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Aline Meysonnat, Joan Muysken and Adriaan van Zon

Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)
email: info@merit.unu.edu | website: http://www.merit.unu.edu

Maastricht Graduate School of Governance (MGSoG)
email: info-governance@maastrichtuniversity.nl | website: http://mgsog.merit.unu.edu

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands
Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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Poverty traps: the neglected role of vitality

Aline Meysonnat[a], Joan Muysken[b], Adriaan van Zon[c]

Abstract

This paper proposes an integrated framework that incorporates both the "physical" and the "behavioural" dimensions of poverty in developing countries and their consequences for aggregate savings behaviour. To this end a concept is introduced, labelled "vitality", which captures the idea that being near subsistence consumption levels not only has an impact on the ability to save, but also on the willingness to save. We introduce the notion of a "vitality threshold" which marks a situation where the willingness to invest into the future changes – this is represented by a change in the discount rates.

The recognition of transition paths from a "pessimistic", low-savings regime with high discount rates to an "optimistic" regime with relatively high savings enables us to analyse the transition of countries through various stages of development. In addition to this, we can shed new light on poverty traps by looking at below subsistence consumption scenarios. Finally we can infer specific policy implications concerning development aid. For instance, if a country is in a pessimistic, low-savings regime, we argue that a transfer should be high enough to push a country above the subsistence-level consumption threshold by far enough to enable it to reach the optimistic, high savings regime and consequently grow out of poverty. The existence of vitality thresholds implies that marginal changes in development assistance may have non-marginal long-term effects.

JEL Code: O1,O2,I13

Key words: poverty trap, subsistence consumption, vitality, foreign aid

[a] Department of Economics, SBE, Maastricht University.
Corresponding author: a.meysonnat@maastrichtuniversity.nl
[b] Department of Economics, SBE, Maastricht University; UNU-MERIT.
[c] Department of Economics, SBE, Maastricht University; UNU-MERIT.

1. Introduction

One of the most pressing economic concerns still to this day deals with the question why some countries achieved economic success and were able to improve their standards of living, while other countries are stuck at low to very low income per capita levels and do not seem to be able to "catch up" to countries with a relatively high income per capita. In the low income countries as classified by the World Bank, average income per capita was $440.94 a year (in constant 2005 US dollars) in 2012, which is roughly 16% that of a middle income country and only 1.4% that of a high income country. Additionally, the Millennium Development Goals Report 2014 indicates that in 2010 roughly 1.2 billion people still lived on less than $1.25 a day (United Nations, 2014). However, for the chronically poor, poverty is not only a matter of very low income per capita, but rather a multidimensional deprivation which includes hunger, malnutrition, illiteracy, unsafe drinking water and lack of access to basic health services (Shepherd et al., 2014).

This paper explores the complexity of poverty further. In line with Carter and Barrett (2006) we take the position that there are several critical thresholds that need to be achieved before economic development can take off. This is in contrast to the position taken in most strands of the literature relating to savings traps, where the focus is on the subsistence consumption threshold as a physical impediment to savings (Ben-David, 1998; Steger, 2000; Sachs et al., 2004; Sachs, 2006). In our analysis we add to this literature the notion that consuming close or below subsistence might also lead to a change in inter-temporal preferences and thus change people's inter-temporal welfare trade-offs that drive their willingness to invest in the future. This might lead to a poverty trap caused by behavioural aspects.

This paper proposes an integrated framework that incorporates both the "physical" and the "behavioural" dimensions of poverty and their consequences on savings behaviour. To this end an additional concept, "vitality" is introduced, which captures the idea that being near subsistence consumption levels not only has an impact on the ability to save, but also on the willingness to save. A "vitality threshold" is then added that marks a situation where the willingness to invest into the future changes – this is represented by a change in the discount rates.

As a consequence, two consumption thresholds are distinguished, one relating to people physically not being able to save ("subsistence consumption") and one that relates to the willingness to invest in the future ("threshold consumption"). Consuming above threshold consumption then positively adds to vitality, while consuming below it reduces vitality. Once vitality is above its threshold, people have a low discount rate and are willing to invest in the future, while when vitality falls below its threshold, people have a high discount rate and are much less inclined to invest.

With this integrated framework we add to the literature in various ways: First, the framework enables us to analyse the transition of countries through various stages of development instead of focussing on the steady state solely. This follows from the recognition of transition

paths from a pessimistic regime with high discount rates and low savings to an optimistic regime with relatively high savings. Second, because of the focus on the "behavioural" implications of near-subsistence consumption in relation to savings behaviour we can shed new light on poverty traps by looking at below subsistence consumption scenarios and the implications for a countries' ability to grow out of poverty. Finally, given a country's position in the consumption-vitality plane in relation to the consumption and vitality thresholds we can infer specific policy implications concerning development aid. If a country is in a pessimistic, low-savings regime, we can in principle calculate the minimum amount of transfer needed for a country to be pushed above the consumption threshold far enough to be able to reach the optimistic, high savings regime and consequently grow out of poverty.

As we elaborate below, the framework has some limitations. A first limitation is that we use this framework from an aggregate perspective, i.e. at the country-level. As a result, we do not consider inequality issues, even though inequality might be a major driver in the discussion of saving rates, especially in developing countries.[1] A second limitation is that we use the perspective of the central planner. On the one hand this allows us to infer which solutions can be achieved under 'ideal' circumstances, in absence of market imperfections. On the other hand this prevents us to analyse the impact of market imperfections, which definitely play an important role in the economies of developing countries (Dercon, 2003; Azariadis and Stachurski, 2005). A final limitation, which follows from the AK type production function, is that we only have one factor of production, capital, with an exogenously given productivity, ignoring for example human capital and thus the possibility for productivity to evolve endogenously.[2]

The second part of this paper elaborates on the degree to which the concepts and threshold levels introduced above can be characterised using observed data. Poverty is such a complex phenomenon that it should not come as a surprise that the connection between reality and concepts like subsistence consumption and vitality is imperfect. However, the connection is strong enough to take at least the theoretical analysis further.

The paper starts out in section 2 with a review of the literature on the existence of poverty traps, including a discussion on possible dynamics around poverty traps, with a closer look at a savings traps and critical threshold levels. Section 3 introduces an integrated framework with vitality and consumption thresholds, summarising the model developed in Meysonnat (2016) and van Zon, Meysonnat and Muysken (2016). Next, section 4 elaborates on the role of aid in our framework. Section 5 discusses the different indicators for vitality and consumption. It also discusses their relation to the framework, while ignoring thresholds. Thereafter, section 6 evaluates the underlying characteristics of the framework in light of the

[1] One can imagine that a small group in a country is able and willing to save while a majority group in the country might not be able to save due to consumption near subsistence consumption levels

[2] Meysonnat (2016, Ch6) expands the framework by assuming that above threshold consumption also implies a positive externality on health and thus increases in productivity. Reaching the vitality threshold then not only implies an optimistic discounting regime but also a more productive economy enabling a country's economic progression from a low economic development stage with low savings and low productivity to a high economic development stage with high savings and a higher productivity.

data, cumulating in the description of the model with thresholds. Section 7 discusses the limitations of the framework. Section 8 concludes the paper and provides a discussion on the findings.

2. Economic Growth and the existence of poverty traps

Poverty traps

Already in the 1940's the argument was put forward that there are certain traps in which countries might fall preventing them to catch up to wealthier countries and forcing them to stay in a low income per capita steady-state. For instance, Rosenstein-Rodan (1943) put forward the idea of the need for a "big push" to shift countries out of poverty and Nelson (1956) remarked that "the notion of low-level stagnation is scarcely new". The literature then shifted to the Solow-Swan growth model, which we discuss below in section 0, and the debate on conditional convergence – see Durlauf and Quah (1999) for a survey. However, the notion of poverty traps was largely ignored.

Recently, there has been an increased interest in mechanisms that cause poverty to persist and result in countries which remain stuck in a "poverty trap" (Azariadis and Stachurski, 2005). One of the concerns is whether poverty traps exist in general - see the surveys in Azariadis and Stachurski (2005) and Durlauf, Johnson and Temple (2005)). An additional question is to what extent self-reinforcing mechanisms exist that imply different economic long-run outcomes in income per capita given similar environments and similar population groups (Azariadis and Drazen, 1990; Durlauf and Johnson, 1995; Quah, 1996; Bianchi, 1997; Desdoigts, 1999; Easterly and Levine, 2003). The divergence in economic development patterns has been discussed by Azariadis (1996), who emphasises that economies with similar characteristics might follow different development paths given differences in initial conditions. The economic starting position of a country may therefore determine whether an initially poorer country will remain stuck in a development trap or will join the club of wealthy nations – see also Galor (1996) and Durlauf and Quah (1999). Recent surveys of structural mechanisms that can generate poverty traps are provided by Barrett and Carter (2013) and by Kraay and McKenzie (2014)).

There are two "fundamental" causes of poverty, leading to cross-country differences in prosperity and a poverty trap. The "geography hypothesis" maintains that geographical location, ecology and climate determine the technology available to a country and thus influence economic outcomes. Bloom, Canning and Sevilla (2003) for example look at geographic location as an impediment to growth. Bonds et al. (2010) argue for a "disease-driven" poverty trap where countries with a tropical climate are more prone to infectious diseases than countries with moderate climates, leading to lower productivity in a country. Similar arguments have been made by Gallup and Sachs (2001), Gallup, Sachs and Mellinger (1999), Bloom, Canning and Sevilla (2003) and Jalan and Ravallion (2002).

The “institutional hypothesis” maintains that institutional phenomena prevent countries from developing and achieving a non-poor standard of living. Acemoglu, Johnson and Robinson (2005) argue that the latter argument is even more important than the geography of a country. They identify the “enforcement of property rights”, “constraints on the actions of elites, politicians and other powerful groups” and “some degree of equal opportunity” as key components to the definition of “good” institutions which, if not fulfilled, would impede the economic development of a country. In a similar vein, Engerman and Sokoloff (2005) identify historical developments of a country (and by extension the evolution of institutions) as a driver for economic performance. They find that colonies with extreme inequality were more likely to develop institutions that restricted access to economic opportunities (such as investment into schools or infrastructure) compared to colonies with relative equality. Other authors analysing the impact of institutions on economic growth include Knack and Keefer (1995), Dollar and Kraay (2003), Easterly and Levine (2003), Ravallion and Chen (2003), Rodrik, Subramanian and Trebbi (2004) and Gruen and Klasen (2008). Another argument put forward to explain why some countries are stuck in a poverty trap is conflicts (Collier, 2003).

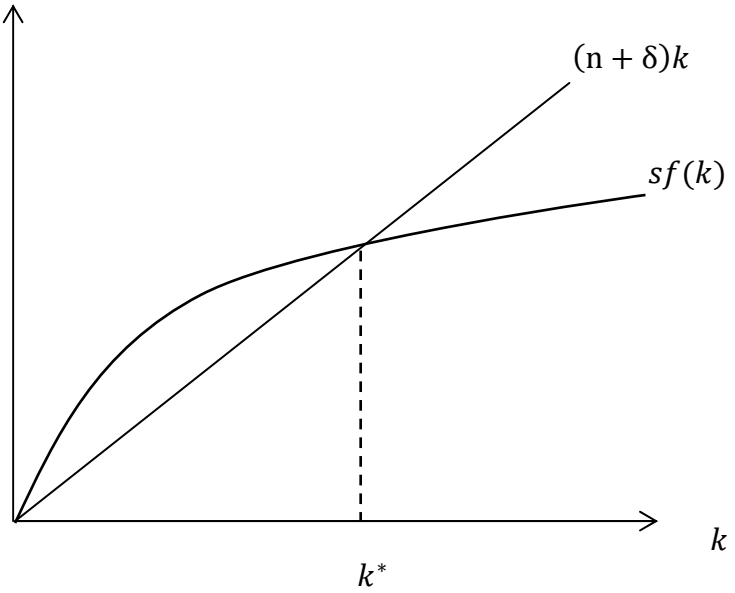
One of the underlying notions of the aforementioned causes of poverty is that countries converge to a single low-income per capita steady-state equilibrium. However, several authors in the convergence literature argue for a bi-modal distribution of income, where countries can converge either to a high income per capita steady-state or a low income per capita steady-state. Countries stuck at the low-level are then considered to be in a poverty trap. One is the argument of a savings trap, i.e. a situation in which some countries are not able to accumulate enough capital to improve their economic situation. The next section elaborates on that notion and discusses mechanisms underlying a savings trap. In particular, we focus on nutrition and behavioural aspects that could lead to countries not being able to save and thus falling into a poverty trap.

Savings trap

The first model to tackle the issue of differences in growth and development and the possibility that some countries might be stuck in a poverty trap was developed by Nelson (1956) who looked at a growth model with low saving and investment rates at low income levels. This simple model of a poverty trap was based on the notion that a country that is poor will remain poor because it is not able to accumulate sufficient capital per capita for income to rise. This notion can also be found in Solow (1956).

We illustrate this, starting from the Solow-Swan growth model in a closed-economy with a simple linear homogeneous Cobb-Douglas production function $f(k) = A \cdot k^{\alpha}$ in which output per capita $y = f(k)$ depends on capital per capita k, a technology level A and diminishing returns to capital α. In equilibrium investment is financed by savings, while savings are a fixed share of output $sf(k)$. The function of savings per capita is presented in Figure 1 with $sf(k)$ being steep at low levels of capital per capita and levelling off at high levels of k.

