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Poverty Traps with Constant Relative Risk Aversion: A Theoretical Analysis

Kuhu Singh

kuhusingh2@outlook.com

Abstract

This paper explores the effect of risk attitudes on the existence and severity of poverty traps, by presenting a theoretical analysis of a poverty trap model in which the preferences of the agent follow constant relative risk aversion, and discussing possible policy implications. The analysis suggests that a poverty trap exists in the presence of constant relative risk aversion preferences. The ratio of the degrees of relative risk aversion for consumption and bequests is an important factor in determining the severity of the poverty trap. For certain extreme values of the ratio, there exists a continuum of steady states which keeps all agents trapped at their initial levels of capital stock.

Keywords: Poverty traps; Risk aversion; CRRA preferences; Capital accumulation; Poverty dynamics.

Introduction:

The discourse on poverty ranges vastly, right from selecting poverty lines that define it, all the way to the most effective ways to eliminate it. Arguably one of the most crucial points of this discourse is – what causes poverty? Or more precisely, what prevents people from breaking out of the grips of poverty? In order to make effective policies that appropriately address the problem, it is essential to understand what keeps people stuck in poverty. To this end, several theories have been proposed to explain the phenomenon of poverty traps, one of which is the effect of introducing a combination of frictions and technological non-convexities to give rise to multiple steady states in a Solow-style capital accumulation model. An inherent part of any saving decision is the risk attitude of the agent, and this paper aims to examine the effect of different risk attitudes on the existence of poverty traps. In particular, we look at the implications for the existence of poverty traps when the agent's preferences follow constant relative risk aversion (CRRA).

The paper is organised as follows: the following sections present a review of the existing literature on poverty traps and risk attitudes, a brief recapitulation of the poverty trap model with production non-convexities, followed by the model with constant relative risk averse preferences, and some possible policy implications before concluding.

Literature Review

The vast and ever-increasing literature on poverty traps includes several distinct approaches of looking at this self-reinforcing mechanism. Individuals could be stuck in poverty traps owing to low nutrition (Dasgupta & Ray,1986), scarcity of cognitive abilities such as patience and self-restraint (Banerjee & Mullainathan, 2010;

Bernheim, Ray, & Yeltekin, 2015; Mani, Mullainathan, Shafir, & Zhao, 2013; Shah, Mullainathan, & Shafir, 2012), having limited access to energy (González-Eguino, 2015; Groh, 2014; Pachauri & Spreng, 2011), owing to the role played by the economic and political institutions they live under (Acemoglu & Robinson, 2012), or simply due to being stuck in low productivity locations (Jalan & Ravallion, 2002). Extensive empirical work has found evidence for several of these kinds of poverty traps (Duflo, Kremer, & Robinson, 2011; Jalan, & Ravallion, 2002; Laajaj, 2017; Luo, Zhang, Wan, & Jin, 2020; Shah, Zhao, Mullainathan, & Shafir, 2018).

However, one of the most prevalent ways of examining poverty traps continues to be via the lens of asset accumulation, usually based on the Solow Model framework (Barret & Carter, 2006; Ghatak, 2015). The key characteristic of these poverty traps is that incorporating frictions like imperfect capital markets and technological non-convexities gives rise to multiple possible equilibria, each corresponding to different levels of income and standards of living. Individuals stuck at the low-level equilibria, merely owing to the initial asset level that they started off with, are thus stuck in a poverty trap and are unable to converge to the higher equilibrium. The evidence on multiple equilibria poverty traps is arguably mixed. Several studies do not find significant evidence in the support of multiple equilibria poverty traps (Giesbert & Schindler, 2012; Jalan & Ravallion, 2004; Lokshin & Ravallion, 2001; Naschold 2012; Naschold 2013; Quisumbing & Baulch, 2013), but some of these do find that the poor recover from shocks at a slower rate than the non-poor, which may make an argument for social safety nets that cushion the impacts of shocks on the poor. Giesbert and Schindler (2012) and Naschold (2013) note that the areas studied, rather than being in a dynamic poverty trap, appear to be stagnating at very low long run equilibrium levels, in a 'structural' poverty trap. Similarly, Naschold (2012) finds no evidence of non-convexities, and instead finds that factors like caste, land sizes and education levels play a role in converging to a higher asset equilibrium. On the other hand, studies like Barret et al. (2006) do find empirical evidence of poverty traps due to multiple stable equilibria.

