2010). His contribution also neglects the effect of aid on nutrition and thus on children's health (see Kraak *et al* 1999).

Unlike Azarnert (2008), Neanidis (2010) examines the influence of foreign aid on population growth and health capital using a two period OLG model. He assumes that aid is allocated to every child and adult. His model accounts for the endogeneity of parents' allocation of time to childrearing, and in this way allows the impact of their decisions to be internalized. He finds that aid per child (flows of medication) increases the children's survival probability, thereby reducing fertility, while also contributing positively to children's health status. On the other hand, aid per adult increases fertility by reducing the quantity cost of children, thereby reducing the time that parents spend in rearing their children. However Neanidis neglects the fact that the survival probability of children should also depend on health expenditure by parents (see Boucekkine and Laffargue, 2010; Chakraborty and Das, 2005); he assumes that it depends only on foreign aid. He also ignores the complementarity that exists between health, education and human capital accumulation (see Galor and Mayers, 2003; Curais *et al.*, 2010). This complementarity is crucial because there are foreign aid programs (such as school feeding programs) whose goal is not only to increase the nutrition status of children, but also to encourage them to stay at school, and to diminish the prevalence of child labor.

In contrast to these studies, the quantity/quality trade-off in our framework depends on fertility and on parental expenditure on the nutrition of their children, as well as on the length of time that parents allow their children to spend at school. Moreover, we evaluate the effect of foreign food aid at different levels of initial human capital. Accounting for these considerations in the model allows complex effects of foreign food aid to be analyzed.

The model is extended by implementing four different foreign aid policies (mainly provided by the WFP). Total nutrition is constituted by foreign aid and the nutrition available from parents. The WFP provides school meals or fixed amounts of food in households, subsidizes prices and improves the infrastructure of local food industries in developing countries. The main results are that providing school meals and fixed amounts of nutrition to households locks poor developing countries into poverty. In particular, these foreign aid programs increase fertility by reducing the quantity cost of children. As a result parents invest less in the nutrition of their children, leading to a slowdown in human capital accumulation which may trap the recipient country into poverty. However, if the WFP decides to provide large amounts of food in schools or in households, then child nutrition depends only on foreign aid programs and the developing country can escape from the poverty trap: when the WFP subsidizes the price of nutrition for children there is an income effect, and parents can afford to offer more nutrition. The total nutrition therefore rises, thereby increasing the survival probability of children and their human capital. As a result, poor countries can escape from the poverty trap.

School feeding programs are more efficient for middle-income developing countries than the other two foreign aid programs. School feeding programs increase the length of schooling and improve the human capital of future generations even if the total nutrition remains unchanged (Jacoby *et al.*, 1996; Powell *et al.*, 1983; Murphy *et al.*, 2003 and Agarwai *et al.*, 1989). Child labor decreases, and so middle-income countries can achieve economic development.

Finally, we consider the case when the WFP improves the infrastructure of local food industries or supports local farmers financially, so as to increase the quality of food and to improve agricultural productivity. This improvement is captured in my framework by the effect of the technological level on human capital. An increase in the technological level raises the human capital of future generations, and hence poor countries can achieve economic development.

The model is calibrated at the end of this paper. Following the technique developed by Bils and Klenow (2000), we obtain the human capital stock by using United Nations surveys (UNESCO, 1977; 1983). Also, using data from Barro and Lee's(1993) data base, the World Bank and the Food and Agriculture Organization, the parameters of human capital accumulation can be estimated for 66 developing countries (almost half of them in Africa). All the variables that feature as determinants of changes in human capital (nutrition, education and parental human capital) are significant. Other parameters are based on existing research.

A numerical example of our model is presented for the following reasons. First, we know that the majority of developing countries are rural economies. A linear production function is used in the model so that analytical results can be obtained. In the calibration part, the linear production function (as in the theoretical part) and the decreasing-returns-to-scale production function that characterizes rural economies are investigated. The results are same in both the theoretical and the numerical analysis. The numerical example is also intended to investigate what level of assistance from the WFP is needed to lift countries out of poverty for each foreign aid policy. Finally, a sensitivity analysis of the parameters is provided to ensure the validity of our results.

The rest of the paper proceeds as follows. Section 2 presents the benchmark model, Section 3 illustrates the dynamics of human capital, Section 4 presents the different foreign aid programs incorporated in the benchmark model, Section 5 illustrates a computational experiment and Section 6 presents the conclusions of this study.

2 The Benchmark Model

Fertility, mortality and net reproduction. Consider an OLG economy in which activity extends over an infinite horizon. In each generation, individuals live for two periods: childhood and adulthood. All the decisions are taken by adults. Let L_t denote the number of adults in period t, and n_t the number of births per adult. The probability of survival from childhood to adulthood is denoted by $\pi_t \in [0,1]$. In particular, it is synonymous with the fraction of children, born in period t who become adults in period $t+1$. We assume that the children live throughout the period t. At the end of the period t, the children either die or become adults in period $t+1$. It follows that the net reproduction rate is $\pi_t n_t$. Thus, the adult population at period $t+1$ is:

$$L_{t+1} = \pi_t n_t L_t. \tag{1}$$

We also assume that the survival probability is endogenous and a function of the total level of nutrition. In particular, we assume that $\pi_t = \pi(M_t)$, where $\pi^{'}(M_t) > 0$ and $\pi^{''}(M_t) < 0$. This is similar to Fogel's (1994) contribution, which showed that better nutrition in childhood affects health and life span during the adult years of life. Moreover, it is consistent with Gloom and Palumo (1993) who analyzed a life cycle model where the survival probability was determined by health capital accumulated via nutritional investment. The survival probability of children is expressed by the function:

$$\pi_t = min[M_t^{\sigma}, 1]. \tag{2}$$

with $0 < \sigma < 1$.

The specification of survival probability is similar to that of Chakraborty and Das (2005) and Boucekkine and Laffargue (2010):

Preferences and optimization. Adults maximize the utility which they derive from their consumption c_t, the number of children n_t, and the human capital h_{t+1} of their children, and the children's survival probability π_t. The utility function is given by:

$$\ln c_t + \beta \ln(\pi_t n_t h_{t+1}). \tag{3}$$

The parameter $\beta > 0$ is the altruism factor. Notice that the parents care about the quantity $n_t\pi_t$ and quality h_{t+1} of their surviving children. This type of preference specification has been used in the literature on fertility and growth (see for instance, Galor and Weil, 2000; Hazan and Berdugo, 2002; Moav, 2005).

The adults are endowed with one unit of time. Raising one child takes the fraction $\phi \in (0,1)$ of an adult's time. The income of an adult is $w_t h_t$ where w_t is the wage per unit of human capital and h_t is an adult's human capital. Consequently, as is standard in the literature (see for instance Barro and Becker, 1989; de la Croix and Doepke, 2003; Azarnet, 2008) the existence of the opportunity cost $w_t h_t \phi n_t$ creates a trade-off between the quality and the quantity of children. Furthermore, an adult has to choose a consumption profile c_t, the number of children n_t, the level of nutrition of the children m_t, and the number of years of schooling per child e_t.

Here, we measure the length of schooling, e_t as the number of post-primary years of schooling (as primary school is usually compulsory). Hence, q represents the minimum education received in primary school in developing countries. This parameter ensures that human capital is positive. This reasoning has been extensively used by other researchers(see de la Croix and Doepke, 2003; Hazan and Berdugo, 2002). However, Curais *et al.* (2010) measures q from infancy in their human capital accumulation model.

The human capital of children h_{t+1} thus depends on their level of education e_t and total nutrition M_t. In the benchmark model total nutrition equals with the nutrition offered by parents, m_t. The human capital accumulation is:

$$h_{t+1} = BM_t^{\theta_1}(e_t + q)^{\theta_2} h_t^{1-\theta_1-\theta_2}. \tag{4}$$

We assume that the changes in human capital depend on the human capital of the parents h_t, and B which is the productivity of human capital (technological level). This law motion of human capital is different from that used by Curais *et al.*(2010) since we include the human capital of parents and the productivity of human capital. Furthermore, B is taken as constant. More precisely, we assume that it is equal to one and it can be influenced exogenously. h_t captures the intergenerational transmission of human capital within a family. In other words young individuals inherit some of the human capital of their parents. This reflects cultural transmission within the family. Our model of human capital accumulation differs from that of de la Croix and Doepke (2003) since it contains nutrition and we take q to be primary education.

Children can also contribute to family income. Children have an endowment of 1 unit of time. This time is spent either learning e_t or working $(1 - e_t - q)$. The earnings of a working child are $w_t\gamma(1 - e_t - q)$. The child worker lacks experience and physical strength compared to adult worker. Thus, we assume that $0 < \gamma < 1$.

Moreover, since we have homogenous agents in each sector of the model, we assume that all children have the same productivity and their human capital does not influence it. Furthermore, the parents spend all the household revenue on their own consumption and the nutrition of their children. Thus, the budget constraint has the form:

$$c_t + m_t n_t = w_t h_t(1 - \phi n_t) + w_t\gamma(1 - e_t - q)n_t. \tag{5}$$

Firms. Firms produce using a constant-returns-to-scale technology:

$$Y_t = H_t, \tag{6}$$

where H_t is the total amount of human capital in the workforce. This assumption allows analytical results to be obtained, although we know that constant returns to scale are not realistic in rural economies. The same assumption was made by Adbus and Rangazas (2010), who investigated the effects of food consumption on economic growth in England during the mid-18th century. The main reason that linear production functions are used is for simplicity and to obtain analytical results [1]. At the labor-market equilibrium, we have:

$$H_t = [1 - \phi n_t]h_t + \gamma[1 - e_t - q]n_t. \tag{7}$$

The workforce participation of parents consists of their remaining time after childbearing and educating their children. It is therefore equivalent to the time for which a child works. As the labor market is competitive, the child's wage equals the child's marginal productivity at each date t, which is constant and normalized to $w_t = 1$ for simplicity.

At this point in the analysis, I will impose two assumptions. Assumption 1 ensures the positivity of human capital in the steady state. Hazan and Berdugo (2002) and Curais *et al.* (2010) apply a similar condition. [2]

Assumption 1. $h_0 > \frac{\gamma}{\phi}$.

The second assumption ensures the positivity of the optimal choices.

Assumption 2. $1 - \theta_1 - \theta_2 - \sigma > 0$.

Optimal choices. Maximizing Equation 3 subject to Equations 4 and 5 yields the optimal solutions for education, nutrition and fertility. These are:

$$e_t = \begin{cases} 0 & h_t \leq h_1, \\ \frac{\theta_2[h_t\phi - \gamma]}{\gamma(1-\theta_1-\theta_2-\sigma)} - q & h_1 < h_t < h_2, \\ 1 - q & h_t \geq h_2. \end{cases} \tag{8}$$

[1] In my numerical example I also present a decreasingÐreturns-to-scale production function, $Y = H_t^\alpha$, that is consistent with agricultural economies

[2] They assume that the income generated by children is accrued to parents and the time taken to rear a child is intensive. As a result the increasing differential wage(between parental and child labor) leads to a decrease in child labor when the initial human capital is large enough.

The threshold levels of adult human capital[3] $h_1 = \frac{(q(1-\theta_1-\theta_2-\sigma)+\theta_2)\gamma}{\theta_2\phi}$ and $h_2 = \frac{\gamma(1-\theta_1-\sigma)}{\phi\theta_2}$ define three distinct situations. In the low regime (developing countries), children only attend primary school, and the rest of their childhood is dedicated to increasing the family income. The time spent in education is positive and increasing with parents' income when human capital increases. In the high regime (developed countries), children spend all their time in education. In other words, there is no child labor in the high regime.

The nutrition level offered by constitutes the total nutrition that children receive:

$$m_t = M_t = \begin{cases} \frac{(\sigma+\theta_1)(h_t\phi-\gamma(1-q)}{1-\sigma-\theta_1} & h_t \leq h_1, \\ \frac{(\sigma+\theta_1)(h_t\phi-\gamma)}{1-\sigma-\theta_1-\theta_2} & h_1 < h_t < h_2, \\ \frac{(\sigma+\theta_1)(h_t\phi)}{1-\sigma-\theta_1} & h_t \geq h_2. \end{cases} \tag{9}$$

The optimal level of nutrition given by this equation is the same as that given by with Arcand (2001) and Wang *et al.* (2003). As already mentioned, these studies show that low income level is related to low nutrition levels (see Appendix A and Figure 1). Hence, the optimal nutrition choice is an increasing function of human capital. They used information on GDP and average daily per capita calorie intake in 114 countries, and showed that countries with higher GDP have higher levels of nutrition. When the maximum level of nutrition is reached the number of children per adult decreases[4].

$$n_t = \begin{cases} \frac{(1-\sigma-\theta_1)h_t\beta}{(1+\beta)(h_t\phi-\gamma(1-q))} & h_t \leq h_1, \\ \frac{\beta h_t(1-\theta_1-\theta_2-\sigma)}{(1+\beta)(h_t\phi-\gamma)} & h_1 < h_t < h_2, \\ \frac{(1-\sigma-\theta_1)\beta}{(1+\beta)\phi} & h_t \geq h_2. \end{cases} \tag{10}$$

[3]Which can also be considered as income because they involved a linear production function.