Figure 1 The standard neoclassical growth model

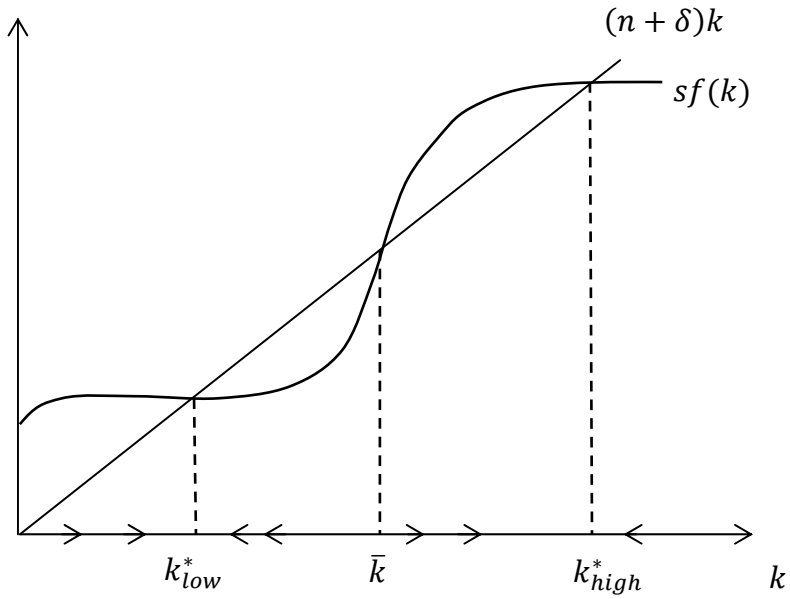


The steady state level of gross investment, consistent with a rate of depreciation δ and population growth n, is given by $(n + \delta)k$. This is represented by the straight line in Figure 1. When k is low, the fraction of output saved exceeds steady state investment hence actual investment is higher and k increases. When k is high the opposite process occurs. The economy reaches a unique stable steady-state level of capital stock per capita k^* once the fraction of output per capita saved exactly offsets depreciation and population growth. However, Solow (1956) remarks that $sf(k)$ should not necessarily take the functional form shown in Figure 1, but that other *a priori* configurations might be possible.

Sachs et al. (2004) argue that at low levels of income the marginal productivity of capital also tends to be low because there is a minimum threshold of capital needed before economic growth can be reached. At low levels of income per capita it is assumed that it is difficult to save, thus saving rates are low, while intermediate levels of income per capita entail a higher savings rate. This is illustrated by the savings per capita curve in Figure 2 which starts out flat when countries are poor, increases sharply over some intermediate range and then levels off again (Sachs et al., 2004). At low levels of development savings and investment are low, such that there is a stable low-level equilibrium at k^*_{low} beyond which the country cannot grow. However, if a country is able to accumulate capital above some threshold value $\bar{k}$, the equilibrium will be reached at a high steady-state capital stock per capita k^*_{high}. Such a framework provides a mechanism generating two possible steady-state equilibrium outcomes for a country, depending on its initial capital endowment, one with a high capital stock, and thus prosperity, and one with a low capital stock, resulting in a poverty trap.[3]

[3] Any shock that alters the underlying parameters of the model can in principle generate a situation with multiple steady states and a low-level poverty trap.

Figure 2 A neoclassical growth model with the possibility of a poverty trap



Subsistence consumption and undernourishment

Consistent with the previous analysis Bowles, Durlauf and Hoff (2006) note that in order to explain a savings trap one should introduce certain economic threshold levels necessary for economic growth. One of the most familiar thresholds that could account for the S-shape curve shown above in Figure 2 is the concept of subsistence consumption.[4] If countries or individuals are close to subsistence levels of consumption, they might be too poor to save and thus cannot accumulate capital.[5]

Azariadis (1996) identifies below-subsistence consumption as one of the reasons why countries might be stuck in a poverty trap. Similarly, Ben-David (1998) finds that the poorer a country is, the lower its savings rates will be. Near-subsistence consumption can account for downward "convergence clubs" but this does not necessarily imply that countries stay impoverished forever. Steger (2000) introduces subsistence consumption into a growth model with a Stone-Geary Utility function, noting that subsistence consumption restricts people's ability to save at least for the lower range of income. As a result, countries on the lower range of income (near-subsistence) are stuck in a poverty trap, while above subsistence consumption countries show a rise of savings per capita along with per capita income. However, Steger (2000) presents only an above-subsistence scenario. Sachs et al. (2004) note that with subsistence considerations, near-subsistence consumption implies low savings because impoverished households do not save. Once basic needs are met, households are able

[4] Sharif (1986) gives an extensive review of the existing literature concerning the measurement and definition of subsistence consumption.

[5] An alternative view is provided by Carter and Barrett (2006) who understand a poverty trap as a critical minimum asset threshold, below which families are unable to successfully improve their economic position.

to save. Thus subsistence consumption can result in a savings per capita curve consistent with Figure 2.

Kraay and Raddatz (2007) do not find empirical evidence for an S-shaped curve as described in Figure 2. They explicitly introduce a minimum consumption level in the preference function of a representative consumer similar to Steger (2000) and Ben-David (1998). While savings rates and productivity increase with income levels, they do not increase in the non-linear way required to generate a stable low-level equilibrium associated with the notion of poverty traps. Instead, Kraay and Raddatz (2007) note that at low levels of development (measured in income per capita), growth reflects the balance of two forces: First, the marginal utility of consumption is very high, leading to lower savings and lower growth. Second, the marginal product of capital is high because there are low levels of capital investment and diminishing returns have not yet a strong impact. If the attractiveness of savings and investment dominates, given plausible parameter calibrations, countries may grow out of their subsistence constraint.

However, only when countries are very close to subsistence levels does the model suggest that savings and investment would be so low that growth will be expected to stagnate for an extended period of time. Kraay and Raddatz (2007) conclude that there is little empirical evidence for a poverty trap based on subsistence consumption. As a result, in our view, there should be additional thresholds that keep countries in an impoverished state, next to subsistence consumption. For example, next to not being able to save, people might be so destitute that they are not willing to save (Sachs, 2006), either because consuming at subsistence levels has a negative impact on people's physical well-being and productivity or because consuming near subsistence levels changes people's inter-temporal preferences (i.e. discount rates or intertemporal elasticities of substitution).

In line with consuming near or below subsistence consumption, persistent poverty can be caused by nutritional deficits. The argument is that because poor individuals are too malnourished to physically be able to work productively, they cannot earn enough income or produce enough food to overcome malnourishment and thus fall into a nutritional poverty trap. This argument was discussed by Dasgupta and Ray (1986) who developed a model emphasising malnutrition as an impediment to productivity and linking it to unemployment. The model has been extended to poverty traps in Dasgupta (1997).

The relation between health and nutrition, productivity and economic growth has been well-established in the economic literature (Spurr, 1983; Strauss and Thomas, 1998; Van Zon and Muysken, 2003; Bloom, Canning and Sevilla, 2004). Productivity aspects in combination with health can then also be linked to poverty traps, for example in a "disease-driven" poverty trap. Another link between poverty and health is via the nutrition argument as many countries also calculate their poverty lines according to how much it costs to obtain enough food (calculated on the basis of 2000 calories a day) and differences in calories intake (Deaton, 2006). Nutritional requirements can be used to calculate thresholds that constitute positive externalities towards health, while for those consuming below these thresholds health levels are falling. Thirlwall (2006) estimates that over one billion people in the world suffer

from various types of malnutrition, with children being affected the most. Undernourishment can therefore have vast consequences on people's physical capabilities such as a reduced concentration span for children in school (Brown and Pollitt, 1996) and lower productivity levels in adults due to hunger (Dasgupta, 1997). Similary, Behrman, Alderman and Hoddinott (2004) show that there are considerable impacts of nutritional deficiencies in early childhood on a person's physical and mental development and benefits to alleviate such deficiencies. However, Strauss and Thomas (1998) find that while nutrition affects productivity, the relationship does not tend to follow the S-shaped pattern usually associated with a poverty trap. However, as Kraay and McKenzie (2014) note, this does not mean that there is no scope for policy to ease malnutrition.

In light of the findings above, we interpret "subsistence consumption" as a strict lower bound below which people cannot survive. The lower band will be further indicated by $\bar{C}$.

Changing time preferences and vitality

This paper does not focus on the relationship between health and productivity, although that may also play an important role, but we introduce a threshold level in terms of physical and mental health in order to explain different savings patterns and the possibility to grow out of poverty traps. In recent years a new strand of literature discusses how persistent poverty may cause preferences to change endogenously.[6] Duflo (2006) shows how poverty affects behaviour, as being poor means to be cut off from many opportunities available resulting in differences in time preference parameters and discount rates. She furthermore argues that poor people often have a negative outlook on life and even fall into phases of desperation.

In an earlier study Lawrance (1991) finds that poor households in the United States have subjective time preference rates up to five percentage points higher than rich households. This difference increases when controlling for race and education, where relatively rich, white college-educated families may have time preferences up to 12%. In contrast, poor, non-white families without college education may have time-preferences up to 19%. This finding is consistent with Haushofer, Schunk and Fehr (2013) who link negative income shocks to increases in discounting and find a direct causal effect of income shocks on discount rates. Additionally, Haushofer and Fehr (2014) find that poverty can have psychological consequences such as increased stress levels which in turn may lead to short-sightedness and risk-averse decision making resulting in persistent poverty.

Laajaj (2012) analyses the impact of economic prospects on one's time preference. It is argued that poverty causes cognitive dissonance, the uncomfortable tension felt when simultaneously holding conflicting thoughts. Among the poor this can occur when simultaneously caring about future welfare while facing gloomy economic prospects. Not being able to consider the future can reduce their psychological distress at the expense of their future economic well-being. This can result in high discount rates and a poverty trap

[6] See for example Lawrance (1991), Duflo (2006), Haushofer, Schunk and Fehr (2013), Haushofer and Fehr (2014).

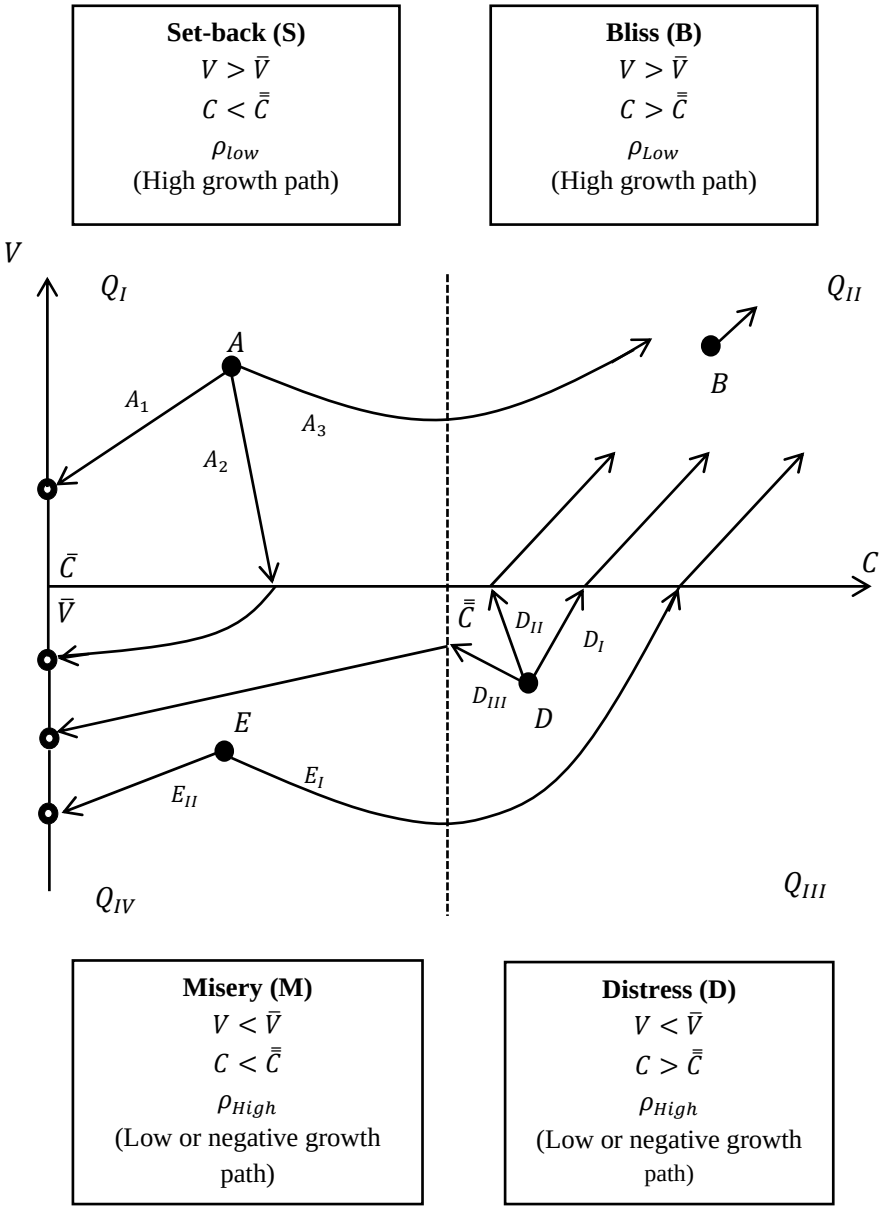
caused by psychological factors. Similar studies on behavioural poverty traps in developing countries can be found in Lybbert and McPeak (2012), Yesuf and Bluffstone (2008), Pender (1996), Tanaka, Camerer and Nguyen (2010). If poor people have different preferences compared to richer people, the constant time preference rate used in the theory of inter-temporal allocation must be modified. Indeed, Uzawa (1968) and Epstein and Hynes (1983) note that constant rates of time-preference might be too rigid and they propose a class of utility functions that endogenises these preferences. In the case of poverty, groups of people with low levels of income might discount the future more heavily, either because they have to consume their entire income to survive or because they are too desperate to save. In contrast, groups with higher income have lower discount rates. A related view is presented by Chakrabarty (2012) who notes that there is a high correlation between life expectancy and the standard of living and endogenises time preferences by tying impatience to longevity, influenced by investments in public health. Poor nations are caught in a poverty trap since they cannot afford to invest in public health, resulting in brief life cycles and short planning horizons. Similarly, Chavas (2013) develops a model to show that heavy discounting of the future is a basic characteristic of malnutrition. In the case of under-nutrition due to poverty, it is sufficient to note that starving individuals cannot be expected to be concerned about the long-term future if the short-term result of their condition is death.

We capture the change in preferences to invest into the future due to poverty, more specifically due to consumption near subsistence levels, by the concept of "vitality". In our perception, vitality is closely connected to one's physical well-being as well as a mental state which allows a positive perspective on life. Having a low level of vitality then implies a more gloomy perspective on life, to the extent that people may become "utterly destitute" and see no reason to invest in the future (Sachs, 2006) – in this situation subjective discount rates are high. Conversely, if vitality levels are such that individuals have a positive outlook on life, discount factors may be low enough to allow for future saving and capital accumulation. From here on we use the concept of vitality and particularly a hypothesised vitality threshold level $\bar{V}$, to distinguish between regimes of low and high discounting. We also introduce an additional threshold of consumption tied to vitality, which is different from the afore-mentioned "subsistence consumption" level $\bar{C}$ as a threshold below which people cannot survive. This "threshold consumption", from hereon denoted by $\bar{\bar{C}}$, determines whether vitality will be increasing or not – it is assumed that $\bar{C} \leq \bar{\bar{C}}$. If people consume between $\bar{C}$ and $\bar{\bar{C}}$, vitality will be falling, even though consumption is above subsistence consumption. If people consume above $\bar{\bar{C}}$, vitality will increase. We elaborate the implications of these notions for the analysis of the dynamics of poverty traps in the following sections.

