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Endogenous time horizon and behavioral poverty trap: Theory and evidence from Mozambique

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ABSTRACT

This paper provides a model where a long-term planning horizon improves economic decisions but also increases the salience of anticipated future utility. Hence, a gloomy future induces the agent to shorten her time horizon in order to reduce distress caused by the anticipation of poverty, at the cost of worsening her realized future consumption, resulting in a behavioral poverty trap where poverty and shortsightedness reinforce each other. The paper also provides primary empirical evidence of the endogenous determination of time horizon and of the existence of a behavioral poverty trap. Using a randomized controlled trial in Mozambique that provided agro-input subsidies and a Matched Savings program, I show that improvement in economic prospects resulted in a significant increase in the planning horizon of the poor beneficiaries. Moreover, the increase in horizon significantly predicts asset accumulation of beneficiaries during the two years following the intervention.

> "*My third maxim was to endeavor always to conquer myself rather than fortune, and change my desires rather than the order of the world.*"

Rene Descartes, Discours de la Méthode (1637), III, p. 595–596, Translated by John Veitch 1901.

1. Introduction

Since John Rae stated that what he called the "effective desire of capital accumulation" as the psychological factor that most affects the growth of countries (Rae, 1834, p. 109), time preference has been widely considered an important determinant of wealth accumulation. The economic literature provides multiple models and empirical evidence of the role of time preference as a determinant of long-term prosperity (Lawrance, 1991; Tanaka et al., 2010). The under-use of profitable investments in rural developing settings remains a major puzzle (Duflo et al., 2008; Conley and Udry, 2010), which some scholars attribute to time inconsistency causing heavy discounting on distant payoffs (Mahajan and Tarozzi, 2012). However, only more recently has economists' attention been given to the possibility that time discounting itself may be affected by wealth (Becker and Mulligan, 1997). The endogeneity of preferences raises the possibility of a behavioral poverty trap and the need to better understand it in order to design interventions that can break this vicious cycle.

This paper investigates whether poverty leads to a shortening of one's time horizon in order to reduce the distress generated by the anticipation of future hardship. The time horizon of an individual is defined as the extent to which she identifies with her future selves. Hence, a shorter time horizon (one which fades away rapidly) means that the individual is more present biased and less time consistent.[1] I introduce two elements in a standard intertemporal utility maximization model: 1) utility from anticipation, and 2) the endogenous determination of the agent's time horizon. An increase in time horizon leads to a level of investment that is higher and closer to the optimum, but also results in an increase in the weight on utility from anticipation. This generates a tradeoff for the poor, for whom the utility from future anticipation is experienced as distress, or disutility, but not for the non-poor, for whom this anticipation is a source of "savoring."[2]

The predictions are tested using a field experiment that included 1589 households in rural Mozambique, among whom the beneficiaries of an agro-input subsidy and a Matched Savings intervention were randomly selected. The model predicts that an exogenous increase in one's wealth leads to an increase in her time horizon only if her initial wealth is below a given threshold, but has no impact on the time horizon of individuals with an initial wealth above this threshold. In accordance with the predictions, both the subsidy and the Matched

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[1] Section 2.5 more formally decomposes the time discounting into time preference and time horizon. The former is consistent across time, while the latter is a psychological bias toward selves that are closer to the present.

[2] The term savoring is used in behavioral economics to refer to a utility from anticipation that brings positive feelings.

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Savings significantly increased the planning horizon of the initially poor, but not the non-poor. Furthermore, the model predicts that the planning horizon is a determinant of asset accumulation. I find that a higher planning horizon translates into more input use, savings, and durable goods, as well as a higher level of assets, and greater optimism about the future, in the two years that follow the intervention, even when controlling for savings, input use and assets at the time when the time horizon was measured. Putting the evidence together, I find that an exogenous increase in wealth translates into an increase in time horizon, and that poor individuals with a longer time horizon tend to accumulate more assets, thus providing evidence of the two directions of a vicious cycle between poverty and shortsightedness. This evidence is consistent with the model presented in this paper, as well as other models of behavioral poverty traps. Rather than a test of the specific mechanisms of this model, the empirical results should be interpreted as a broader test of the existence of behavioral poverty traps.

After observing particularly low levels of asset accumulation among the poor, Duflo and Banerjee (2007) conclude that "*one senses a reluctance of poor people to commit themselves psychologically to a project of making more money. Perhaps at some level this avoidance is emotionally wise: thinking about the economic problems of life must make it harder to avoid confronting the sheer inadequacy of the standard of living faced by the extremely poor*" (p. 165). The intuition of the authors is very close to the one presented in this paper, which builds on insights from the psychology literature to provide a formal model and new empirical evidence of the interaction between poverty and attitude toward the future.

A number of models in the recent literature attribute a poverty trap to behavioral constraints. Becker and Mulligan (1997) provide a model in which the individual can invest in a "forward looking capital" in order to build patience, and find that the time discounting is increasing in her initial wealth. Banerjee and Mullainathan (2010) attribute a behavioral poverty trap to the impulse to consume temptation goods, which represent a higher share in the consumption of the poor. Mani et al. (2013) show that the stress related to poverty impedes one's cognitive capacity. Bernheim et al. (2013) present an intrapersonal dynamic game where poverty perpetuates itself because the lack of assets undermines the agent's ability to exert self-control. By contrast, the theory proposed in this paper attributes the behavioral poverty trap to distress generated by anticipation of future poverty, which increases the cost for the poor to have a long-term planning horizon. There is no previous representation of this intuitive mechanism, which builds on findings from the psychology literature on neuroscience and cognitive dissonance. As discussed in Section 4.4, the empirical evidence of the endogenous time horizon and behavioral poverty trap fits very well with the predictions of the new mechanisms put forward in the model in this paper. However, the evidence is also consistent with these alternative models, where poverty can affect a person's attitude toward the future through alternative mechanisms.

In the analytical solution of the problem, when an individual is poor, a small reduction in her time horizon leads to a first-order gain due to the reduction of the weight on the disutility from anticipated poverty and a second-order loss in the utility derived from realized consumption due to the reallocation. Hence, a poor person will not opt for the maximum time horizon, which corresponds to the optimal behavior based on purely economic outcomes. She will opt for the time horizon that equalizes the marginal cost of the misallocation to the marginal benefits of a reduction in distress. This analysis shares similarities with Brunnermeier and Jonathan (2005) for whom the agent endogenously determines beliefs on the return of future investments in order to maximize utility derived from consumption and anticipatory utility and who find that a small optimistic bias in beliefs is optimal.

To the best of my knowledge, this paper is the first to provide experimental evidence of the endogenous determination of time horizon and the extent to which people are present biased. It is also the first to provide empirical evidence of the existence of a behavioral poverty trap. The empirical approach addresses a number of issues inherent to the measurement of endogenous change in time preference. The survey was implemented after the randomly selected households were involved in the interventions, but before they reaped its economic benefits. The purpose was to isolate the impact of the change in the respondents' economic prospects from the change in their current economic conditions. Furthermore, the theoretical model shows that it is unlikely that poor households have a shorter time horizon because they are "too poor to save," since the marginal cost of consumption misallocation across time is more acute for the poor, which compensates for the fact that the poor have less money to allocate across periods. This rather mechanical effect of wealth on horizon is also rejected by the fact that, even when controlling for wealth, an increase in time horizon is a significant predictor of long-term savings and investments in fertilizer and assets.

I discuss the limitations of the use of standard time discounting questions in this setting and use a measurement of the planning horizon inspired by Ameriks et al. (2003), who find that financial planning substantially increases savings and asset accumulation. They instrument the financial planning with attitudes that determine the individual's propensity to plan, but due to a lack of an exogenous instrument for wealth, they do not examine the impact of wealth on financial planning. I adapt their question to a population with a lower level of wealth and education and obtain a proxy of the individual's time horizon, which measures how far ahead the respondent plans her future expenditures.

The proposed decomposition of time discounting into time preference and time horizon clarifies that time horizon is equivalent to present bias, but it is generalized in order to allow it to take a broader range of functional forms, allowing the bias to fade more progressively over time. Hence, this paper strongly relates to the burgeoning literature on inconsistent time preference and its consequence on savings, investment and asset accumulation (e.g., Laibson, 1997; O'Donoghue and Rabin, 1999), pioneered by Strotz (1955) and Pollak (1968). The observation of time inconsistency motivated interventions, such as "nudging" farmers to use fertilizers (Duflo et al., 2009) or commitment savings (Ashraf et al., 2005; Brune et al., 2011) has been qualified by Loewenstein et al. (2008) as "light paternalism." Because economists generally take time discounting as exogenous, they may design interventions that address the symptom rather than the source of the issue, which limits their chances of generating a permanent change in the economic path of the beneficiaries. Evidence of the existence of a behavioral poverty trap points toward a different set of interventions, which aim at triggering a long-lasting change in time horizon and poverty dynamics.

This work is close in spirit to Appadurai (2004); Ray (2006); Bernard et al. (2011); Beaman et al. (2012), and Macours and Vakis (2014) who attribute some underinvestment of the poor to the aspiration gap. Aspirations are affected by economic opportunities, social interactions, role models and other socioeconomic conditions. Although the concept of aspiration varies among these papers, it always includes some orientation toward the future. For example, in Macours and Vakis's experiment in Nicaragua, in a beneficiary's own words, "*Before the program, I just thought about working in order to eat from day to day. Now I think about working in order to move forward through my business.*" High aspirations refer to the belief that a better future is possible, which encourages the individual to take initiatives in the present in order to reach this goal. However, scholars have not yet provided a theoretical framework positing how gloomy economic prospects affect aspirations and orientation toward the future. This article aims at filling that gap.

2. The psychological causes behind the endogeneity of time discounting

This section provides five main insights from the psychology literature that will be incorporated into the model in the following Section. 1) The burden of poverty comes not only from poverty itself, but also from the anxiety that is generated by the anticipation of future poverty. 2) Different parts of the brain are activated in decisions about present versus future gratification, which can explain excessive discount of future payoffs. This time inconsistency decreases with the individual's psychological connectedness with future selves, which is the degree to which the present self associates with future selves. 3) Cognitive dissonance can explain why some preferences are endogenously determined in a way that reduces the dissonance. Hence one can decide to reduce the extent to which he associates with future selves in order to reduce the present distress related to the expectation of low levels of future consumption. 4) Utility from anticipation can be negative when low future consumption is a source of distress but positive when high future consumption is a source of "savoring." Whether anticipation is a source of distress or savoring depends on whether it is below or above a decent consumption level at which basic needs are satisfied (which I define as my poverty line). 5) We decompose time discounting into two parts: (1) an exogenous and time-consistent exponential time preference and (2) an endogenous time horizon, which is a function that describes the extent to which the present self associates with future selves. This is a generalization of hyperbolic discounting and other forms of inconsistent time preference in the literature, by giving it a very flexible functional form.

2.1. Anxiety and the anticipation of poverty

This paper argues that anxiety from future poverty can be such that individuals may prefer to be shortsighted in order to avoid it, even though they are aware of the negative economic consequences of shortsightedness. Narayan and Ebrary (2000) asked 20,000 poor people across the developing world about their perception of poverty and found that anxiety represents a large part of the burden. This was especially the case in Africa, where the sources of anxiety "are closely related to basic agriculture and survival that depend on the vagaries of nature, rains, droughts" (p.154). The book includes many quotes that describe the anxiety of the poor:

Mental health problems-stress, anxiety, depression, lack of self-esteem and suicide-are among the more commonly identified effects of poverty and ill-being by discussion groups. (p.93)

"As if land shortage is not bad enough we live a life of tension worrying about the rain: will it rain or not? There is nothing about which we say, "this is for tomorrow." We live hour to hour." - A woman, Kajima, Ethiopia (p.156)

"These agonizing decisions take their toll. People cope by focusing on one day at a time, becoming indifferent, apathetic or hovering near losing their mind." - A member of the research team, Ghana (p.255)

*In Malawi, ukavu means a state of constant deprivation. It is explained that households described in this group lack peace of mind because they are always worried about how to make ends meet. In most ukavu households, couples quarrel and fight a lot because they desire good lifestyles (umoyo uwemi), but they lack the means. "It is not surprising that most men from these households are drunkards because they drink to forget home problems." (p.32)*These quotesindicate distress caused by the inability to reach for better economic prospects. The toll of anxiety is omnipresent, yet the most striking feature of this testimony is the apparently irrational reaction to poverty by living day to day rather than making all possible efforts to plan a long-term exit strategy.

The idea that future disutility is a source of distress is closely related to utility (or disutility) from anticipation, a concept that goes as far back as Bentham (1789). It was first applied in intertemporal choice by Jevons (1879) and his son Jevons (1905), and has been formalized by Loewenstein (1987).[3] While Jevons (1905) assumes that individuals always maximize their present utility, which incorporates utility from the anticipation of pleasure or pain, Loewenstein analyzes an agent that maximizes her intertemporal utility, given that the utility in each period incorporates the anticipation of future consumption.

With an exogenous preference for the present, the inclusion of anticipated utility makes individuals more willing to save. However, if one has the possibility to alter her focus toward the future, then she may close her eyes on that future to avoid the permanent distress of gloomy prospects. Whether the anticipation of future poverty can be such that individuals prefer a more acute, but myopic, poverty is an empirical question that is investigated in Section 4 of this paper. Caplin and Leahy (2001) show how anticipatory utility can provide an explanation for many time inconsistencies by analyzing a model that incorporates the anxiety caused by uncertainty into the utility function. They claim that the cost of uncertainty about the future includes not only the loss caused by risk aversion, but also the psychological effect of this uncertainty. The example they use is about the impact of uncertainty on portfolio management, yet one can imagine that anxiety is likely to be higher when one's food security depends on rainfall.

2.2. Getting into the brain

Neuroscientists have also paid particular attention to time preferences. McClure et al. (2004) recorded neuro-images of subjects who were asked to select from options that may or may not provide immediate gratification. The researchers distinguished a "delta part" of the brain, which includes regions that are related to cognitive functions, from a "beta part" of the brain, which has consistently been implicated in impulsive behaviors such as drug addiction. While the delta part is activated similarly for all decisions and was found to be more active in individuals more likely to opt for delayed gratification, the beta part is significantly more active in decisions that involve immediate gratification. Jamison and Wegener (2010) later compared the neural activity during decision making between immediate and delayed gratification to the neural activity during decision making between oneself and others, concluding that "the decision making process involving a tradeoff between our current and future selves is substantially the same as the decision making process involving a tradeoff between ourselves and other individuals." The findings of Jamison and Wegener (2010) confirm Parfit (1971)'s claim that *psychological connectedness* determines the level of altruism both toward other individuals and toward future selves. Hence, since Glass (1964) found that asking students to give electric shocks to victims increased their unfriendliness toward the victims, the same phenomenon may occur between present and future selves. When the pressing needs of the present push a poor individual to "punish" future selves by saving very little money for them, distancing herself from these future selves allows her to reduce cognitive dissonance. This, in turn, makes the poor more vulnerable in the long run, generating a behavioral poverty trap.

In addition to indicating that the attitude toward future selves is likely to be affected by the individual's economic conditions, these findings from neuroscience corroborate economic models with a distinction between present and future selves (e.g., Laibson, 1997, and O'Donoghue and Rabin, 1999), and also corroborate models that incorporate two selves with different preferences at any single point in time. For example, Thaler and Shefrin (1981) model a farsighted principal who controls the myopic agent through the alteration of

[3] For more historical background, Loewenstein and Elster (1992) provide an excellent review of the history of the economics of intertemporal choices.

incentives and limitations of his opportunities. More recently, Fudenberg and Levine (2006) show that this dual self model gives a unified explanation for several observed forms of time inconsistencies. This paper also presents a dual self model that separates the consumption decision from the endogenous determination of time horizon.

2.3. Cognitive dissonance and endogenous time discounting

Since Festinger (1957), cognitive dissonance has been one of the most influential theories in social psychology. It was introduced into economics by Hirschman (1965) and was first modeled by Akerlof and Dickens (1982). Cognitive dissonance is the feeling of uncomfortable tension that comes from holding conflicting thoughts in the mind at the same time. In response, an individual's mind alters her beliefs or preferences in a way that reduces this dissonance. Bramel (1962) relates cognitive dissonanceto ego-defensive processes, showing that, in some situations, an individual can attribute undesirable characteristics to other people in order to preserve self-esteem. In a well-known illustration of this mechanism, Glass (1964) found that students who were asked to give electric shocks to victims tended to attribute undesirable characteristics to those victims in order to preserve their self-esteem.