When studying the savings and investment decisions made by individuals in the asset-based approach, we inherently must make a claim about what we believe brings them utility, and how they weigh the utility from these sources. In a world where the only constant is uncertainty, an essential piece of this puzzle is an individual's attitude towards risk. The differences in people's risk preferences are often reflected in the choices they make in economic settings, especially those relating to consumption and investment. Neither the risks nor the choices are merely one-period phenomena. When repeated over several time periods, over a lifetime, these decisions could lead to starkly different outcomes for the agents.

Given that we are interested in consumption and investment behaviour, an appealing choice that comes to mind is assuming the constant relative risk aversion (CRRA) utility function, which is widely used in a large proportion of the macroeconomic literature studying dynamic stochastic general equilibrium (DSGE) models in which agents make intertemporal consumption and investment decisions. This has two advantages: not only does it allow us to study decisions in a setting that is generally agreed to replicate real world scenarios (Chiappori & Paiella, 2011; Szpiro, 1986; Szpiro & Outreville, 1988), but it also enables us to evaluate the popular claim that impatience and risk aversion are driving forces behind why the poor remain stuck in poverty.

In addition to impacting the consumption and saving decisions based on utility maximization, risk attitudes also impact the agents' willingness to take up new innovative production technologies, and to access the credit market, especially in occupations that are highly exposed to shocks such as agriculture. (Boucher, Carter, & Guirkinger, 2008; Dercon and Christiaensen, 2011; Khor, Ufer, Nielsen, & Zeller, 2018; Liu, 2013).

Anusandhanvallari
Vol 2024, No.1
June 2024
ISSN 2229-3388

However, risk attitudes are unlikely to be the same for all individuals in an economy, or even for the same individual across time. Dohmen et al. (2005) find that women and older people are less willing to take risks than men and younger people, respectively. While these may hold at the level of a country or a province, we may also expect that people's risk attitudes are highly likely to be affected by other factors such as wealth, social and cultural norms, political and economic situations that vary over nations and provinces. Cardenas and Carpenter (2008) compare several studies that estimate the degrees of risk aversion of individuals (Barr, 2003; Binswanger, 1980; Harrison, Humphrey, & Verschoor, 2005; Holt and Laury, 2002; Jimenez, 2003; Nielsen, 2001; Wik and Holden, 1998) and find that this expectation is in fact not borne out by the literature, and there is not enough evidence to say that people in developing nations are any more risk averse than their counterparts in developed nations.

When the environment involves risk in multiple areas, say consumption, health, investment, and so on, individuals' risk preferences for one area may be influenced by the magnitude of risks and uncertainty faced in the other areas, and by the extent to which they can be avoided. Consumers who expect they may face liquidity constraints in the future, tend to be more risk averse in the present day (Gollier, 1999). In addition to this, the prospect of unavoidable risks that cannot be insured against, may lead to agents becoming more risk averse towards other risks that may be avoided (Eeckhoudt, Gollier, & Schlesinger, 1996; Kimball, 1993; Pratt & Zeckhauser, 1987). These findings have important implications for individuals whose sources of income are subject to high uncertainty, such as daily wage workers that work in the absence of any formal contracts or social security nets and farmers whose harvests rely heavily on sufficient rainfall and conducive weather conditions. We would expect such agents to be more risk averse in other aspects of their lives, such as consumption.

Another factor that could come into play here is wealth, as posited by Binswanger (1980). Having more wealth would ideally shield the agents from suffering severe losses when their risky ventures do not pay off well, and thus we could expect wealthier individuals to be less risk averse. Although Binswanger (1980) does not find sufficient evidence in support of this, other studies (Chiappori & Paiella, 2011; Yesuf & Bluffstone, 2009) find that risk aversion decreases significantly as wealth increases.