3. A model with vitality and consumption thresholds

In van Zon, Meysonnat and Muysken (2016) we develop a model in which initial endowments of vitality and capital (and hence initial consumption levels) in relation to their respective threshold levels, together with preferences for the future as represented by the discount rate ρ, play a pivotal role in determining whether a country can grow out of poverty – see also Meysonnat (2016). In Figure 3 a diagram is presented displaying the different possible trajectories.[7] This section provides an overview of the relevant features of the model.

Figure 3 A model with consumption and vitality thresholds



[7] The diagram is a simplified representation of the model, since paths might actually be discontinuous when moving from one quadrant to the next. This will be discussed in more detail in later sections.

The vertical axis represents vitality V and the horizontal axis represents consumption C. On the horizontal axis are two points which are especially relevant for our model. The first point is at $(\bar{C}, \bar{V})$, where subsistence consumption $\bar{C}$ is a strict lower bound on consumption below which people fail to function. Hence, as soon as $C = \bar{C}$ the economy (ultimately) collapses.[8] The second point is at $(\bar{\bar{C}}, \bar{V})$, where when $C < \bar{\bar{C}}$ vitality falls, but people are physically still able to function. Vitality is increasing for $C > \bar{\bar{C}}$. The horizontal axis marks the vitality threshold $\bar{V}$, which determines people's outlook on the future and consequently their willingness to save. When $V < \bar{V}$, people have little hope for the future, thus a high discount rate ρ_{High} and low saving rates, which result in a low growth path. Conversely, $V > \bar{V}$ marks a situation in which people discount the future less, have a low discount rate ρ_{Low}, save more and the economy is on a high growth path. Additionally, we assume that $\rho_{High} > \rho_{Low}$. Table 1 summarises the key assumptions of the model with respect to $\bar{V}$ and $\bar{\bar{C}}$.

Table 1 Key properties of the model with respect to vitality.

Condition	Properties
$V > \bar{V}$	$\rho = \rho_{Low}$
$V < \bar{V}$	$\rho = \rho_{High}$
$C > \bar{\bar{C}}$	Vitality increasing
$C < \bar{\bar{C}}$	Vitality decreasing

The boundaries $\bar{V}$ and $\bar{\bar{C}}$ dissect the diagram in Figure 3 in four quadrants. We label the low discount quadrants Bliss (quadrant Q_{II}) and Set-back (quadrant Q_I) and the high-discount rate quadrants Distress (quadrant Q_{III}) and Misery (quadrant Q_{IV}), respectively. The names will become clear below. Within these quadrants we allow for differences in consumption growth rates (negative and positive growth rates), labelled using roman numerals in the high discount rate quadrants.[9] In quadrants Q_{III} and Q_{IV}, the trajectories labelled I represent a situation where the (relatively high) discount rate is such that there is positive consumption growth, and II and III mark trajectories with a (relatively high) discount rate such that consumption growth is negative. In the low discount rate quadrants, Q_I and Q_{II} differences in consumption growth rates are labelled using Arabic numbers, where trajectories with positive growth rates are represented by the numbering 2 and 3 (Where A_2 and A_3 represent two different trajectories), and the negative growth rate trajectory is labelled 1. The characteristics of each quadrant are summarised in Table 2.

[8] It could be that it is "optimal" for people to spend the last part of their lives with $C = \bar{C}$, given the absence of external aid. If a level of consumption equal to $\bar{C}$ would also give utility, then there is a theoretical possibility that it might be optimal to spend some time at the subsistence level of consumption before the economy collapses.

[9] There might be the possibility of zero growth rates as well. But since that case is relatively uninteresting, we will only discuss the case of positive and negative growth rates.

Table 2 Key characteristics of quadrants

Quadrant	Vitality	Consumption	Discount rate	Movement in Vitality
Q_I : Set-Back	$V > \bar{V}$	$C < \bar{\bar{C}}$	Relatively low ρ	Vitality decreasing
Q_{II} : Bliss	$V > \bar{V}$	$C > \bar{\bar{C}}$	Relatively low ρ	Vitality increasing
Q_{III}: Distress	$V < \bar{V}$	$C > \bar{\bar{C}}$	Relatively high ρ	Vitality increasing
Q_{IV}: Misery	$V < \bar{V}$	$C < \bar{\bar{C}}$	Relatively high ρ	Vitality decreasing

The quadrants Q_{II} (Bliss) and Q_{IV} (Misery) are the standard scenarios in the literature. In Bliss positive growth is observed consistently (Steger, 2000). In Misery negative growth occurs and the economy is in a poverty trap, falling back to a situation where consumption reaches its subsistence level and the economy ultimately collapses (Sachs et al., 2004). In our model initial endowments of capital and vitality and their distance from the respective thresholds described above determine in which quadrant an economy ends up.[10] We add to the literature by noting that the positioning of a country's endowments in combination with the discount rate determines whether a country can grow out of poverty, even when starting out at low development levels.

An example is given by the situation in quadrant Q_{IV}, where $V < \bar{V}$ and $C < \bar{\bar{C}}$. Depending on the specific parameter constellation and (relatively high) discount rate, starting from point E consumption growth can be either negative (E_{II}) or positive (E_I).[11] Since vitality is decreasing for $C < \bar{\bar{C}}$, trajectory E_{II} implies a high discount rate, such that consumption reaches its lower boundary and the economy ultimately collapses. Alternatively, people lose vitality initially, but the discount rate is such that consumption growth is positive and consumption levels are increasing – cf. trajectory E_I. As a result, once $\bar{\bar{C}}$ is reached, both vitality and consumption are rising, effectively pushing the economy towards Bliss.

A second example is given by the situation in quadrant Q_{III}. In that quadrant, point D shows a structural endowment of capital and vitality in an economy where $V < \bar{V}$ and $C > \bar{\bar{C}}$. The trajectory D_I has a sufficiently low discount rate such that consumption growth is positive, hence Bliss (Q_{II}) will be reached.[12] The trajectories D_{II} and D_{III} both illustrate the case of a relatively higher discount rate, such that consumption growth is negative. On the trajectory D_{III}, vitality is increasing since $C > \bar{\bar{C}}$. However, the discount rate is so high that consumption declines fast and the $\bar{\bar{C}}$ threshold is reached before $\bar{V}$ is reached. As a

[10] Since consumption is a control variable, the initial level of consumption is determined endogenously in the model.

[11] Arguably, the economy could also be in a situation where there is zero consumption growth and the economy only loses vitality if $C < \bar{\bar{C}}$. However, we will not allow for such a situation within this framework, since this is an atypical situation.

[12] Note however, that there is a jump in the discount rate at $V = \bar{V}$ which potentially could entail an "optimal" downward jump in the consumption level. The downward jumps occurs because low discount rates make for higher saving rates, hence (initially) lower levels of consumption, *ceteris paribus*. If the jump is such that $\bar{\bar{C}}$ is not crossed, the economy keeps on moving towards Bliss. Otherwise the economy moves towards Misery.

consequence the economy moves to quadrant Q_{IV} and ultimately back into a poverty trap. On the other hand, if the discount rate is not too high, such that consumption declines slowly, vitality increases to $\bar{V}$ before $\bar{\bar{C}}$ is reached – see trajectory D_{II}. In that case the economy can move to Bliss.[13] This could happen if a country for example receives aid, pushing it further away from the $\bar{\bar{C}}$ threshold and thus giving it more time to reach $\bar{V}$. This situation could also occur when an economy initially in Misery (Q_{IV}) receives a capital transfer pushing it into Distress (Q_{III}).

A similar story holds for point A, which is a situation where $C < \bar{\bar{C}}$, but where the discount rate is relatively low since $V > \bar{V}$. Such a situation could emerge for example if an economy started out in Bliss (Q_{II}), but a catastrophe pushes it back to Set-back (Q_I). If the discount rate is such that consumption growth is positive, again two possibilities emerge. The economy can move toward Bliss if the increase in consumption outweighs the decrease in vitality such that $\bar{\bar{C}}$ is reached before $\bar{V}$. However, if the opposite is true, the economy falls into Misery (Q_{IV}).

From this analysis, we can first illustrate that even if consumption growth is negative, there is still a possibility to grow out of poverty, provided structural endowments are high enough (D_{II}). Additionally, since initial endowments and their distance to their respective thresholds are of central importance, foreign aid can play a role in speeding up the process of reaching Bliss in case consumption growth is positive (E_I). More importantly, even if actual consumption growth is negative, foreign aid can push an economy far enough above the $\bar{\bar{C}}$ mark such that Bliss can still be reached even though discount rates are still high. These observations also hold for foreign aid after a national disaster, compare the situation in point A of Figure 3. The next section briefly elaborates on the effectiveness of foreign aid as observed in the literature.

4. Initial capital endowments and development aid

The effectiveness of foreign aid on an economy's development has been debated since the 1950s and surged in 2000 with the introduction of the Millennium Development Goals (MDGs). The literature with regard to the effectiveness of foreign aid in developing countries is divided – for a review see Radelet, Clemens and Bhavnani (2004) and Channing, Jones and Tarp (2009). One group of authors makes a case in favour of aid, claiming that it is a means to escape poverty traps (Stiglitz, 2002; Sachs et al., 2004; Sachs, 2006). Another group takes a more conservative approach to foreign aid, arguing that aid has been historically ineffective in promoting growth (Easterly, 2005, 2006; Rajan and Subramanian, 2008). A third group makes the point that foreign aid can be effective under certain conditions such as for example good governance and sound macroeconomic policies (Burnside and Dollar, 1997). Empirically, the question of the effectiveness of aid on economic growth also shows inconclusive results with some authors suggesting a positive relationship between aid and

[13] Provided that the downward jump in consumption does not push the economy below $\bar{\bar{C}}$.

growth (Burnside and Dollar, 1997; Collier and Dollar, 2002; Dalgaard, Hansen and Tarp, 2004), while others find no effect on growth (Boone, 1996; Easterly, 2005).

Within our framework foreign aid can play a crucial role as it augments savings and capital accumulation. Thus, foreign aid can push a country above subsistence levels and towards a high steady state as we elaborated above. Kraay and Raddatz (2007) calibrate a model with subsistence consumption and note that even in the absence of foreign aid, countries would eventually reach the high steady state on their own. However, foreign aid can significantly accelerate the process. Additionally, aid inflows can have strong effects on growth, both in terms of capital accumulation as well as by the indirect effect of foreign aid. Thus, the subsistence constraint becomes less binding. However, Kraay and Raddatz (2007) also note that the evidence for a poverty trap due to subsistence consumption is weak. Nevertheless, they suggest that even though subsistence consumption alone might not result in a poverty trap, a variety of processes operating simultaneously can generate a poverty trap. In such a situation, large-scale increases in aid could push countries out of a poverty trap.

In our model we recognise a situation where a country both falls short of threshold consumption and the vitality threshold and also has a negative growth rate of consumption. In this case the country ultimately collapses, as is represented by the D_{III} trajectory. Then foreign aid can push a country above the $\bar{\bar{C}}$ threshold to reach Bliss. On the other hand, if the country is already on the D_{II} trajectory towards Bliss, foreign aid can accelerate the process of reaching Bliss.

Development aid can also play an important role after a natural disaster, which relates to the Set-Back quadrant in our framework. The importance of aid is particularly relevant in developing countries. Carter et al. (2007) for example show that developing countries are especially vulnerable after a natural disaster because poor households cannot insure themselves against the loss of their assets, which may lead to a poverty trap. Strömberg (2007) finds that disaster fatalities are on average higher in low-income countries than in high-income countries. This observation is supported by the finding of Toya and Skidmore (2007) who find that even though there is no apparent relation between economic development and exposure to natural catastrophes, the impact of the latter is different due to differences in pre-emptive protection measures in high income countries.

Several authors discuss the impact of aid on the economy and long-run economic growth. Skidmore and Toya (2002) for example show that GDP generally increases after disasters; however, most of the losses occur in capital and durable goods, which are not included in GDP. Cavallo and Noy (2009) provide a survey of the aggregate impact of disasters on the economy and find that natural disasters have on average a negative impact on the short-run economic growth, while the literature on the long-run effects of natural disasters is inconclusive. This result is supported by Jackson (2014) who finds that in the short and medium run aid increases GDP per capita growth through increases in household consumption, but does not find long run effects on growth.

In the literature on poverty traps aid helps in the transition phase right after a disaster. However, the literature is inconclusive on the long-term effects of aid on economic growth after catastrophes. Our model is consistent with the former finding. In addition, we conclude that aid also has positive long-term consequences on economic growth by preventing countries to fall into a poverty trap. This is in line with Cavallo and Noy (2009) who show that aid can alleviate the severe consequences of disasters on poor countries by providing better-targeted reconstruction measures after a natural catastrophe.

In this vein, the models developed in this thesis integrate the importance of aid for the initial endowments of a country and their distance to their respective thresholds. Additionally, it allows us to calculate a minimum amount of aid needed to follow trajectories towards Bliss (such as D_{II} and A_3) instead of falling to Misery.

5. An illustration of the framework

The previous sections have developed a framework in which vitality and consumption thresholds and initial positions in the vitality-consumption plane play a pivotal role in determining whether a country can grow out of poverty. The underlying model combines the presence of a consumption threshold levels and behavioural aspects of poverty as important ingredients to explain a potential poverty trap. A logical next step is to see to what extent this framework corresponds to the observed data in developing countries. Several questions are addressed: To what extent can the framework presented in section 3 be represented by observed data? Do we find the relationships discussed in section 3 and can we find sensible threshold values for vitality and threshold consumption? If the connection between the theoretical framework and reality is not perfect, what are other factors that could explain the results?