Leibow's (1967) classic ethnographic book on street-corner men is revisited by Montgomery (1994) to explain their behavior using the concept of cognitive dissonance. The contradiction between the social values that dictate that a man must financially support his family and the inability of the street-corner man to do so generates a cognitive dissonance that causes him major distress. Hence (through a mostly unconscious process), the man who cannot afford to support the members of his family detaches himself from them in order to limit this feeling of failure and cognitive dissonance. Similarly, the poor can either face anxiety and low self-esteem, or detach themselves from future selves, which harms their long-term economic development. The quotes from Narayan and Ebrary (2000) in the introduction indicate that, at least in some cases, the poor opt for the latter option. The present paper provides a model of endogenous time horizon that formalizes this change in attitude toward the future and empirical evidence that it is a widespread phenomenon among households that are not self-sufficient in their maize production in the Manica province in rural Mozambique.

This study argues that cognitive dissonance generates a tension in the brain, resulting in a change in preference in order to reduce it. Cognitive dissonance explains why preferences can be endogenously determined in a way that reduces anxiety, as is the case in this paper's theoretical model.

2.4. Anxiety or savoring

The model in Section 3 incorporates a utility from anticipation which, like Loewenstein (1987), is proportional to the actualized utility to be derived from future consumption. The cognitive dissonance is a source of disutility when a decent living condition will not be achieved in the future. Let z be the "decent" level of consumption, which can be interpreted as a local poverty line in a way that is similar to Montgomery (1994). Below z, the lack of basic food, shelter, clothes, and the potential needs that result from social expectations, create anxiety, as that arises with anticipation. Above z, resources are used for other goods and services, for which anticipation takes the form of savoring. Also, let $\bar{u} = u(z)$ with $u(c_t)$ being an increasing and concave utility function derived from immediate consumption. When $c_t = z$, the utility from anticipation should be null. The utility from anticipation of consumption at period t is proportional to $u(c_t) - \bar{u}$. Hence, for a poor individual, the loss in utility from anticipation caused by cognitive dissonance is proportional to the loss in utility caused by the poverty gap in period t. By normalizing $u(z) = 0$, we can see that the utility from anticipation is proportional to $u(c_t)$; it is negative when the individual will be poor at time t and positive when she will be above the poverty line.[4] The model assumes an absolute threshold for average future utility, below which individuals experience anxiety, and above which they "savor" the expectation of future consumption. One could imagine that this threshold could be relative, in which case utility from anticipation should depend on future consumption compared to the present consumption (especially if the opportunity cost of not projecting oneself in the future is to be more in the present). The choice of this paper is motivated by qualitative insights from the field: the anxiety about being able to put enough food on the table was commonly expressed by poor farmers in the study. A caloric intake goal would generate a threshold that is independent of one's current level of consumption. Still, further research could explore whether that threshold is absolute or relative and how this affects the predictions of the model[5].

2.5. Decomposition of time discounting into time preference and time horizon

The effective time discounting of an individual is a combination of two distinct elements: the time preference and the time horizon. The time preference tells the real valuation of different time periods if the individual were able to extract himself from any present bias. The discounting does not need to be positive, given that some individuals would not prefer a consumption path that is decreasing over their lives. The time horizon is a function that designates the psychological connectedness between current and future selves. As the time span increases between now and a perceived future, the psychological connectedness toward this future self decreases. With it, altruism toward the future self is reduced, affecting both the planning of consumption and the utility from anticipation. In other words, the time horizon expresses the bias toward the present due to a neglect of future selves because one tends to identify more with her current self than with her future selves. The time horizon function can be understood as a "present-biasness" function allowing that bias to progressively vanish as one considers future selves that are farther away in time. I also use the concept of planning horizon, which is a measure of the farthest ahead that a person tends to plan future expenditures. This is the question that was asked during the survey because it was easier to capture, and I show at the end of this section that it is expected to be closely related to the time horizon defined in this theoretical framework.

In the following model, the time preference is exogenous and the time horizon H is endogenously determined[6].

Time preference must be time consistent; the discounting between consumption at time t and time $t + \theta$ should not change between time $i < t$ and time t and should only be a function of θ. Hence, it should be represented by an exponential function (or the power function in discrete time). By contrast, the time horizon function can vary; the discounting between time t and time τ can change depending on i, which is the point in time at which the current self is located.

Formally, the discount factor is obtained by multiplying the time preference by the time horizon. In continuous time, the discount factor is

[4] For models in which the possibility to experience (or not experience) utility is given, it can matter that the anticipated utility is negative or positive (e.g., Becker and Posner, 2005). This does not contradict the fact that the utility function should not be sensitive to the addition of a constant, since this would cancel out in $u(c) - \bar{u}$, when future utility is compared to the reference point (which is the "decent" level of consumption).

[5] It is likely that a relative threshold would lead to a number of similar results given that the interventions lead to an increase of both absolute and relative future expected utility, but wealthier people may be affected as well, and the long term dynamics would become more complicated (e.g., they would depend on whether the consumption growth could be sustained over time).

[6] This contrasts with Becker and Mulligan (1997), who did not distinguish between these two components, allowing the real time preference to vary. The implications of this important difference are discussed in Section 3.3.

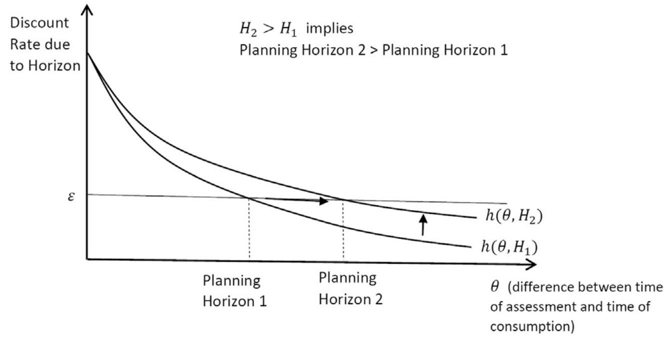

Fig. 1. Relationship between Horizon function and planing Horizon.

given by:

$$d(\theta) = e^{-\rho\theta}\ h(\theta, H) \tag{1}$$

and in discrete time:

$$d(\theta) = \delta^{\theta}\ h(\theta, H) \tag{2}$$

where $d(\theta)$ is the discount factor that multiplies the value of the reward, θ is the delay before receiving the reward, ρ is a parameter governing the degree of discounting in real time preference, and $h(\theta, H)$ is the time horizon function, which is non-increasing in θ and increasing in H and must satisfy $d(\theta) \ge 0$ and $d(0) = 1$ (given that the current self fully connects with himself at the current time). Effective time discounting at any given time can thus be divided into two elements. The objective time preference ($e^{-\rho\theta}$ in the case of continuous time), is consistent over time, and $h(\theta, H)$ indicates how much individual i cares about his future self $i + \theta$, which is driven by the extent to which one identifies with his future self.

When an individual is not myopic, then psychological connectedness remains equal among present and future selves: $h(\theta, H) = 1\ \ \forall\ \theta$, which recovers the exponential utility function. Perhaps the most intuitive perception of the distinction between the time preference and the time horizon is associated with the quasi-hyperbolic utility function, used in discrete time, where $d(\theta) = \begin{cases} 1 & if\ \theta = 0 \\ \beta\ \delta^{\ \theta} & if\ \theta > 0 \end{cases}$, which can be rewritten: $d(\theta) = \delta^{\theta}\ h(\theta, \beta)$ with $h(\theta, \beta) = \begin{cases} 1 & if\ \theta = 0 \\ \beta & if\ \theta > 0 \end{cases}$. in which case $H = \beta$

It is commonly understood that in the "beta-delta" preferences, the delta refers to the real time preference, and the beta represents the bias for the present. In a similar but less tractable way, in continuous time, the horizon function $h(\theta, \beta) = \frac{e^{\rho\theta}}{1+\beta\theta}$ will result in a hyperbolic discounting function.

In the empirical section, the respondents are asked, "How far ahead do you plan your future expenditures?" in order to approximate the horizon function. This can be literally interpreted as the following degenerate horizon function: $h(\theta, H) = \begin{cases} 1 & if\ \theta \le H \\ 0 & if\ \theta > H \end{cases}$, which means that an individual at time i fully identifies with her future self until time $i + H$ and not at all with her future self after $i + H$.[7]

Fig. 1 illustrates the relationship between the horizon function and parameter H used in the theory section and the planning horizon, as it was asked and is used in the empirical section. I assume that the individual will plan for future consumption and investments as long as $h(\theta, H)$ is above a given threshold $\varepsilon \in (0, 1)$. Hence, the planning horizon is given by the intersection between $h(\theta, H)$ and ε. As shown in Fig. 1, an increase in H (from H_1 to H_2) moves the function $h(\theta, H)$ upward, which increases the planning horizon. As a consequence, the planning horizon is always increasing in the time horizon parameter H. Therefore, for any initial horizon function decreasing in θ, increasing in H and such that $h(\theta, H) \ge 0$ and $h(0, H) = 1$, up to a monotonic transformation, the variable H can also be interpreted as the planning horizon. This question potentially offers a way to ask more directly about preferences and how much one cares about future selves, as opposed to standard time discounting questions, which can be affected by how much money the respondent expects to have at different times.

3. A model with anticipated utility and endogenous time horizon

This section presents a model where a utility (or disutility) from anticipation of consumption is incorporated, and the individual's time horizon (or association with future selves) is endogenous. When future consumption is expected to be below a decent living condition, its anticipation generates distress. This distress can be reduced by reducing the association with future selves; however, this causes poorer economic decisions, characterized by excessive consumption and a level of investment that is below the optimum. A behavioral poverty trap results, where poverty and shortsightedness are mutually reinforced.

Drawing on the psychology literature, the model assumes multiple selves. At any given time, the "outer self" makes the consumption decision, taking his time discounting as exogenous. The "inner self" determines the outer self's time horizon (which is a component of the outer self's time discounting). The inner self chooses the time horizon by anticipating its effect on the behavior of the outer self. The inner self's decision is fully rational in that she maximizes the intertemporal utility of the "whole self" without being present biased. Even though the inner self is farsighted, she may opt for a shorter time horizon in order to reduce the weight on utility from anticipation, which is a burden when future consumption is expected to be low. The model is deterministic; future work should aim at incorporating risk and uncertainty, which would add additional insights. It also does not allow for borrowing, and for simplicity it assumes that the inner self selects the optimal time horizon only once and that this time horizon does not change over time. It then uses comparative statics to see how the optimal time horizon varies depending on initial wealth. A model with a dynamic time horizon would also be an extension to this work that could bring further insights.

3.1. The decision process

The game describes an agent's consumption decision from period 0 to T, with the succession of actions as follows:

1. The inner self chooses the time horizon $H \in (0, \overline{H}]$ which will determine the horizon function $h(\theta, H)$, defined in Section 2.5. θ is the distance between a present and given future self, H is the horizon parameter, and $h(\theta, H) \in (0, 1]$ is decreasing in θ and increasing in H. When $H < \overline{H}$, the outer self i is myopic, and the consumption plan is consistently updated.
2. The outer self i (starting with i=0) makes the consumption plan $\{c_t^i\}_{t=i}^{t=T}$ that maximizes his (myopic) intertemporal utility function which incorporates, for every period t, the utility from consumption at time t and the utility from the anticipation of consumption from period t to T. c_t^i is the consumption at time t planned at time i (*i.e.,* planned by the outer self i). Only immediate consumption c_i^i actually occurs in the consumption plan of the outer self i. The remainder of the consumption plan of the outer self $i\{c_t^i\}$ affects only the utility from anticipation at time i.
3. Wealth continuously increases (or decreases) by the difference between the returns from assets and immediate consumption c_i^i, and the following outer self continuously repeats step 2) until i=T.

[7] This function does not belong to the set of functions previously defined, because this horizon function is not continuous and differentiable in H; it is, instead, a limit of the set of possible functions. The online appendix provides a version of the model and the proofs of the propositions in the case of the degenerate horizon function.

The outer self is not "sophisticated." Both his consumption choice and his utility from anticipation are "naive" since he does not take into account the fact that the preferences of the following selves (at time $t > i$) will potentially be different from the outer self's preference at time i, and thus his consumption plan at time i may not occur. However, consumption c_i^i always occurs immediately, at the time when it is planned. In this model, the "sophistication" of the outer self is replaced by the rationality of the inner self, who chooses H in order to maximize the utility of the whole self, knowing the response function of the outer selves. The following subsection first describes the decision process of the outer selves (steps 2 and 3) before describing the decision of the inner self (step 1). In order to distinguish one from the other, I use the feminine for the inner self (i.e., "she") and the masculine for the outer self (i.e., "he").

3.1.1. The succession of outer selves (steps 2 and 3)

The outer self i acts as a typical consumer, maximizing his intertemporal utility function, incorporating the utility from anticipation at each period. He applies two forms of time discounting toward a future self at time $t = i + \theta$: the first reflects his real time preference $e^{-\rho(\theta)}$, and the second, the time horizon $h(\theta, H)$, reflects the extent to which he identifies with his future selves.

The outer self considers time discounting as exogenous, given that the real time preference ρ is fully exogenous and the time horizon is previously fixed by the inner self. The horizon function affects both the weight of future selves in a given outer self's maximization and the extent to which future consumption generates utility from anticipation.

The utility to be experienced at time t from the perspective of the outer self i is composed of the utility from the instantaneous consumption c_t and anticipation of future consumption c_τ from time t to time T:

$$v_t^i(\{c_t^i\}, H) = e^{-\rho(t-i)}h(t-i, H)\left[u(c_t^i) + \gamma\int_t^T e^{-\rho(\tau-t)}h(\tau-t, H)u(c_\tau^i)d\tau\right] \tag{3}$$

where v_t^i is the outer self i's valuation of his utility at time t, which incorporates first $u(c_t^i)$, the utility directly derived from the consumption of c_t^i (the consumption at time t planned at time i), and second, the anticipation of consumption c_τ^i for $t < \tau < T$. γ is an exogenous parameter that indicates the weight placed on utility from anticipation[8], and ρ is the (objective and exogenous) time preference.[9]

The outer self i maximizes an intertemporal utility function that incorporates, for every period t, the utility from consumption at time t and from anticipation of following consumption that will occur at time $t < \tau < T$:

$$\begin{aligned}\max_{\{c_t\}} U_i(\{c_t\}, H) = \int_i^T v_t^i dt = \int_i^T e^{-\rho(t-i)}h(t-i, H)\\ \left[u(c_t^i) + \gamma\int_t^T e^{-\rho(\tau-t)}h(\tau-t, H)u(c_\tau^i)d\tau\right]dt\\ s.\,t.\quad w_i = \overline{w_i}\\ \dot{w}_t = rw_t - c_t^i\\ w_t \geq 0\end{aligned} \tag{4}$$

where w_t is the wealth at time t, and $\overline{w_i}$ is the wealth available to the agent at time i taken as exogenous by the outer self i. A continuum of outer selves i successively solves the maximization problem of Eq. (4) at time i. Let $\{c_t^i(w_i, H)\}$ be the consumption at time t planned by the outer self i that solves the intertemporal maximization problem of Eq. (4), and let $v_t^i(w_i, H) = v_t^i(H, \{c_t^i(w_i, H)\})$.

At any given time i, the utility from consumption $c_i^i(w_i, H)$ and the one from the anticipation of the consumption plan $\{c_t^i(w, H)\}$ provide the instantaneous utility:

$$v_i^i(w_i, H) = u(c_i^i) + \gamma\int_i^T e^{-\rho(\tau-i)}h(\tau-i, H)u(c_\tau^i)d\tau \tag{5}$$

When $H < \overline{H}$, the instantaneous utility v_i^i given in Eq. (5) is the utility that is actually felt by the agent i at time i, while the instantaneous utility v_t^i for $t \in (i, T]$ is planned at time i, but never realized, since the consumption plan is updated before it occurs. When $H = \overline{H}$, the consumption plan remains unchanged with time because the individual's time discounting is time consistent.