[4]Appendix A contains an analysis of nutrition at different levels of human capital. The optimal fertility as h_t increases is also investigated. This shows that nutrition increases and fertility decreases as human capital rises. This effect can be seen in Figure 1.

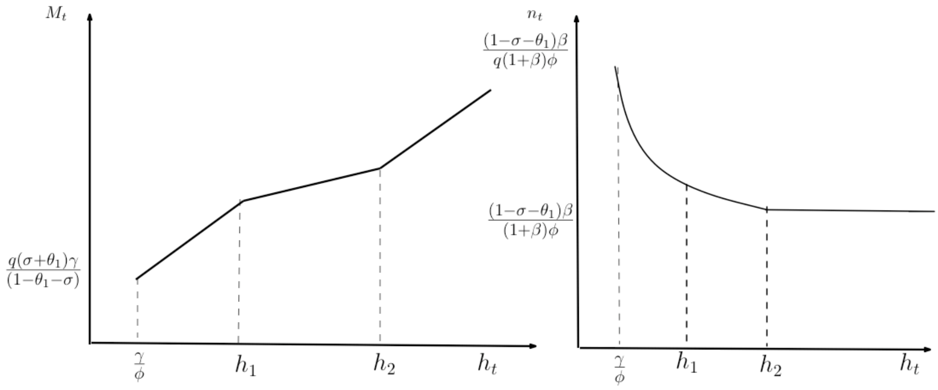

Figure 1: Nutrition and Fertility in Benchmark model

Fertility is positive and decreasing with parental human capital (see Appendix A and Figure 1). This mechanism dates to Becker (1960), where fertility decisions are based on a quantity/quality trade-off for children. This trade-off arises because the utility of parents depends on both the number of their surviving children and their quality (as captured by their level of human capital). Human capital accumulation arises through investments in education and nutrition, both of which are costly, hence the trade-off. Thus, as human capital increases through nutrition and education, fertility decreases. In other words, parents choose child quality over child quantity. This is consistent with the empirical evidence that shows that the fertility rate is lower in developed countries (for instance see Galor and Weil, 2000; Chakraborty, 2004; Azarnet, 2006; Moav, 2005) and it tends towards a constant value.

3 Evolution of human capital

Using the optimal decisions on education, total nutrition and fertility, the following picture for human capital accumulation is obtained:

$$h_{t+1} = \begin{cases} \frac{(\sigma+\theta_1)^{\theta_1}(h_t\phi-\gamma(1-q))^{\theta_1} h_t^{1-\theta_1-\theta_2} q^{\theta_2}}{(1-\theta_1-\sigma)^{\theta_1}} & h_t \leq h_1, \\ \frac{(\sigma+\theta_1)^{\theta_1}(h_t\phi-\gamma)^{\theta_1+\theta_2} h_t^{1-\theta_1-\theta_2} \theta_2^{\theta_2}}{(1-\theta_1-\sigma-\theta_2)^{\theta_1+\theta_2}\gamma^{\theta_2}} & h_1 \leq h_t \leq h_2, \\ \frac{(\sigma+\theta_1)^{\theta_1}(h_t\phi)^{\theta_1} h_t^{1-\theta_1-\theta_2}}{(1-\theta_1-\sigma)^{\theta_1}} & h_t \geq h_2. \end{cases} \tag{11}$$

Further assumptions are needed to ensure that children receive a minimum human capital equal to or greater than their parents' (Assumption 3) and above the minimum q (Assumption 4).

Assumption 3

$$lim_{h_t \to \frac{\gamma}{\phi}} h_{t+1} \geq \frac{\gamma}{\phi}. \tag{12}$$

Assumption 4.

The q value lies in the interval $q \in (q_{min}, q_{max}]$, where

$$q_{max} = \frac{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}} (\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}} \phi\theta_2}{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}} ((\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}} \phi - (1-\theta_1-\theta_2-\sigma)\gamma^{\frac{\theta_2}{\theta_1+\theta_2}})(1-\theta_1-\theta_2-\sigma)}$$

and $q_{min} >> 0$.

This assumption defines a lower and an upper boundary for q. Figure 2 shows the existence of three steady states, one for each regime. Depending on the parameter values, the highest steady state could be above or below h_2[5].

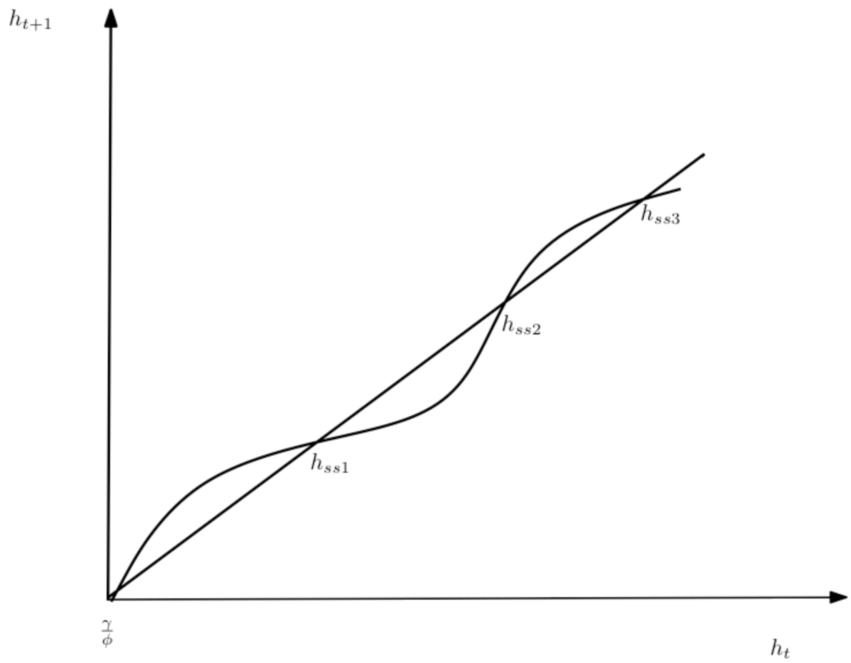

Figure 2: Human capital

[5]The three steady states are presented in the Appendix

When the level of human capital is below h_2, the economy converges to an equilibrium with low nutrition, high fertility and low human capital h_{ss1}, which is locally stable (see Figure 2). This steady state is a poverty trap because it is an asymptotic destination of any economy whose initial human capital stock is in the interval $(\frac{\gamma}{\phi},\ h_{ss2})$. A poverty trap can be defined as "any self-reinforcing mechanism which causes poverty to persist" (Azariadis and Stachurski, 2005).

However there are two additional steady states, one unstable and one stable. As a result, the economy either falls into poverty or achieves economic development.

Proposition 1.

1. *Under Assumptions 1 to 4 and $h_{ss3} < h_2$, a single locally steady state, h_{ss1} and an unstable steady state, h_{ss2} exist. Hence, if the country's initial human capital stock lies in the interval $(\frac{\gamma}{\phi},\ h_{ss2})$ the economy will fall into a poverty trap.*

2. *If $h_{ss3} > h_2$ and $h_{ss2} \in [h_1, h_2]$, then there are two locally stable steady states and one unstable.*

Proof. See Appendix B. □

Proposition 1 argues that whether there are two or three steady states depends on the initial human capital of the country. Two of them are locally stable and one unstable. If the initial level of human capital is greater than the threshold h_2 the whole economy converges to the low fertility, high nutrition and high human capital equilibrium h_{ss3} which is locally stable. On the other hand if the initial human capital lies in $h_{ss3} < h_2$ then the total economy converges to the low nutrition, high fertility and low levels of human capital which is the poverty trap (see Figure 2).

There are several international organizations (the World Food Programme (WFP), Food and Agriculture Organization (FAO), UNESCO etc.) that provide food aid to developing countries not only to relief short-term hunger but also to help them out of poverty. In the following sections, we will evaluate the different foreign aid policies that WFP has implemented.

4 Foreign food aid

In this section, we will explore the different ways to escape from the poverty trap and to help countries achieve economic development. There are a variety of ways to escape from the poverty trap: in particular, changing the initial conditions of the system by foreign aid, or a parallel rise in the transition function h_{t+1}. More precisely, we will examine the aid provided by the WFP, and investigate whether all aid programs are equally efficient in helping countries to escape from the poverty trap.

The WFP provides food to developing countries. Some of its main activities are to implement feeding programs in schools, procure food for households, supply financial aid for local farmers and local economies in general, and provide emergency aid in difficult situations. In the following subsection, we explore the implications of feeding programs in schools, in Subsection 2, we assume that WFP subsidizes the cost of child nutrition and as a result decreases its price. In Subsection 3, the effects of WFP providing a fixed amount of nutrition to households is studied, while Subsection 4 considers the efficacy of WFP financial support of local farmers and local food industries in improving the quality of nutrition and the infrastructure of the developing country.

4.1 Feeding programs in school

WFP's school meal programs work towards achieving several Millennium Development Goals (MDGs)[6]. They directly address the goals set for 2015 of reducing hunger by half, and achieving universal primary education and gender parity in education. In particular, WFP has become the largest organizer of school feeding programs in the developing world. In 2003, WFP fed more than 15 million children in schools in 69 countries. Working with national governments, local authorities, donors and international and local aid groups, WFP uses food to attract children to school and to keep them there.

The WFP transfers available resources to children at each period t in order to improve the human capital according to the following rule. A fixed quantity of nutrition T per unit of time is transferred to each child in education.

The child's survival probability is given by:

$$\pi_t = (m_t + T(e_t + q)))^{\sigma} \tag{13}$$

where $T(e_t + q)$ stands for the meals given to the child during the time he/she spends in school. The movement of human capital is given by:

$$h_{t+1} = (m_t + T(e_t + q))^{\theta_1}(e_t + q)^{\theta_2} h_t^{1-\theta_1-\theta_2}. \tag{14}$$

The survival probability and human capital accumulation both depend on the nutrition provided by parents and the foreign aid which is the school meals. The total nutrition is $M_t = m_t + T(e_t + q)$.

Maximizing the welfare of Equation (3) subject to Equations (5) and (14) yields the following optimal solutions for education, nutrition and fertility:

$$e_t = \begin{cases} 0 & h_t \leq h_1(T), \\ \frac{\theta_2[h_t\phi-\gamma]}{(\gamma-T)(1-\theta_1-\theta_2-\sigma)} - q & h_1(T) < h_t < h_2(T), \\ 1-q & h_t \geq h_2(T), \end{cases} \tag{15}$$

where $h_1(T) = \frac{q(1-\theta_1-\theta_2-\sigma)(\gamma-T)+\theta_2\gamma}{\theta_2\phi}$ and $h_2(T) = \frac{\gamma(1-\theta_1-\sigma)-T(1-\theta_1-\theta_2-\sigma)}{\phi\theta_2}$ are thresholds and depend on T.

Proposition 2. *Under Assumption 2, h_1 and h_2 decrease whenever T increases.*

Proof. See Appendix C. □

[6] The Millennium Development Goals are: 1)to eradicate extreme poverty and hunger; 2)to achieve universal primary education; 3) to promote gender equality and empower women; 4) to reduce child mortality; 5)to improve maternal health; 6)to combat HIV/AIDS, malaria and other diseases; 7) to ensure environmental sustainability; and 8) to develop a global partnership for development.

The threshold levels of human capital decrease with T. Changes in policy alter behavior with respect to fertility, nutrition and human capital investments. After introducing school feeding programs, the total optimal nutrition of children depends on the nutrition provided by parents and by the school meals. The optimal total nutrition of children is:

$$M_t = m_t + T(e_t + q) = \begin{cases} \frac{(\sigma+\theta_1)[h_t\phi-\gamma(1-q)-Tq)}{(1-\sigma-\theta_1)} & h_t \leq h_1(T), \\ \frac{(\theta_1+\sigma)}{(1-\theta_1-\theta_2-\sigma)}[h_t\phi-\gamma] & h_1(T) < h_t < h_2(T), \\ \frac{(\sigma+\theta_1)[h_t\phi-T(1+q)]}{(1-\sigma-\theta_1)} & h_t \geq h_2(T). \end{cases} \tag{16}$$

As can be seen in Figure 3, the total level of nutrition of children is still an increasing function of human capital. The total nutrition is lower than the benchmark in the low regime because of T, and remains at the benchmark level in the second (middle-income) regime, which is independent of T.