The data section of this chapter is organised as follows. First, the axes of Figure 3 are defined consistent with observed data. Next, the position of each country is shown in the equivalent of Figure 3 for two periods. We find that there is a shift in the distribution of countries in the North-East direction (Bliss in the context of our framework) over time, which is consistent with the predictions of our model. Finally, we present in the next section "guestimates" of the threshold values of vitality and consumption in order to explore the empirical characteristics of the relationships described in our framework.

The dataset

To assess the characteristics of countries in the context of our concepts above, we use information from various data sources. The main economic and development indicators were taken from the World Development Indicators database (WDI) collected by the World Bank.[14] For outside influences such as disasters and wars, two additional sources were used: (1) the International Disaster Database EM-DAT provided by the Centre for Research on the

[14] Available at: http://data.worldbank.org.

Epidemiology of Disasters (CRED) for specific disasters such as floods, storms and earthquakes, and (2) the UCDP/PRIO (2014) Armed Conflict Dataset collected by the Uppsala Conflict Data Program at the University of Uppsala for wars. The dataset was completed by including Human Development Index estimates from the Human Development Report (2014) provided by the United Nations Development Programme (UNDP).[15]

The dataset contains information on 34 countries classified as "low-income countries" by the World Bank over a time span of 22 years from 1990 until 2012.[16] For our purpose the 34 countries defined as "low income countries" were used (except for 7 countries, which did not provide enough data for the above-mentioned years) – this roughly coincides with the countries defined as "least developed countries" by the UN classification system.[17] In short, the dataset consists of 27 individual countries over a time period from 1990 until 2012.

Table 3 displays the list of developing countries, their geographical location, averages of aid as a percentage of GDP, damages from natural disasters as a percentage of GDP and GDP per capita over the periods 1990-2000 and 2001-2012, respectively. The year 2000 has been chosen as a demarcation between the two periods because in that year the Millennium Development Goals have been introduced, which implied a coordinated policy change in developing countries. Several observations can be made from Table 3. First, the majority of the sample lies in Sub-Saharan Africa, which still to this day is among the poorest regions of the world (United Nations, 2014). Second, in the period before the introduction of the Millennium Development Goals, 1990-2000, the average aid as a percentage of GDP was 15.9% and the average damages as a percentage of GDP were 5.6% (in current US dollars). In the sample 21 countries have received at least 10% of their GDP in development aid: Liberia has the highest average ratio of Aid/GDP of 48%, followed by Mozambique with 39% and Rwanda with 28.8%. In the period after the introduction of the Millennium Development Goals, the average aid to GDP ratio was 13.5%. In the same period, most countries improved their GDP per capita. Nonetheless, still 14 countries received more than 10% of their GDP in aid with the highest recipients being Burundi, Liberia and Mozambique. A third observation is that some of these countries had a major conflict either in the period before 2000, or after 2000, or both.[18] Especially Burundi, Rwanda, Liberia and Uganda were affected by wars both before and after the introduction of the Millennium Development Goals. Indeed, Collier (2003) suggests that there is a link between wars and poverty traps, which could explain that these countries stayed in poverty. A final observation is that several

[15] Available at: http://hdr.undp.org/en/data.

[16]. While there is data available for some countries for 2013 and 2014, as well as for years before 1990, we used the period that provides the most complete information available for all indicators that we need, which for this dataset was the range 1990 until 2012.

[17] The classification of countries according to their income levels is revised by the World Bank every year based on estimates of gross national income (GNI) per capita from the previous year. Low income countries are thus defined as countries with a GNI per capita of $1,035 or less;[17] low and middle income countries together are sometimes referred to as "developing countries". The remaining categories are: "lower middle income" (GNI per capita between $1,036 and $4,085), "upper middle income" (GNI per capita between $4,086 and $12,615) and "high income" (GNI per capita of $12,615 or more).

[18] Two definitions of a conflict are provided in PRIO, "minor conflicts" and "war"; here only countries with "war" are shown.

countries have been hit by natural catastrophes such as storm, floods and earthquakes. The average damages as a percentage of GDP before 2000 was 5.6% while after 2000 it was 13.8%. However, the largest incident by far after 2000 was the earthquake in Haiti, causing damage as a percent of GDP of 62%.

Table 3 Aid, natural disasters and wars for low-income countries, 1990 - 2012[19]

			1990-2000				2001-2012			
Country Name	**Country Code**	**Location** [20]	**Aid (% of GDP)**	**Wars**	**Disasters (% of GDP)**	**GDP per Capita**	**Aid (% of GDP)**	**Wars**	**Disasters (% of GDP)**	**GDP per Capita**
Burundi	BDI	SSA	18,7	2000		182	29,0	2001-2		149
Benin	BEN	SSA	12,1			477	9,1			543
Burkina Faso	BFA	SSA	15,7			302	12,8			419
Bangladesh	BGD	RoW	4,1		5,9	303	1,9		3,4	463
Central African Republic	CAF	SSA	13,6			346	9,6			383
Comoros	COM	SSA	17,0			621	9,6			622
Ethiopia	ETH	SSA	9,8	1990-1		131	13,6			191
Guinea	GIN	SSA	10,1			276	6,5			304
Gambia, The	GMB	SSA	10,1			419	11,9			440
Haiti	HTI	RoW	11,7		3,6	499	14,6		62,0	460
Kenya	KEN	SSA	7,9			519	4,2			545
Cambodia	KHM	RoW	11,3		4,0	278	8,2		4,1	513
Liberia	LBR	SSA	48,3			108	54,4	2003		210
Madagascar	MDG	SSA	12,3			288	10,7		3,9	277
Mali	MLI	SSA	17,2			347	12,4			461
Mozambique	MOZ	SSA	39,0	1990-1	5,9	202	22,4			331
Malawi	MWI	SSA	26,2			207	20,1			229
Niger	NER	SSA	15,6			273	13,5			267
Nepal	NPL	RoW	9,6		5,5	264	5,6	2002-5		340
Rwanda	RWA	SSA	28,8	1990/4/8		222	19,1	2001/9		304
Sierra Leone	SLE	SSA	19,3	1995/8/9		303	21,5			335
Chad	TCD	SSA	14,4	1990		396	6,3	2006		605
Togo	TGO	SSA	10,3			399	7,1			391
Tajikistan	TJK	RoW	7,7	1992/3/6	9,1	347	9,0		6,2	361
Tanzania	TZA	SSA	17,7			290	12,6			398
Uganda	UGA	SSA	15,5	1996		232	12,8	2002/4		344
Zimbabwe	ZWE	SSA	5,5			675	6,5		3,5	467
Average			**15,9**		**5,6**	**330**	**13,5**		**13,8**	**383**

Source: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators

From Table 3 one observes that the low-income countries in this dataset were exposed to many shocks. Nonetheless, it remains interesting to see whether some patterns can be identified which are consistent with our framework and the notions discussed in section 3. We explore this in the next sections.

[19] The data on aid and disasters are yearly averages over the period considered.
[20] SSA (Sub-Saharan Africa), RoW (Rest of the World).

Vitality

This section discusses the measurement of the variable "vitality" on the vertical axis of Figure 2, which we need to observe in order to identify the position of each country in the figure. We introduced the notion of vitality as a concept capturing changes in discounting behaviour due to persistent poverty and implicitly consumption near subsistence levels.

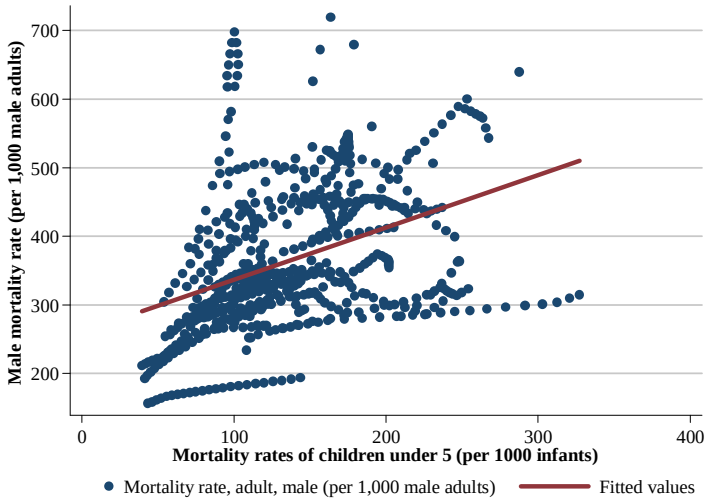
Section 2 discussed the behavioural aspects of poverty together with the link between on the one hand persistent poverty and consumption near subsistence levels and on the other hand preferences to invest in the future (represented by discount rates). The section concluded that persistent poverty may cause preferences to change endogenously. The latter notion is well documented in the literature, observing that consumption per capita can be used to endogenise discount rates (Koopmans, 1960; Uzawa, 1968; Epstein and Hynes, 1983; Obstfeld, 1990). Additionally, Becker and Mulligan (1997) investigate how different economic variables, such as wealth, mortality and uncertainty affect the degree of time preference.

One of the key ideas underlying these models is that discount rates defining saving and investment decisions are implicitly governed by the probability of surviving the next period. The lower the probability is to survive, the higher the discount rate and the higher the urge to use available resources for current consumption. How the probability of survival is modelled, however, is subject to debate. For example, Chakraborty (2004) modelled the probability of one agent surviving from one period to the next as being dependent on health capital that can be augmented through public investment in health. Countries with high mortality rates and low public health investment do not grow faster as shorter life-spans discourage savings and can thus lead to a poverty trap. Chakrabarty (2012) models an individual's probability of survival to be dependent on past levels of consumption and finds that countries may converge to different levels of income depending on initial conditions, *ceteris paribus*. In line with the study conducted by Chakrabarty (2012), this paper uses the probability of survival as an indicator for which time preferences are used (represented by "vitality" in the context of our framework).

The World Bank Development Indicators provide several indicators related to the probability of survival which could be linked to our concept of vitality. A first indicator is the crude death rate for adults per year, which is the number of people passing away per year per 1000 population estimated in the middle of the year. However, even though the actual death rate within a year might is related to the expected probability of living up to 60, saving and investment decisions are more closely connected to surviving well into the future. We therefore prefer to use the mortality rate as an indicator. Also, we note that the pattern for the mortality rate for males and females is similar and thus use the male mortality rate (per 1000 adults) as an indicator. This rate is defined as "the probability of dying between the ages of 15 and 60, that is the probability of a 15-year old dying before reaching age 60, if subject to current age-specific mortality rates between those ages" (World Bank, 2014). Similar probabilities can be constructed for under-five mortality (per 1000 infants), i.e. the

probability that a new-born baby will not be able to reach the age of 5. The correlation between male mortality rates with under-five mortality in the countries of our sample is roughly 42% (P-value 0.000). Moreover, Figure 4 shows the positive relationship between under-five mortality rates and male mortality rates over the period of 1990 until 2012. This relationship holds in particular for individual countries.

Figure 4 Male mortality rates plotted against mortality rates of children under 5 in low-income countries from 1990 – 2012 (pooled data)[21]



To evaluate our framework we use the probability of survival defined by the male mortality rates provided by the World Development Indicators for the concept of vitality. We compare this measure below with other plausible candidates like "life expectancy" and the Human Development index, and show that these are closely correlated with the male mortality rate.

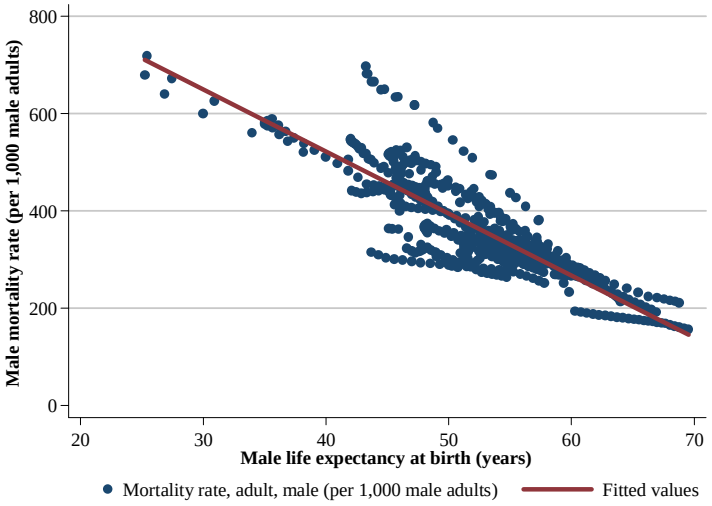
Directly related to mortality rates is the calculation of "life expectancy at birth" defined as "the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life" (World Bank, 2014). In other words, it predicts the number of years the average individual of any given cohort is expected to live from the time of birth. In order to estimate the life expectancy at birth, death rates per cohort are used, as well as the number of people surviving. However, the thus obtained value of life expectancy may change throughout the decades for the same cohort due to unforeseen technical and medical advancements, or war and warlike conflicts.

Figure 5 shows the relationship between the male mortality rates (per 1000 male adults) and life expectancy at birth for males in low-income countries over the time-span of 22 years. There is a negative relationship between mortality rates and life expectancy, with a highly significant correlation of -0.87 (P-value 0.000). As a result, "life expectancy at birth" and "mortality rate" are often used interchangeably, even though from a conceptual point of view they are different (the former pertaining to an estimation of how many years a newborn

[21] This graph has been drawn for the male population in a country, a similar pattern can be found when using female mortality rates.

would live given prevailing mortality patterns and thus includes pre-teen years, while the latter gives the probability of a 15 year old dying before the age of 60, thus excluding pre-teen years and old age).