The wealth continuously changes following $\dot{w}_i = rw_i - c_i^i$, and the following agent continuously repeats the same steps, solving again Eq. (4). Hence, once all the outer selves have played, the agent (the whole self) receives the actualized utility:

$$U(w_0, H) = \int_0^T e^{-\rho(i)}v_i^i(w_i, H)di \tag{6}$$

This is the utility resulting from the maximization of the succession of outer selves, considering their horizon parameter H as exogenous. The utility of the whole self is subject to objective discounting at rate ρ, reflecting the individual's true time preference, but is not subject to the discounting of the horizon function.

Eq. (4) is equivalent to Eq. (7) below (under the same constraints):

$$\begin{aligned}\max_{\{c_t^i\}} U_i(\{c_t^i\}, h_i) = \int_i^T e^{-\rho(t-i)}u(c_t^i)\Big[h(t-i, H)\\ + \gamma\int_i^t h(\pi-i, H)h(t-\pi, H)d\pi\Big]dt\end{aligned} \tag{7}$$

Eq. (4) is the sum of the utility (from instantaneous consumption and anticipation of future consumption) at every point in time between i and T, while Eq. (7) is the sum of the utility derived from every consumption c_t^i, from instantaneous consumption and its anticipation at time π between i and t. The two are equivalent.

3.1.2. The inner self (step 1)

Aware of $U(w_0, H)$ and of $c_t^i(w_0, H)$, the response function of the outer selves, the inner self selects the horizon boundary $H \in (0, \overline{H}]$, which maximizes the agent's intertemporal utility given by Eq. (6) in which I substitute Eq. (5) to obtain the following:

$$\begin{aligned}\max_H U(w_0, H) = \int_0^T e^{-\rho(i)}\Big[u(c_i^i(w_0, H))\\ + \gamma\int_i^T e^{-\rho(\tau-i)}h(\tau-i, H)u(c_\tau^i(w_0, H))d\tau\Big]di\end{aligned} \tag{8}$$

such that $\{c_t^i\}$ (where t can be i or τ) solves the maximization problem of each outer self i for $0 < i < T$, described in Eq. (4). H represents the horizon parameter of all outer selves i. Notice that the inner self is farsighted in the sense that her objective function is the actualized utility of the whole self. The following propositions analyze the horizon parameter $H(w_0) \in (0, T]$ chosen by the inner self, which is the solution that maximizes Eq. (8).

3.2. Results

The propositions together show that, for the poor (but not for individuals with high initial wealth), a reduction in initial wealth increases the cost of being forward looking, and thus pushes the agent to opt for a shorter time horizon, creating a behavioral poverty trap. The appendix provides a detailed resolution of the problem and the

[8] γ plays a role different from H because it allows the weight on utility directly derived from consumption to differ from the weight on utility from anticipation, independently of the time of consumption relative to the current self, whereas H affects the weight on utility when it is experienced later in time, independently of whether it is utility from consumption or from anticipation. For simplification, γ could be removed or set to 1 without affecting the results, however, it is intuitive and standard in a model with utility from anticipation to allow it to carry a different weight than the utility that is experienced directly from consumption.

[9] For simplification, unlike Loewenstein (1987), the same time discount rate ρ applies to discounting at time i of the utility felt at time t and to discounting of the anticipation of c_τ at time t.

proof of the three propositions.

We first assume that $u'(c_t^i) > 0$, $u''(c_t^i) < 0$ and $\lim_{c_t^i \to 0} u(c_t^{\ i}) = -\infty$. This minimal assumption ensures the concavity of the utility function and excludes zero consumption as a possible solution. It is the only assumption about the utility function required for proposition 1.

Proposition 1. *$\exists\ \widehat{w_0}$ such that $H(w_0) \in (0, \overline{H})\ \forall\ w_0 < \widehat{w_0}$ and $H(w_0) = \overline{H}\ \ \forall\ \ w_0 \geq \widehat{w_0}$.*

In words, a level of wealth $\widehat{w_0}$ exists such that, if and only if the initial wealth is below $\widehat{w_0}$, then the inner self decides to be myopic in the sense that she selects a time horizon H shorter than $\overline{H}$, and will thus have a time preference that is not consistent across periods.

For an intuitive interpretation of the proof of proposition 1, Eq. (9) shows the tradeoff, where closing one's eyes to the future reduces the (dis)utility from anticipation, but improves the allocation of consumption across time.

$$\underbrace{\int_0^T e^{-\rho i} u'(c_i^i) \frac{dc_i^i}{dH}\left(1 + \gamma \int_0^i h(i-\pi, H) d\pi\right) di}_{\text{Marginal benefit of correcting the misallocation}} = \underbrace{-\int_0^T e^{-\rho i} u(c_i^i) \gamma \int_0^i \frac{dh(i-\pi, H)}{dH} d\pi di}_{\text{Marginal benefit of closing the eyes}} \tag{9}$$

This tradeoff occurs during the determination of the optimal time horizon of the inner self. The LHS of Eq. (9) represents the increase in utility that is due to a better allocation of consumption when H increases. This is always positive, hence the tradeoff exists only when the RHS of Eq. (9) is positive. The RHS is the integral of future consumption weighted by how much the weight on the anticipation of the consumption in each period would be reduced by a marginal decrease in H. As a reminder, each $u(c_\pi^i)$ is negative if c_π^i is below the poverty line. This weighted average of utility from future consumption being negative can be interpreted as the individual being predominantly poor in the future. In this case, the anticipation of future consumption generates more anxiety than savoring, and thus, ceteris paribus, the agent would prefer to reduce the anticipation of future (dis)utility.

If the initial wealth is above $\widehat{w_0}$, an increase in the time horizon increases the weight on the anticipation of positive utility, and the right-hand side of Eq. (9) becomes negative, meaning that the individual no longer faces a tradeoff between improving the allocation of consumption and closing one's eyes on a gloomy future. Hence, in this model, the non-poor person has no reason to be myopic; as a result, she will choose $H(w_0) = \overline{H}$, implying $h(\theta, \overline{H}) = 1\ \forall\ \theta$. By contrast, for the poor, when $H(w_0) = \overline{H}$, any marginal reduction of $H(w_0)$ will cause a first-order reduction of the disutility from anticipating future consumption, but only a second-order increase in disutility due to the misallocation of consumption over time (by the envelope theorem, when $H(w_0) = \overline{H}$, the marginal benefit of correcting the reallocation is equal to 0). Hence, for the poor, it is always optimal to choose $H(w_0) < \overline{H}$.

For propositions 2 and 3, we assume that $u(c_t^i)$ is a log utility function. The log utility function is scale neutral, making the relative allocation of consumption across periods independent of wealth (for a given H). Individuals with different wealth have the same need to smooth consumption across time; hence, the *LHS* of Eq. (9) becomes independent of wealth, and the results are purely driven by the fact that poverty increases the benefits of closing one's eyes on the future. The following section provides a discussion on the choice of the log utility function and the use of alternative functions.

Proposition 2. *for any $w_0 < \widehat{w_0}$ then any local maximum $H(w_0)$ satisfies $\frac{dH(w_0)}{dw_0} > 0$.*

This proposition states that, for any individual with a level of initial wealth below $\widehat{w_0}$, the time horizon of that individual is increasing in his or her initial wealth. This results from the fact that the marginal benefit of closing one's eyes on the future decreases with w_0, and, with a log utility function, the marginal benefit of correcting the misallocation is unchanged.

Proposition 3a:. *when $w_0 < \widehat{w_0}$, then $\frac{d\frac{\dot{w}_i}{w_i}}{dw_0} > 0$ for any i,*

Proposition 3b:. *when $w_0 < \widehat{w_0}$ and $\underline{r}(i) < r < \overline{r}(i)$, then:*
$\exists\ \widetilde{w_0}$ such that when $w_0 < \widetilde{w_0}$ then $\frac{\dot{w}_i}{w_i} < 0$, and when $w_0 > \widetilde{w_0}$ then $\frac{\dot{w}_i}{w_i} > 0$.

Proposition 3 highlights the divergence in the accumulation of assets, which is at the origin of the behavioral poverty trap. Proposition 3a states that individuals who are initially relatively rich (starting with a higher w_0) will accumulate assets at a faster pace than individuals who are initially poor. Proposition 3b explains that there is a tipping point $\widetilde{w_0}$ above which asset accumulation becomes positive. This confirms the existence of a behavioral poverty trap that is a function of whether the initial wealth is below or above the tipping point $\widetilde{w_0}$.
$\underline{r}(i) = \frac{1}{\int_i^T k_\tau^i(\overline{H}) d\tau}$ is the interest rate such that an individual with $H = \overline{H}$ would choose $\frac{\dot{w}_i}{w_i} = 0$

As defined and explained in more detail in the appendix, $k_t^i(H)$ is the total weight that the outer self i puts on her consumption at time t, including the utility directly derived from consumption at time t and the utility of its anticipation between time i and time t:

$$k_t^i(H) = e^{-\rho(t-i)}\left[h(t-i, H) + \gamma \int_i^t h(\pi - i, H) h(t-\pi, H) d\pi\right] \tag{10}$$

Let $H_l = \lim_{w_0 \to 0} H(w_0)$, then $\overline{r}(i) = \frac{1}{\int_i^T k_\tau^i(H_l) d\tau}$ is the interest rate such that an individual with $H = H_l$ would choose $\partial\frac{\dot{w}_i}{w_i} = 0$.

The condition $\underline{r}(i) < r < \overline{r}(i)$ ensures that for sufficiently high level of w_0, the asset accumulation would be positive, and for a sufficiently low level of w_0, the asset accumulation becomes negative. Note that the conditions on r vary with i and that $\frac{\underline{r}(i)}{\overline{r}(i)} \to 1$ when $i \to T$. The range of values of r for which a tipping point exists shrinks because the individual's time horizon matters less when the remaining time is small.

3.3. Interpretation of the theoretical findings and comparison with previous literature

The results show that when the time horizon is endogenously determined - and when this horizon determines both the consumption plan and the utility from anticipation - then the gloomy prospect caused by poverty discourages people from being forward looking. The poor individual would decide to reduce her time horizon in order to reduce the distress associated with the combination of poverty and a long-term horizon. As a consequence of the shorter time horizon, the poor will have a lower accumulation of assets, which creates a behavioral poverty trap. The proof of Proposition 1 is methodologically close to Brunnermeier and Jonathan (2005), who show in an endogenous belief model that a small optimistic bias in beliefs about the returns to one's investments leads to a first-order increase in utility from anticipation but only a second order loss in utility from realized outcome.

The framework of my model shares some similarities with that of Becker and Mulligan (1997), who posited that the individual can invest in “forward looking capital” in order to build patience, finding that the discount factor is increasing in the initial wealth of the individual. Some findings are similar in both models, but for different reasons. Using the proposed decomposition of time discounting into true time preference and time horizon (Section 2.5), the adjustment of the “forward looking capital” of the authors corresponds to a joint change in the two components of time discounting, whereas my model only allows the agent to adjust the time horizon (and adds utility from anticipation). In their model, it is relatively mechanical that a very poor

Table 1A
Treatment conditions.

		Voucher Treatment	
		No	*Yes*
90Savings treatments	*Control*	C: Pure Control (N=258)	T2: Subsidy (N=247)
	Information	T3: Basic savings (N=278)	T5: Subsidy & Basic savings (N=303)
	Match	T4: Matched savings (N=248)	T6: Subsidy & Matched savings (N=246)

Notes: Subsidy vouchers for agricultural inputs distributed one time, at start of 2010-2011 agricultural season (Sep-Dec 2010). Savings treatments administered in Mar-Jul 2011. Matched savings treatment provides temporary high interest rates in Aug-Oct 2011 and Aug-Oct 2012. Savings treatment conditions randomized across 94 study localities, each with 1/3 probability (32 control, 30 basic savings, 32 matched savings localities). Subsidy vouchers randomized at individual level (with 50% probability) within each study locality. Number of individual observations in parentheses. Total N=1589.

person would decide at time t to concentrate all consumption in early periods, and ignore future periods in order to reach a higher utility evaluated at time t. But then it is unclear why, in the following periods, this poor individual would not regret that choice and wish that she had better smoothed her consumption. This weakens the authors' assumption of rational agents. In my model, such an easy solution would not be possible because ignoring the future would be too costly in future periods; the introduction of the (dis)utility from anticipation is the reason why time horizon decreases with poverty[10]. The model of Becker and Mulligan (1997) provided the core reasoning on endogenous time discounting; this paper complements their work by using recent insights from the literature on time preference, time inconsistencies, cognitive dissonance, and neuro-imaging in order to better pinpoint the mechanisms behind the endogenous determination of time discounting.

4. Empirical analysis

This section first explains the context and the two randomized interventions: an agro-input subsidy and a savings intervention, with a variation that included matched savings, which provided financial incentives for opening an account and saving money in it. Carter et al. (2014) describe the interventions in detail and give a straightforward economic analysis showing that the agro-input subsidy resulted in a significant increase in maize production and wealth of the beneficiaries, even after the end of the subsidy. Section 4.1 describes the outcome of interest, which is a measure of the time horizon of the beneficiaries, with some validations of this new measure inspired by Ameriks et al. (2003), and adapted to this Mozambican rural population. Section 4.3 shows that an improvement in the economic prospects generated by the interventions causes an increase in the planning horizons of poor individuals (but not in wealthier individuals), which is in line with Propositions 1 and 2. It then uses the results from the three rounds of surveys that followed the intervention to show that the initial increase in time horizon predicts asset accumulation (more investments, savings, and purchase of durable goods) and medium-term outcomes (level of assets and optimism about the future), providing additional validation of the time horizon measure. Taken together, this provides new evidence that poverty and shortsightedness reinforce each other, which is compatible with multiple models that claim the existence of a behavioral poverty trap.

4.1. Context, intervention, and identification strategy

The model described earlier predicts that a poor individual's time horizon should be increasing in her initial wealth, or more generally in the actualized value of the expected wealth[11]. Hence, the expectation of future payoffs should increase the horizon in a similar way. To test this prediction, I use data from a project where two treatments – an agro-input subsidy and a monetary incentive to save money – were randomly allocated. Both interventions were aimed at helping beneficiaries reach self-sufficiency in their production of maize, which is the staple food in the Manica province, Mozambique. Participant selection was completed by the agricultural public extension service, under the supervision of our partner organization, the International Fertilizer Development Center (IFDC). The sample of the pseudo-baseline survey includes a total of 1589 households in 94 localities. Table 1A describes the treatment assignments and Table 2 provides selected summary statistics on basic economic outcomes. The population is poor, but slightly less so than the population across the region, because the agro-input subsidy program intentionally targeted progressive small-scale farmers (defined as farmers interested in modernizing their production methods and engaging in commercial farming). Individuals were deemed eligible for a voucher coupon if they met the following program criteria: 1) farming between 0.5 hectare and 5 hectares of maize; 2) being a progressive farmer, as defined above; 3) having access to agricultural extension and to input and output markets; and 4) being willing and able to pay for the remaining 27% of the package cost. In practice, public extension officers were responsible for the selection of beneficiaries; they were given the criteria, but only had limited informal information about the farmers.

The voucher intervention was randomized at the individual level; within each village, half of the progressive farmers were assigned vouchers that provided a 73% subsidy for a seed and fertilizer package for a half hectare of maize production. The package consisted of 12.5 kg of improved maize seeds[12] and 100 kg of fertilizer (50 kg of urea and 50 kg of NPK 12-24-12). The market value of this package was MZN 3163 (about USD 117), with farmers required to co-pay 27% of the total cost (USD 32).[13]

The second intervention randomly assigned one third of the localities to a control group, one third to a savings treatment (ST),

[10] In a previous version of this paper, keeping the same framework as Becker and Mulligan (1997) with a constant cost to increase the horizon, but allowing only the time horizon to vary (not the true time preference), I showed that the optimal time horizon becomes independent of the initial wealth. In this paper's present version, the fixed cost to increase the horizon is replaced by utility from anticipation, which makes the cost higher for the poor and explains why the optimal time horizon is increasing in initial wealth. Even when an individual reaches future periods, she will not regret having chosen a low time horizon because it reduced the distress caused by poverty.