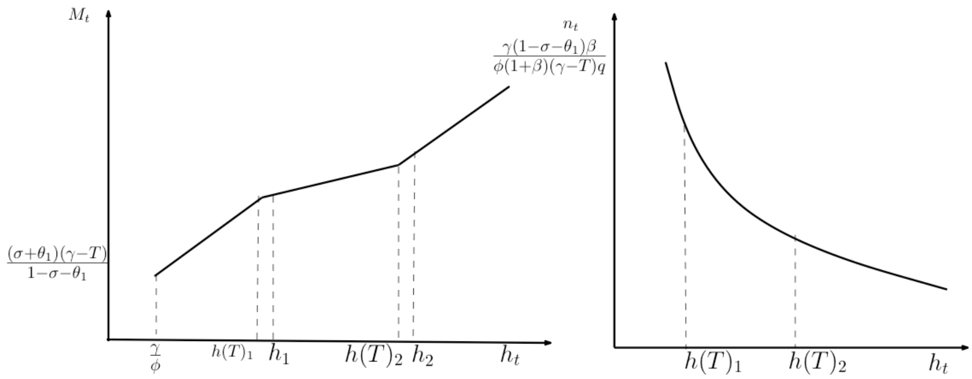

Figure 3: Nutrition and fertility with school feeding programs

The nutrition provided by parents is a decreasing function of human capital because of T:

$$m_t = \begin{cases} \frac{(\sigma+\theta_1)(h\phi-\gamma)}{1-\theta_1-\sigma} + \frac{[[\sigma+\theta_1]\gamma-T]q}{1-\theta_1-\sigma} & h_t \leq h_1(T) \\ \frac{(\theta_1+\sigma)}{(1-\theta_1-\theta_2-\sigma)}[h_t\phi-\gamma] - \frac{T\theta_2[[h_t\phi-\gamma]}{(\gamma-T)(1-\theta_1-\theta_2-\sigma)} & h_1(T) < h_t < h_2(T) \\ \frac{(\sigma+\theta_1)(h_t\phi)-T(1+q)}{1-\sigma-\theta_1} & h_t \geq h_2(T). \end{cases} \tag{17}$$

Fertility depends on the level of T. Fertility increases and nutrition decreases with T compared to those of the benchmark model. The product of the quality/quantity trade-off[7] is independent of T, and remains the same as that in the benchmark model[8]. This means that, as parents increase the number of their children, they will decrease the amount of nutrition provided to each child. Compared to the benchmark model, fertility is a decreasing function of human capital(see Figure 3).

$$n_t = \begin{cases} \frac{(1-\sigma-\theta_1)h_t\beta}{(1+\beta)((h_t\phi-\gamma(1-q))-Tq)} & h_t \leq h_1(T), \\ \frac{\beta h_t(1-\theta_1-\theta_2-\sigma)}{(1+\beta)(h_t\phi-\gamma)} & h_1(T) < h_t < h_2(T), \\ \frac{(1-\sigma-\theta_1)\beta h_t}{((1+\beta)(h_t\phi)-(1+q)T)} & h_t \geq h_2(T). \end{cases} \tag{18}$$

Equations (16) and (17) show that feeding programs in school decrease the amount of nutrition parents give their children in all regimes. Education has a negative effect on the total child nutrition provided by parents because it prevents children from working. In poor developing countries, foreign food aid decreases not only total nutrition but also total human capital. Here, there is a trade-off between the number of children a family has and the human capital developed in each child. In the interval $h_t \leq h_1(T)$, school feeding programs increase fertility by reducing the "quantity cost" of children, thereby shifting resources from the quality to the quantity of children. In other words, parents decrease the nutrition of their offspring and increase their number. This trade-off takes place as long as the fixed commodity, T, is sufficiently small (see Equations (10) and (19)). This result is consistent with Azarnet's (2008) finding that humanitarian aid increases fertility by reducing the investment of parents in their children education, and consequently their accumulation of human capital. Neanidis (2010) also found that when the average aid per adult increased, so did the fertility rate, because the "quantity cost" of children was reduced. This shifted resources from the quality of children to their quantity.

The main differences between Neanidis's (2010) contribution and the model we are using are: 1) in our model aid does not reduce the childbearing time but does reduce the investment parents make in the nutrition of their children; 2) the survival probability depends on both the nutrition provided by parents and that coming from foreign aid. It is important to mention that as the total nutrition level decreases, the survival probability decreases. This shows that there is an inverse relation between fertility and survival probability, which is consistent with Agenor's (2009) findings.[9]

Proposition 3 summarizes the effect of school feeding programs on the optimal choices of parents with respect to the number and quality of their offspring:

Proposition 3. *School Feeding programs generate a substitution effect away from quality of children toward quantity of children in poor developing countries if T is small.*

[7]This trade-off is more obvious in developing countries than in developed ones. In a developing country such as India, Burundi, which has neither a well-functioning public education system nor generous support for childbearing and childcare, the cost of quality is mostly borne by the parents. However there is also some evidence for a quality/quantity trade-off in studies of public health in developing countries. See for instance Karmaus and Botezan (2002).

[8]Since the utility function is logarithmic, the quality/quantity trade-off is a constant fraction of household income.

[9]Agenor (2009) argues that if the survival probability of children decreases there is an increase in the demand for children.

Proposition 4 implies that:

- Parents decrease their investment in nutrition if T is sufficiently small (*proof*: see Equation (16)).
- When T is sufficiently small, parents increase the number of their children (*proof*: see Equation (18)).

This proposition is valid as long as the fixed commodity T is smaller than the nutrition provided by parents. When T is higher than $\frac{(\sigma+\theta_1)((1-\theta_1-\sigma)\gamma)}{(1-\theta_1-\theta_2-\sigma)(\sigma+\theta_1)+\theta_2}$ parents decide to stop providing food at home and school meals constitute the total nutrition of children [10]. Hence, the human capital accumulation of children depends only on foreign aid. If this aid is higher than $\frac{(\sigma+\theta_1)((1-\theta_1-\sigma)\gamma)}{(1-\theta_1-\theta_2-\sigma)(\sigma+\theta_1)+\theta_2}$ the poor country can escape from the poverty trap.

Proposition 4. *For values of T higher than $\frac{(\sigma+\theta_1)((1-\theta_1-\sigma)\gamma)}{(1-\theta_1-\theta_2-\sigma)(\sigma+\theta_1)+\theta_2}$ parents stop providing food at home, and the children's nutrition depends on the level of nutrition of foreign food aid. In this situation poor countries can escape from the poverty trap.*

Proof. See Appendix D. □

Consequently, we conclude that the WFP should offer large quantities of school meals in developing countries if it wants to keep children in school, and ameliorate hunger and poverty.

Foreign aid has different results in middle-income countries. More precisely, school feeding programs increase the length of time children stay in school time, and as result children work less. School feeding programs are thus very effective in reducing child labor in middle-income countries. Furthermore, they lead to an improvement in human capital and produce better conditions for the generations to come (see Chandler, Walker, Connelly and Grantham-McGregor, 1995; Chang, Walker, Himes and Grantham-McGregor, 1996). Human capital increases only through the channel of education, because the total nutrition stays the same as without the feeding program. This result is confirmed by four studies which show that the benefit to nutrition from school meals was less than expected in areas like Peru (Jacoby *et al.*, 1996); Jamaica (Powell *et al.*, 1983); Kenya (Murphy *et al.*, 2003) and India (Agarwai *et al.*, 1989). The authors of two of these studies concluded that children who were offered a substantial supplement at school were provided with less food at home (substitution).

Propositions 5 and 6 summarizes these results.

Proposition 5. *School feeding programs increases the length of schooling and reduce child labor in middle-income countries.*

Proposition 6. *In middle income developing countries, school feeding programs do not improve children's overall nutrition, but they do increase the length of time that children stay in school.*

- These two propositions imply that that total human capital increases when school feeding programs are implemented in middle-income countries (*Proof* see Equations (16), (17) and (18)).

[10]In this situation, the optimal choices for total nutrition and fertility change

Feeding programs in school have positive implications that are not captured by this model. In particular, in developing countries, school meals can provide short-term hunger relief, since in the poorest areas families may not have enough basic food for their children. School meals can also affect help with HIV/AIDS, orphans, disabled and former soldiers Đ categories that are not included in our model.

Looking at the total welfare of parents at the different levels of human capital (regimes), we can see that there are ambiguous effects in the first regime and improvements in the second.

Finally, it is worth mentioning that there is evidence (e.g. Bro, Shank, Williams and McLaughlin (1994; 1996) which show that a generous breakfast cooked in a practical class before the school day began improved students' attention to set tasks. Their data also suggests that a school meal can be a social event that stimulates and motivates the students. This aspect is not captured by my model.

4.2 Food provision in households

In this part of the analysis, we assume that WFP provides two forms of aid: first, it subsidizes the price of food, and second, it provides a fixed amount of nutrition to each child in a household. We assume that all the households of the recipient country receive this kind of humanitarian aid.

4.2.1 Subsidizing the cost of feeding children or procurement by the WFP

Food prices in developing countries have declined since 2008 but remain much higher than in previous years. The high cost of food continues to raise concern for the food security of populations in urban and rural areas, who spend a large proportion of their incomes on food (see for instance FAO, 2009). Consequently, the WFP tries not only to stabilize food prices but also to reduce them by subsidies.

In this subsection we assume that the WFP purchases food at the most advantageous price, taking into account the cost of transport and shipping, with a preference towards local or regional procurement in developing countries whenever possible(see for instance WFP (2006b) on Egypt).

We assume that WFP buys a percentage of each child's nutritional requirements, η_t, which is given to each child's family as a voucher or as cash which may only be spent on food for children, Assume that the price of nutrition is 1. Thus the WFP's contribution is $\eta_t m_t n_t$ in each household. This aid takes the form of a WFP project providing continuous aid for several years in a developing country, or it is bilateral food aid supplied by government to government. Later the government provides this food to households without cost.

Of course there are certain types of food aid that can actually be destructive. Dumping food on poor nations (i.e. free, subsidized, or cheap food, below the market price) undercuts local farmers, who cannot compete and are driven out of jobs and into poverty. We exclude this kind of aid from my framework. The food that parents provide for their children constitutes their total nutrition.

Young adults' welfare, as described in Equation (3), can be maximized under the budget constraint

$$c_t + (1 - \eta_t)m_t n_t = h_t(1 - \phi n_t) + \gamma(1 - e_t - q)n_t, \tag{19}$$

and the motion of human capital given by Equation (4).

The optimal choices for education, nutrition and fertility are

$$e_t = \begin{cases} 0 & h_t \leq h_1, \\ \frac{\theta_2[h_t\phi-\gamma]}{\gamma(1-\theta_1-\theta_2-\sigma)} - q & h_1 < h_t < h_2, \\ 1-q & h_t \geq h_2. \end{cases} \tag{20}$$

The thresholds h_1 and h_2 are defined in the benchmark model. The level of education remains the same as before the aid was provided (see Equation (8)).

$$M_t = m_t = \begin{cases} \frac{(\sigma+\theta_1)(h_t\phi-\gamma(1-q))}{(1-\sigma-\theta_1)(1-\eta_t)} & h_t \leq h_1, \\ \frac{(\sigma+\theta_1)(h_t\phi-\gamma))}{(1-\sigma-\theta_1-\theta_2)(1-\eta_t)} & h_1 < h_t < h_2 \\ \frac{(\sigma+\theta_1)(h_t\phi)}{(1-\sigma-\theta_1)(1-\eta_t)} & h_t \geq h_2. \end{cases} \tag{21}$$

Equation (21) shows that the nutrition of children increases in all regimes (see Figure 4). Low prices for nutrition allow parents to spend more on it than before. Thus, the total level of nutrition increases.

$$n_t = \begin{cases} \frac{(1-\sigma-\theta_1)h_t\beta}{(1+\beta)(h_t\phi-\gamma(1-q))} & h_t \leq h_1, \\ \frac{\beta h_t(1-\theta_1-\theta_2-\sigma)}{(1+\beta)(h_t\phi-\gamma)} & h_1 < h_t < h_2, \\ \frac{(1-\sigma-\theta_1)\beta}{(1+\beta)\phi} & h_t \geq h_2. \end{cases} \tag{22}$$

Equation (22) shows that the level of fertility is not affected by the availability of this foreign aid.