Figure 5 Male mortality rates plotted against male life expectancy in low-income countries from 1990 – 2012 (pooled data)[22]

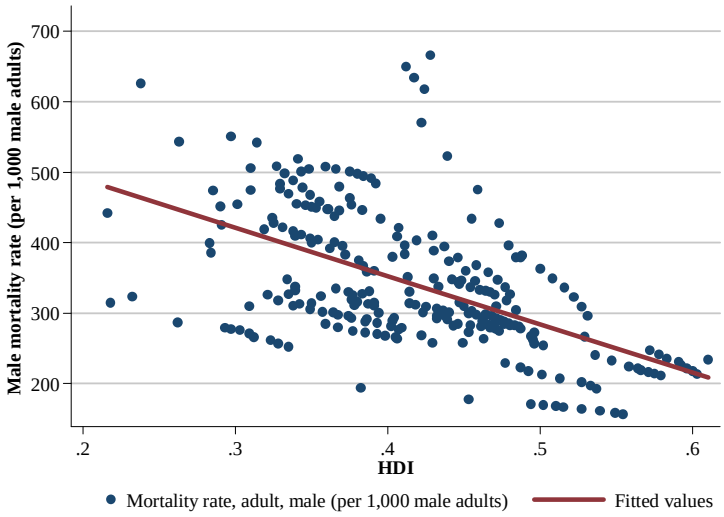


Another indicator used to determine a country's development state is the Human Development Index (HDI) developed by the United Nations Development Programme (UNDP) and was first published in the Human Development Report in 1990 (UNDP, 1990). The HDI was constructed to reflect the notion that the development of a country should be based on its people and their capabilities instead of focusing on per capita GDP growth. The HDI is an aggregate measure of "key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living."[23] Life expectancy at birth, mean years of schooling and gross national income per capita are translated into a health index, an education index and a standard of living index, respectively, which scores in turn are then aggregated into a composite index using a geometric mean with equal weights.

While the HDI has been praised for its simplicity and ease of use, it has also been subject to various critiques relating to functional form, choice of variables and use of weights – for a survey see Kovacevic (2010) and Klugman, Rodríguez and Choi (2011). Even though it is tempting to use the HDI in a development context, it provides *a priori* a less-clear relationship towards saving's behaviour, compared to using the probability of survival which is more directly tied to time-preferences. However, Figure 6 shows that there is a negative relationship between mortality rates and the Human Development Index.

[22] This graph has been drawn for the male population in a country, a similar pattern can be found when plotting female mortality rates against life expectancy.
[23] This definition can be found on the UNDP website http://hdr.undp.org/en/content/human-development-index-hdi.

Figure 6 Male mortality rates plotted against the Human Development Index for low-income countries from 1990 – 2012 (pooled data)



Additionally, correlating the HDI and male mortality rates in the countries of our sample, (except for some countries such as Kenia and Guinea-Bissau) correlation coefficients were between -0.8 to -0.9, suggesting a high correlation between the two variables.[24] We therefore use in this paper the probability of survival illustrated by the male mortality rates provided by the World Development Indicators in order to operationalise the concept of vitality.

Consumption

This section discusses the measurement of the variable "consumption" on the vertical axis of Figure 3, which we need to observe in order to identify the position of each country in the figure. Even though an obvious choice would be to take consumption per capita as a direct measurement of the horizontal axis in Figure 3, we also need to define the two consumption thresholds "subsistence consumption" and "threshold consumption" introduced in section 2. Moreover, we argued in section 2 that growth models mostly looked at above-subsistence consumption growth paths, while below-subsistence development paths were disregarded. With these additional notions in mind, this section looks more closely at possible measurements for the horizontal axis in Figure 3.

Sharif (1986) gives an extensive review on how subsistence consumption can be measured, ranging from using a basket of basic needs commodities to estimate the income necessary for a certain level of subsistence to commodities satisfying certain nutritional needs. The interpretation of subsistence as a mode of consumption (represented by the income needed to buy a pre-defined basket of basic goods) corresponds to the interpretation of a poverty line, which identifies that part of the population that is considered to be absolutely poor. In 1990 the World Bank released the World Development Report (World Bank, 1990) with the "1$ a day" (in constant 1980 PPP) global poverty line as a reference point for calculating the

[24] This result is not surprising given that mortality rates and life expectancy at birth are closely related and roughly 1/3 is given by life expectancy at birth.

percentage of the population close to subsistence and thus living in "absolute poverty". The line was calculated by taking the average of national poverty lines of the world's poorest countries expressed in US dollars. Since then the global poverty lines have been updated in Chen and Ravallion (2008) due to better data on PPP as well as new survey data. Chen and Ravallion (2008) identify 5 poverty lines, ranging from 1$ a day in 2005 prices to 1.25$ a day as the average line of the 15 poorest countries to 2$ a day. The poverty headcount ratio at 1.25$ a day (PPP) and 2$ a day (PPP) in the World Bank Indicators represents the percentage of the population falling short of these two estimates. Ravallion, Chen and Sangraula (2009) conclude that the 1990 World Development Report sample of national poverty lines used to calculate the global poverty line was not representative for developing countries as a whole, with the current sample being more representative. Steger (2000) uses the global poverty lines proposed by the World Bank (1990) to show the differences between income and the subsistence level of consumption (represented by the poverty line). He notes that income exceeds the "low" poverty line, calculated at 275$ a year in 1988 prices, only "marginally" in low-income countries and falls short of the "high" poverty line, calculated at 370$ a year in 1988 prices. He concludes that subsistence considerations play a major role in low-income countries and less so in middle to high-income countries (Steger, 2000).

The average GDP per capita in our sample in 2012 for all countries was 423.05$ (in constant 2005 prices), with a minimum of 153.14$ and a maximum of 737$. Comparing this to the lower poverty line of roughly 456$ a year (in constant 2005 prices), the average of the sample in 2012 falls below the lower poverty line of 1.25$ a day. From Figure 7 one sees that taking the average over the period 1990-2000, most countries do fall below the 1.25$ a day line between 1990 and 2000 (shown in red) and only five countries are above the lower poverty line. In the period 2000-2012 the latter number of countries increased to nine, as is shown in Figure 8.

Both figures show that below subsistence consumption scenarios (if measured by poverty lines) do indeed occur. Therefore growth models should not solely focus on above subsistence consumption scenario's, as in Steger (2000), but consider below-subsistence consumption scenario's as well, since they are an intrinsic part of the problem of development. In addition to this, being below subsistence income per capita seems to be the norm rather than the exception. Thus, both from a pragmatic and from a policy point of view the coverage of the non-Bliss quadrants in the analysis seems to be a logical step forward.

Figure 7 and Figure 8 illustrate that GDP per capita might not be a proper indication of the level of consumption in our model, nor can it be used to identify $\bar{C}$ and $\bar{\bar{C}}$ in the way the literature suggests.

Figure 7 Average GDP per capita in US $ (constant 2005 prices) in low-income countries in the period 1990-2000

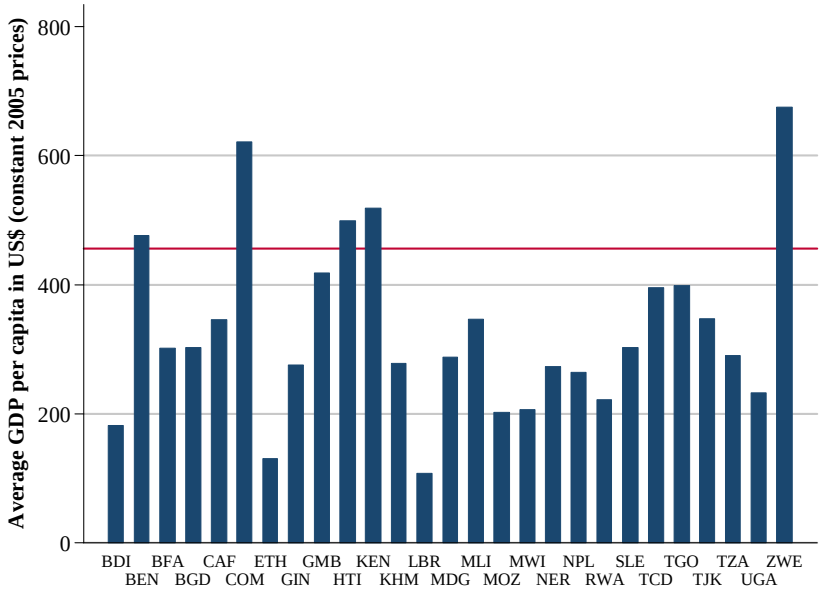
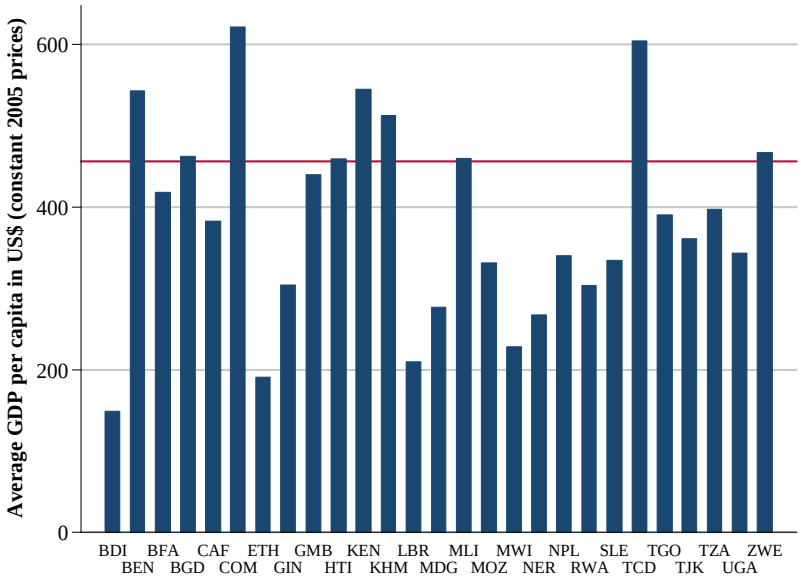


Figure 8 Average GDP per capita in US $ (constant 2005 prices) in low-income countries in the period 2001-2012



Another approach would be to use consumption per capita as a direct measurement of consumption on the horizontal axis in our framework. In that case a picture can be drawn as shown in Figure 7 and Figure 8, which leads to very similar results (see Appendix A.1). Again below-subsistence consumption scenarios are abundantly observed. Hence, the question pertains whether a universal measurement for all countries for $\bar{C}$ and $\bar{\bar{C}}$ in an absolute sense exists.

Indeed, although the poverty estimates proposed by the World Bank are widely used in the poverty literature, there has been a growing body of literature criticising the methodological foundations of these lines (Deaton, 2001; Reddy, 2004; Pogge and Reddy, 2005). Deaton (2001) argues that with the current global poverty lines it is difficult to define a poverty line that is consistent across countries. The poverty lines are based on Purchasing Power Parity (PPP) conversion rates and the basket of goods used to establish PPP might not be representative of the basket of goods that poor people would consume. Additionally, as mentioned above, PPP estimates were recalculated based on better information on prices (Chen and Ravallion, 2008), causing shifts in poverty estimates in the period of 1990-2012. As Deaton (2010) remarks, the updating of poverty lines changes the countries of reference that are considered poor. India, for example, was set as a reference country for the 1$ a day line in 1990, but does not appear in the group of countries used to set the 1.25$ a day line in 2005 prices. Ravallion, Chen and Sangraula (2009) note that countries do not stay reference countries "forever" and that the new sample of national poverty lines implies a higher global poverty line than the old sample of countries in the 1980s. Other issues raised relate to the underlying surveys to assess a household's income and expenditures, discrepancies between survey-based estimates of average household consumption and national account-based estimates (Ravallion, 2003) and the distribution of income within households, where even if a household as a whole consumes above the poverty line members within the household might consume below it.

In view of these criticisms, Heltberg (2009) proposes an additional indicator based on nutrition arguments to assess absolute deprivation in a country. He claims that indicators such as low height and low weight are "relatively precise" and "reflect the preferences and concerns of many poor people" (Heltberg, 2009). Malnutrition can be seen as an acute deprivation of the most basic needs, which manifests itself the most in children's weight and hight shortfall. While the measurement of income poverty or consumption poverty on the one hand and undernourishment on the other hand are two different concepts, studies have suggested that income poverty and under-nutrition are closely related and are consistent with measures of absolute poverty. Low income could then lead to inappropriate nutrition, which in turn leads to lower labour productivity and ultimately leads to a lower standard of living and lower learning capabilities (Subramanian and Deaton, 1996; Dasgupta, 1997; Ravallion, 1997). In line with this argument, Chavas (2013) investigates the linkages between malnutrition and incentives to invest and accumulate capital. He develops a model where the discount factor (reflecting time preferences) is endogenous and depends on food intake. His conclusion is that hunger can strengthen the positive effects of income on consumption; this leads to discounting the future heavily and weakens the incentives to invest. We therefore conclude that a better approximation of the horizontal axis in our model might be to use an indicator such as the prevalence of undernourishment, which relates more closely to a threshold level of consumption.[25]

[25] Although we have not elaborated this above, another disadvantage of using GDP or consumption per capita as a direct measurement is that it ignores distributional effects within a country. These effects are not reflected in the country-wide average of consumption per capita, but they do influence the prevalence of undernourishment.

The World Bank Development Indicators give several statistics that relate to undernourishment. Amongst others, they include information on "Prevalence of Malnourishment" as a percentage of the population, defined as the "population below minimum level of dietary energy consumption or the percentage of the population whose food intake is insufficient to meet dietary energy requirements continuously" (World Bank, 2014). Additionally, the dataset contains information on the malnutrition prevalence, measured in height for age and weight for age as a percentage of children under 5. More precisely, the prevalence of child malnutrition is defined as the "percentage of children under age 5 whose height for age (stunting) is more than two standard deviations below the median for the international reference population ages 0-59 months." However, data points for stunting were less frequent than the data points for the prevalence of malnourishment for the whole population.