[11] Both are equivalent in the absence of credit constraint.

[12] The seeds were either OPV (Open Pollinated Varieties) or hybrid, depending on availability. The main difference is that OPV can be used again for planting, whereas hybrid varieties should be purchased again every season.

[13] At the time of the study, one US dollar (USD) was worth roughly 27 Mozambican meticals (MZN).

Table 1B
Timeline.

Period	Activities
Aug-Sept 2010	Selection of beneficiaries
Nov 2010	Vouchers Distribution
April 2011	"Baseline" survey
May 2011	Beginning of Savings and MS training sessions
May-July 2011	Harvest 2011
Aug 2011	First Follow-up Survey
Aug-Oct 2011	MS 3 month period (payment in November)
May-July 2012	Harvest 2012
Aug 2012	2nd Follow-up Survey
Aug-Oct 2012	2nd MS period
May-July 2013	Harvest 2013
Aug 2013	3rd Follow-up Survey

MS refers to the Matched Savings Intervention

and one third to the Matched Savings treatment (MST). The ST group was encouraged to open savings accounts through easier access and financial education. The MST group received the same encouragement to save, as well as a "bonus" of 50% of the minimum amount of savings left in the account between the harvest and the time to purchase fertilizer (from 1 August to 31 October, 2011), with a maximum match of MZN 1500 per individual (approximately USD 56), which was provided for up to two years. The financial reward was aimed at assisting farmers in developing a habit of savings in order to carry forward the benefits of the agro-input subsidy from year to year and to sustainably self-finance their inputs for maize production. In the first year of intervention, the savings treatment raised account ownership from 20% in the control group to 35% in the treatment group, and the MST raised account ownership to 42%. Then, the proportion of account owners remained relatively stable in the following two years. In the follow-up survey, the amount of financial savings of the household, which was about USD 40 in the control group, increased by about USD 18 in the ST, and USD 55 in the MST. In the MST, 20% of participants received the match in at least one of the two years it was offered, (and 0% in ST by definition); the average match received was roughly equivalent to USD 50. The farmers had relatively little prior experience with financial savings; hence the promoted access to this "new technology" may have increased expectations. In the short term, however, the subsidy offered by the matched savings is expected to generate higher economic prospects in the MST compared to the ST.

In this paper, I investigate the endogenous determination of the time horizon with two comparisons: first, by comparing the farmers assigned to the Voucher Treatment with their control group; second, by comparing the farmers in the MST group with the ST group. The latter comparison excludes the control group, because the financial training provided to the MST and ST groups could influence the beneficiaries' time horizons.

Timing (presented in Table 1B) is an important element of the identification strategy. The subsidized agro-input package was made available in December 2010, and its harvest was expected from May to June 2012. The pseudo-baseline survey, used to measure the impact of the voucher program on time horizon, was implemented prior to harvest, in April 2011. Hence, the first round of the survey is not a true baseline since it occurred after assignment to the first treatment and after planting and the use of the subsidized input, but prior to the

Table 2
Descriptive Statistics and Verification of Randomization.

	Control (C)	Subsidy (T2)	Basic savings (T3)	Matched savings (T4)	Basic savings + Subsidy (T5)	Matched savings + Subsidy (T6)	All sample	p-value of Wald test of 5 treatments	p-value of Voucher vs No Voucher	p-value of MS versus Savings
Hh size (nb)	7.4 [2.88]	7.8 [3.59]	7.6 [3.34]	7.6 [3.41]	7.9 [3.86]	7.5 [3.26]	7.6 [3.41]	0.62	0.34	0.62
Hh head educ (yrs)	4.8 [3.32]	4.7 [3.01]	4.8 [3.41]	4.7 [3.14]	4.8 [3.42]	4.4 [3.24]	4.7 [3.27]	0.93	0.67	0.38
Hh head male (%)	0.85 [0.36]	0.85 [0.36]	0.87 [0.34]	0.85 [0.35]	0.82 [0.38]	0.82 [0.38]	0.84 [0.36]	0.69	0.18	0.73
Hh head age	45.8 [14.09]	46.4 [13.76]	46.6 [14.19]	46.4 [13.68]	46.2 [13.90]	46.0 [13.94]	46.2 [13.91]	0.97	0.89	0.95
Hh head literacy (%)	0.79 [0.41]	0.76 [0.43]	0.74 [0.44]	0.76 [0.43]	0.77 [0.42]	0.73 [0.45]	0.76 [0.43]	0.64	0.61	0.49
Electricity (%)	0.10 [0.30]	0.11 [0.31]	0.13 [0.34]	0.10 [0.30]	0.15 [0.35]	0.08 [0.27]	0.11 [0.32]	0.77	0.95	0.44
Banking account (%)	0.13 [0.34]	0.18 [0.39]	0.21 [0.41]	0.23 [0.42]	0.20 [0.40]	0.22 [0.41]	0.20 [0.40]	0.15	0.64	0.22
Livestock value (MZN) 1	30,978 [41,511]	34,173 [47,939]	35,977 [47,453]	37,100 [49,496]	36,071 [50,208]	35,791 [48,045]	35,021 [47,519]	0.85	0.76	0.56
Total area owned (ha) 1	8.4 [12.78]	7.9 [9.47]	9.1 [14.21]	8.7 [11.20]	8.6 [12.79]	7.5 [9.63]	8.4 [11.90]	0.85	0.30	0.63
$Areaformaize(ha)_{t-1}$	3.4 [3.09]	3.3 [3.94]	3.7 [3.96]	3.8 [3.74]	3.8 [4.72]	3.5 [3.20]	3.6 [3.85]	0.89	0.66	0.85
$Fertilizerformaize(kg)_{t-1}$	29.3 [84.11]	23.5 [59.32]	22.3 [95.69]	28.6 [167.25]	26.0 [66.77]	19.1 [64.90]	24.8 [95.83]	0.77	0.45	0.85
$MaizeProduction(kg)_{t-1}$ 1	2208 [2377.05]	2118 [2655.78]	2301 [2782.31]	2375 [2522.20]	2260 [2788.08]	1949 [2310.13]	2207 [2589.51]	0.25	0.10	0.80
$MaizeYield(kg/ha)_{t-1}$ 1	979 [1114.46]	913 [1013.70]	889 [1017.27]	839 [795.75]	925 [1052.86]	806 [839.01]	895 [984.78]	0.73	0.71	0.17
Number of observations	267	247	278	248	303	246	**1589**			

1: The top 1% of the values have been replaced by the 99th percentile, to limit the influence of extreme values.
Standard deviations in brackets. All statistics are from baseline survey, prior to assignment to savings and Matched Savings treatments, after the distribution of input vouchers, but before harvest. Information on maize cultivation are based on recalls about the prior agricultural campaign (before assignment to voucher treatment).
Last 3 columns provide p-values of Wald test that 1) the 5 treatment dummies are all equal to zero, 2) Voucher and Non Voucher are equal and 3) MS and Savings are equal.

corresponding harvest. For this reason, Table 2 verifies the randomization by comparing both variables that are not expected to vary in the short term as a result of the randomization (e.g., household size, education, access to electricity) and information on maize cultivation during the 2010–2011 agricultural season, based on recall in April 2012 about the previous campaign. At the time of the pseudo-baseline survey, both the farmers receiving the voucher and those in the control group were in similar economic conditions on average, but the economic prospects of the farmers in the voucher treatment group were higher, thus, a difference in time horizon at that time can be attributed to the difference in economic prospects between the two groups. Because, at the time of the pseudo-baseline, the savings interventions had not started and the farmers did not know about any savings intervention, regressions on the impact of the voucher on planning horizon do not include the allocation to savings treatments.

The week following the pseudo-baseline survey (April to May 2011), farmers in each locality of the ST or MST group were invited to the first financial education session and were encouraged to open savings accounts. Beneficiaries of the MST group were informed of their selection for participation in the MST program and received an explanation of how MS is calculated. The first follow-up survey (used to evaluate the impact of MS on the planning horizon) was implemented in July-August 2011, after the beneficiaries had been informed of the MS program and had started opening accounts and saving, but two to three months before they received the Matched Savings (deposited in the accounts of the beneficiaries the first week of November 2011). Therefore, at the time of the survey, the two groups had similar economic situations but different economic prospects. For simplicity, the main results exclude the control villages (without the savings and matched savings intervention), and combine voucher and non-voucher beneficiaries. The results in Table 6 of the paper and in Table A1 of the online appendix, using the entire sample and a dummy for each possible treatment combination, show that the impact of matched savings on time horizon for the poor is observed on voucher beneficiaries as well as non-beneficiaries, and this impact does not differ significantly between the two groups.

4.2. The measure of time horizon

Following the decomposition of time discounting into time preference and time horizon, as presented in Section 2.5, I measured the extent to which an individual associates with her future selves by asking “How far ahead do you plan your future expenditures?” I call the reply to this question the “horizon” variable. No specific unit was given to the respondent, and the

Table 3
Horizon mean and median conditional on economic variables.

		Nb of hh	Horizon Variable		
			Median	Mean	Standard Error
Has a savings account	No	1238	122	207	8.65
	Yes	303	365**	257***	15.12
Has already received a credit from a formal bank	No	1356	152	210	8.02
	Yes	187	244	264**	22.59
Cultivated more than 2ha of maize in 2009-2010 campaign	No	710	122	206	10.82
	Yes	813	183**	230	10.94
Used Fertilizer in 2009-2010 campaign	No	1251	152	214	8.81
	Yes	284	183	235	14.6
Sold some of its maize production of 2009-2010 campaign	No	839	91	206	11.39
	Yes	707	183***	231*	9.76
Believes that the hh's economic situation will be better in 5 years	No	163	61	159	13.65
	Yes	1368	183**	225***	8.43
All households		1546	152	217	7,63

The stars indicate the p-value of the equality of means and medians; ***p< 0.01, **p< 0.05, *p< 0.1

Table 4A
Impact of the voucher subsidy and Matched Savings program on Horizon.

	(1)	(2)	(3)	(4)	(5)	(6)
	Impact of the voucher subsidy				**Impact of Matched Savings**	
	ITT - OLS		ATE - IV		ITT - OLS	
	Horizon	IHS horizon	Horizon	IHS horizon	Horizon	IHS horizon
Voucher Treatment	37.55**	0.13				
	[15.94]	[0.09]				
Voucher(s) received			100.79**	0.34		
			[42.85]	[0.23]		
Matched Savings Tr.					24.48	0.12
					[18.16]	[0.08]
Mean in Reference group	200.4	4.46	200.4	4.46	161.4	4.37
Observations	1546	1546	1540	1540	960	960

*** p<0.01, ** p<0.05, * p<0.1. Regressions (1) to (4) use the time horizon measured during the pseudo baseline (after inputs were used but before the assignment of any savings treatment). In these regressions the reference group is made of farmers who were not selected to receive a voucher. In regressions (1) to (4), heteroskedasticity-robust standard errors are in brackets. The regressions include village fixed effects. Regressions (5) and (6) use the time horizon measured in the first follow- up survey. In these regressions, the reference group is made of households in savings treatment localities. In regressions (5) and (6), standard errors are clustered by locality (the level of randomization). The regressions include fixed effects at stratification level (groups of 3 localities by proximity). The dependent variable of columns (2), (4) and (6) is the inverse hyperbolic sine transformation of the horizon, given by $IHS(x) = log(x + (x^2 + 1)^0.5)$, which can be interpreted like a log transformation but allows for non positive horizon values.

response was converted to number of days. When the respondent had some difficulty providing an answer to this question, the enumerator asked whether the respondent had any plans for future consumption or investment, and when the respondent expected to make this expenditure[14]. The answers to this question varied greatly, with 15% planning no more than a week ahead (including no planning at all), 36% planning a year ahead, and 5% planning more than a year ahead.[15] The question was inspired by Ameriks et al. (2003), who measured, among highly educated Americans, their propensity to plan, finding that it has a strong impact on actual savings.

I use the horizon variable, rather than typical time discounting questions (e.g., "Do you prefer receiving X today or Y a month from now?"), because the latter may also be affected by the cost of remembering the debt and the trust that the money will be given or not a month later (Andreoni and Sprenger, 2012). Such issues may be accentuated by the low level of income and education of our sample. These issues can increase the noise, which reduces the precision of the estimation but would not create a bias (to the extent that they similarly affect individuals in the control and treatment groups). A greater source of concern appears when the programs evaluated affect the wealth of the beneficiaries at some point in time; this would affect the marginal utility of money across time, since the beneficiaries might have a lower need for money at a time when the program provides

[14] This was part of the training provided to the enumerators, because, during piloting, there were cases where additional explanations appeared to be needed. However, in practice, no more than 10% of respondents needed this additional explanation. This question results from my extensive piloting and qualitative discussion about the interpretation of the question, in order to find a simple question that elicits the following information: at the time when the question is asked, what are the respondent's expenditure plans that are farthest ahead in the future? The text provides a translation of the question,which was asked in the local dialects of the different areas. When the respondents were (qualitatively) asked why they chose this duration, common answers included that they were saving to build a roof, or saving for medium- to long-term investments, such as fertilizer, irrigation, or making improvements in their shop. Such answers suggested a good understanding of the question. It cannot be fully excluded that a proportion of respondents interpreted the question as an average of planning for different possible expenditures, rather than how far ahead they would plan for their longest-rang expenditures. This would add noise to the measurement. However, as long as the understanding of the question remains orthogonal to the treatments, an increase in the average response among treated participants is unambiguously a sign that the treatments made the beneficiaries more forward looking.

[15] One could expect cognitive ability to affect the ability to plan; however, to the extent that the randomization ensures that such ability is randomly distributed among households in the control and treatment groups, this should not bias the results.

Table 4B
First stage of the IV regression.

VARIABLES	Voucher(s) received
Voucher Treatment	0.37***
	[0.021]
Mean in reference group	0.12
Observations	1546
R-squared	0.263

*** p<0.01, ** p<0.05, * p<0.1. Heteroskedasticity-robust standard errors in brackets. Regressions include village fixed effects.

them with more money. For example, if at the time when the question is asked, the voucher increased the future revenue but not the current revenue of the respondents, then they might prefer receiving the money immediately, not because they became more impatient, but because this choice would better smooth their revenue. In this case, the beneficiaries of the program would erroneously appear to have become less patient than the control group, which would bias the results if one used typical time discounting questions to measure time preference and present bias.

Time horizon is expected to be positively correlated with indicators of economic welfare, either because individuals with a longer time horizon accumulate more assets, or because wealth makes individuals more forward looking. Indeed, Table 3 shows a higher time horizon among respondents who have a savings account, who have already received a formal credit, who used fertilizer for maize production and who sold some of their maize production during the previous treatment phase, or who are more optimistic about their future. The median owner of a savings account has a planning horizon that is three times longer than the median individual without a savings account, and individuals who believe that their economic situation will be better in five years have a median planning horizon that is three times longer than that of individuals who think that their situation will be identical or worse. The latter evidence indicates a strong link between economic prospects and the planning horizon, as predicted by the model. The causality will be explored more rigorously in the following subsection.

4.3. Empirical estimations and results

4.3.1. Model specification

The pseudo-baseline survey occurred before the harvest of 2011, corresponding to the campaign in which fertilizer was subsidized for those who received a voucher. Therefore, the farmers who received a voucher experienced an exogenous increase in their economic prospects. Hence, the model predicts that the two treatments should extend the time horizon of the beneficiaries, who are poor.

\Because the selection of beneficiaries of the voucher treatment was random, the following regression provides an unbiased estimate of the intention to treat effect:

$$H_{ij} = \beta_0 + \beta_1 VS_{ij} + \theta_j + \epsilon_{ij} \tag{11}$$

where H_i is the horizon of individual i in locality j measured in the pseudo-baseline, VS_{ij} indicates whether individual i has been randomly selected to receive the voucher and θ_j are locality fixed effects, ensuring that estimated impacts of subsidies reflect only comparisons of subsidy voucher winners and losers within each locality, not comparisons across localities (which was the unit of stratification for the voucher randomization).