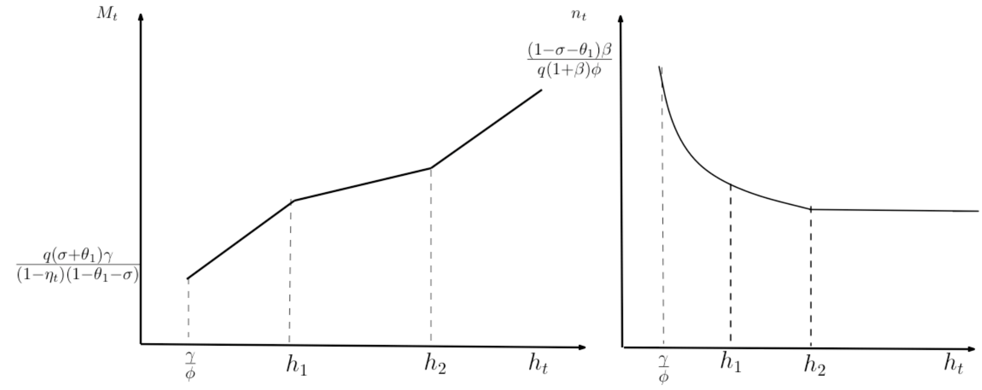

Figure 4: Nutrition and Fertility with subsidizing food

Proposition 7. *There is a level of* η_t *which allows a country to escape from the poverty trap. This level is given by:*

$$\eta_t > 1 - \frac{h_1^{(-\theta_1-\theta_2)^{1/\theta_1}} q^{\frac{\theta_2}{\theta_1}} (\sigma+\theta_1)(h_1\phi - \gamma(1-q))}{(1-\sigma-\theta_1)}$$

.

Proof. See Appendix E. □

As pointed out earlier, the allocation of time to education remains the same as in the no-aid scenario. On other hand, there is an improvement in the nutrition level, leading to an improvement in human capital. This kind of aid raises the probability of a child's survival, thereby indirectly reducing fertility, while at the same time contributing to children's health status though improving nutrition. Neanidis (2010) reported a similar result. This has a positive effect on growth and it allows poor developing countries to escape from the poverty trap when aid reaches a certain value (see Proposition 8). However children will continue to work and there is no reduction in child labor if the level of aid is low. The reduction of child labor is an indirect consequence of the increase in human capital through nutrition. In other words, food aid programs may have positive intergenerational effects, which can lead the developing countries out of poverty.

Looking at the total welfare of parents, we can see that food provision to households produces an improvement in welfare in all regimes. As mentioned above, this aid can have a negative impact on the economy if the WFP does not subsidize food prices, but buys a percentage of the subsidized food from outside the country. The main reason is that the majority of people in developing countries are farmers, and such aid can lower their incomes. In this framework, we assume that either the government or the WFP buys food from local providers. This assumption has an indirect effect on the income of the total economy that is not captured by the model.

4.2.2 Food provision to households

In this subsection, we investigate the situation where the WFP provides a fixed amount of nutrition for each child in a household. A nice example of this the situation in Pakistan in 2010, where the WFP provided 36,500 metric tons of food aid to assist families. This aid can provide a small amount of supplemental feeding for each child in a household. Supplemental feeding is available to poor households, which are unable to cover the expenses of feeding their children. In our model, we assume that each household in the receipient country receives this kind of aid.

Maximizing the utility function of young adults (Equation (3)) subject to the budget constraint (Equation (5)) yields the following equation for changes in human capital:

$$h_{t+1} = (m_t + \bar{m})^{\theta_1}(e_t + q)^{\theta_2} h_t^{1-\theta_1-\theta_2}. \tag{23}$$

Total nutrition depends on the food provided by parents and the fixed amount of nutrition, $\bar{m}_t$, provided by the WFP, where $M_t = m_t + \bar{m}$. As a result, the survival probability is $\pi_t = (m_t + \bar{m})^{\sigma}$.

The optimal choices are then:

$$e_t = \begin{cases} 0 & h_t \leq h_1(\bar{m}), \\ \frac{\theta_2[h_t\phi-\gamma)-(\theta_2)\bar{m}}{(\gamma(1-\theta_1-\theta_2-\sigma)} - q & h_1(\bar{m}) < h_t < h_2(\bar{m}), \\ 1-q & h_t \geq h_2(\bar{m}). \end{cases} \tag{24}$$

where $h_1(\bar{m}) = \frac{(q(1-\theta_1-\theta_2-\sigma)+\theta_2)\gamma+\theta_2\bar{m}}{\theta_2\phi}$ and $h_2(\bar{m}) = \frac{((1-\theta_1-\sigma)\gamma+\theta_2\bar{m}}{\theta_2\phi}$ depend on $\bar{m}$. Equation (24) shows that the length of schooling decreases when this kind of aid is provided to middle-income countries. With the optimal choices of nutrition and fertility, the total level of nutrition, the nutrition provided by parents and the fertility all decrease as the amount of food provided to households increases.

$$m_t = \begin{cases} \frac{(\sigma+\theta_1)(w_t h_t\phi-w_t\gamma(1-q)-\bar{m}}{1-\sigma-\theta_1} & h_t \leq h_1(\bar{m}) \\ \frac{(\sigma+\theta_1)(w_t h_t\phi-w_t\gamma)-(1-\theta_2)\bar{m}}{1-\sigma-\theta_1-\theta_2} & h_1(\bar{m}) < h_t < h_2(\bar{m}) \\ \frac{(\sigma+\theta_1)(w_t h_t\phi)-\bar{m}}{1-\sigma-\theta_1} & h_t \geq h_2(\bar{m}) \end{cases} \tag{25}$$

As highlighted above, children's total nutrition is the sum of the nutrition provided by parents and the fixed amount of nutrition available from the WFP. Thus, the following equation constitutes the total nutrition level. It is an increasing function of human capital (see Figure 5).

$$M_t = \begin{cases} \frac{(\sigma+\theta_1)(h_t\phi-\gamma(1-q)-[\sigma+\theta_1]\bar{m}}{1-\sigma-\theta_1} & h_t \leq h_1(\bar{m}), \\ \frac{(\sigma+\theta_1)(h_t\phi-\gamma)-(\sigma+\theta_1)\bar{m}}{1-\sigma-\theta_1-\theta_2} & h_1(\bar{m}) < h_t < h_2(\bar{m}), \\ \frac{(\sigma+\theta_1)(h_t\phi)-(\sigma+\theta_1)\bar{m}}{1-\sigma-\theta_1} & h_t \geq h_2(\bar{m}). \end{cases} \tag{26}$$

Parents decrease the nutrition provided to their children and they increase the number of their children such that the product of the quantity/quality trade-off remains the same as in the benchmark model. This product is independent of the fixed amount of food provided by the WFP.

$$n_t = \begin{cases} \frac{(1-\sigma-\theta_1)h_t\beta}{(1+\beta)(h_t\phi-\gamma(1-q))-\bar{m})} & h_t \leq h_1(\bar{m},) \\ \frac{\beta h_t(1-\theta_1-\theta_2-\sigma)}{(1+\beta)(h_t\phi-\gamma-\bar{m})} & h_1(\bar{m}) < h_t < h_2(\bar{m}), \\ \frac{(1-\sigma-\theta_1)\beta h_t}{(1+\beta)(h_t\phi-\bar{m})} & h_t \geq h_2(\bar{m}). \end{cases} \tag{27}$$

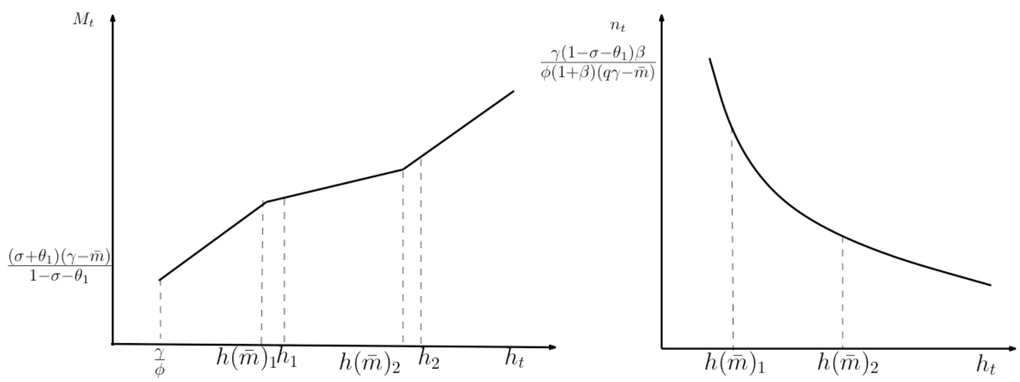

Figure 5: Nutrition and fertility with fixed food input from the WFP

These results show that providing fixed amounts of food does not solve the poverty problem. In particular, if the WFP continues to provide a fixed amount of food to households in middle income developing countries, it can lead to increased deprivation. This kind of aid does not only decrease the total level of nutrition of children, but also the length of time they spend in schooling. Parents decide not only to reduce their investment in the health of their children through nutrition, but also the time that their children spend at school. However they increase the number of their children, so that the quality/quantity trade-off remains the same as in the benchmark model.

Proposition 8 summarizes the effect of school feeding programs on the optimal choices of parents with respect to the number and quality of their offspring.

Proposition 8. *Fixed amount of nutrition provided to households by the WFP generate a substitution effect away from quality of children toward quantity of children in poor and middle income developing countries when $\bar{m}$ is small.*

This implies that:

- Parents decrease their investment in the nutrition of their children if $\bar{m}$ is sufficiently small (*proof* see Equations (25) and (26)).
- Parents increase their total fertility (*proof*: see Equation (27)).

- In middle-income countries parents decrease not only their investment in their children's nutrition but also their length of schooling (*proof* see Equations:(24), (26) and (27)).

This proposition implies that, when $\bar{m}$ is below the level of nutrition that parents can afford, countries are locked into the poverty trap. When $\bar{m}$ is higher than $\frac{(\sigma+\theta_1)\gamma}{\theta_2}$, parents decide to stop paying for food and childrenÕs total nutrition is equal to the fixed amount provided by the WFP[11]. Hence, the human capital accumulation of children depends only on the foreign aid provided by WFP. If this aid is higher than $\frac{(\sigma+\theta_1)\gamma}{\theta_2}$ the poor country can escape from the poverty trap.

Proposition 9. *For values of $\bar{m}$ higher than $\frac{(\sigma+\theta_1)\gamma}{\theta_2}$ parents stop buying food at home. Therefore, the children's nutrition depends solely on the level of nutrition they can get from foreign aid. In this case, poor countries can escape from the poverty trap.*

Proof. See Appendix F. □

Poor countries can escape from the poverty only if the WFP offers a large amount of food to households. Then, as in school feeding programs, parents stop offering food to their children and children's total nutrition consists of the fixed amount of aid. This kind of aid actually hurts the recipient countries, and WFP should consider carefully where such aid should be provided. Looking at the welfare of parents, there are ambiguous effects in the first regime (where levels of human capital are low), but welfare decreases in the second. It is important to mention that this kind of aid is important even if this result was not expected. Aid can provide short-term hunger relief to poor countries when terrible events happen.

4.3 Other strategies to help developing countries escape from the poverty trap

In this subsection, we consider various foreign aid policies which have not been mentioned above. Most foreign aid policies cover improvements in infrastructure, in the hope that this will lead to a parallel shift up of the transitory function h_{t+1}. This type of aid is efficient and can lead developing countries out of the poverty trap. In particular, any improvement in infrastructure and quality of food increases the technological level, B, of human capital accumulation.

There are some programs such as Food for Work and/or Training (FWT) which provide food in exchange for labor in public works projects (such as the development of rural infrastructure, roads, or irrigation schemes). These can stimulate the local economy and lay the foundation for the development of a secure local capacity. FWT not only provides food for the workers in the short run but also improves the infrastructure which has a positive impact on communities and the country in the long run.

There are also national organizations which provide food in clinics and in other health institutions to combat malnutrition for the poor and the sick. Kraak *et al.*(1999) show this kind of food aid directly benefits poor people, and improves the diet of people with HIV/AIDS. Moreover, governments, interested in improvements to nutrition, try to find

[11] When the food needs of children are based only on the fixed amount of foreign aid, the optimal choices for total nutrition and fertility change. In this situation, developing countries can temporarily escape from the poverty trap. If the WFP decides to reduce the amount of fixed food and parents start to provide food for their children again, the countries fall back into poverty (see second regime). Such aid is usually provided in situations where parents cannot offer food to their children (natural disasters and war).

donors who are willing to finance health programs and to contribute to the health infrastructure of their country (see, for instance, the report of Economic and Social Council of the United Nations for Namibia, ESC-UN 2010). Aid to the health sector often targets mothers and children. These exogenous interventions aim not only to reduce infant mortality, underweight rates, and micronutrient deficiencies but also to improve and develop human capital and the economic growth of the country.