Figure 9 Prevalence of undernourishment and children malnutrition prevalence measured in height for age and weight for age in low-income Countries from 1990 - 2012

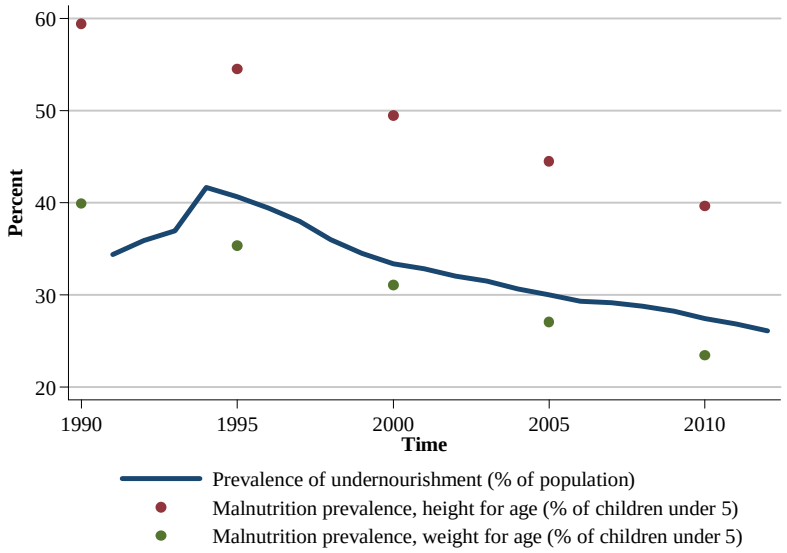


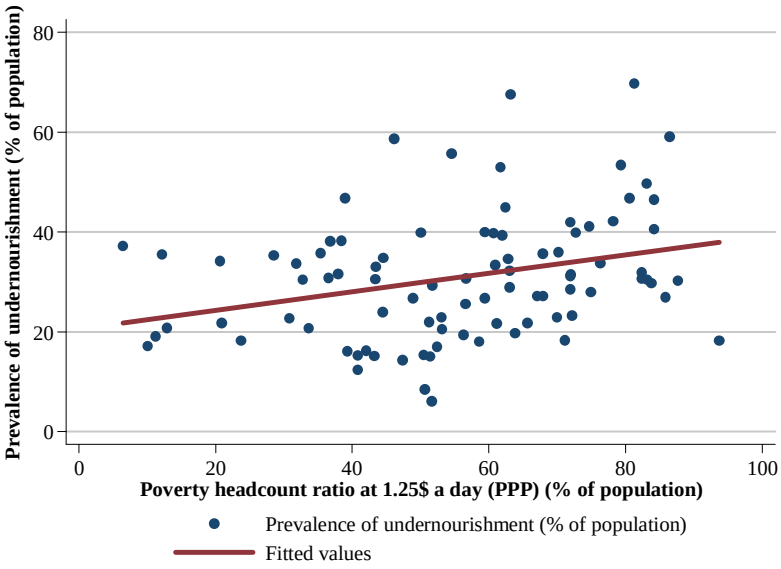
Figure 9 shows the prevalence of undernourishment in the overall population and the prevalence of malnutrition in children under 5 (in height for age and weight for age, measuring "stunting" in children). It can be seen that both malnutrition prevalence in children measured in weight for age and height for age has been decreasing over time, where the percentage of children under 5 considered malnourished in terms of their height for age is consistently higher than when measured in weight for age. Similarly, the prevalence of undernourishment in the population as a whole has been increasing until the mid-90s, but has been steadily decreasing to below 30% from then on. Correlating the prevalence of undernourishment (% of population) with poverty measures such as the poverty headcount ratio below 1.25$ and 2$ a day (% of population), we get a correlation coefficient of 0.30 (P-value 0.035) and 0.25 (P-value 0.016) respectively. Despite the correlation being significant at 5% and 2% respectively, it is relatively low, which could be due to different time-spans for the measurement of the poverty lines and the percentage of population involved. It could also

mean that in a low income situation, the link between variations in undernourishment and income is more random than when low income and high income situations are compared.

Poverty based on hunger was also one of the original ideas of setting up a poverty line, i.e. the budget needed to buy a certain amount of calories and some extra necessities (such as clothes and shelter). A poor person was then defined as someone who did not have enough income to buy the amount of calories necessary to survive (Banerjee and Duflo, 2011).

Figure 10 shows a positive relationship between the prevalence of undernourishment and the percentage of the population falling under the lower poverty line (1.25 $ a day) over the years.

Figure 10 Prevalence of undernourishment versus the poverty headcount ratio at 1.25$ a day for low-income countries and for the period 1990-2012 (pooled data)



For the remainder of this paper we use the prevalence of undernourishment on the horizontal axis of our framework in Figure 3. However, as we show in Appendix A our conclusions also hold when consumption per capita is used directly.

Country positions in a consumption-vitality framework

Using male mortality rates as a proxy for the vertical axis (vitality) and the prevalence of undernourishment for the horizontal axis (consumption), we can depict the position of the countries in our framework presented in Figure 3. We compare the positions in the pre-2000 period to the post-2000 period. Since the establishment of the millennium development goals has increased efforts to eradicate poverty, we expect that in the period before 2000 more countries are situated in the Q_{IV} (Misery) and Q_{III} (Distress) quadrants, but that over time, in particular in the time-period after 2000, countries moved towards quadrant Q_{II} (Bliss). As a

consequence we expect that there is a movement over time of countries towards the North-East in Figure 3, i.e. from Misery and Set-back towards Bliss.

Figure 11 Average male mortality rates versus the average prevalence of undernourishment for the period 1990-2000

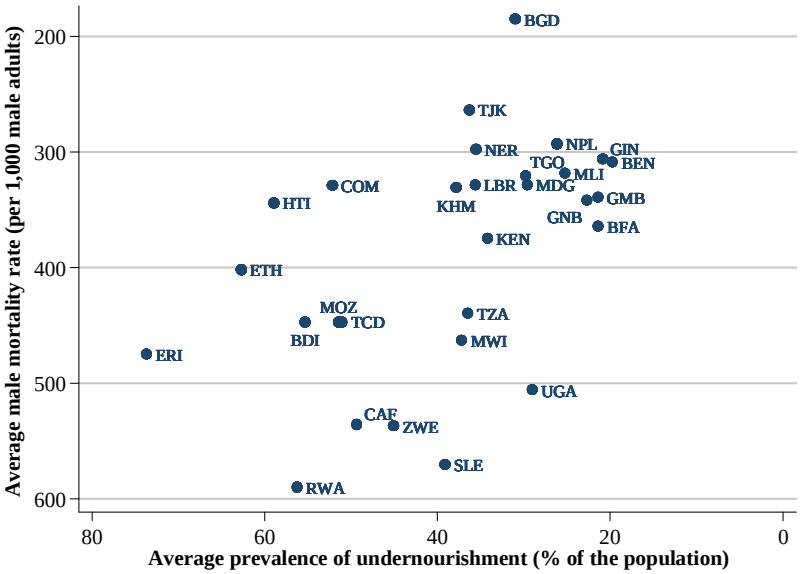


Figure 12 Average male mortality rates versus the average prevalence of undernourishment for the period 2001-2012

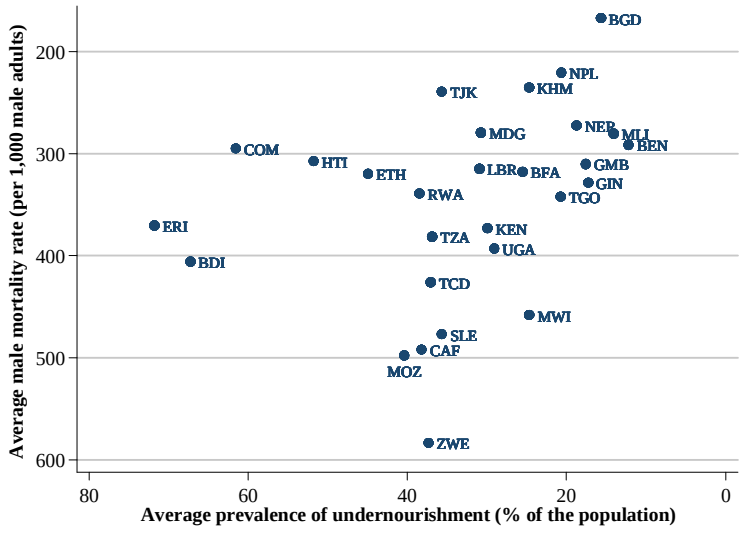


Figure 11 and Figure 12 show the position of countries in the pre-2000 period and post-2000 period, respectively. Note that the axes have been reversed, such that low mortality rates and low prevalence of undernourishment correspond to the Bliss quadrant in Figure 3, while high mortality rates and high prevalence of undernourishment is represented by the Misery quadrant in Figure 3.

Comparing Figure 11 and Figure 12 shows a clear shift towards the North-East.[26] One observes that the cross countries average of the mortality rate decreased from 386 (per 1000 male adults) towards 346 (per 1000 male adults) and the prevalence of undernourishment decreased from 38% towards 32%. Also when one takes as rough thresholds the mortality rate of 400 and the prevalence of undernourishment of 40, one observes that before 2000 there were 7 countries in the Misery quadrant, compared to only 2 countries after 2000. Similarly 14 countries were in the Bliss quadrant prior to 2000 compared to 17 after 2000. However, these are rough thresholds. Moreover, while some countries, such as for example Rwanda, Uganda and Ethiopia have progressed in the North-East direction, other countries, such as Eritrea and Mozambique have shown little to no movement towards Bliss. We will present below a more sophisticated analysis to discuss potential thresholds, allowing for country-specific elements related to our framework. Moreover, this analysis also enables us to evaluate the mechanisms we discussed in our framework to explain the shift in the North-East direction.

6. A tentative evaluation of the framework

We have shown that there is a shift of the position of countries in the North-East direction from the pre-2000 period to the post-2000 period. This section takes a closer look at the explanations for this shift using available data; it also evaluates the relation between the notions of a vitality threshold and consumption thresholds within our framework. The section starts with exploring the empirical characteristics of the relationships described in our framework and then provides a rough "guesstimate" of where the threshold levels are given our model presented in Figure 3.

Discount rates and the growth rate of mortality and their relationship to threshold consumption and vitality

In our framework, the central planner can allocate resources either towards consumption or savings: delaying consumption to the future implies a high savings rate and can be used to illustrate a low discount rate (Uzawa, 1968; Epstein and Hynes, 1983; Becker and Mulligan, 1997). In economic theory, saving is driven by preferences and income (Deaton, 1992; Zhan and Grinstein-Weiss, 2007). Using experimental studies to estimate discount rates, savings can be shown to be correlated with discount rates (Chabris et al., 2008). A similar point has been made for poverty and savings behaviour in relation to inter-temporal discounting showing that relatively poor households have a higher discount rate than richer households (Lawrance, 1991; Beverly, 1997; Cardenas and Carpenter, 2008).

In line with these findings, we use the Gross Domestic Savings Rate of a country (as described in the World Development Indicators) to illustrate the preference to invest and accumulate capital, as represented by the discount rate. Countries with a high savings rate are

[26] Using consumption per capita directly on the horizontal axis a similar pattern can be found, as is shown in 0.

assumed to have a low discount rate while countries with a low savings rate discount the future more heavily.[27] In the World Bank Development Indicators "Gross Domestic Savings as a percentage of GDP" are defined as GDP less total consumption, where GDP is defined as "the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products".[28]

The growth rate of mortality per year is calculated from the male mortality rates (per 1000 adult males). In section 3 we proposed a framework introducing for quadrants and concepts like subsistence consumption $\bar{\bar{C}}$, vitality V and discount rates ρ. Table 1 and Table 2 show the key assumptions of our model together with the underlying properties of each quadrant. We integrate these two tables using the data indicators chosen above, i.e. using mortality rates as an indicator for vitality and the prevalence of undernourishment as falling short of subsistence, in Table 4.

Table 4 Key properties of the model using observed data (empirical characteristics)

Condition	Properties
$V > \bar{V}$ (mortality > mortality threshold)	Relatively low ρ (high savings rate)
$V < \bar{V}$ (mortality < mortality threshold)	Relatively high ρ (low savings rate)
$C > \bar{\bar{C}}$ (undernourishment > undernourishment threshold)	Vitality increasing (mortality rates decreasing)
$C < \bar{\bar{C}}$ (undernourishment < undernourishment threshold)	Vitality decreasing (mortality rates increasing)

Finding optimal thresholds

In the discussion of our model in section 3 we present several *a priori* notions concerning the relationships between consumption and vitality. To verify the consistency of these notions in the data, we have to specify the threshold values for $\bar{V}$ and $\bar{\bar{C}}$. Two problems are encountered: First, the thresholds might not have the same value in an absolute sense for each country. Second, the observations on the relationships might be affected by other influences such as wars and natural disasters. For both reasons a certain margin of observations should be allowed within which the actual thresholds lie – thus a low bound and a high bound for each threshold, respectively. Taking consumption as an example, the low and high bounds are $\bar{\bar{C}}_{low}$ and $\bar{\bar{C}}_{high}$, respectively, such that holds $\bar{\bar{C}}_{low} \leq \bar{\bar{C}} \leq \bar{\bar{C}}_{high}$; the threshold $\bar{\bar{C}}$ itself is unobserved. This implies that whenever $C < \bar{\bar{C}}_{low}$, we know that holds $C < \bar{\bar{C}}$. But when

[27] Note that the validity of this argument depends on the non-existence of inequality within a country. However, if the inequality (as represented for example by the GINI Index) in a country is high, the gross domestic savings rate might be driven by the savings behaviour of the richer part of the population – the assumption is that rich people save more. However, a large part of the population might be poor and undernourished and thus cannot save. Thus, if a country has a high savings rate this does not imply that discount rates are low on a country level but might be the result of high inequality. However, this scenario is not accounted for in our model. Hence, we use the simple notion that countries with a low savings rate are assumed to have a high discount rate and vice versa.

[28] Available at http://data.worldbank.org/data-catalog/world-development-indicators.

$\bar{\bar{C}}_{low} < C < \bar{\bar{C}}_{high}$, it is also possible that $C > \bar{\bar{C}}$ does hold since $\bar{\bar{C}}$ can be at any place between $\bar{\bar{C}}_{low}$ and $\bar{\bar{C}}_{high}$. Below we describe a procedure to find the relevant margins from the data, in order to obtain an estimate of the bounds.

To determine the margins for the thresholds $\bar{V}$ and $\bar{\bar{C}}$ in an optimal way, given the pre-conceived notions in Table 4 and the data available, we programmed a procedure in Mathematica©Wolfram.[29] This procedure classifies countries into Set-Back (Q_I), Bliss (Q_{II}), Distress (Q_{III}) and Misery (Q_{IV}) for certain thresholds. To find the appropriate bounds, the procedure conducts a grid search in the vitality-consumption plane and savings-mortality growth plane simultaneously. For each of these four variables, the range of variation the procedure can search in is restricted to 17% above and below the average over all countries for the period 1990-2000.[30] Within this range a grid of 10 steps is used to identify the low and high bounds for the thresholds $\bar{V}$ and $\bar{\bar{C}}$ from the data.