Additionally, individuals' risk preferences may be linked to their time preferences (Anderhub, Güth, Gneezy, & Sonsino, 2001) and cognitive skills too (Benjamin, Brown, & Shapiro, 2013; Burks, Carpenter, Goette, & Rustichini, 2009; Dohmen, Falk, Huffman, & Sunde, 2010). However, the overall link between cognitive ability and risk aversion is ambiguous, with some of the literature uncovering a positive relation between higher cognitive skills and higher risk aversion, and others finding that lower cognitive skills are correlated with higher risk aversion. To quite an extent, risk attitudes also may be genetically determined (Carpenter, Garcia, & Lum, 2011). Indeed, there is a lot about risk attitudes that we are yet to be able to model appropriately, and they are inherently characterised by a large amount of unexplained heterogeneity, which may be attributed to personal tastes (Guiso & Paiella, 2008).

Basic Model

This section presents a review of the basic model in which a poverty trap arises, as given in Ghatak (2015), since it is a benchmark that the future results will be contrasted against. We consider the case of a representative individual who uses capital k to produce output q according to the production function:

$$q = A\,f(x)$$

As in the Solow model, A is the productivity parameter. We assume that the preferences of the representative individual are homothetic in income, and that the production function $f(x)$ has the standard neoclassical properties, and is of the Cobb-Douglas form. The capital k depreciates fully after use, and thus the depreciation rate $\delta = 1$. If capital markets functioned perfectly, then in this framework, all representative agents would produce at their efficient levels. Those who had a lower capital endowment than the optimal, could borrow from those who had more capital than they ideally needed. In this case, nothing would trap an individual in poverty as agents could always borrow capital to produce their efficient amount, and save up until they did not need to borrow any more.

We assume that the representative individuals live for one period, save a constant fraction s of their income, and pass that on as bequests to the next generation, b. The utility of individuals for consumption and bequests can be expressed by the following log utility function:

$$U(c, b) = \log c + \beta \log b$$

With $\beta \geq 0$. The constant saving rate s can be obtained by maximizing $U(c, b)$ subject to the individual's budget constraint $c + b \leq y$. This gives $s = \frac{\beta}{1+\beta}$. The derivation of the saving rate can be found in Appendix I.

Let the subscript t denote the value of a variable in time t. Today's bequests become tomorrow's capital, that is, $b_t = k_{t+1}$. Under this framework, all agents will eventually converge to the steady state level of capital $k^* = \frac{s\pi}{1-sr}$. Even if capital markets functioned imperfectly, or in the extreme case, were absent, all individuals would accumulate capital and reach the steady state. The presence of capital markets and the ability to borrow and lend capital would only speed up the convergence process, with no effect on the level of the steady state or on who attains the steady state.

However, if we examine the case in which capital markets are absent and the production technology is subject to nonconvexities, the picture appears to be quite different. Suppose that individuals face set up costs, so that at a level of capital below $\underline{k}$, they can only access a subsistence technology which produces an output of w, and with capital stock equal to $\underline{k}$, they can utilise a better technology which enables them to produce an output of $Af(k)$. Thus, their production function takes the form:

$$q = A\,f(k) \qquad \text{for } k \geq \underline{k}$$

$$q = w \qquad \text{otherwise.}$$

Without capital markets, the amount of output saved today will get added to tomorrow's capital stock. Depending on the production activity that the agent is involved in, the transition equations for capital will be as follows:

$$k_{t+1} = sAf(k_t) \qquad \text{for } k \geq \underline{k}$$

$$k_{t+1} = s(w + k_t) \qquad \text{otherwise.}$$

Anusandhanvallari
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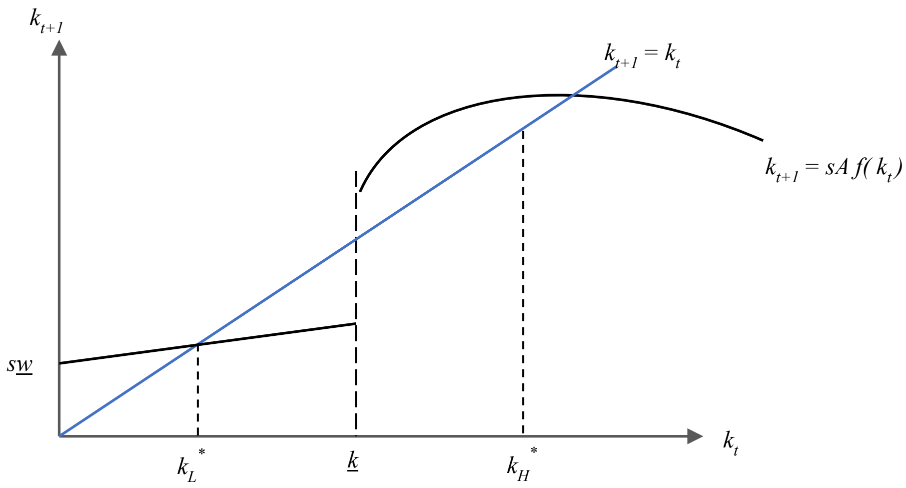

Figure 1. Poverty trap in the basic model.

There will be two possible steady states, as shown in figure 1. Along the 45° line, the agent's capital stock remains constant. If the transition equation lies above the 45° line, the agent accumulates capital, while if it lies below, the agent decumulates capital. The capital stock of the agent stays constant only at points where the transition equation intersects the 45° line.

An individual who starts off with a capital endowment lower than $\underline{k}$ can only access the subsistence technology, and thus moves along the linear transition equation $k_{t+1} = s(w + k_t)$ to reach the steady state k_L^*. On the other hand, an individual that starts off with a capital endowment above $\underline{k}$ can access the more productive technology, moving along the transition equation $k_{t+1} = sAf(k_t)$ and eventually reaching the higher steady state, k_H^*. Since individuals cannot borrow or lend capital, their initial capital endowment is a deciding factor for which steady state they end up in. People starting at a low level of capital cannot borrow capital to use the more productive technology and reach the higher steady state, and thus are stuck in a poverty trap. However, increases in s or w could enable these individuals to save up and escape the poverty trap.

Model with Constant Relative Risk Aversion

The model described in the previous section made an important assumption on the functional form of the utility function, namely it assumed log utility. In this section, we examine what the framework would look like if individuals displayed constant relative risk aversion (CRRA). A large proportion of the macroeconomic literature studying the consumption and investment decisions made by agents, especially in DSGE models, uses CRRA utility to model risk preferences as it provides a close replication of realistic situations. The CRRA utility function generally takes the following form:

$$u(w) = \begin{cases} \frac{w^{1-\gamma}}{1-\gamma} & \gamma \geq 0, \gamma \neq 1, \\ \ln(w) & \gamma = 1 \end{cases}$$

As before, we assume that the individual lives for only one time period and passes on bequests b to the next generation. However, we do not impose a constant saving rate now, to reflect the fact that agents may wish to save at different rates in different circumstances. Thus the utility function of the agent, under CRRA preferences, takes the following form:

$$u(c,b) = \frac{c^{1-\nu}-1}{1-\nu} + \frac{b^{1-\eta}-1}{1-\eta},$$

where ν and η are the degrees of relative risk aversion for consumption and bequests, respectively. The agent maximises this utility, subject to his budget constraint $c + b \leq y$. The optimisation yields a savings rate that varies with bequests: $s_t = \frac{1}{1+b^{\frac{\eta}{\nu}-1}}$. The derivation of the savings rate can be found in Appendix II.

As before, capital at time t is denoted by k_t, and bequests b_t from generation t to the next generation t+1 determine the capital endowment in period t+1, that is, $b_t = k_{t+1}$. This gives us a relation between the savings rate and the capital stock: $s_t = \frac{1}{1+k_{t+1}^{(\eta/\nu)-1}}$.