The WFP invests in local food industries in developing countries to enable it to find local sources for blended and fortified foods. Thanks to such work, food quality is improving. For instance, in 2004, the WFP decided that local food processors in Southern Africa should conform to international standards so as to control quality for the entire manufacturing process in the region. With a grant from the Government of Canada, an extensive study was launched to provide support to the WFP in this effort. Thus, the WFP supported local processors in the food sector and helped Southern Africa meet quality standards.

All these types of aid programs can be captured in my model by B, which is the technological level or efficiency parameter of human capital. We assume that improvements in the quality of food (Fogel, 1994, Kraak *et al.*, 1999) and health(Shultz, 1961; Kuznets, 1966; Barro and Sala-i-Martin, 1995) can raise the efficiency and the labor productivity of adults and children. Hence unpredictable exogenous improvements in health infrastructure and in the local food industries can increase the efficiency of human capital, B, and as a consequence the changes in human capital. All these exogenous shocks have positive results in economic growth and help to reduce poverty. Equation 31 illustrates the rise in B which is needed for a poor country to escape the poverty trap.

$$B > \frac{h_1}{[h_1\phi - \gamma(1-q)]^{\theta_1} q^{\theta_2} h_1^{1-\theta_1-\theta_2} [\sigma + \theta_1]^{\theta_1}} \tag{28}$$

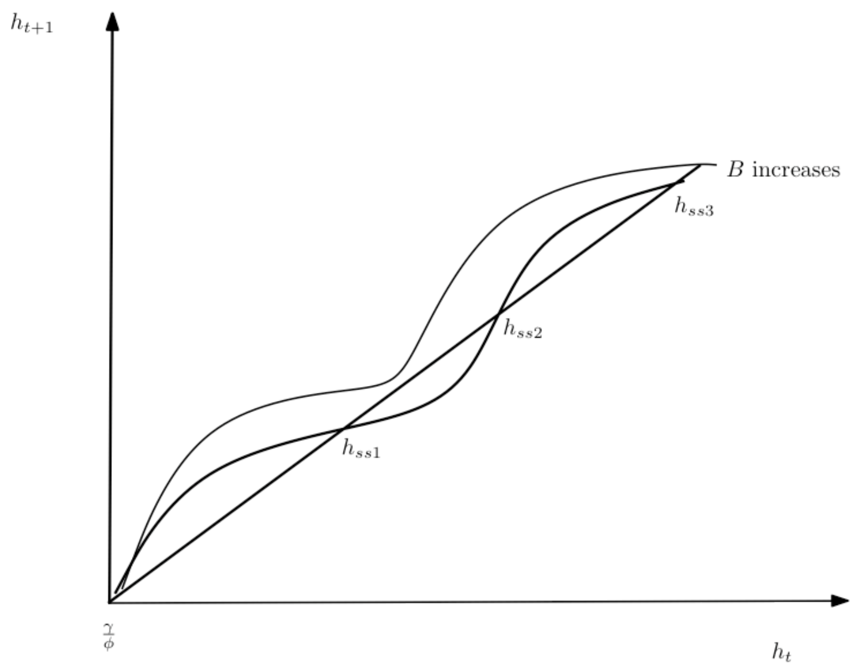

Figure 6: Increasing B

Figure 6 illustrates the increase in B that induces the changes in human capital to move upwards. This type of aid can provide a big push towards solving the problem of poverty of developing countries.

5 Computational Experiment

In this section, we shall examine the quantitative implications of both the benchmark and the extensions of my model. The calibration was carried out with values taken from the existing literature. The weight, β, of children in the utility function governs the growth rate of population in the balanced growth path. This parameter is set to 0.216, as in Fernandez-Villaverde and Kruger (2004). A similar value was used by Attanasio, Kitao and Violante (2010).

The technological level of human capital B is set to 1 for simplicity. The time cost parameter ϕ for having children defines the overall opportunity cost of having children. Although they do not include child labor in their model, we use the same value for as ϕ de la Croix and Doepke (2003), i.e. 0.075. De la Croix and Doepke used evidence from Haveman and Wolfe (1995) and Knowles (1999) which suggests that the opportunity cost of a child is equal to 15% of the parents' time endowment. This cost only accumulates while the child is living with the parents. They argue that if children live with their parents for 15 years, and the adult period lasts for 30 years, the overall time cost should be 50% of the time cost per year when the child is present.

This parameter ϕ also sets an upper limit on the number of children a person can have. Using these figures, people who spend all their time raising children would have, on average, slightly over 13 children each.

The productivity of children is set to $\gamma = 0.0006$ [12]. This is an arbitrary value and in the section on sensitivity analysis we investigate its behavior. We select this low value of the variable because child labor laws restrict the use of child labor (Doepke, 2004). In addition $\phi > \gamma$ has to be set so as to ensure the positivity of the optimal choices. The theoretical reasoning is that the parents' cost must be higher than that of not having children (otherwise the children would live separately from their parents). Furthermore, we assume that, in a one sector model with homogenous agents, the productivity of children remains the same and is not influenced by their human capital.

The elasticity of survival probability, σ, is set to 0.1. This is an arbitrary value that is used in the sensitivity analysis of my numerical example. In particular, we find that an increase in σ leads to an increase in the level of nutrition that parents provide for their children. There is also an increase in the length of schooling and consequently in human capital.

The value of time in primary school, q, is set to 0.1 in line with Assumption 4.

The process of calibrating the elasticities of human capital accumulation still need to be discussed. Before we start this analysis, we will estimate the elasticities of human capital for developing countries in order to calibrate the theoretical framework[13] and investigate its main dynamics. As an econometric technique, we use constrained OLS regression, since we need the sum of the elasticities to be equal to one. The data for our regression, is taken from a group of developing countries. Taking the logarithms of Equation 5 the motion of human capital can be written as:

$$\ln(h_{t+1}) = \theta_1 \ln(m_t) + \theta_2 \ln(e_t + q) + (1 - \theta_1 - \theta_2) \ln(h_t) + \epsilon_t. \tag{29}$$

The empirical literature (see for instance Becker, 1974; Lee and Lee, 1995) mostly uses enrollment rates at school as a proxy for human capital. However that is not possible here because my model of the changes in human capital depend on education, nutrition and parental human capital. Consequently, we use the approach adopted by Bils and Klenow (2000) to avoid problems of endogeneity and correlation between the variables. Their methodology allows to us to obtain a proxy for human capital, by taking the stock of human capital stock as the dependent variable and enrolment rates at school as the independent variable in the regression, thereby avoiding endogeneity bias[14]. This human capital stock consists of

[12]In the numerical example for the second regime, we take γ=0.006, for two reasons. First, the value is arbitrary, and can therefore be set at any level; and second because $\gamma = 0.0006$ is too small and is inversely related to education. If this figure is used the high steady state is achieved without international aid, since the second equilibrium is unstable. Since we want to show the influence of the various foreign aid programs we take γ=0.006. If this value is used in the first regime, where human capital is low, parents stop feeding their children, whose nutrition status is therefore based only on foreign aid, particularly for school feeding programs

[13]In previous studies (Azariadis *et al.* 2004; Quan, 1993, 1996) persistent poverty can be explained by poverty traps. But persistent poverty and emergent bimodality can be used as a proof that poverty traps explain the data. In this paper, we do not try to investigate the existence of poverty traps empirically. Lacking sufficient data, we try to estimate the coefficients of the changes in human capital for an homogenous sample (developing countries). According to the assumptions of my model, these changes are constant. The reason for undertaking this regression is to calibrate the model. To test the robustness of my results we provide a sensitivity analysis with numbers taken from previous studies.

[14]Since human capital depends only on the percentage gains in human capital from each year of education, and experience is independent of the enrollment rates. Thus, we can regress the human capital stock on the enrollment rates.

the percentage gains in human capital from each year of education and experience. More precisely, Bils and Klenow (2000) constructed human capital stocks from 1960 to 1990 by country as follows. They first constructed an estimate of human capital for workers at each age from 25 to 59 for both 1960 and 1990 incorporating schooling, experience and teacher's human capital specific to each age. Then, using population weights by age, they weighted the age-specific human capitals into an aggregate for 25 to 59-year- olds. Their measure of human capital for an individual is based on Mincer's (1991) model of human capital accumulation generalized for an impact from the human capital of the previous generation. It also allows for experience to have a quadratic form in their model. Returns to experience and experience-squared are chosen such that the experience/earnings profiles mimic the average profile of the sample of Mincer's estimates. They calculated educational attainment because an individual's human capital is a function of the human capital in past cohorts[15]. Their analysis is based on surveys compiled by the United Nations and reported in two UNESCO publications on the Statistics of Educational Attainment and Illiteracy (1977, 1983) and the Penn Word tables Summers and Heston, 1991).

As mentioned above, Bils and Klenow's technique allowed them to regress human capital stocks with schooling without problems of endogeneity and correlation. We adopt the same methodology and use the Penn World tables, the UNESCO publications and Mincer's earnings estimations as given in the appendix of their paper to obtain the human capital stocks for 1960 and 1990. These represent two different generations for our model since each generation lasts for approximately 30 years. Thus we consider that $\ln h60 = \ln h_t$ and $\ln h90 = h_{t+1}$ in our model. There are 66 developing countries in our data set. There is insufficient data from other countries for them to be included in the data set. This regression is only used to estimate the coefficients needed to calibrate our model. Later, we will provide a sensitivity analysis of them. For the length of schooling, we use data from the Barro-Lee(1993) and World Bank databases.

In considering nutrition, we use the approach adopted by Arcand (2001) FAO (1996) who took the prevalence of food inadequacy (PFI) [16] as a proxy for nutrition[17]. Our data came from the Food and Agriculture Organization (FAO) of the United Nations (1996)[18].

Assuming that the error term is log normal multiplicative, Table 1 presents the results of our constraint OLS regression. [19]. We use constraint regression as method of estimation since we need to keep the sum of elasticities of human capital equal to one.

The group of countries considered in the analysis is small because no more data is available using Bils and Klenow's (2000) technique. We control for heteroskedasticity and serial correlation [20]. All the variables were significant at the 1% level. This is in accord with Bils and Klenow (2000), Arcand (2001) and Wang *et al.Õs* (2003) results. Specially, these studies have shown that nutrition status is significant in the long run, and has an impact on the rate of growth of real GDP per capita.

Abdus and Rangazas (2010) chose a value of 0.304 for the returns of education to human capital. Kalemli-Ozcan, Ryder and Weil (2000) used the same approach as Bils and Klenow

[15]For more details, see Bils and Klenow(2000)

[16]PFI is a measure which involves comparing household food consumption with a minimum dietary energy requirement, and the classification of individuals in households with per capital calorie consumption levels below the minimum requirement as being in the undernourished category.

[17]Arcand (2001) used several variables as proxies for nutrition, including PFI and the Dietary Energy Supply(DES). He claims that there is a measurement error in the DES indicators constructed by the FAO. Hence, we prefer to use PFI.

[18]All the data can be provided after request to the author

[19]The regression takes into account the assumptions of the theoretical model to ensure the positivity of the coefficients i.e. Assumption 1.

[20]we use the command 'Robust' in STATA to control for heteroskedasticity.

(2000), and imposed a value of 0.32. Consequently, my coefficient for education is close to that used by other researchers. Table 2 summarizes the values of the parameters.

Table 2: Values of the parameters

θ_1	0.2	θ_2	0.25
σ	0.1	γ	0.0006
ϕ	0.075	β	0.216

Assuming that the parameters were set at their baseline, we compute the effects of foreign food aid on child nutrition, length of schooling, level of human capital and fertility. The first analysis concerned the value of such aid that allows a developing country to escape from the poverty trap. The second focused on a simulation in which the intergenerational effect of foreign food aids, in particular feeding programs and price subsidies for nutrition, were compared to the development of the system in the absence of these aids. The simulation exercise was carried out under two different production functions. In the first scenario, we use $Y_t = H_t$ (as in the theoretical section) and in the second, $Y_t = H_t^{\alpha}$, where α is set at 0.33[21].

5.1 Values that allow the poverty trap to be escaped

The values of foreign food aid which allow a country to escape from the poverty trap are summarized in Table 3.

Insert Table 3

η_t is 0.96. This means that organizations such as WFP should provide 96% of the nutrition that parents buy for their children. At this percentage the country can escape of the poverty trap. This value is much too high. It is obvious that it is difficult to solve poverty by foreign food aid alone.

Since the productivity of human capital, B, is set at 1, an increase of 100% in this value would be needed. Investing in local food industries, so that the quality of food increased, or investing in the agricultural sector by subsidizing local farmers, would lead this economy out of poverty only if the investment were sufficiently high. This result is in line with previous research (Harris, 2003; Smedley and Kinniburg; 2001) which argue that the investments in infrastructure and the support for local industries should be high if developing countries are to achieve economic development.