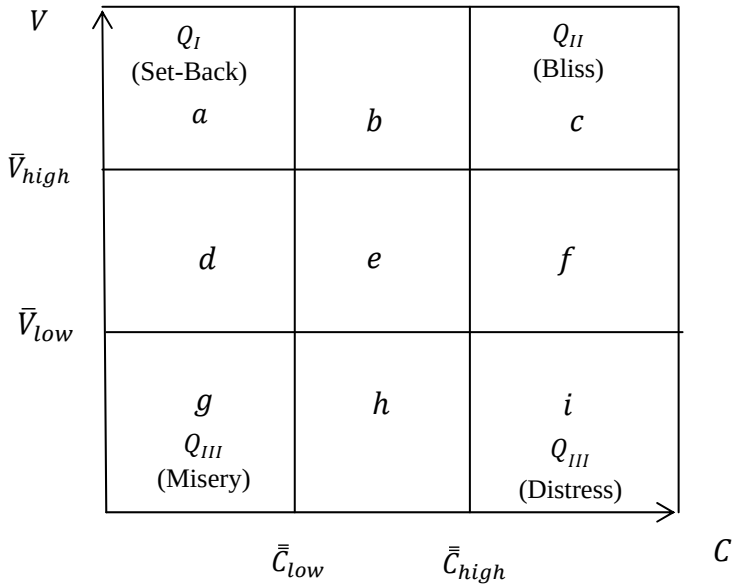
For each step in the grid search a value for the bounds $\bar{\bar{C}}_{low}$, $\bar{\bar{C}}_{high}$, $\bar{V}_{low}$ and $\bar{V}_{high}$ is selected in the vitality-consumption plane. These low and high bounds divide the vitality-consumption plane into 9 smaller rectangles (labelled $a - i$) shown in Figure 13. Each of the rectangles can be associated with one or more of the quadrants presented in Figure 3. The rectangles that are positioned in the most outward region of Figure 13 are labelled "strong".[31] Conversely, rectangles that are closer to the centre of Figure 13 are labelled "weak". We motivate these labels by noting that countries falling in the most outward rectangles should definitely pertain to a specific quadrant in Figure 3, while countries falling more towards the middle might pertain to several quadrants in Figure 3 depending on the threshold levels of consumption and vitality. Given these notions, rectangles a, c, i and g are strong, belonging to the quadrants Set-Back, Bliss, Distress and Misery, respectively, while the rectangles b, d, e, f and h are weak. For example, countries in rectangle b in Figure 13 can be part of either quadrant Bliss or Set-Back, depending on the exact position of $\bar{\bar{C}}$, which is unknown. Similarly, countries in rectangle e can be part of all quadrants.

[29] Optimality in this context is dependent on several pre-conceived notions resulting from the set-up of the model in section 3. Hence optimality is rather understood as constrained optimality.

[30] This specific restriction was chosen because it allowed for the highest number of countries allocated correctly into all four quadrants, with the highest objective function, the least restriction on the range of variation and a saving rate that offset a depreciation of 3%. However, we used the full range observed in the data for the growth rate of mortality, since the variation of this variable over countries is relatively low.

[31] Most outward in this case meaning north-west for Set-Back, north-east for Bliss, south-east for Distress and south-west for Misery.

Figure 13 The model with low and high bounds for consumption and vitality thresholds



Each quadrant has underlying attributes in terms of savings and the growth rate of mortality that have to hold in order to be classified as being in Set-Back, Bliss, Distress or Misery – see Table 2 and Table 4 for an overview. The procedure then works as follows: given a certain saving rate and growth rate of mortality, the procedure first determines in which quadrant a specific country falls in the savings, growth rate of mortality grid. At the same time, given a value for the bounds of vitality and the prevalence of undernourishment, it determines into which rectangle the country falls in the vitality - consumption plane (strong and weak). A country then is counted as belonging to the strong rectangle only if the observations for this country fits the pre-conceived notion of savings and the growth rate of a quadrant *and* falls into the corresponding strong rectangle in the consumption-vitality grid Figure 13. Similarly, the country is counted as belonging to the weak rectangle if it fits the preconceived notions of savings and the growth rate of mortality of a quadrant *and* falls into a corresponding weak rectangle in Figure 13. We label countries that are counted in the procedure according to these criteria as being allocated "correctly". All other countries are ignored.

Next, we need to rank the results from the simultaneous grid-search described above to find the bounds combination, which defines an "optimal" solution. The aim is to find clusters of countries with combinations of underlying characteristics that fit the *a priori* notions described in Table 4. To this end, we calculated for each step in the grid search the density of countries per weak rectangle and strong rectangle.[32] We use the density of countries per size of the rectangle instead of the pure frequency count, since the size of the rectangles varies over the grid search. The bounds combination that yields the "optimal" solution was

[32] The density of observations of a quadrant is defined as $D = f/area$, where f is the frequency of correctly allocated countries. Taking for example the quadrant Bliss, D_c^S corresponds to the number of countries correctly allocated in the rectangle *c*, relative to size of *c*; D_x^W , *with x ={b, e, f}* corresponds to the number of countries correctly allocated in the rectangles *b*, *e* and *f*, relative to size of *b*, *e* and *f*, respectively.

determined using an objective function with a weighted average of the sum of densities of all strong rectangles and the sum of densities of all weak rectangles given by equation 2.1:

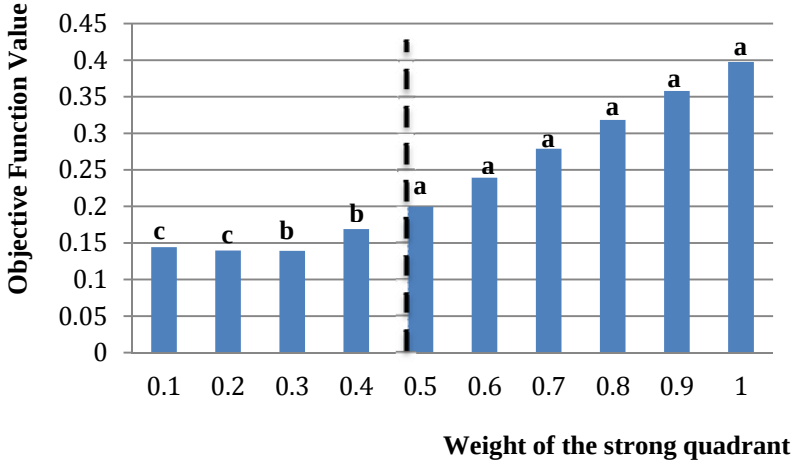
$$obj = w_S \cdot \sum_{i\in\{a,c,i,g\}} D_i^S + w_W \cdot \sum_{i\in\{b,d,e,f\}} D_i^W \quad (2.1)$$

Where obj is the objective function, w_S and w_W are the weight of countries correctly allocated in the strong and weak rectangles, respectively,[33] D_i^S is the density for the strong rectangle $i \in \{a, c, i, g\}$ and D_i^W is the density for the weak rectangle $i \in \{b, d, e, f, h\}$. In order to obtain the optimum threshold levels the procedure then evaluated each combination of bounds with the search-grid according to (2.1). It then selects the combination of bounds that corresponds to the maximum value of the objective function.

Results: The model with optimal thresholds

Figure 14 shows the maximum value of the objective function (2.1) with respect to the bounds on the thresholds for consumption and vitality given different weights on the strong quadrant. Interestingly, the bounds do not change for the range of weights from 0.5-1 (indicated by a dashed line in Figure 14). However, we show below, in Table 5, that most countries are allocated to the strong rectangles corresponding to the quadrants of Set-Back, Bliss, Distress and Misery. Thus, the highest objective function value is given by placing the highest weight on strong rectangles, i.e. $w_S = 1$ ($w_W = 0$).

Figure 14 Objective function value for different weights on the strong quadrant



a: $\bar{C}_{low} = 35\%,\ \bar{C}_{high} = 47\%$, $\bar{V}_{low} = 333,\ \bar{V}_{high} = 443$ **(11 countries allocated)**
b: $\bar{C}_{low} = 35\%,\ \bar{C}_{high} = 35\%$, $\bar{V}_{low} = 333,\ \bar{V}_{high} = 346$ **(8 countries allocated)**
c: $\bar{C}_{low} = 36\%,\ \bar{C}_{high} = 37\%$, $\bar{V}_{low} = 333,\ \bar{V}_{high} = 333$ **(9 countries allocated)**

Figure 15 shows the framework described in section 3 with the optimal selected bounds in the period 1990 - 2000. The vitality threshold $\bar{V}$ is in the range for the mortality rate between

[33] Additionally, we assume $w_W + w_S = 1$.

333 and 443 per 1000 adult males. The threshold consumption is in the range of a prevalence of undernourishment between 35% and 47%.[34] By construction the bounds for $\bar{V}$ and $\bar{\bar{C}}$ are centred around the average of the overall dataset. The overall observed range of variation for the mortality rate lies between 185 and 590 per 1000 adults, with a cross-country average of 386 per 1000 adults. The average of prevalence of undernourishment in the observed data is 38%; it varies from 20% in Benin to 62% in Ethopia. Thus, the selected bounds for undernourishment are in a reasonable range given the observed data.

Finally, the grid search resulted in a cut-off for savings at 7.28% and decreasing vitality as mortality growth lower than 0.46% per year. The cut-off savings rate found in the procedure might be considered extremely low. However, the average savings rate for the period 1990-2000 ranges from a minimum of -5.9% in Rwanda to a maximum of 18.79% in Tajikistan, with a cross-country average of 6%. Such low savings rates are not unusual in developing countries. Loayza, Schmidt-Hebbel and Servén (2000) for example find an average savings rate in Sub-Saharan Africa below 15% and remarks that there is no reason for countries to choose similar saving rates if they face different circumstances in terms of preferences, demographics or income streams. Thus, the cut-off savings rate of 7.28% is a reasonable outcome, given the dataset used. The growth rate of mortality in our framework marks the division between increasing vitality and decreasing vitality. As a result, the cut-off should be either at, or close to, 0%. Since the minimum of the average growth rate of mortality in the period 1990-2000 in the observed data ranges from -2.9% in Cambodia to 5.5% in Zimbabwe with a cross-country average of 0.14%, the cut-off growth rate of mortality found in our procedure is a reasonable result.

Within the grid depicted in Figure 15, 11 countries are allocated correctly (shown in red). Hence 40% of the dataset could thus be allocated into strong and weak quadrants, while 60% did not correspond to all the a priori notions specified in Table 4 and were excluded in the counting process.[35]

[34]Note that in Figure 15 the axes have been reversed to fit closely to the model, thus $\bar{\bar{C}}_{low}$ and $\bar{V}_{low}$ are plotted to the right and above $\bar{\bar{C}}_{high}$ and $\bar{V}_{high}$, respectively.

[35] Note that the axes in Figure 15 have been reversed. Thus, for example, to be allocating a country "correctly" in(to) the strong version of Bliss, the country has a low mortality rate (thus $V > \bar{V}_{low}$) and a low prevalence of undernourishment (thus $C > \bar{\bar{C}}_{low}$), while at the same time exhibiting a saving rate above 7.28% and a mortality growth rate lower higher 0.46%. Conversely, to be allocated "correctly" into the weak version of Bliss, the country has a low mortality rate (thus $V > \bar{V}_{high}$) and a low prevalence of undernourishment (thus $C > \bar{\bar{C}}_{high}$).

Figure 15 Average male mortality rates versus the average prevalence of undernourishment for the period 1990-2000 with threshold levels at $\bar{\bar{C}}_{low} = 35\%$, $\bar{\bar{C}}_{high} = 47\%$,$\bar{V}_{low} = 333$, $\bar{V}_{high} = 443$

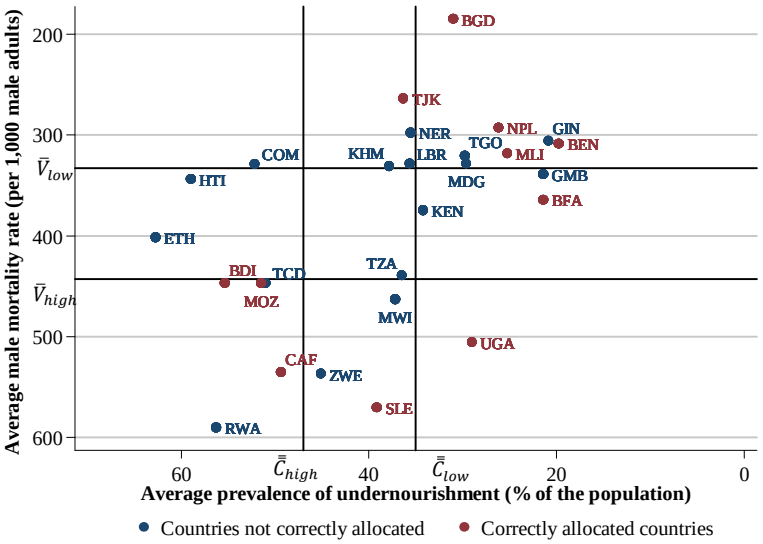


Figure 16 Average male mortality rates versus the average prevalence of undernourishment for the period 2001-2012 with threshold levels at $\bar{\bar{C}}_{low} = 35\%$ $\bar{\bar{C}}_{high} = 47\%$ $\bar{V}_{low} = 333$ $\bar{V}_{high} = 443$

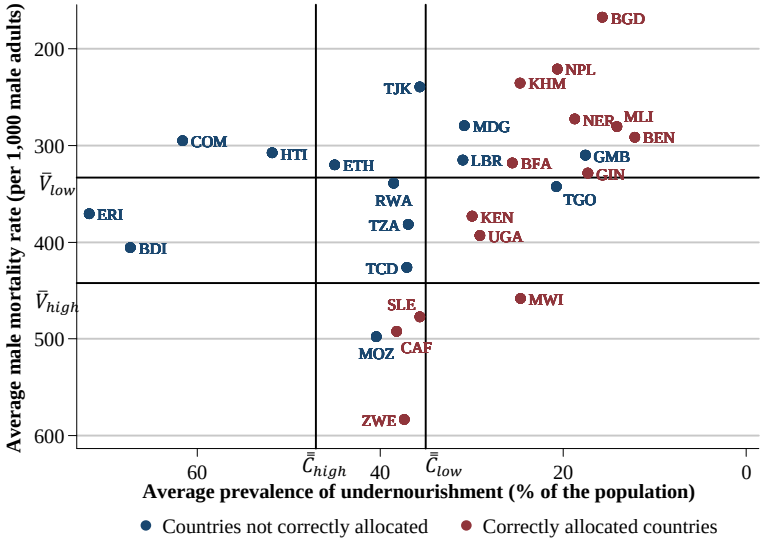


Figure 16 shows the framework for the period 2001 until 2012 for all developing countries using the *same* threshold levels as for the period 1990 to 2000.[36] Several observations can be made: First, there is a movement to the northeast part of the graph for all countries, with more countries moving towards Bliss. Second, the number of correctly allocated countries has increased towards 14, over 50% of our data set. Mainly because the number of countries in

[36] Since the thresholds are calculated from the observed data, different thresholds pertain to the period 1990 to 2000 and 2001 to 2012. However, we want to study the movement of countries from the pre-2000 period to the post-2000 period. To this end, we used the thresholds calculated using the data from 1990-2000 also in the graph for the post-2000 period. Indeed, one would expect the thresholds in the post-2000 period to move in a north-east direction as well, but for comparison we used the same thresholds for both periods.