However, winning the randomization did not always translate into receiving the voucher, because the farmers who were unable to complete the remaining 27% of the price of the package declined the voucher, and some farmers who lost the randomization managed to acquire a voucher. A consistent estimator of the impact on the time horizon among compliers can be obtained by an instrumental variable approach, where the first stage regression is:

$$V_{ij} = \alpha_0 + \alpha_1 VS_{ij} + \theta_j + v_{ij} \tag{12}$$

where V_i indicates whether the individual i declared that he received a voucher in his own response to the survey.

The second stage provides an estimation of the local average treatment effect, i.e., the impact of using the voucher on the horizon for farmers who used the voucher only if they were selected by the randomization to be beneficiaries:

$$H_i = \beta_0 + \beta_1 \widehat{V}_{ij} + \theta_j + \epsilon_{ij} \tag{13}$$

with $\widehat{V}_i = \widehat{\alpha}_0 + \widehat{\alpha}_1 T_i$

In order to check that the results are not driven by extreme values, the regressions are made using both the horizon (in number of days) and the inverse hyperbolic sine (IHS) of the horizon, proposed by Johnson (1949), which is given by $IHS(x) = log(x + (x^2 + 1)^{1/2})$. As with the logarithmic transformation, the slopes' coefficients can be interpreted as elasticities, which has been shown by Burbidge et al. (1988) to be a better way to handle outliers and non-positive values than adding a constant to the log or dropping the non-positive values.[16]

When examining the Matched Savings intervention, I compare only the savings group to the Matched Savings group in order to isolate the impact on the horizon of the subsidy that encourages savings from the impact of financial training, which was provided in both the ST and MST groups, but not in the control group. Thus, the members of the control group are always excluded from these regressions.

Similarly to the analysis of the voucher intervention, the MST group is compared to those in the ST group at a time when they are in similar economic conditions but with different expectations. During the first follow-up survey (July-August 2011), the households in the MST group expect an exogenous increase of their wealth in November 2011, when the Matched Savings would be disbursed.

Only the ITT is estimated in the case of the financial intervention. The IV approach cannot be used because the self-selection into treatment (i.e., compliance) is different among the ST and the MST.

$$H_{ijk} = \gamma_0 + \gamma_1 M_{jk} + \mu_k + \epsilon_i \tag{14}$$

where M_j is a dummy equal to one if the locality was selected for Matched Savings and equal to zero for the savings intervention. μ_k are stratification cell fixed effects.[17]

Randomization of the savings treatment is at the locality level j, so I report standard errors clustered at the level of the 94 localities (Moulton, 1986). In this regression, the coefficient γ_1 tells us by how much the expectation of matched savings leads to a higher time horizon among the MST group compared to the ST group.

I also estimate a model similar to that in Eq. (14), where I include the control group and dummies for each possible treatment combination. This gives some comparison with the control group as well and

[16] Only 1.6% had 0 days of time horizon (no more planning than day-to-day expenditures). In the regressions of this paper, the log and the IHS methods lead to very similar results.

17For the randomization of the savings treatments, we created stratification cells of three nearby localities, one locality randomly assigned to each of the no-savings, basic savings, or matched savings locality-level treatments. We introduce this stratification level in fixed effects.

allows us to see whether the effect of matched savings on time horizon differs among farmers who received the voucher and those who did not.

4.3.2. How improvement in economic prospects affected the beneficiaries' time horizon

This subsection proposes a test of Propositions 1 and 2 of the theoretical subsection. It uses the exogenous variation of the economic prospects caused by the randomly allocated intervention, and investigates how that affects the time horizon of the beneficiaries. In order to test the predictions of the propositions, I separately look at the impact on time horizon for the farmers who are self-sufficient versus those who are not, i.e., those for whom future consumption is likely to be a source of anxiety affecting their time horizon.

Table 4A shows the impact of the two programs on the time horizon of the beneficiaries, regardless of their level of wealth, and Fig. 2 shows the distributions of time horizon (in number of days) by treatment group. On average, winning the voucher randomization increased an individual's time horizon by more than a month, from about 200 days to 238 days, increasing it by about 19% on average. The third column indicates that, once instrumented (by the result of the randomization), receiving a voucher increased the recipient's time horizon by about 101 days (though the 95% confidence interval of the effect goes from 17 days to 185 days).

Table 4B shows that being selected increased the probability of receiving the voucher by 37 percentage points (from 12 to 49 percent) and that the instrument is very significant. This compliance rate of the input subsidy implies that the ITT should be about 0.37 times the LATE, which is very close to what is observed in Table 4A[18] When interpreting the size of the ITT effects shown in the following Tables, one must bear in mind that this is only driven by the impact on the compliers, who only represent 37% of the sample.[19]

The results in level are not very robust to the use of the IHS, and the impact of the MST on the time horizon of the recipient is potentially sizable but not significant. This may be due to the underlying assumption of a homogeneous impact of the interventions on the time horizons of the entire population, while the theoretical model predicts a distinct effect among poor and non-poor beneficiaries.

The change in time horizon should affect only the time horizon of individuals with a level of wealth below a certain threshold, but not the horizon of people above it. The difficulty lies in choosing the poverty line, here defined as the level of consumption below which its anticipation is a source of anxiety. Given that the program aims to help farmers reach self-sufficiency through an increase in maize production, it is natural to approximate the poverty level by the level of self-sufficiency of the household. *Xima*, a porridge made exclusively of corn flour and water, is by far the most common meal in rural Manica, and it is very common for members of poor households to eat nothing but *xima* in a typical meal. Consuming a more diverse range of foods is generally a goal that comes after providing a sufficient quantity of *xima* to the family.[20] Hence, in a first estimation, I calculate the quantity of maize per capita that would be required to provide caloric needs for a year, finding this quantity to be 386.1 kg.[21]

Table 5.A shows the impact of the two interventions on the time horizon when the population is split according to whether the household's maize production per capita in the preceding season (2009–2010) is above or below 386.1 kg. As shown, the beneficiaries who are not self-sufficient increased their time horizon by 41 days after being selected to receive the voucher, and by 49 days when assigned to the MST group. However, the 95% confidence intervals remain quite large since the ITT effect of the voucher ranges from 10 to 72 days and the ITT effect of the MST ranges from 0 to 97 days. By contrast, the programs had no significant impact on households that are self-sufficient in maize production, which is compatible with Propositions 1 and 2 of the model.

The number of kilos based on a caloric need fully satisfied by maize production would be overstated if farmers fulfill part of their caloric need from the self-production of other products, or from any other source of income in the household. It could also be understated if farmers need to sell some maize to purchase other sources of nutrients, which would come at a loss in calories, given that maize is the cheapest calorie intake available. Another source of understatement would occur if, in the presence of risk, farmers would need to reach an average production level beyond their consumption in order to have a buffer that allows them to not worry excessively about their future consumption. Hence, I suggest two alternative approaches.

The first alternative approach consists of using Hansen's (2003) method for threshold estimation. This method tests the null hypothesis that the impact is homogeneous across the whole population against the hypothesis of a breakpoint based on the maize production per capita. For this, I use a heteroscedasticity consistent Lagrange Multiplier test for a large number of breakpoints at regular intervals of maize production per capita, and I compute the p-values using a bootstrap. Fig. 3 provides the graph obtained by the procedure adapted from Hansen (2003). In the absence of a prior on the localization of the breakpoint, the evidence does not reject the null hypothesis of a constant impact of winning the Matched Savings randomization (p-value is 0.656), but it rejects the null hypothesis of a constant impact of the assignment to the voucher (p-value=0.022). Interestingly, both estimations identify extremely similar threshold levels of maize production per capita: the former identifies the threshold at 224 kg of maize per capita and the latter at 225 kg per capita. This marks the value of the threshold at which the coefficient of the impact of the intervention on the time horizon is most likely to switch. Fig. 3B shows possible values for the threshold ranging from 210 to 290 kg of maize per capita. This threshold is smaller than the one obtained by the calculation of caloric needs provided by maize production, which can be explained by the existence of alternative sources of food and revenue. Table 5 panel B presents the results once the samples have been separated using this estimated threshold of 225 kg of maize production per capita and per year. For both interventions, I find impacts on time horizon that are more robust among the farmers who are not self-sufficient. Again, there is no significant impact among the farmers who are self-sufficient.

The second alternative is to consider that the households may have

[18] For conciseness, in the rest of the paper, the regressions only show the ITT (results of the LATE are available upon request). The ratio between LATE and ITT is closely maintained in all regressions, and the level of significance very similar. Standard econometric calculations show that (in the simple case of an IV with one regressor), the LATE is equal to one over the compliance rate times the ITT. This remains true in expectation when the control variables are not correlated with the instrument.

[19] Non-compliers can be farmers who did not use their vouchers, but also farmers who managed to obtain and use a voucher even though they were not selected to receive it. Both groups may have reacted differently to an improvement in their economic prospects.

[20] The choice of the variable that is used to separate poor and rich households is also constrained by the availability of data that measures variables prior to the intervention. Given that the “pseudo-baseline” occurred after voucher distribution and the planting season, it would not have been appropriate to use consumption at the time of the pseudo-baseline to define the groups, because this would have been affected by the intervention. The regressions use recall of the maize production prior to the intervention. Table 2 confirms that the recall has not been affected by the intervention, since the Wald test

(*footnote continued*)
does not reject the hypothesis of equal means of maize production (prior to the interventions) across the treatment groups. We did not record any production other than maize in the pseudo-baseline survey. It is also preferable to use prior production rather than consumption, given that the consumption decision results from the initial horizon, and, thus, a household that is initially more patient would appear to be poorer for a given income because it would save more and consume less.

[21] Energy requirements, derived from an Energy and Protein Requirement Report of a joint FAO/WHO/ONU expert consultation from the Geneva World Health Organization, Technical Report Series No 724, are those for the population of a developing country with moderate activity level. The formula used is: (2320kcal)*365.25 days/(0.62kg*3540kcal) =386.1kg of maize, where 2320kcal is the daily energy requirement per person, 0.62 is the number of kg of corn flour obtained from one kg of maize, and 3540kcal is the number of calories in one kg of corn flour.

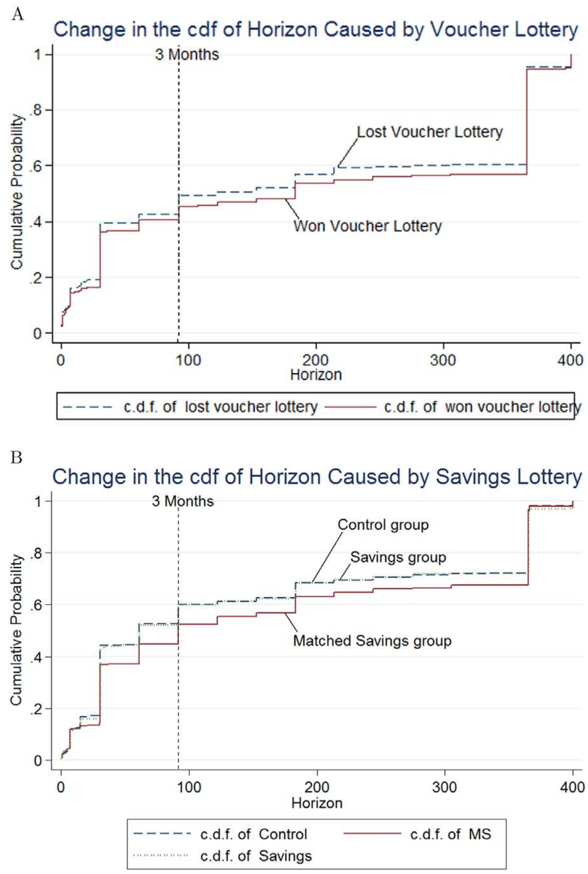

Fig. 2. .

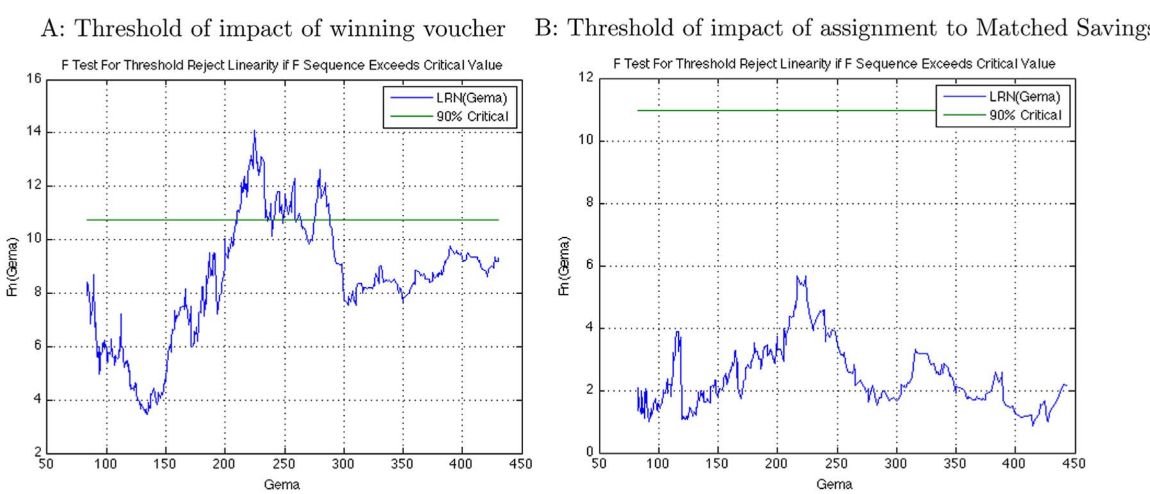

Fig. 3. A: Threshold of impact of winning voucher B: Threshold of impact of assignment to Matched Savings. The procedure designed by Hansen (2003) estimates a threshold regression by least squares, and provides tests of the null of the homogeneous impact of the treatment conditional on the level of maize production per capita against the alternative of a significant change of impact at a threshold. It rejects the null hypothesis of constant impact of the assignment to receiving the voucher at the 95% level (p-value=0.022), identifying a threshold at a maize production level of 225 kg per capita (used for the regressions in Table 5B), but it does not reject the null of constant impact of being assigned to the Matched Savings (p-value is 0.656), with the threshold most likely to occur at 224 kg of maize per capita.

revealed that they are self-sufficient when they sold part of their maize production in the previous agricultural campaign, which is a sign that they have enough maize to feed their families. Transforming subsistence farmers into commercial farmers (who sell part of their maize production) is a major objective that was initially stated in the voucher program. Also, this method is not affected by the fact that the threshold can be different for each household, due to a difference in its need per capita or a difference in other sources of revenue. The median maize production per capita is 129 kg among the households that did not sell their maize production after the harvest of 2010 and 310 kg among the households that sold some of their maize production, which clearly shows that the commercial farmers tend to be the ones who have sufficient production to feed their families. Table 5, Panel C shows that receiving the voucher increased the horizon of non-self-sufficient beneficiaries by 116 days, and the assignment to the MST group increased their planning horizon by 47 days. Although this result is not

Table 5
Impact of the voucher subsidy and Matched Savings program on Horizon, by food security level.

5.A Households are separated based on whether the household is self-sufficient in maize production, based on caloric need per capita (maize production/capita/year > = 386kg)

	(1)	(2)		(3)	(4)		(5)	(6)		(7)	(8)	
Treatment:	**Impact of being selected to receive the Voucher Subsidy**						**Impact of the Matched Savings (vs savings only)**					
Outcome variable:	**Horizon**			**IHS Horizon**			**Horizon**			**IHS Horizon**		
Sample:	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**
ITT - OLS	40.86*** [15.80]	14.86 [52.85]	0.60	0.19* [0.10]	-0.11 [0.21]	0.14	48.70* [24.40]	-20.35 [23.62]	0.07	0.22** [0.09]	-0.03 [0.19]	0.33
LATE - IV	109.71*** [42.50]	39.18 [137.14]		0.52* [0.27]	-0.30 [0.54]							
Nb of obs.	1144	355		1144	355		696	232		696	232	

5.B Households are separated endogenously, using Hansen(2003)'s method for threshold estimation (resulting theshold is at maize production/capita/year > = 225kg)

	(1)	(2)		(3)	(4)		(5)	(6)		(7)	(8)	
Treatment:	**Impact of being selected to receive the Voucher Subsidy**						**Impact of the Matched Savings (vs savings only)**					
Outcome variable:	**Horizon**			**IHS Horizon**			**Horizon**			**IHS Horizon**		
Sample:	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**	**Not self-sufficient**	**Self-sufficient**	**p-val of difference**
ITT - OLS	36.13** [16.77]	42.37 [29.71]	0.85	0.16 [0.12]	0.16 [0.14]	1.00	76.52** [35.71]	-26.65 [16.05]	0.01	0.41*** [0.10]	-0.13 [0.11]	0.01
LATE - IV	92.19** [42.62]	121.24 [85.00]		0.40 [0.29]	0.45 [0.39]							
Nb of obs.	854	645		854	645		528	400		528	400	

significant, the IHS transformation specification tells us that it increased the time horizon of the beneficiaries by a significant 20%. This provides further evidence of the robustness of the results.