Finally, in the above table, we present the value of the fixed commodity that is provided as a meal in school or at home at which parents decide to stop feeding their children at home, and which also releases the country from poverty. This value is T=0.0032 and $\bar{m}$=0.00069 [22].

5.2 Computational experiment

Tables 4, 5, 6 and 7 present the first and second regimes under two different production functions, the linear one and the diminishing returns to scale. The levels of nutrition,

[21] In this situation wages are no longer constant, and so the boundaries between the regimes (i.e. developing and middle-income countires) are not constant, since succeeding regimes move over time and cannot be characterized analytically.

[22] The maximum T and $\bar{m}$ are units of commodities

human capital, fertility and length of schooling before and after the school feeding or price subsidy programs are presented. The values for the total nutrition represent the amount of commodity needed. Length of education is the number of years spent at secondary school and university, and fertility is the number of children.

Insert Table 4
Insert Table 5
Insert Table 6
Insert Table 7

Predictions have been computed for three generations (i.e. 120 years, each generation lasting 30 years). This computational experiment is used to investigate the effects of the implementation of the two different production functions for foreign aid in the two regimes. We also investigate whether my theoretical results are robust under the two different production functions (linear and diminishing returns)[23]. The results are similar for both production functions. Similar results were found by Hansen and Tarp (2001), Economides *et al.* (2008) and Daalgard *et al.* (2004), who showed that whether the aggregate aid impacts on growth positively or negatively is independent of the production function.

Tables 4 and 6 show that school feeding programs increase the length of schooling and as a result there is an improvement in human capital. In the theoretical part of this article we show that the total nutrition initially remains the same (Jacoby *et al.*, 1996; Powell *et al.*, 1983; Murphy *et al.*, 2003 and Agarwai *et al.*, 1989). However it increases after two generations (see Tables 4 and 6, Generation 3) through the intergenerational transmission of human capital. This is a line with the empirical evidence (Simon, 1998).

On the other hand, Tables 5 and 7 show that low levels of commodity T reduce not only the total nutrition but also the human capital. As a consequence, the total economy of the developing country is locked in the poverty trap. In particular, there is a quantity/quality trade-off. Parents decrease the nutrition they provide for their children, total nutrition decreases, and they increase the number of children they have. Since there is a decrease in human capital, the negative consequences become even worse across the generations in poor developing countries.

If WFP subsidizes the price of food, the total level of nutrition increases. This is easy to understand. Having the same income, parents can provide higher levels of nutrition to their children and hence their human capital increases in both regimes.

It is worth noting that both types of foreign aid reduce the prevalence of child labor. Child labor is a phenomenon in all developing countries, but is socially undesirable[24].

Thus, we can conclude that these two types of foreign food aid not only reduce short term hunger and improve human capital, but also increase the length of schooling, especially in middle-income countries. This is true for both direct (school feeding programs) and indirect (subsidizing food prices) programs.

5.3 Sensitivity analysis

This last subsection provides a sensitivity analysis for the parameters. All the above tables illustrate the baseline parameters used in the numerical example. Now, we present the effects of variations in the parameters on the main variables, namely nutrition resources, length of schooling and human capital.

[23]With diminishing returns, the wage is not constant and depends on the population. There are no analytical solutions incorporating this production function. Thus the calibration is necessary.

[24]According to UNICEF, there are an estimated 158 million children aged 5 to 14 in child labor worldwide, excluding child domestic labor

Insert Table 8
Insert Table 9

First, let us consider the parameter θ_1 which represents the return to nutrition and includes the direct effects of nourishment on human capital. When θ_1 is decreased so are the resources dedicated to child nutrition. On the other hand, the human capital and the length of schooling increase. The reverse results are obtained by varying the return to schooling, θ_2.

Another important parameter is γ, children's earnings from work when the production function is $Y_t = H_t$). This parameter has an inverse relationship to the length of schooling, and the higher it is the less likely children are to attend school. On the other hand, it increases nutrition resources, since there is more income in the family, and also increases human capital.

If the elasticity of the survival probability, σ, rises, so too do the level of nutrition, human capital and education. This means that as the elasticity of the survival probability decreases, parents spend more on the nutrition of their children to keep them alive. (Boucekkine and Laffargue(2010) employ the same approach in their model[25]).

We do not provid sensitivity analyses for β and ϕ since these two parameters have straightforward effects on fertility. In particular the effects of increasing the time-cost of bringing up a child, ϕ, leads to a reduction in fertility but increases in education and nutrition resources, and thus in human capital.

6 Conclusions

Our aim in this paper has been to evaluate the efficiency of the various foreign food aid programs provided by the WFP to developing countries.

We develop a two-period OLG model in which agents choose their present consumption, the number of children they have, the length of the children's schooling, and the amount of resources dedicated to nutrition for each of their children. It is assumed that children share the unit of their available time between work and education in accordance with the decision their parents make. Like other researchers, we assume that children's human capital accumulation depends on their nutrition, education and parental human capital. Thus, our framework captures the complementarity of child nutrition and child learning capacity (see Curais *et al.*, 2010). Multiple equilibria emerge from my benchmark model and may explain the existence of poverty traps. In particular, countries with low human capital find themselves trapped in conditions of low nutrition, high child labor rates, and high fertility rates.

We extend our model to mimic four different foreign aid policies provided by the WFP. First, we examine the case where WFP provides school meals in developing countries. School meals provide an enhancement to children's nutrition status, and, as a consequence, in our model they improve the human capital accumulation and the survival rate of children. However school meals appear to lock poor developing countries into poverty. In particular, this aid increases fertility, because the cost of having children decreases. Thus parents invest less in the nutrition of their children, leading to a slowdown in human capital accumulation. The recipient economy is locked into a poverty trap. However, if the WFP provides a large amount of food in schools, parents decide to stop feeding their children at home, and their total nutrition depends only on the school meals. The developing country can then escape from the poverty trap. School feeding programs are particularly efficient for middle-income

[25]In contrast to my framework they consider that when there is a mortality shock and the survival probability of adults decreases, there will be an increase in their investment in health.

countries. More precisely, they increase the length of schooling and improve the human capital for future generations even though the total nutrition remains unchanged (Jacoby *et al.*, 1996; Powell *et al.*, 1983; Murphy *et al.*, 2003 and Agarwai *et al.*, 1989). Consequently, middle-income countries can achieve economic development.

Second, we explore the effects of the WFP subsidizing the price of food for households. This program can be characterized as very efficient when the level of subsidy is high, as shown by the calibration of the model. It allows poor countries to escape from poverty because there is an income effect. Now, parents can afford to provide more nutrition for their children. The total nutrition rises and therefore the survival probability of children and their human capital.

However the policy of proving a constant level of nutrition to all households is not effective. Both poor and middle income countries sink into a poverty trap. This type of foreign aid increases fertility, because the quantity cost of children falls. As a result, parents decrease not only the nutrition level but also the length of schooling of their children.

Some WFP aid is used to improve the infrastructure of local food industries or support local farmers financially, so as to increase the quality of food and improve agricultural productivity. This improvement is captured in our framework by the technological level of my model of changes in human capital. An increase in the technological level raises the human capital of future generations and hence poor countries can achieve economic development.

Finally, we provide a computational experiment which shows that our theoretical results are robust under different production functions. We also show that introducing school feeding programs generates an indirect increase in total nutrition across the generations in middle-income countries.

References

[1] Abdus S. and Rangazas P. (2010). "Adult nutrition and growth", Review of Economic Dynamics, Forthcoming

[2] Acemoglu D. and Johnson J. (2007). "Disease and development: The effect of life expectancy on economic growth", Journal of Political Economy, vol. 115, pp. 925-985.

[3] Agarwal D. K., Agarwal K. N. and Upadhay S. K. (1989). "Effect of a mid-day meal program on physical growth and mental function", Indian J Medical Resources, vol. 90, pp. 163-174.

[4] Agenor P-R. (2009). "Public capital, health persistence and poverty traps", University of Manchester, Centre for Growth and Business Cycle Research, Working paper No. 115.

[5] Alderman H., Hoddinott J. and Kinsey B., (2006). "Long term consequences of early childhood malnutrition", Oxford Economic Papers, vol. 58, pp. 450-474.

[6] Arcand J. (2001). "Under-nourishment and economic growth: The efficiency cost of hunger", Economic and Social Development, No 147. FAO Rome, Italy

[7] Arora S. (2001). "Health and human productivity and long-term economic growth", Journal of Economic History, vol. 61, pp. 699-749.

[8] Attanasio O., Kitao S. and Violante G. (2010). "Financing Medicare: a general equilibrium analysis", Demography and the Economy, pp. 333-366.

[9] Azariadis C. and Stachurski J. (2005). "Poverty traps", Handbook of Economic Growth, Elsevier, Chapter 5.

[10] Azarnert L. V. (2008). "Foreign aid, fertility and human capital accumulation", Economica, vol. 75, pp. 766-81.

[11] Barro R. J., (1974). Schooling, Experience and Earnings, New York: Columbia University Press.

[12] Barro R.J. and Lee J.W. (1993)."International Comparisons of Educational Attainment", Journal of Monetary Economics, vol. 32, pp.363-394.

[13] Becker G. (1975). Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education, 2nd edition, NBER Books, National Bureau of Economic Research, Number 75-1.

[14] Beherman J. (1993). "The economic rationale for investing in nutrition in developing countries", World Development, vol. 21, pp. 1749-1771

[15] Beisel W. R. (1996). "Nutrition in pediatric HIV infection: Setting the research agenda", Journal of Nutrition, vol. 126, pp. 2611S-2615S.

[16] Berti C. (2001). "Poverty traps and human capital accumulation", Economica, vol. 68, pp. 203-219.

[17] Bils M. and Klenow, P. (2000). "Does schooling cause growth?", American Economic Review, vol. 90, pp. 1160-1183.

[18] Boucekkine R. and Laffargue, J. P. (2010). "On the distributional consequences of epidemics", Journal of Economic Dynamics and Control, vol. 34, pp. 231-245.

[19] Bro R. T., Shank L., Williams R. and McLaughin T. F. (1994). "The effects of an in-class breakfast program on attendance and on-task behavior of high school students", Child and Family Behavior Therapy, vol. 16, pp. 1-8.

[20] Bro R. T., Shank L., Williams R. and McLaughin T. F. (1994). "Effects of a breakfast program on on-task behavior of vocational high school students", Journal of Educational Resources, vol. 90, pp. 111-115.

[21] Chakraborty S. (1996). "Endogenous lifetime and economic growth", Journal of Economic Theory, vol. 116, pp. 119-137.

[22] Chakraborty S. and Das M. (2005). "Mortality, human capital and persistent inequality", Journal of Economic Growth, vol. 10, pp. 159-192.

[23] Chandler A. M., Walker S. P., Connolly K. and Grantham-McGregor S. M. (1996). "School breakfast improves verbal fluency in undernourished Jamaican children", Journal of Nutrition, vol. 17, pp. 894-900.

[24] Chang S. M., Walker S. P., Himes J. and Grantham-McGregor S. M. (1996). "Effects of breakfast on classroom behavior in rural Jamaican school children", Food Nutrition Bulletin, vol. 17, pp. 248-257.

[25] Collier P. and Dehn, J. (2001). "Aid, shocks, and growth", World Bank Working Paper No. 2688.

[26] Corry Mann, H. C. (1926) Diets for boys during the school age, London: Medical Research Council.

[27] Coulter J., Goodland A., Tallantire A. and Stringfellow F. (1999) Marrying farmer cooperation and contract farming for service provision in a liberalizing sub-Saharan Africa, Natural Resource Perspectives, No. 48

[28] Currais L., Rivera R. and Rungo P. (2010). "Effects of the complementarities of child nutrition and education on persistent deprivation", Economic Letters, vol. 106, pp. 67-69.

[29] Daalgard C., Hansen H. and Tarp F. (2004). "On the empirics of foreign aid and growth", Economic Journal, vol. 114, pp. 191-216.

[30] Devadas R. P., Jamala S. and Surabhi A. (1996). "Effects of breakfast on classroom behaviour in rural Jamaican schoolchildren", Food Nutrition Bulletin, vol. 17, pp. 248-257.

[31] Doepke M. (2004). "Accounting for fertility decline during the transition to growth", Journal of Economic Growth, vol. 3, pp. 347-383.

[32] Easterly W., Levine R. and Roodman D. (2004). "Aid, policies, and growth: Comment", American Economic Review, vol. 94, pp. 774-80.

[33] Economides G., Kalyvitis S. and Philippopoulos A. (2008). "Does foreign aid distort incentives and hurt growth? Theory and evidence from 75 aid-recipient countries", Public Choice, vol. 134, pp. 463?88.