Similar to the previous model, we introduce frictions by assuming that capital markets do not exist and that individuals face set up costs. For a capital stock lower than $\underline{k}$, they can only access the subsistence technology which gives them a wage of w, and they cannot access the better technology that produces $Af(k_t)$ unless they have a capital stock higher than the threshold $\underline{k}$. Depending on the relative magnitudes of η and ν, we get three possible situations, and three different sets of transition equations for capital. We now examine them case by case below.

Case I: Equal degree of relative risk aversion

First, we consider the scenario in which the individual has an equal degree of relative risk aversion for both consumption and bequests. Thus, the individual equally dislikes large fluctuations in the two, and would ideally like to smooth both of them to an equal extent. In this case, $\eta = \nu$, and hence $(\eta/\nu) - 1 = 0$.

Substituting this in the expression for savings results in a constant savings rate, equal to $1/2$. This leads to transition equations of the following form:

$$k_{t+1} = \frac{1}{2}(w + k_t) \qquad \text{for } k_t < \underline{k}$$

$$k_{t+1} = \frac{1}{2}Af(k_t) \qquad \text{for } k_t > \underline{k}$$

Plotting these results in a similar poverty trap as found in the benchmark model. Individuals with a capital stock less than the threshold level $\underline{k}$ will accumulate along the first equation and converge to the lower steady state k_L^*, while those with capital stock above $\underline{k}$ have access to the more productive technology and can accumulate along the second equation, finally converging to the higher steady state k_H^* . Since we assumed capital markets to be absent, there is no way in which individuals below the threshold can cross the threshold and escape the poverty trap, with the same parameters, unless they are given a capital transfer large enough to push them beyond $\underline{k}$. It may be possible for the individual to escape the poverty trap if the subsistence wage w increases. Since we have taken w to be exogenous, and not dependent on the agent's productivity or effort, any change in the wage will only affect the transition equation for capital stock in the subsistence activity, without influencing the other decisions taken by the agent. If the increase in the subsistence wage is large enough, it may shift the transition equation entirely above the 45° line, thus enabling the agent to keep accumulating capital stock each period until the high production technology becomes affordable, and then reach the high steady state. This may be possible in countries with strict minimum wage laws and a strong presence of worker unions, however this is unlikely to be the case in most developing economies. It is also possible for individuals to escape the trap if their savings rate increases. A large enough increase in s would work in a way similar to the increase in subsistence wages, and shift the transition equation above the 45° line, now enabling agents to save their way out of the poverty trap.

Case II: Higher degree of relative risk aversion for bequests

Now we move to the case in which the individual has a higher degree of relative risk aversion for bequests. This individual dislikes large fluctuations in both consumption and bequests, but values a smooth time path for bequests more than a smooth time path for consumption. In this case, $\eta > \nu$, and hence $\left(\eta/\nu\right) - 1 > 0$. For an individual with capital lower than $\underline{k}$, the transition equation for capital takes the form $k_{t+1} = s_t(w + k_t)$, and for an individual with capital above $\underline{k}$, the transition equation for capital takes the form $k_{t+1} = s_t Af(k_t)$. Plugging in the expression for s_t and re-arranging the terms, we get:

$$k_{t+1} + k_{t+1}^{\eta/\nu} = w + k_t \qquad \text{for } k_t < \underline{k}$$

$$k_{t+1} + k_{t+1}^{\eta/\nu} = Af(k_t) \qquad \text{for } k_t > \underline{k}$$

With CRRA preferences, both the transition equations are now non-linear in k_{t+1}. In order to plot these, we have to make an assumption here about the ratio of the coefficients of relative risk aversion. Assuming that the coefficient of relative risk aversion for bequests is 1.5 times that for consumption (that is, $\eta = 1.5\ \nu$), we get quadratic transition equations. As seen in figure 2, there are two possible steady states that an individual could converge to, depending on the initial level of capital that he starts off with. Agents with capital stock lower than the threshold level $\underline{k}$ will eventually converge to the lower steady state, k_L^*, and those with capital stock above $\underline{k}$ converge to the higher steady state k_H^*. For a sufficiently low level of the subsistence wage, a poverty trap exists at extremely low levels of capital. It seems that when the relative risk aversion for bequests is higher, only the very poorest are stuck in poverty in this situation.