The results are rather consistent across the different specifications. None of the two treatments has a significant impact on any of the 12 ITT specifications on the sample of self-sufficient households.In fact, its coefficient is negative five times out of 12. By contrast, among farmers who are not self-sufficient, the coefficient is always positive and it is significant in 10 out of the 12 regressions. The size of the impacts are also relatively consistent across the different regressions, except for a coefficient that is stronger in the case of the Matched Savings program for the poorest group (less than 225 kg of maize production per year), perhaps because the poorest are most sensitive to the risk reduction that results from the opportunity to save. The magnitude of the change appears to be potentially high, but with wide confidence intervals, given the power of the estimation; hence, it also allows impacts that are much smaller in magnitude.

The effect of the voucher on the time horizon is often more significant in level than in inverse hyperbolic sine transformation. This can raise a concern that the results are driven by extreme values. However, Fig 2 also shows an impact of the voucher on the horizon that tends to occurs over the entire distribution of time horizons. As a robustness check, Table A2 in the online appendix shows the equivalent median quantile regressions. This table shows an impact of winning the randomization on the horizon of non-self-sufficient farmers that is significant at 1 percent in two out of the three specifications (and not significant in the third one), which generally confirms that the effect of the voucher on the planning horizon is not driven by extreme values.

In Table 5, all regressions include p-values of the difference of the effect of the treatment on time horizon between self-sufficient and non self-sufficient farmers. This can be interpreted as a test of Propositions 1 and 2 together. This test is more demanding, in that it requires sufficient difference in the reaction of the poor compared to the non-poor when facing the treatment (and that the split between the two groups used for the regression is the correct one). In the case of the Matched Savings, 3 out of the 6 p-values are significant. The significance level is highest when the split is estimated using Hansen's method for threshold estimation. In other cases, the differences are large in magnitude between the two groups but the regressions seem to be underpowered for this test. The issue is accentuated when the sample size of a group becomes very small. In the case of the voucher treatment, none of the six p-values of the difference between the two groups is significant. In this case, it seems that the change in economic prospects increased the time horizon of farmers in both groups (self-sufficient or not).

Table 5 shows the impact on planning horizon separately for the case of the voucher treatment and the case of the matched savings (compared to savings alone). The effect of the voucher treatment on time horizon is estimated using the time horizon measured before the implementation of the savings interventions; hence, there is no concern

Table 6
Impact of the five treatment combinations on Horizon, by food security level.

Outcome variable:	Horizon			IHS Horizon		
	Not self-sufficient	Self-sufficient	p-val of difference	Not self-sufficient	Self-sufficient	p-val of difference
Subsidy (T2)	31.07	-33.43	0.02	0.23	-0.19	0.13
	[20.19]	[24.09]		[0.18]	[0.21]	
Basic savings (T3)	13.84	30.45	0.60	0.21	0.13	0.73
	[22.40]	[26.42]		[0.16]	[0.21]	
Matched savings (T4)	64.28***	-19.91	0.01	0.43**	-0.14	0.03
	[21.43]	[23.67]		[0.16]	[0.22]	
Basic savings + Subsidy (T5)	-7.91	-7.74	1.00	-0.01	-0.09	0.75
	[21.21]	[21.89]		[0.16]	[0.21]	
Matched savings + Subsidy (T6)	81.35**	-11.48	0.05	0.55***	-0.14	0.02
	[38.26]	[28.68]		[0.16]	[0.27]	
	[13.78]	[17.70]		[0.12]	[0.17]	
P-values of:						
T4 - T3	0.04	0.03	0.00	0.18	0.10	0.02
T6 - T5	0.06	0.88	0.08	0.00	0.82	0.01
(T6 - T5) - (T4 - T3)	0.29	0.14	0.87	0.13	0.39	0.66
Observations	786	593		786	593	

*** p<0.01, ** p<0.05, * p<0.1 The standard errors in brackets are clustered by locality, and all regressions include fixed effects at stratification level (groups of 3 localities by proximity). The time horizon measured in the first follow- up survey, after assignment of savings treatment (but before payment of matched savings). HIS Horizon is the inverse hyperbolic sine transformation of the horizon, given by $IHS(x) = log(x + (x^2 + 1)^0.5)$, which can be interpreted like a log transformation but allows non positive values of x.

that its effect was altered by the savings interventions. However, because the savings interventions were initiated after the voucher intervention, one could be concerned that the effects of the matched savings on planning horizon may differ among recipients of the voucher subsidy and non-recipients. To analyze this, Table 6 shows the impact of the five possible treatment combinations on time horizon (measured after the savings intervention started, but before participants received the matched savings money), keeping the control group in the sample. It uses the split obtained by Hansen's method for threshold estimation. The first p-value in the bottom part of the table assesses whether the difference between the impact of matched savings and basic savings on planning horizon is significant in the group of non-beneficiaries of the voucher program (T4-T3). The second p-value assesses the same question among voucher beneficiaries (T6-T5).

The third and sixth columns assess whether this difference between matched savings and savings differs significantly between the self-sufficient and non self-sufficient farmers. In this specification, the difference is significant in all four cases (whether they were voucher beneficiaries or not, and whether one looks at regressions in level or in log). The third line of p-values in the bottom part of the table assesses whether the difference between matched savings and savings is significantly different among voucher beneficiaries and non-beneficiaries, which is never the case. Similar tables for the two other splits presented in Table 5 appear in Table A1 of the online appendix. They also never show significant heterogeneity in the effect of the matched savings (compared to savings) on planning horizon between farmers selected to receive the voucher compared to those who were not selected. Hence, they do not provide much more information than the results of Table 5, Columns 7 to 12, which combine those selected to receive the voucher and those who were not.

4.3.3. *Closing the loop: how time horizon affects future decisions and economic outcomes*

This subsection provides empirical evidence compatible with Proposition 3, which claims that time horizon affects capital accumulation and thus can result in a behavioral poverty trap. In order to do this, Table 7 uses the planning horizon to predict decisions and outcomes during the three years that follow the intervention. Horizon at that time was affected by the treatments, randomly allocated, but also by other factors that are potentially endogenous; hence, in this subsection, the identification is less clean than in previous sections. The results should be interpreted with caution and causality cannot be inferred[22].

Table 7 also shows the relationship between the horizon, which was affected by the interventions, and the long-term outcomes. Importantly, I control for the five treatment dummies as well as fertilizer use, savings, and asset value in April 2011, at the time when the planning horizon was measured: after the vouchers were distributed and the input was used, but before harvest. In line with the predictions of Proposition 3, the time horizon is significantly and positively correlated with savings, fertilizer use, purchase of durable goods, and the total value of assets in the two years that follow the intervention.[23] These results confirm that the time horizon is a predictor of real economic outcomes such as savings, investment in fertilizer and asset accumulation, as well as the purchase of durable goods (which naturally requires a longer term horizon), and persistent optimism about one's future (which is the channel highlighted in the model). The order of magnitude is potentially high, but also includes smaller effects given that the confidence intervals remain quite large. For example, with a 95% confidence interval, a 50% increase in time horizon can lead to an increase in fertilizer use that is very close to 0 in its lower bound, but about 9 percent in its upper bound.

The previous subsection showed that the increase in actual wealth leads to an increase in time horizon, and this subsection shows that an increase in time horizon translates into an increase in investments and wealth accumulation. Together, this provides evidence consistent with the existence of a behavioral poverty trap caused by the vicious cycle between poverty and shortsightedness.[24] In the regression where the

[22] Ideally, to properly identify the impact of time horizon on long-term asset accumulation, one would need an instrument that moved the time horizon without directly affecting economic conditions. However, because this paper argues that the time horizon is mostly affected by expected economic conditions, finding a proper instrument would be challenging.

[23] In the same way as in Carter et al. (2014) and following the recommendation of McKenzie and Baseline (2012), outcomes of multiple following rounds are used to look at the average impact on future periods while gaining power through a reduction of the noise related to temporary shocks and measurement errors on the outcome variable.

[24] Results using the time horizon in level rather than IHST, and the time horizon of

Table 7
Closing the loop: the impact of Horizon on long term outcomes, (controlling for changes in input use, savings and assets in initial survey).

VARIABLES	Fertilizer Use Aug 2012–13		Total Savings Aug 2012–13		Purchase of Durable Goods Aug 2012–13		Total Value of Assets and Savings Aug 2012–13		Optimism (better off in 5 years) Aug 2012–13	
Time Horizon		0.094**		0.073*		0.12***		0.025*		0.039***
April 2011 (IHST)		[0.046]		[0.041]		[0.029]		[0.014]		[0.012]
Voucher Treatment	0.61**	0.56**	0.43**	0.43**	-0.0012	-0.030	0.14**	0.12*	0.085*	0.074
	[0.24]	[0.25]	[0.20]	[0.20]	[0.17]	[0.18]	[0.066]	[0.069]	[0.048]	[0.049]
Savings Treatment	0.041	-0.024	0.29	0.28	0.030	0.044	0.12	0.12	-0.057	-0.076
	[0.38]	[0.39]	[0.23]	[0.22]	[0.17]	[0.17]	[0.096]	[0.094]	[0.066]	[0.066]
MS Treatment	0.35	0.30	1.02***	0.98***	0.14	0.11	0.16**	0.14*	0.056	0.025
	[0.36]	[0.38]	[0.23]	[0.22]	[0.15]	[0.15]	[0.077]	[0.079]	[0.063]	[0.064]
Voucher + Savings	0.38	0.25	0.64***	0.58***	0.13	0.089	0.12	0.11	0.022	-0.0065
	[0.35]	[0.37]	[0.22]	[0.21]	[0.15]	[0.16]	[0.087]	[0.091]	[0.061]	[0.063]
Voucher + MS	0.11	0.038	0.66***	0.65***	-0.053	-0.056	0.12	0.10	0.040	0.012
	[0.34]	[0.35]	[0.22]	[0.21]	[0.15]	[0.16]	[0.085]	[0.087]	[0.067]	[0.068]
Fertilizer use	0.35***	0.36***	0.093***	0.091***	0.058***	0.055***	0.023***	0.023***	0.013**	0.011**
April 2011 (IHST)	[0.028]	[0.029]	[0.017]	[0.017]	[0.012]	[0.012]	[0.0063]	[0.0064]	[0.0051]	[0.0052]
Total Savings	0.066***	0.076***	0.14***	0.14***	0.033***	0.035***	-0.0077	-0.0068	0.0095*	0.0086
April 2011 (IHST)	[0.022]	[0.023]	[0.019]	[0.020]	[0.011]	[0.012]	[0.0059]	[0.0060]	[0.0054]	[0.0054]
Total Asset Value	0.21***	0.19***	0.14***	0.13***	0.51***	0.51***	0.49***	0.49***	0.049***	0.048***
April 2011 (IHST)	[0.052]	[0.052]	[0.046]	[0.046]	[0.048]	[0.047]	[0.033]	[0.034]	[0.013]	[0.013]
Observations	1,530	1,487	1,534	1,491	1,534	1,491	1,534	1,491	1,533	1,490

***p<0.01, **p<0.05, *p<0.1. The standard errors in brackets are clustered by locality (which is the unit of randomization of the savings interventions). Control variables are Fertilizer use, Total Savings and Total Asset value, all in Inverse Hyperbolic Sine Transformation, and all measured in April 2011, at the time when the Time Horizon was measured.

outcome is the total asset value in 2012–2013, the introduction of the time horizon reduces the coefficient of the impact of the voucher treatment by about 18%. This provides an order of magnitude of the share of the impact of the intervention on asset accumulation that is driven by the behavioral effect.[25]

4.4. Interpretation of the results and discussion of alternative explanations

This section explores the possible explanations of the empirical evidence provided in this paper. I first describe a set of rather classical interpretations: 1) nutritional effects of poverty 2) less money mechanically leads to less planning because one has no money to allocate, 3) beneficiaries extended their time horizon only because they were waiting for the payment and 4) a habit formation effect. Theoretical arguments and empirical evidence suggest that these interpretations are unlikely. By contrast, the evidence is consistent not only with the theoretical model of this paper, but also with some recent papers, providing different possible mechanisms that lead to a behavioral poverty trap (Mani et al., 2013; Banerjee and Mullainathan, 2010; Bernheim et al., 2013). The paper provides initial evidence suggestive of the existence of a behavioral poverty trap. However, distinguishing the mechanisms at play will require additional research, with more comprehensive measures of the behavioral changes and intermediate outcomes.

4.4.1. Mechanical and non-behavioral effects?

Undernutrition can limit one's ability to think and make the right decisions. Also, since hunger is a visceral need, it can make it more difficult for the individual to apply self-control with respect to food. While this effect can reinforce the channel analyzed in this paper, it is unlikely to explain its results. The identification strategy for both interventions consists of examining an improvement in the economic prospects of the individual. At the time of the survey, the farmer had not yet benefited from the harvest or matched savings resulting from the interventions, meaning their economic conditions had not yet been affected. Still, in principle, they were able to reallocate their food consumption across periods because of the expectation of future benefits. However, I find that, at the time when the planning horizon was measured, food consumption per capita of the voucher beneficiaries was not significantly different from that of non-beneficiaries (p-value 0.372). The results are similar for the beneficiaries of the matched savings versus savings intervention (p-value 0.225)[26]. Hence, there is no evidence to support the undernutrition mechanism.

An alternative explanation would be that less money to allocate across time mechanically leads to less planning. Taken to the extreme, someone who has no money at all would have no reason to plan at all. The first element of the answer to this argument is theoretical. More wealth increases the value of planning by having more money to allocate across time, but wealth also reduces the marginal utility of consumption, and thus the marginal cost of a misallocation across time. With a log utility function, the two effects compensate each other exactly. In the model of this paper, it can be shown, that, if the cost of planning were fixed (rather than accentuated by the disutility gener-

(*footnote continued*)
the following periods, are very consistent with the findings of Table 7. They are not presented, for conciseness, but are available from the author upon request.

[25] In the presence of measurement errors on the time horizon, and if the multi-dimensional behavioral changes could be better captured by a larger set of questions, this 18% would be a lower bound on the share of the impact that is driven by the behavioral channel. On the other hand, if the time horizon is correlated with non-behavioral channels other than the ones in the control variables, then this would lead to an overestimate of the share. Hence, this estimate must be taken cautiously.

[26] This statement holds whether we measure food consumption per capita in level or in inverse hyperbolic sine transformation. Results are available upon request

ated by the distress of projecting oneself into a gloomy future), then the optimal time horizon would be independent of the individual's initial wealth. Intuitively, no matter how little money a household has, it still has as much need as a wealthier household to plan and save (in relative proportions) because poverty sharpens the cost of neglecting the future. Hence, without the reluctance to project oneself into a gloomy future (analytically represented by inclusion of the disutility from anticipation), poverty in itself does not explain a reduction of the planning horizon.

The second element of the answer is empirical. The results of Section 4.3.3 show that, even when controlling for input use, savings, and assets, an increase in time horizon still leads to a significant increase in investment and assets during the following years. If the increase in time horizon (observed in Section 4.3.2) reflected only a mechanical increase in planning due to the increase in wealth, then, once I control for wealth, time horizon would not have any power to predict future investments and asset accumulation.