[34] FAO (1996). The Sixth World Food Survey, Food and Agriculture Organization of the United Nations, Rome, Italy.

[35] FAO (2009). "Crop prospects and food situation", Food and Agriculture Organization of the United Nations, No. 3.

[36] Fernandez-Villaverde J. and Kruger D. (2004). "Consumption and saving over the life cycle: How important are consumer durables?", Society for Economic Dynamics, 2004/357.

[37] Fogel R. W. (1994). "Economic growth, population theory and physiology: The bearing of long-term processes on the making of economic policy", American Economic Review, vol. 84, pp. 369-395.

[38] Fogel R. W. (2002). "Nutrition, physiological capital and economic growth", Pan American Health Organization and Inter-American Development Bank, Washington, D.C., available at: http://www. paho.org/English/HDP/HDD/fogel.pdf.

[39] Fogel R. W. and Wimmer L. T. (1992). "Early indicators of later work levels, disease and death", National Bureau of Economic Research, NBER Historical Working paper 038

[40] Galor O. and D. Mayer. (2002). "Food for thought: Basic needs and persistent educational inequality", mimeo, Brown University.

[41] Galor O. and Moav O. (2002). "Natural selection and the origin of economic growth", Quarterly Journal of Economics, vol. 117, pp. 1133-1192.

[42] Galor O. and Weil D. (2000). "Population, technology and growth: From Malthusian stagnation to the demographic transition and beyond", American Economic Review, vol. 90, pp. 806-828.

[43] Glomm G. and Palumbo M. (1993). "Optimal intertemporal consumption decisions under the threat of starvation", Journal of Development Economics, vol. 42, pp. 271?291.

[44] Hansen H. and Tarp F. (2001). "Aid and growth regressions", Journal of Development Economics, vol. 64, pp. 547-70.

[45] Harris C. (2003). "Private participation in infrastructure in developing countries", World Bank Working Paper No. 5.

[46] Haveman R. and Wolfe B. (1995). "The determinants of children attainments: A review of methods and findings", Journal of Economic Literature, vol. 33, pp. 1829-1878.

[47] Hazan M. and Berdugo B. (2002). "Child labour, fertility and economic growth", The Economic Journal , vol. 112, pp. 810-828.

[48] Huff H. B. and Jimenez M. (2003). "The food aid convention: Past performance and future role within the new global trade and development environment", paper presented at the International Conference on Agricultural Policy Reform and the WTO: Where are we Heading? Capri, Italy.

[49] Jacoby E., Cueto S. and Pollit E. (1996). "Benefits of school breakfast program among Andean children in Huarez, Peru", Food and Nutrition Bulletin, vol. 17, pp. 54-64.

[50] Jayachandran S. and Lleras-Muney, A. (2008). "Life expectancy and human capital investments: Evidence from maternal mortality declines", National Bureau of Economic Research, 2008/13947.

[51] Kalemli-Ozcan S., Ryder H. E. and Weil D. N. (2000) "Mortality decline, human capital investment and economic growth", Journal of Development Economics, vol. 62, pp. 1-23.

[52] Karmaus W. and Botezan C. (2002) "Does a higher number of siblings protect against the development of allergies and asthma? A review", Journal of Epidemiology and Community Health, vol. 56, pp. 209-217.

[53] Knowles J. (1999). "Can parental decisions explain US income inequality?", mimeo, University of Pennsylvania.

[54] Kraak V. I., Pelletier D. L., Frogilo E. A. Jr. and Rajabiun S. (1999). "The potential role of food aid for AIDS mitigation in East Africa: Stakeholder views", Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development, Washington, DC.

[55] Kuznets S. (1966) Modern Economic Growth, Yale University Press, New Haven, CT.

[56] Lee D. W. and Lee T. H. (1995) "Human capital and economic growth: Tests based on international achievement ", Economic Letters, vol. 47, pp. 219-227.

[57] Lucas R. E. (1988). "On the mechanism of economic development", Journal of Monetary Economics, vol. 22, pp. 3-42.

[58] Mincer J. (1991). "Economic growth in a cross-section of countries", Quarterly Journal of Economics , vol. 106, pp. 407-444.

[59] Moav O. (2005). "Cheap children and the persistence of poverty", Economic Journal, vol. 115, pp. 88-110.

[60] Murphy S. P., Gewa C., Liang L. J., Grillenberger M., Bwido N. O. and Neumann C. G. (2003). "School snacks containing animal source foods improve dietary quality of children in rural Kenya", Journal of Nutrition, vol. 133, pp. 3950-3956.

[61] Neanidis K. (2010). "Humanitarian aid, fertility and economic growth", Economica, pp. 1-35.

[62] Powell C., Grantham-McGregor S. and Elston M. (1983). "An evaluation of giving the Jamaican government school meal to a class of children", Human Nutrition - Clinical Nutrition, vol. 37, pp. 381-388.

[63] Psacharopoulos G. (1994). "Returns to investment in Education: A global update", World Development, vol. 22, pp. 1325-1343.

[64] Quah D. (1996). "Twin peaks: Growth and convergence in models of distribution dynamics", The Economic Journal, vol. 436, pp. 1045-1055.

[65] Quah D. (1997). "Empirics for growth and distribution stratification, polarization and convergence club", Journal of Economic Growth, vol. 2, pp. 27-59.

[66] Roodman D. (2007). "The anarchy of numbers: Aid, development and cross-country empirics", World Bank Economic Review, vol. 21, pp. 255-77.

[67] Schultz T. W. (1961). "Investment in human capital", The American Economic Review, vol. 1, pp. 1-17.

[68] Smedley P. L. and Kinniburgh D. G. , (2002). "A review of the source behaviour and distribution of arsenic in natural waters", Applied Geochemistry, vol. 17, 517-568. bibitemStrulik H. (2004). "Child mortality, child labor and economic development", Economic Journal, vol. 114, pp. 547-568. bibitemStrulik H. and Weisdorf J. (2010). "How child cost and survival shaped the industrial revolution and the demographic transition: A theoretical inquiry", Leibniz University, Hannover, Discussion Paper, No. 442.

[69] Summers R. and Heston A. (1991). "The Penn World Table (Mark 5): An Expanded Set of International Comparisons", Quarterly Journal of Economics, vol. 106, pp. 327-368.

[70] Taniguchi K. and Wang X. (2003). "Nutrition intake and economic growth", Food and Nutrition Bulletin, vol. 106, pp. 82-133.

[71] Udry C. (2003) Child labor. Yale University Economic Growth Center, Discussion Paper No. 856.

[72] United Nations (1994). The Sex and Age Distribution of the World Population: The 1994 Revision, United Nations, New York.

[73] UNESCO (1977). Statistics of Educational Attainment and Illiteracy, 1945-1974, Paris, France.

[74] UNESCO (1983). Statistics of Educational Attainment and Illiteracy, 1970-1980, Paris, France.

[75] Walker D., Coulter J. and Hodges R. (2005) "Policy implications arising from the development impact of local and regional procurement of food aid", University of Greenwich Natural Resources Institute.

[76] WFP(2006a). World Hunger Series 2006: Hunger and Learning, World Food Programme of the United Nations, Rome.

[77] WFP(2006b). "Country Program-Egypt 2, ", World Food Programme/Executive Board, 2/2006/8/4.

Appendices

A Proof of optimal choices

To prove that the optimal choice of nutrition is an increasing function in all the different regimes (i.e. at all different levels of development) the maximum of each regime is compared with the minimum of the next. In particular, the nutrition in the first regime is compared with that in the second, using the same value of h_1 in both cases.

$\frac{(\sigma+\theta_1)\left(\frac{q\gamma(1-\theta_1-\theta_2-\sigma)}{\theta_2}+\gamma q\right)}{1-\sigma-\theta_1} < \frac{(\sigma+\theta_1)\left(\frac{q\gamma(1-\theta_1-\theta_2-\sigma)}{\theta_2}\right)}{1-\sigma-\theta_1-\theta_2}$

Thus, $\frac{(-\theta_1-\theta_2-\sigma)q\gamma}{(1-\sigma-\theta_1)} < \frac{q\gamma(1-\theta_2-\theta_1-\sigma)}{(1-\sigma-\theta_1-\theta_2}$

$(1-\theta_1-\theta_2-\sigma)(-\theta_1-\theta_2-\sigma)q\gamma < q\gamma(1-\theta_1-\theta_2-\sigma)(1-\theta_1-\sigma)$

$(-\theta_2)(1-\theta_1-\theta_2-\sigma)q\gamma < q\gamma(1-\theta_1-\theta_2-\sigma)$

$0 < 1+\theta_2$ which is valid.

The value of nutrition in the second regime is then compared with that in the third.
$\frac{(\sigma+\theta_1)\left(\frac{\gamma(1-\theta_1-\sigma)}{\theta_2}-\gamma\right)}{1-\sigma-\theta_1-\theta_2} < \frac{(\sigma+\theta_1)\left(\frac{\gamma(1-\theta_1-\sigma)}{\theta_2}\right)}{1-\sigma-\theta_1}$

$\frac{\gamma(-\theta_1-\sigma)}{\theta_2(1-\sigma-\theta_1-\theta_2)} < \frac{\gamma(1-\theta_1-\sigma)}{\theta_2(1-\sigma-\theta_1)}$

$0 < 1-\theta_2$ which is valid since θ_2 is between zero and one.

When the levels of fertility across the different regimes are compared it can be seen, by taking the derivative with respect to h_t, that the fertility decreases with h_t.

$\frac{\partial n_t}{\partial h_t} = \frac{-\gamma(1-q)}{(1+\beta)^2(h_t\phi-\gamma(1-q)} < 0$

Since all the parameters are positive, the fertility decreases as long as h_t increases.

B Steady states

Denote the steady state equilibrium by h_{ss1} in the interval $(\frac{\gamma}{\phi}, h_1]$.

$$h_{ss1} = \frac{(h_{ss1}\phi-\gamma)^{\theta_1}(\sigma+\theta_1)^{\theta_1}h_{ss1}^{1-\theta_1-\theta_2}}{(1-\theta_1-\sigma)^{\theta_1}}. \tag{A. 1}$$

In the interval $(h_1, h_2]$, the steady state equilibrium is given by:

$$h_{ss2} = \frac{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}}(\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}}\gamma}{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}}(\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}}\phi-(1-\theta_1-\theta_2-\sigma)\gamma^{\frac{\theta_2}{\theta_1+\theta_2}}}. \tag{A. 2}$$

Finally for the interval $[h_2, \infty)$ the equilibrium is

$$h_{ss3} = \frac{(\sigma+\theta_1)^{\frac{\theta_1}{\theta_2}}\phi^{\frac{\theta_1}{\theta_2}}}{(1-\theta_1-\sigma)^{\frac{\theta_1}{\theta_2}}} \quad \text{(A. 3)}$$

C Proof of Proposition 1

1. To prove the existence of a unique steady state which is locally stable, I defined two functions. The first function is the 45^o line, $f(h_t) = h_t$(see Figure 1) and the second is the first regime of Equation (11), $g(h_t) = \frac{(\sigma+\theta_1)^{\theta_1}(h_t\phi-\gamma(1-q))^{\theta_1}h_t^{1-\theta_1-\theta_2}q^{\theta_2}}{(1-\theta_1-\sigma)^{\theta_1}}$. To prove the existence of a unique steady state it is necessary to prove that the functions f and g cross; or in other words to show that $f(h) < g(h)$ for $h = \frac{\gamma}{\phi}$ (which holds because of Assumption 2) and that $f(h_1) > g(h_1)$ (which is true because of Assumption 4). If the g function is concave, then the steady state is locally stable and hence a poverty trap. So the problem is to prove that $g(h_t) = \frac{(\sigma+\theta_1)^{\theta_1}(h_t\phi-\gamma(1-q))^{\theta_1}h_t^{1-\theta_1-\theta_2}q^{\theta_2}}{(1-\theta_1-\sigma)^{\theta_1}}$ is a concave function.

   k can be defined as $\frac{\sigma+\theta_1^{\theta_1}q^{\theta_2}}{(1-\sigma-\theta_1)_1^{\theta}}$. The first derivative is $\frac{\partial g}{\partial h_t} = k\theta_1[h_t\phi-\gamma(1-q)]^{\theta_1-1}h_t^{1-\theta_1-\theta_2}\phi + k(1-\theta_1-\theta_2)[h_t\phi-\gamma(1-q)]^{\theta_1}h_t^{-\theta_1-\theta_2}$. It is positive. The second derivative is $\frac{\partial^2 g}{\partial^2 h_t} = k\theta_1(\theta_1-1)[h_t\phi-\gamma(1-q)]^{\theta_1-2}\phi^2 h_t^{1-\theta_1-\theta_2} + 2k\theta_1(1-\theta_1-\theta_2)[h_t\phi-\gamma(1-q)]^{\theta-1}h_t^{-\theta_1-\theta_2}\phi + k(1-\theta_1-\theta_2)(-\theta_1-\theta_2)[h_t\phi-\gamma(1-q)]^{\theta_1}]h_t^{-\theta_1-\theta_2-1} =$
   $k[h_t\phi-\gamma(1-q)]^{\theta_1-2}h_t^{-\theta_1-\theta_2-1}[h_t^2\phi^2\theta_1(\theta_1-1) + 2\theta_1(1-\theta_1-\theta_2)\phi[h_t\phi-\gamma(1-q)]h_t + (1-\theta_1-\theta_2)(-\theta_1-\theta_2)[h_t\phi-\gamma(1-q)]^2$

   The first part is positive, the second part negative because the discriminant of the quadratic polynomial is negative. Consequently, the second derivative is less than zero. As a result, a unique steady state exists and it is locally stable.