Bliss has doubled from 5 to 10 – see also Table 5. This also brings us to the third observation that most correctly allocated countries are in the weak and strong parts of Distress and Bliss and have moved away from Misery.

Table 5 Comparison of the number of countries allocated per quadrants for a model with optimal thresholds for the period 1990-2000 and 2001-2012 (given 1990-2000 threshold levels)

Quadrant	**Number of countries 1990-2000**	**Number of Countries 2001-2012[a]**
Set-Back (strong)	0	0
Set-Back (weak)	1	0
Bliss (strong)	4	8
Bliss (weak)	1	2
Distress (strong)	1	1
Distress (weak)	1	3
Misery (strong)	3	0
Misery (weak)	0	0

a. given the same thresholds as 1990-2000

These results imply that we have found some evidence for the economic improvement of countries in terms of vitality and consumption relative to their thresholds. Additionally the analysis in our framework is to some extent corroborated by the data, in spite of the limitations of the analysis which we elaborate in the next section.

7. Limitations

There are several limitations to the above analysis. We have discussed in the context of Table 3 that the causes of poverty are complex. Thus, while threshold levels of undernourishment and mortality rates and a country's initial position with respect to these thresholds could be one of the reasons why some countries improved their relative economic situation and others did not, other influences might have played a role.

First, some countries experienced a war during the period observed. Most countries with a prevalence of undernourishment higher than 50.6% experienced conflicts. Burundi and Eritrea for example (located in quadrant Misery) were in involved a war before 2000, Ethiopia experienced a conflict in the 1990's and Rwanda had ongoing conflicts from 1990 until 2012. Second, several other countries were riddled by natural disasters. Haiti was hit by the tsunami (earthquake) in 2010. Bangladesh and Mozambique suffered several floods during the period 1990-2012. Third, most countries received aid in the period 1990-2000, but less on average after 2000 with the introduction of the Millennium Development Goals.[37] For example, Burkina Faso received an average of 18% Aid/GDP in the period before 2000 while development efforts decreased thereafter. However, the country developed from Distress to

[37] In general average development aid as a percentage of GDP is roughly 16% prior to 2000 and 13.5% thereafter (see Table 3).

Bliss within these two periods. In contrast, Burundi and Mozambique received above 20% of Aid/GDP, but could not improve their economic situation.

In terms of our analysis the observations on Burkina Faso, Burundi and Mozambique can be explained by aid as a way to improve a country's initial position relative to $\bar{\bar{C}}$ and $\bar{V}$, allowing countries to grow out of poverty as we discussed when presenting the model (see sections 3 and 4). In that context Burkina Faso was in a more favourable position, as Figure 15 illustrates. Next to that, Burundi and Mozambique were confronted by wars and natural catastrophes. The latter typically are characteristics that might prevent a country from improving its economic situation, but lie outside the scope of our analysis. Hence, we recognise that initial positions with respect to consumption and vitality threshold levels are only part of the explanation of the variety of observed development paths.

8. Discussion and conclusion

The debate on poverty and about how countries can improve their economic position is still as pressing as it was half a century ago. This paper has shown that there are many mechanisms that can lead to poverty traps. Our focus was on mechanisms where countries can converge to a high income per capita steady state and a low income per capita steady state. In particular, we looked at a savings trap where people are not able to save in order to improve their economic situation. Several reasons for a savings trap have been presented, among which consuming near subsistence consumption levels; also the behavioural consequences of poverty are highlighted as an impediment to the ability to save. The behavioural aspects motivated us to introduce vitality as a concept that describes the notion that vital people may be considered to be more forward-looking than non-vital people. Consequently, vitality has a crucial impact on how people perceive their future and adjust their savings behaviour accordingly. More importantly, there are critical thresholds that need to be reached for countries to take off. Vitality levels above a critical value $\bar{V}$ lead to a more forward looking perspective on life, while populations with below critical vitality show rates of discount that are significantly higher. Additionally, the relation between subsistence consumption and vitality plays a crucial role in determining people's inter-temporal welfare trade-offs. As a result, we distinguished between subsistence consumption $\bar{C}$ and threshold consumption $\bar{\bar{C}}$, which relates to people's outlook on the future. By adding to vitality in a positive way, consuming above threshold consumption levels plays a pivotal role in achieving vitality levels necessary to have a positive perspective on the future and to have low discount rates.

By integrating subsistence consumption and vitality in our framework we add to the literature by combining two underlying characteristics of poverty traps. The framework places a crucial importance on threshold levels of vitality and consumption. This leads to four quadrants describing the initial conditions of a country: Misery, Distress, Set-Back and Bliss, respectively. Bliss is the case in which a country faces no impediments to grow, whereas Misery is characteristic for countries facing a poverty trap. Both situations are well documented in the literature, whereas the other two quadrants, Distress and Set-Back,

describe new situations. We show that under certain conditions countries which are below (one or both of) their threshold levels, hence not in a situation of Bliss, can evolve towards Bliss. In that case they breach the thresholds and grow out of a poverty trap. However, if the threshold levels are not reached, countries fall back towards a poverty trap. The interesting feature of this framework is the focus on the transition paths between quadrants for different initial endowment conditions and parameter constellations. Additionally, the model underlying this framework allows for an analysis of concrete policy measures in terms of aid needed for countries to grow out of poverty.

To make a connection between the framework developed in Figure 3 and observed data, we illustrated the concepts of vitality and falling short of subsistence consumption by the male mortality rates as a proxy for vitality and the prevalence of undernourishment as a proxy for (below) subsistence consumption, respectively. Several countries have improved their economic situation, with an increasing number of countries reducing their mortality levels and the prevalence of undernourishment. However, some countries were not able to reach low mortality levels and still have a high prevalence of undernourishment, being stuck in a low-income per capita situation. Additionally, we could calculate threshold levels for vitality and subsistence consumption that allocated countries into all four quadrants of our model in the pre-2000 period. More importantly, most countries improved their economic situation over time. However, it was also recognised that other factors such as wars and natural catastrophes have played a role in some countries, which have not been able to "catch up" with relatively wealthier countries. Nevertheless, we could identify a reasonable number of countries that fit the empirical features of our framework. This result has encouraged us to elaborate on the analytical background of the conceptual framework discussed in Figure 3, in order to determine the necessary initial endowment conditions of vitality and capital and the structural parameter constellations that enable countries to grow out of poverty in Meysonnat (2016) and van Zon, Meysonnat and Muysken (2016).

Appendix A

This appendix shows the analysis described in section 5 using consumption per capita on the horizontal axis of Figure 3 instead of the prevalence of undernourishment. Note that in period 1990-2000 data was only available for 19 countries, while in the post-2000 period the sample consisted of the 27 countries listed in section 5. The missing countries are indicated in Figure 17.

A1. Average Consumption per capita compared to the 1.25$ poverty line in the pre-2000 and post-2000 period

Figure 17 shows that for the period 1990-2000 using consumption per capita as a direct proxy for the consumption axis in Figure 3, all countries in the dataset are below subsistence consumption. The 1.25$ a day poverty line is used as an indicator for subsistence consumption, indicated by the red line in the figure. Additionally, in the period 2000 until

2012, only three countries consumed above the subsistence consumption line, as appears from Figure 18. This is in line with our findings in section 5.

Figure 17 Average Consumption per capita in US $ (constant 2005 prices) in low-income countries in the period 1990-2000

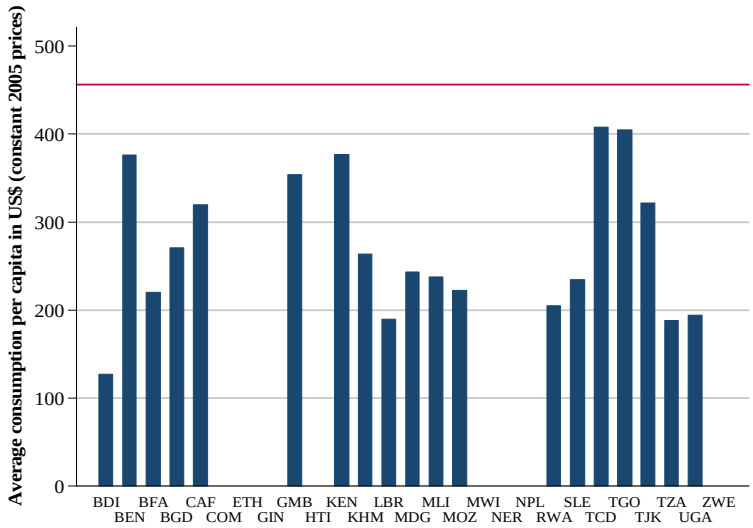
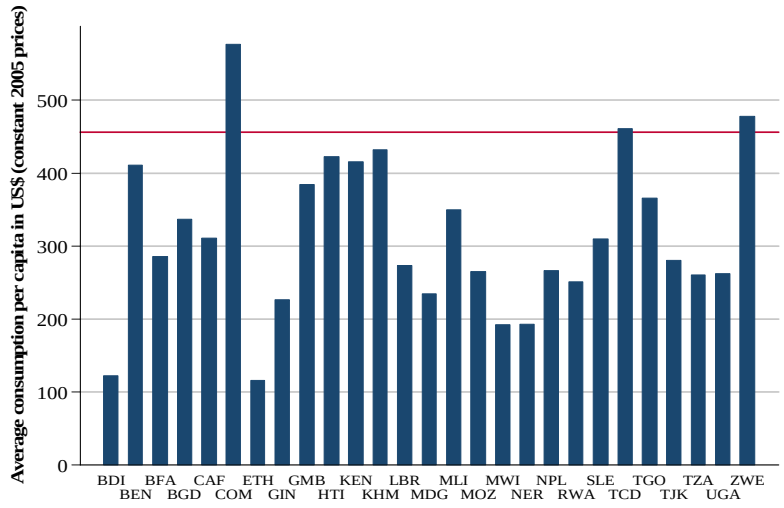


Figure 18 Average Consumption per capita in US $ (constant 2005 prices) in low-income countries in the period 2001-2012



A2. Positions of countries in a consumption – vitality plane using average consumption per capita

Figure 19 and Figure 20 show the model presented in Figure 3 with consumption per capita on the horizontal axis instead of the prevalence of undernourishment. Two observations can be made: First, there are more countries in the dataset after 2000 (the additional countries were marked in red). Second, there is a movement in the north-east direction of the graph. This is in line with our findings in section 5.

Figure 19 Average male mortality rates versus average consumption per capita for the period 1990-2000

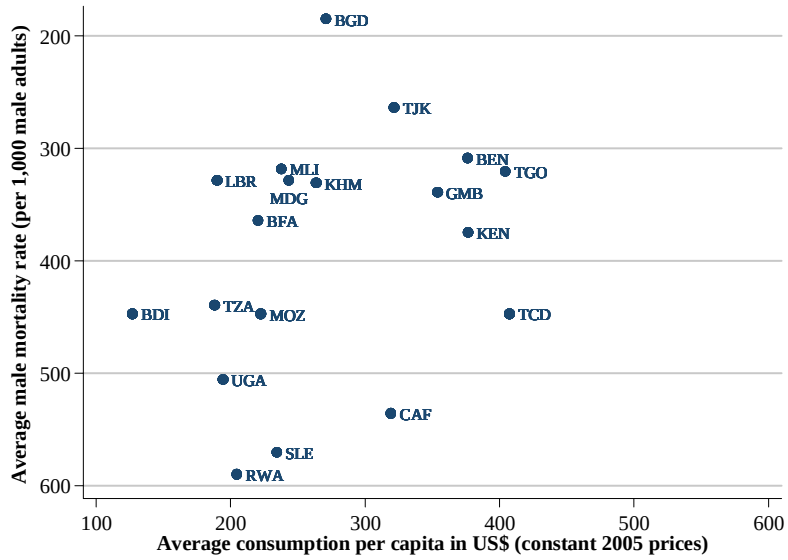
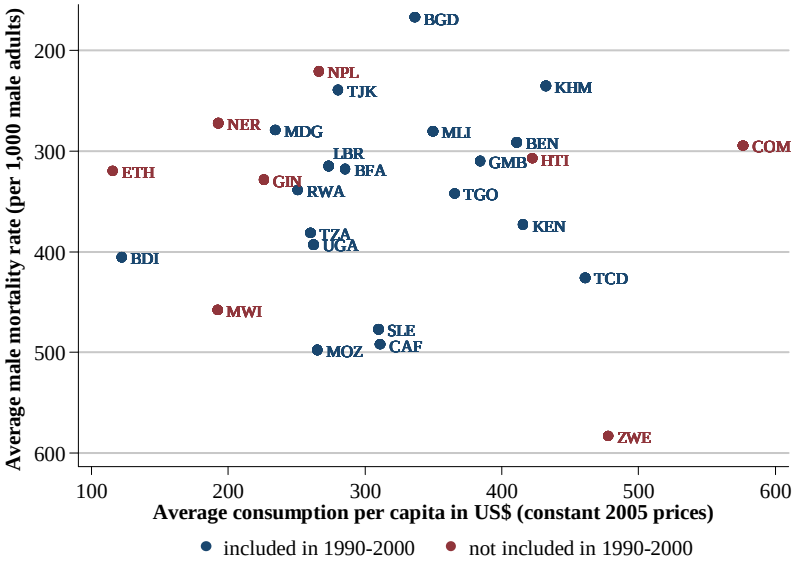


Figure 20 Average male mortality rates versus average consumption per capita for the period 2000-2012



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