One can also be concerned that the beneficiaries may have been waiting for the future resources coming from harvest or the Matched Savings. The first survey (used to analyze the impact of the voucher) was implemented two to three months before the harvest, and the second survey (used to analyze the impact of the Matched Savings) preceded the payment of Matched Savings by three months. If farmers were simply waiting for the harvest or the Matched Savings payment, the effect would be a concentration of planning horizons around the three-month period. Fig. 2 A and B show the distribution of the planning horizon for the control group and the two treatment groups, and no particular concentration of planning horizon around the three-month period for the treatment group is noticeable. There is an increase in time horizon, which is relatively evenly spread among the different initial levels of planning horizon. Hence, the results are not driven by individuals simply waiting for their payments.

Another concern is that the impact on time horizon could have been a result of habit formation and the change in activity caused by the interventions (i.e., farming with more inputs or the use of savings accounts), more so than the improvement of future economic prospects. Fig. 2B shows strikingly similar distributions of the planning horizon among the control group and the ST group, despite the fact that the ST increased the proportion of beneficiaries with a savings account by 13 percentage points (versus 21 for the MST), and that considerable time and effort was invested in the financial training for those in the ST and the MST groups. Hence, the data suggests that the financial training and opening of savings accounts had no impact on the time horizon of the beneficiaries, but the money (and potentially the incentive to save) provided by the Matched Savings had a considerable impact. The interventions do not allow us to confirm that a pure cash transfer would have had a similar impact, given that these programs include additional changes (e.g., the incentive to save or to invest) and are implicitly designed with the intention to generate a change in behavior. In fact, improving our understanding of how the design of the transfer may enhance the impact of transfers on the time horizon appears to be a very promising area for future research.

4.4.2. Alternative models with behavioral poverty traps

The evidence is compatible with the novel mechanisms that this paper proposes, but also with alternative mechanisms highlighted in the recent literature, all leading to the possibility of a behavioral poverty trap. Mani et al. (2013) provide evidence that poverty-related concerns consume mental resources, leaving less cognitive capacity to perform other tasks[27]. This mechanism shares many similarities with the channel evidenced in this paper, in that both link anxiety related to poverty to poorer economic decisions, with the distinction that the cited paper identifies a cognitive bandwidth effect, rather than this paper's channel focuses on avoiding the disutility from anticipation. There is no direct evidence that the change in economic prospects reduced the bandwidth tax; however, the reduction in planning horizon could be a consequence of this effect. Hence, the evidence in this paper is compatible with a cognitive bandwidth effect as well. Banerjee and Mullainathan (2010) present a dynamic optimization framework, where poorer individuals have a consumption basket that includes a higher proportion of visceral goods, for which it is more difficult to behave rationally. The authors separate regular goods from temptation goods (such as fatty or sugary foods), which are assumed to provide immediate gratification, but are not valued by the long-run self, and act as a temptation tax. They find that, if this temptation tax rate is higher among the poor, then poor individuals may react to the prospect of future income growth by saving more, generating a behavioral poverty trap similar to the one discussed in this paper, though for quite different reasons. The implications of their model for an individual's time horizon as defined in my model are not straightforward, but their model would plausibly predict that poor people appear to be less oriented toward the future, which would generate predictions similar to the evidence of this paper.

A recent paper from Bernheim et al. (2013) describes an interpersonal game played by the time-inconsistent decision maker. They find a behavioral poverty trap that results from the fact that self-control is more difficult when initial assets are low, which results in similar economic consequences. The authors also conclude that a temporary increase in assets can have long-term consequences on wealth through changes in attitude toward the future. Ultimately, I cannot reject that the models of Mani et al. (2013); Banerjee and Mullainathan (2010) and Bernheim et al. provide alternative explanations of the empirical findings of this paper. The empirical results of this paper support both the conclusions of my model and those of these alternative causes for behavioral poverty traps. It is also possible that the mechanisms put forward by these authors and the one in this paper reinforce each other in the creation of a behavioral poverty trap. Future work is needed to better disentangle the mechanisms behind the observed behavioral poverty trap.

5. Conclusion and policy implications

Effective development interventions require structural changes that outlive the timespan of the interventions themselves. Poverty dynamics show that patience is a fundamental factor for an individual's willingness to make the sacrifices required to transit toward a higher equilibrium. This paper looks at the psychological causes behind myopic economic behaviors, and offers a new theoretical approach, building on the psychology literature, according to which the anticipation of future poverty generates disutility and makes it costly for the poor to have a long-term planning horizon. It shows that a behavioral poverty trap can exist even in the absence of non-convex production technologies or any other standard external cause of a poverty trap (Barrett and Michael, 2013).

The paper also provides initial empirical evidence that is consistent with the endogeneity of one's planning horizon and with the existence of a behavioral poverty trap. In a field experiment among Mozambican maize producers, I test the predictions using two different interventions. As predicted, both interventions have a large and significant impact for households that are not self-sufficient in maize production, but no significant impact for households that are self-sufficient (although the difference between the two groups is significant only in some specifications). The results are relatively consistent using different definitions of self-sufficiency. I find that, among the households who were initially not self-sufficient in maize production, benefiting from an agro-input subsidy of a value equivalent to USD 65 increased their planning horizon by about 100 days[28], and being offered Matched Savings with an average transfer of USD 34 increased the time horizon

27Also, in a lab experiment in India, Spears (2011) find that poverty is associated with diminished behavioral control after participants are asked to make a difficult economic decision.

of small producers by about 48 days. These are substantial increases from an average of 200 days in the control group of the pseudo-baseline survey. Finally, I find that the time horizon is a strong predictor of savings and asset accumulation. This last result is suggestive rather than decisive, in that it analyzes a variation in horizon that is partly caused by the experiment, but partly endogenous as well. This closes the loop of the evidence in favor of a vicious circle between poverty and shortsightedness. I find that about 18% of the asset accumulation in the two years that followed the intervention can be attributed to the behavioral change. These findings provide evidence compatible with the model proposed in the paper, but also with alternative models with a behavioral poverty trap. Future work should aim at better disentangling these mechanisms through a closer look at possible channels and intermediary outcomes.

In the case of the project described in this paper, Carter et al. (2014) show impacts of the intervention on maize production, asset accumulation, and welfare indicators that outlive the duration of the project, which can be explained in part by the findings of this paper. The long-term implications also depend on whether the change of attitude toward the future is permanent or temporary. Hence, further research is necessary to better understand this dynamic, particularly in the context of rural areas in developing countries.

To the best of my knowledge, this paper provides the first model that explains how disutility from anticipation can dissuade the poor from being forward looking. It also provides new evidence of the endogeneity of one's attitude toward her future, especially among households that are not self-sufficient, and about the existence of a behavioral poverty trap. The two interventions were designed to leverage the amounts transferred by requiring contributions from the farmers, and to orient farmers toward productive and forward looking activities. Hence, simple cash transfer of the same amount may or may not have a lower impact on the beneficiaries' planning horizon. Future research could try to answer this question. More interestingly for policy implications, scholars should investigate what type of intervention best extends the beneficiary's time horizon. Variants to be compared can include individual versus group intervention, or whether or not the benefits require the recipient's contribution (in money, time or effort). This article contributes to a better knowledge of the mechanisms that affect economic aspirations, which will inform the design of projects that enhance these effects. Further analysis could use a broader measure of time horizon (using a set of questions to construct an indicator), and could look at a broader set of socio-emotional skills (such as locus of control or grit) which can contribute to a behavioral poverty trap.

Individual Development Accounts (IDAs), which offer a match at a fixed rate on savings toward the acquisition of assets, provide a good example of an intervention that explicitly aims at generating behavioral changes that put the beneficiary on a wealth accumulation path. Schreiner et al. (2001) explain that IDAs have an impact through both economic and psychological effects, and that “If people have savings to savor, then they fear less and hope more”. This change of attitude toward the future is confirmed by this empirical analysis and acts as a multiplier of the impact of the program on asset accumulation.

An economic intervention can affect the beneficiaries' asset accumulation not only through its direct economic impact, but also through a behavioral impact, which embraces all changes in preferences, as well as aspirations or attitudes that will, in turn, affect economic decisions. Depending on the intervention, the behavioral impact may be positive (e.g., increase in patience or aspirations) or negative (e.g., increase in passivity or moral hazard). Improving the design of future projects requires a deep understanding of both the economic and behavioral impacts of the interventions. While most of the literature has evaluated the economic impact, fewer theoretical and empirical studies have analyzed the behavioral effects and their interaction with the economic effects. This paper provides an attempt to include in a randomized controlled trial an evaluation of the behavioral changes that are expected to be affected by economic interventions. This area has a large untapped potential for future research, at the junction between economics and psychology.

Annexure

Proof of existence of an optimum

Prior to the demonstration of the three propositions, I show that Assumption 1 implies the existence of a maximum (or maxima) of $U(H, w_0)$ reached for $H \in (0, \overline{H}]$.

Because the utility function and horizon function are both continuous and differentiable, and $c_t^i(w_0, H)$ is continuous and differentiable for $H \in (0, \overline{H}]$, then $U(H, w_0)$ is also continuous and differentiable on $H \in (0, \overline{H}]$. Because, by assumption $\lim_{c_t^i \longrightarrow 0} u(c_t^i) = -\infty$, then $\lim_{H \longrightarrow 0} U(H, w_0) = -\infty$. Hence, $\exists\ e > 0$ such that $U(H, w_0) < U(e, w_0)\ \forall\ H < e$. Because, for any w_0, $U(H, w_0)$ is continuous on the closed and bounded interval $H \in [e, \overline{H}]$, then, by the extreme value theorem, $U(H, w_0)$ must attain its maximum(a) in $(0, \overline{H}]$.

Proof of Proposition 1

We start from the outer self's maximization problem, provided by Eq. (7)

$$\max_{\{c_t^i\}} U_i(\{c_t^i\}, h_i) = \int_i^T e^{-\rho(t-i)} u(c_t^i)\left[h(t-i, H) + \gamma \int_i^t h(\pi - i, H) h(t-\pi, H) d\pi\right] dt \tag{15}$$

Let $k_t^i(H)$ be the weight that the outer self i puts on her consumption at time t:

$$k_t^i(H) = e^{-\rho(t-i)}\left[h(t-i, H) + \gamma \int_i^t h(\pi - i, H) h(t-\pi, H) d\pi\right] \tag{16}$$

This weight combines the motivation provided by utility directly derived from consumption at time t with the utility of its anticipation between time i and time t. k_t^i is increasing in H for any $i < t \le T$. Note that $k_i^i = 1$, which is obtained by substituting t into i in Eq. (16).

The marginal change in utility of increasingc_t^i is thus given by $k_t^i\ u'(c_t^i)$.

Given the interest rate r, the actualized unitary cost at time i of consumption at time t is equal to $e^{-r(t-i)}$.

At the optimum, the marginal utility derived from one monetary unit dedicated to consumption must be the same for every period:

$$e^{-r(s-i)} k_t^i(H) u'(c_s^{i*}) = e^{-r(t-i)} k_t^i(H) u'(c_t^{i*})\quad \forall\ \ s, t \in [i, T] \tag{17}$$

Using the fact that $e^{-r(i-i)} k_i^i(H) = 1$, then when t=i, Eq. (17) gives:

$$u'(c_i^{i*}) = e^{-r(t-i)} k_t^i(H) u'(c_t^{i*})\quad \forall\ \ t \in [i, T] \tag{18}$$

From this, an implicit differentiation with respect to w_0 leads to:

$$\frac{dc_i^{i*}}{dw_0} = \underbrace{e^{-r(t-i)}\ k_t^i(H)\frac{u''(c_t^{i*})}{u''(c_i^{i*})}}_{>0}\frac{dc_t^{i*}}{dw_0}\quad \forall\ \ t \in [i, T]$$

which shows that, at the optimum, all c_t^{i*} must vary in the same direction as a reaction to an increase in w_0. Hence, $\frac{dc_t^{i*}}{dw_0} > 0\ \ \forall\ \ t \in [i, T]$.

I now turn to the maximization of the inner self. For conciseness, I will use c_t^i as an abbreviation for $c_t^i(w_0, H)$, referring to the consumption that results from the decisions of the succession of outer selves once w_0 and H are set. Aware of this, the inner self selects the horizon parameter $H \in (0, \overline{H}]$, which maximizes the agent's intertemporal

[28] However, plausible values at the 95% confidence interval range from about 17 days to about 184 days.

utility given by Eq. ((15):

$$\max_H U(w_0, H) = \int_0^T e^{-\rho(i)}\left[u(c_i^i) + \gamma\left(\int_i^T e^{-\rho(\tau-i)}h(\tau-i, H)u(c_\tau^i)d\tau\right)\right]di \tag{19}$$

The solution $H(w_0)$ to the inner self's problem can be either a corner solution at $H(w_0) = \overline{H}$ if it satisfies $\frac{dU(\overline{H}, w_0)}{dH} \geq 0$, or an interior solution satisfying its first-order condition:

$$\frac{dU(w_0, H)}{dH} = \int_0^T e^{-\rho i}u'(c_i^i)\frac{dc_i^i}{dH} + \gamma\int_i^T e^{-\rho\tau}\left(h(\tau-i, H)u'(c_\tau^i)\frac{dc_i^i}{dH} + u(c_\tau^i)\frac{dh(i-\pi, H)}{dH}\right)d\tau\, di = 0 \tag{20}$$

As a reminder, by definition, $h(\theta, \overline{H}) = 1\ \forall\ \theta$. Hence, when $H(w_0) = \overline{H}$, then the objective function of every outer self is the same as the objective function of the inner self; thus, the consumption is not updated at each period ($c_t^{i*} = c_t^{j*}\ \forall\ 0 \leq i \leq j \leq t \leq T$) because the individual is time consistent, and the objective function of every outer self is the same as the one of the inner self, resulting in an optimal allocation of consumption between periods. As a result, for a given outer self i, the marginal utility derived from one monetary unit dedicated to consumption $c_t^i(H, w_0)$ must be the same for every period t. When $H = \overline{H}$, Eq. (17) holds not only for a given outer self i, but also across all outer selves.

Given the fact that consumption is not updated (and thus the anticipated consumption is the consumption that occurs when that time arrives), using reasoning similar to that used to proceed from Eq. (4) to Eq. (7), we can rewrite Eq. (19) to obtain the following one:

$$\max_H U(w_0, H) = \int_0^T e^{-\rho i}u(c_i^i)\left(1 + \gamma\int_0^i h(i-\pi, H)d\tau\right)di \tag{21}$$

Deriving the first-order condition of this equation leads to the following representation of the tradeoff:

$$\underbrace{\int_0^T e^{-\rho i}u'(c_i^i)\frac{dc_i^i}{dH}\left(1 + \gamma\int_0^i h(i-\pi, H)d\pi\right)di}_{\text{Marginal benefit of correcting the misallocation}} = \underbrace{-\int_0^T e^{-\rho i}u(c_i^i)\gamma\int_0^i \frac{dh(i-\pi, H)}{dH}d\pi di}_{\text{Marginal benefit of closing the eyes}} \tag{22}$$

When $H = \overline{H}$, because the allocation of consumption is optimal, by the envelope theorem, any marginal reallocation of consumption $\{c_t^i(H, w_0)\}$ leads to no change in $U(H, w_0)$, implying that the LHS of Eq. (22) is null. To show this formally, with *LHS* being the left-hand side of Eq. (22):

$$LHS = \int_0^T e^{-\rho i}u'(c_i^i)\frac{dc_i^i}{dH}\left(1 + \gamma\int_0^i h(\tau-i, \overline{H})d\tau\right)di = \int_0^T e^{-\rho i}u'(c_i^i)\frac{dc_i^i}{dH}(1 + \gamma\ i)di \tag{23}$$

Using the fact that $c_i^0 = c_i^i$, because the consumption plan is common to all outer selves when $H(w_0) = \overline{H}$, Eq. (18) shows that $u'(c_i^0) = \frac{u'(c_0^0)}{e^{-(r+\rho)i}(1+\gamma i)}$, which can be replaced to obtain:

$$LHS = \int_0^T e^{-\rho i}\frac{u'(c_0^0)(1+\gamma i)}{e^{-(r+\rho)i}(1+\gamma i)}\frac{dc_i^i(H, w_0)}{dH}di = u'(c_0^0)\int_0^T e^{ri}\frac{dc_i^i(H, w_0)}{dH}di \tag{24}$$

The fact that the budget constraint is always binding implies that $\int_0^T e^{ri}\frac{dc_i^i(H, w_0)}{dH}di = 0$. Hence, the LHS of Eq. (22) is equal to 0.