   For this proof, the equilibrium in the interval $(h_1, h_2]$ must be investigated. The equilibrium in this interval is $h_{ss2} = \frac{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}}(\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}}\gamma}{\theta_2^{\frac{\theta_2}{\theta_1+\theta_2}}(\sigma+\theta_1)^{\frac{\theta_1}{\theta_1+\theta_2}}\phi-(1-\theta_1-\theta_2-\sigma)\gamma^{\frac{\theta_2}{\theta_1+\theta_2}}}$ and the accumulated human capital is $h_{t+1} = \frac{(\sigma+\theta_1)^{\theta_1}[h_t\phi-\gamma]^{\theta_1+\theta_2}\theta_2^{\theta_2}h_t^{1-\theta_1-\theta_2}}{(1-\theta_1-\theta_2-\sigma)^{\theta_1+\theta_2}\gamma^{\theta_2}}$. Denoting $\frac{(\sigma+\theta_1)^{\theta_1}\theta_2^{\theta_2}}{(1-\theta_1-\theta_2-\sigma)^{\theta_1+\theta_2}\gamma^{\theta_2}}$ as A and taking the first derivative of the expression for changes in human capital in this interval gives $\frac{\partial h_{t+1}}{\partial h_t} = A(\theta_1+\theta_2)[h_t\phi-\gamma]^{\theta_1+\theta_2-1}\phi h_t^{1-\theta_1-\theta_2} + (1-\theta_1-\theta_2)h_t^{-(\theta_1+\theta_2)}A[h_t\phi-\gamma]^{\theta_1+\theta_2}$. When the steady state is plugged into this derivative we can see that $\frac{\partial h_{t+1}}{\partial h_t}|_{h_{ss2}} > 1$ and h_{ss2} is unstable. This case is represented by Figure 2.

2. To prove the stability of the steady state in the interval $[h_2, \infty)$. Taking the first derivative of the function h_{t+1} in the interval $[h_2, \infty)$ yields $\frac{\partial h_{t+1}}{\partial h_t} = (1-\theta_2)h_t^{-theta_2}\frac{(\sigma+\theta_1)^{\theta_1}\phi^{\theta_1}}{(1-\theta_1-\sigma)^{\theta_1}}$.

   The steady state is $h_{ss3} = \left(\frac{(\sigma+\theta_1)\phi}{(1-\theta_1-\sigma)}\right)^{\frac{\theta_1}{\theta_2}}$. Substituting for the steady state in the derivative above shows that $\frac{\partial h_{t+1}}{\partial h_t} = (1-\theta_2) > 0$ since $0 < \theta_2 < 1$ and $\frac{\partial h_{t+1}}{\partial h_t}|_{h_{ss3}} < 1$. This proves that the steady state h_{ss3} is locally stable.

D Proof of Proposition 2

To derive the human capital thresholds with respect to T consider: $\frac{\partial h_1}{\partial T} = \frac{-2q(1-\theta_1-\theta_2-\sigma)}{\theta_2\phi} <$ 0;

$\frac{\partial h_2}{\partial T} = \frac{-2(1-\theta_1-\theta_2-\sigma)}{\theta_2\phi} < 0$.

Since both these inequalities are negative, the proposition is proven.

E Proof of Proposition 4

The nutrition for the low regime is $m_t = \frac{(\sigma+\theta_1)[h_t\phi-\gamma(1-q)-Tq)}{(1-\sigma-\theta_1)}$ If $T = m_t$, it means that parents stop providing food at home. The threshold is known to depend on T and it is given by $h_1(T) = \frac{q(1-\theta_1-\theta_2-\sigma)(\gamma-T)+\theta_2\gamma}{\theta_2\phi}$. Plugging in the value for h_1 and solving for T gives $T= \frac{(\sigma+\theta_1)(1-\theta_1-\sigma)\gamma)}{(1-\theta_1-\theta_2-\sigma)(\sigma+\theta_1)+\theta_2}$. m_t cannot be negative so for values of T higher than this level, childrenÕs nutrition is better than before and human capital accumulation depends on foreign aid, $h_{t+1} = (T(q))^{\theta_1+\theta_2}h_t^{1-\theta_1-\theta_2}$.

F Proof of Proposition 7

The h_{t+1} function needs to be higher than in the regime h_1 to escape from the poverty trap. Thus: $\frac{(\sigma+\theta_1)^{\theta_1}[h_1\phi-\gamma(1-q)]^{\theta_1}}{(1-\sigma-\theta_1)^{\theta_1}(1-\eta_t)^{\theta_1}}q^{\theta_2}h_1^{1-\theta_1-\theta_2} > h_1$

$$\frac{(\sigma+\theta_1)^{\theta_1}[h_1\phi-\gamma(1-q)]^{\theta_1}}{(1-\sigma-\theta_1)^{\theta_1}h_1}q^{\theta_2}h_1^{1-\theta_1-\theta_2} > (1-\eta_t)^{\theta_1}$$

$$\frac{(\sigma+\theta_1)^{\theta_1}[h_1\phi-\gamma(1-q)]^{\theta_1}}{(1-\sigma-\theta_1)^{\theta_1}}q^{\theta_2}h_1^{-\theta_1-\theta_2} > (1-\eta_t)^{\theta_1}$$

$$\frac{(\sigma+\theta_1)[h_1\phi-\gamma(1-q)]}{(1-\sigma-\theta_1)}q^{\frac{\theta_2}{\theta_1}}h_1^{\frac{-(\theta_1+\theta_2)}{\theta_1}} > (1-\eta_t)$$

$$1-\frac{(\sigma+\theta_1)[h_1\phi-\gamma(1-q)]}{(1-\sigma-\theta_1)}q^{\frac{\theta_2}{\theta_1}}h_1^{\frac{-(\theta_1+\theta_2)}{\theta_1}} < \eta_t$$

This defines the proposition.

G Proof of Proposition 9

The nutrition in the low regime is $\frac{(\sigma+\theta_1)(h_t\phi-w_t\gamma(1-q)-[\sigma+\theta_1]\bar{m}}{1-\sigma-\theta_1}$. For $\bar{m}$=m_t this means that the nutrition provided by parents is equal to zero. We know that the threshold depends on T and equals $h_1(\bar{m}) = \frac{(q(1-\theta_1-\theta_2-\sigma)+\theta_2)\gamma+\theta_2\bar{m}}{\theta_2\phi}$.Plugging in h_1 and solving for $\bar{m}$ gives $\bar{m}$=$\frac{(\sigma+\theta_1)\gamma}{\theta_2}$. For values of $\bar{m}$ higher than this level m_t cannot be negative, thus the nutrition of the children is higher than before, and human capital accumulation depends on the foreign aid: $h_{t+1} = (\bar{m})^{\theta_1+\theta_2}h_t^{1-\theta_1-\theta_2}$.

H Tables

Table 3

Values necessary to escape the poverty trap	
η_t	0.96
T	0.0032
B	2
$\bar{m}$	0.00069

Table 4: Linear production function (Regime 2)

Generations	Nutrition	Human capital	Education	Fertility
Without aid				
Generation 1	0.17	0.18	0.1	2
Generation 2	0.0053	0.1829	0.66	1.8230
Generation 3	0.0026	0.1303	0.27	3.79
Feeding programs with T=0.00009				
Generation 1	0.17	0.18	0.1	2
Generation 2	0.0053	0.1820	0.67	1.8229
Generation 3	0.0027	0.131	0.20	3.75
Food provided in households with η=0.8				
Generation 1	0.17	0.18	0.1	2
Generation 2	0.0263	0.183	0.66	1.82
Generation 3	0.0255	0.1797	0.63	1.91

Table 5: Linear production function (Regime 1)

Generations	Nutrition	Human capital	Education	Fertility
Without aid				
Generation 1	0.12	0.1	Basic	2
Generation 2	0.0030	0.1	Basic	1.7865
Generation 3	0.0014	0.05	Basic	1.9398
Feeding programs				
Generation 1	0.12	0.1	Basic	2
Generation 2	0.0029	0.09	Basic	1.788
Generation 3	0.0013	0.04	Basic	1.94
Food provided in households				
Generation 1	0.12	0.1	Basic	2
Generation 2	00149	0.11	Basic	1.7864
Generation 3	00098	0.07	Basic	1.8531

Table 6: Decreasing returns to scale (Regime 2)

Generations	Nutrition	Human capital	Education	Fertility
Without aid				
Generation 1	0.18	0.18	0.002	1
Generation 2	0.0044	0.1696	0.6386	2.3982
Generation 3	0.0076	0.2257	0.5621	1.9632
Feeding programs				
Generation 1	0.18	0.18	0.002	1
Generation 2	0.0044	0.17	0.65	2.39
Generation 3	0.0077	0.2266	0.57	1.95
Food provided in households				
Generation 1	0.18	0.18	0.002	1
Generation 2	0.0219	0.17	0.63	2.3982
Generation 3	0.0398	0.2328	0.56	1.93

Table 7: Decreasing returns to scale(Regime 1)

Generations	Nutrition	Human capital	Education	Fertility
Without aid				
Generation 1	0.13	0.13	Basic	2
Generation 2	0.0002	0.1214	Basic	1.76
Generation 3	0.0001	0.0284	Basic	2.21
Feeding programs				
Generation 1	0.13	0.13	Basic	1
Generation 2	0.00019	0.1213	Basic	1.77
Generation 3	0.00001	0.0282	Basic	2.29
Food provided in households				
Generation 1	0.13	0.13	Basic	2
Generation 2	0.0088	0.1214	Basic	1.76
Generation 3	0.0030	0.07	Basic	1.85

Table 8: Sensitivity analysis

Generations	Nutrition	Human capital	Education
		Generations	
	Without aid		
Generation 1	0.17	0.18	0.1
Generation 2	0.0053	0.1829	0.66
Generation 3	0.0026	0.1303	0.27
	γ=0.003		
Generation 1	0.17	0.18	0.1
Generation 2	0.0365	0.1829	1
Generation 3	0.0538	0.2503	1
	σ=0.1		
	Without aid		
Generation 1	0.17	0.18	0.1
Generation 2	0.0053	0.1829	0.66
Generation 3	0.0026	0.1303	0.27
	σ=0.2		
Generation 1	0.17	0.18	0.1
Generation 2	0.091	0.1829	0.8836
Generation 3	0.0066	0.1554	0.62

Table 9: Sensitivity analysis of returns to human capital

Generations	Nutrition	Human capital	Education
		Generations	
	Returns to nutrition:0.2		
	Without aid		
Generation 1	0.17	0.18	0.1
Generation 2	0.0053	0.1829	0.66
Generation 3	0.0026	0.1303	0.27
	Returns to nutrition:0.07		
Generation 1	0.17	0.18	0.1
Generation 2	0.0023	0.1843	0.69
Generation 3	0.0023	0.13	0.49

Countries used in the analysis.

	Countries	
Algeria	Tanzania	Ecuador
Benin	Togo	Paraguay
Botswana	Tunisia	Peru
Cameroon	Uganda	Uruguay
Central African Republic	Zaire	Venezuela
Egypt	Zambia	China
Gambia	Zimbabwe	Hong Kong
Ghana	Costa Rica	India
Kenya	Dominican Republic	Indonesia
Lesotho	Guatemala	Iran
Malawi	Haiti	Iraq
Mali	Honduras	Kuwait
Mauritania	Jamaica	Malaysia
Morocco	Mexico	Pakistan
Mozambique	Nicaragua	Saudi Arabia
Niger	Panama	Singapore
Nigeria	Trinidad and Tobago	South Korea
Rwanda	Argentina	Sri Lanka
Senegal	Bolivia	Taiwan
Sierra Leone	Brazil	Thailand
Sudan	Chile	Turkey
Swaziland	Colombia	Papua New Guinea

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