As a result, when $H = \overline{H}$, then:

$$\frac{dU(w_0, \overline{H})}{dH} = \int e^{-\rho i}u(c_i^i)\gamma\int_0^i \frac{dh(i-\pi, H)}{dH}d\pi di \tag{25}$$

Because we showed that $\frac{dc_t^i}{dw_0} > 0\ \forall\ t$, we know that $\frac{dU(w_0, \overline{H})}{dH}$ is strictly increasing in w_0. Hence, ∃a unique $\widehat{w_0}$ such that $\frac{dU(\overline{H}, w_0)}{dH} = 0$. When $w_0 \geq \widehat{w_0}$, then $\overline{H}$ maximizes $U(H, w_0)$; it is a global maximum given the absence of tradeoff: any $H < \overline{H}$ increases the cost of misallocation and reduces the (positive) utility from anticipation.

When $w_0 < \widehat{w_0}$, then $\frac{dU(w_0, \overline{H})}{dH} < 0$, and thus, a marginal deviation from $\overline{H}$ to $H < \overline{H}$ improves the utility of the agent. Hence, the solution is interior, $H(w_0) \in (0, \overline{H})$.

Proof of Proposition 2

Proposition 2 requires the assumption that $u(c)$ is a log utility function. As a result, at the optimum:

$$\frac{e^{-r(s-i)}k_t^i(H)}{c_s^i} = \frac{e^{-r(t-i)}k_t^i(H)}{c_t^i}\quad\forall\ \ s, t \in [i, i+h_i] \tag{26}$$

When s=i, then, because $k_i^i(H) = 1$, it can be simplified to:

$$c_t^i = e^{-r(t-i)}k_t^i(H)c_i^i \tag{27}$$

I introduce the budget constraint: $\int_i^T e^{r(t-i)}c_t^i dt = w_i$, and substitute 27 to obtain:

$$\int_i^T k_\tau^i(H)c_i^i dt = w_i \tag{28}$$

The immediate consumption that is planned and happens at time i is thus:

$$c_i^i = \frac{w_i}{\int_i^T k_\tau^i(H)dt}\quad\forall\ \ 0 \leq i \leq T \tag{29}$$

Re-using Eq. (27), the consumption planned at time i for period t is given by:

$$c_t^i = w_i\frac{e^{-r(t-i)}k_t^i(H)}{\int_i^T k_\tau^i(H)d\tau}\quad\forall\ \ 0 \leq i \leq t \leq T \tag{30}$$

As a reminder, the consumption c_i^i always happens, as opposed to c_t^i for $t \neq i$, which would happen only if the consumption plan has not changed once the outer self reaches period i (only true when $H = \overline{H}$).

From $\dot{w_i} = rw_i - c_i$ and Eq. (29), we obtain:

$$\frac{\dot{w_i}}{w_i} = r - \frac{1}{\int_i^T k_\tau^i(H)d\tau} \tag{31}$$

$\frac{\dot{w_i}}{w_i}$ is independent of w_0 at any i implies that $\frac{w_i}{w_0}$ is independent of w_0. From Eq. (29) and (31), all w_i and c_t^i are proportional to w_0. Hence, $\frac{\partial w_i(w_0, H)}{\partial w0} > 0$ and $\frac{\partial c_t^i(w_0, H)}{\partial w0} > 0$ for any $0 < i < T$. Also, since $w_i(w_0, H)$ and $c_t^i(w_0, H)$ are both proportional to w_0, then $\frac{\partial\frac{w_i(w_0, H)}{w0}}{\partial w0} = 0$ and $\frac{\partial\frac{c_t^i(w_0, H)}{w0}}{\partial w0} = 0$ for any $0 \leq i < T$.

Back to the maximization problem of the inner self, I take the derivative of $U(H, w_0)$ in Eq. (8) with respect to H to obtain the first-order condition:

$$\frac{dU(w_0, H)}{dH} = \int_0^T e^{-\rho i}u'(c_i^i)\frac{dc_i^i}{dH} + \gamma\int_i^T e^{-\rho\tau}\left(h(\tau-i, H)u'(c_\tau^i)\frac{dc_\tau^i}{dH} + \frac{dh(\tau-i, H)}{dH}u(c_\tau^i)\right)d\tau di = 0 \tag{32}$$

I have shown that, for a given H, c_t^i is proportional to $w_0\ \ \forall\ 0 \leq i \leq t \leq T$; the relative allocation of consumption at the optimum is independent from the initial wealth. Hence, with the log utility function, $u'(c_t^i)\frac{dc_t^i}{dH}$ is independent from w_0. As a result, the derivation of Eq. (32) with respect to w_0, simplifies to:

$$\frac{d^2U(H, w_0)}{dH\, dw_0} = \gamma \int_0^T \int_i^T e^{-\rho\tau} \frac{dh(\tau - i, H)}{dH} \frac{dc_\tau^i}{dw_0} u'(c_\tau^i(H, w_0)) d\tau di \ > 0 \tag{33}$$

H and w_0 are complementary because, when the horizon increases, more weight is put on the anticipation of future utility, and a high w_0 leads to a higher level of future consumption, and thus higher benefit from the increased weight on anticipated utility.

In the case of an interior solution $(H(w_0) < \overline{H})$, an implicit differentiation of $\frac{dU(H(w_0), w_0)}{dH} = 0$ with respect to H gives the following:

$$\frac{d^2U(H, w_0)}{dH^2} \frac{dH(w_0)}{dw_0} + \frac{\partial \frac{dU(H, w_0)}{dH}}{\partial w_0} = 0 \tag{34}$$

Because the solution $H(w_0)$ must satisfy the first and second-order conditions, then $\frac{dU(H, w_0)}{dH} = 0$ and $\frac{d^2U(H, w_0)}{dH^2} < 0$.

Hence:

$$\frac{dH(w_0)}{dw_0} = -\frac{\frac{d^2U(H(w_0), w_0)}{dH\, \partial w_0}}{\frac{d^2U(H, w_0)}{dH^2}} > 0 \tag{35}$$

Hence, when $w_{0<}\widehat{w_0}$, then Eq. (35) tells us that $H(w_0)$ is an increasing function.

Proof of Propositions 3

For a given i, Eq. (31) shows that:

$$\frac{\dot{w}_i}{w_i}(w_0, H(w_0)) = r - \frac{1}{\int_i^T k_\tau^i(H(w_0)) d\tau}$$

Because $\frac{\partial \frac{\dot{w}_i}{w_i}}{\partial w_0} = 0$ and $\frac{\partial \frac{\dot{w}_i}{w_i}}{\partial H} > 0$, then:

$$\frac{d \frac{\dot{w}_i}{w_i}}{dw_0} = \frac{\partial \frac{\dot{w}_i}{w_i}}{\partial w_0} + \frac{\partial \frac{\dot{w}_i}{w_i}}{\partial H} \frac{\partial H}{\partial w_0} > 0$$

This indicates that wealthier individuals will save a higher share of their income.

When $r > \underline{r}(i) = \frac{1}{\int_i^T k_\tau^i(\overline{H}) d\tau}$ then $\frac{\dot{w}_i}{w_i} > 0$ for some w_0.

Let $H_l = \lim_{w_0 \to 0} H(w_0)$, then when $r < \overline{r}(i) = \frac{1}{\int_i^T k_\tau^i(H_l) d\tau}$, then $\frac{\dot{w}_i}{w_i} < 0$ for some w_0.

Because $\frac{\dot{w}_i}{w_i}$ is continuous and increasing in w_0, when $\underline{r}(i) < r < \overline{r}(i)$ there exists a unique $\widetilde{w_0}$ such that $\frac{\dot{w}_i}{w_i}(\widetilde{w_0}, H(\widetilde{w_0}))$=0 and such that when $w_0 < \widetilde{w_0}$ then $\frac{\dot{w}_i}{w_i} < 0$ and when $w_0 > \widetilde{w_0}$ then $\frac{\dot{w}_i}{w_i} > 0$.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jdeveco.2017.01.006doi10.1016/j.jdeveco.2017.01.006.

References

Akerlof, G.A., Dickens, W.T., 1982. The economic consequences of cognitive dissonance. Am. Econ. Rev. 72 (3), 307–319.
Ameriks, J., Caplin, A., Leahy, J., 2003. Wealth accumulation and the propensity to plan. Q. J. Econ. 118 (3), 1007–1047.
Andreoni, J., Sprenger, C., 2012. Estimating time preferences from convex budgets. Am. Econ. Rev. 102 (7), 3333–3356.
Appadurai, A., 2004. The capacity to aspire: culture and the terms of recognition. Cult. Public Action, 59–84.
Ashraf, N., D.S. Karlan, and W. Yin, 2005. Tying Odysseus to the mast: Evidence from a commitmentsavings product in the Philippines,Yale University Economic Growth Center Discussion Paper No. 917.
Banerjee, A. and S. Mullainathan, 2010. The shape of temptation: Implications for the economic lives of the poor.
Barrett, Christopher B, Michael, R Carter, 2013. The economics of poverty traps and persistent poverty: empirical and policy implications. J. Dev. Stud. 49 (7), 976–990.
Beaman, L., Duflo, E., Pande, R., Topalova, P., 2012. Female leadership raises aspirations and educational attainment for girls: a policy experiment in India. Science 335 (6068), 582–586.
Becker, G.S., Mulligan, C.B., 1997. The endogenous determination of time preference. Q. J. Econ. 112 (3), 729–758.
Becker, G.S. and R.A. Posner, 2005. Suicide and risk-taking: an economic approach, Unpublished Manuscript, The University of Chicago.
Bentham, J., An introduction to the principles of morals and legislation (1789), The Works of Jeremy Bentham, 1838, 43.
Bernard, T., S. Dercon, and A.S. Taffesse, 2011. Beyond fatalism-an empirical exploration of self-efficacy and aspirations failure in Ethiopia.
Bernheim, B. Douglas, Debraj Ray, and Sevin Yeltekin, 2013. Poverty and self-control, Technical Report, National Bureau of Economic Research.
Bramel, D., 1962. A dissonance theory approach to defensive projection. J. Abnorm. Social. Psychol. 64 (2), 121.
Brune, L., X. Giné J. Goldberg, and D. Yang, 2011. Commitments to save: a field experiment in rural Malawi, World Bank Policy Research Working Paper Series.
Brunnermeier, Markus K., Jonathan, A.Parker, 2005. Optimal expectations. Am. Econ. Rev., 1092–1118.
Burbidge, John B., Magee, Lonnie, Robb, A.Leslie, 1988. Alternative transformations to handle extreme values of the dependent variable. J. Am. Stat. Assoc. 83 (401), 123–127.
Caplin, A., Leahy, J., 2001. Psychological expected utility theory and anticipatory feelings*. Q. J. Econ. 116, 55–79.
Carter, Michael, Laajaj, Rachid, Yang, Dean, 2014. Subsidies and the persistence of technology adoption: field experimental evidence from Mozambique. NBER Work. Pap., 20465.
Conley, T.G., Udry, C.R., 2010. Learning about a new technology: pineapple in Ghana. Am. Econ. Rev. 100 (1), 35–69.
Descartes, R., Discourse on Method, 1637.
Duflo, E., Banerjee, A., 2007. The economic lives of the poor. J. Econ. Perspect. 21 (1), 141–167.
Duflo, E., Kremer, M., Robinson, J., 2008. How high are rates of return to fertilizer? Evidence from field experiments in Kenya. Am. Econ. Rev. 98 (2), 482–488.
Duflo, Esther, Michael Kremer, and Jonathan Robinson, 2009. Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya, Working Paper 15131, National Bureau of Economic Research.
Festinger, L., 1957. A Theory of Cognitive Dissonance. Stanford University Press.
Fudenberg, D., Levine, D.K., 2006. A dual-self model of impulse control. Am. Econ. Rev. 96 (5), 1449–1476.
Glass, D.C., 1964. Changes in liking as a means of reducing cognitive discrepancies between self-esteem and aggression1. J. Pers. 32 (4), 531–549.
Hansen, Bruce E., 2003. Sample splitting and threshold estimation. Econometrica 68 (3), 575–603.
Hirschman, A.O., 1965. Obstacles to development: a classification and a quasi-vanishing act. Econ. Dev. Cult. change 13 (4), 385–393.
Jamison, J. and J. Wegener, 2010. Multiple selves in intertemporal choice, Journal of Economic Psychology.
Jevons, H.S., 1905. Essays on economics, Macmillan and Co., limited.
Jevons, W.S., 1879. The theory of political economy, Macmillan and Co..
Johnson, Norman L, 1949. Systems of frequency curves generated by methods of translation. Biometrika, 149–176.
Laibson, D., 1997. Golden eggs and hyperbolic discounting*. Q. J. Econ. 112 (2), 443–477.
Lawrance, E.C., 1991. Poverty and the rate of time preference: evidence from panel data. J. Polit. Econ., 54–77.
Leibow, E., 1967. Tally's Corner. Little Brown & Co., Boston.
Loewenstein, G., 1987. Anticipation and the valuation of delayed consumption. Econ. J., 666–684.
Loewenstein, G. and J. Elster, 1992. Choice over Time, Russell Sage Foundation

Publications.
Loewenstein, G., Haisley, E., Caplin, A., Schotter, A., 2008. The Economist as Therapist: methodological ramifications of 'light' paternalism. Perspect. Future Econ.: Posit. Norm. Found., 1.
Macours, Karen, Vakis, Renos, 2014. Changing households' investment behaviour through social interactions with local leaders: evidence from a randomised transfer programme. Econ. J. 124 (576), 607–633.
Mahajan, Aprajit and Alessandro Tarozzi, 2012. Time inconsistency, expectations and technologyadoption: The case of insecticide treated nets,Economic Research Initiatives at Duke (ERID) Work-ing Paper, 105.
Mani, Anandi, Mullainathan, Sendhil, Shafir, Eldar, Zhao, Jiaying, 2013. Poverty impedes cognitive function. Science 341 (6149), 976–980.
McClure, S.M., Laibson, D.I., Loewenstein, G., Cohen, J.D., 2004. Separate neural systems value immediate and delayed monetary rewards. Science 306 (5695), 503.
McKenzie, David, 2012. Beyond baseline and follow-up: the case for more T in experiments. J. Dev. Econ. 99 (2), 201–221.
Montgomery, J.D., 1994. Revisiting Tally's Corner. Ration. Soc. 6 (4), 462.
Moulton, Brent, 1986. Random group effects and the precision of regression estimates. J. Econ. 32 (3), 385–397.
Narayan, D., Ebrary, Inc, 2000. Voices of the Poor: Crying Out for Change. Oxford University Press for the World Bank, New York and Oxford.
O'Donoghue, T., Rabin, M., 1999. Doing it now or later. Am. Econ. Rev. 89 (1), 103–124.
Parfit, D., 1971. Personal identity. Philos. Rev. 80 (1), 3–27.
Pollak, R.A., 1968. Consistent planning. Rev. Econ. Stud. 35 (2), 201–208.
Rae, J., 1834. Statement of some new principles on the subject of political economy: exposing the fallacies of the system of free trade, and of some other doctrines maintained in the "Wealth of Nations", Hillard, Gray.
Ray, D., 2006. Aspirations, poverty, and economic change. Underst. Poverty, 409–421.
Schreiner, M., M. Sherraden, M. Clancy, L. Johnson, J. Curley, M. Grinstein-Weiss, M. Zhan, and S. Beverly, 2001. Savings and asset accumulation in individual development accounts, St. Louis, MO: Washington University in St. Louis, Center for Social Development.
Spears, Dean, 2011. Economic decision-making in poverty depletes behavioral control. BE J. Econ. Anal. Policy 11 (1).
Strotz, R.H., 1955. Myopia and inconsistency in dynamic utility maximization. Rev. Econ. Stud. 23 (3), 165–180.
Tanaka, Tomomi, Colin, F.Camerer, Nguyen, Quang, 2010. Risk and time preferences: linking experimental and household survey data from Vietnam. Am. Econ. Rev. 100 (1), 557–571.
Thaler, R.H., Shefrin, H.M., 1981. An economic theory of self-control. J. Politi. Econ. 89 (2), 392–406.