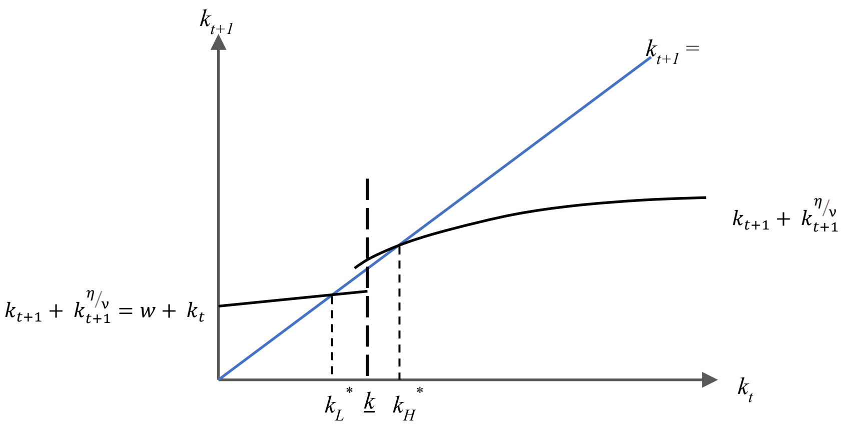

Figure 2. Poverty trap when $\eta > \nu$.

An interesting point to note is that the size of the gap between the two steady states, which in a sense indicates the 'severity' of the poverty trap, is visibly smaller than the one in the previous case. Although a poverty trap does

Anusandhanvallari
Vol 2024, No.1
June 2024
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exist, the difference in the capital levels to which the two groups converge is not that large. Furthermore, this gap in fact depends crucially on the assumption that we make about the ratio of (η/ν). As this ratio increases, that is, as the agent becomes increasingly relatively risk averse for bequests, the gap between the two steady states decreases. For some value of (η/ν), the two transition equations intersect the 45° line at the same point, and there is no poverty trap for that set of values of the parameters. For higher values, the subsistence activity leads to a higher steady state than the high productivity technology! Thus the existence of a poverty trap in this scenario hinges largely on the claims we are willing to make about the value of (η/ν), and indeed the higher ratios that lead to the absence of a poverty trap (or even the existence of a 'reverse' poverty trap), may not be very realistic. It does not seem plausible that an individual could be substantially more risk averse with respect to bequests than consumption, since consumption is a basic necessity vital for any individual's survival. For reasonable values of the ratio, higher than 1 yet not too high, we would expect to see a standard poverty trap albeit one in which both the groups are separated by a relatively small gap in the steady states and in their standards of living.

Case III: Higher degree of relative risk aversion for consumption

Finally, we examine the scenario in which the individual has a higher degree of relative risk aversion for consumption. This individual dislikes large fluctuations in both consumption and bequests, but values a smooth time path for consumption more than a smooth time path for bequests. In this case, $\eta < \nu$, and hence $(\eta/\nu) - 1 < 0$.

Once again, plugging in the expression for s_t into the transition equations and re-arranging the terms, we get:

$$k_{t+1} + k_{t+1}^{\eta/\nu} = w + k_t \qquad \text{for } k_t < \underline{k}$$

$$k_{t+1} + k_{t+1}^{\eta/\nu} = Af(k_t) \qquad \text{for } k_t > \underline{k}$$

Like the assumption made in case II, we now assume that the coefficient of relative risk aversion for consumption is 1.5 times that for bequests (that is, $\nu = 1.5\eta$). Figure 3 plots the resulting transition equations. In this case too, a poverty trap exists with agents below $\underline{k}$ converging to the lower steady state k_L^*, and agents above $\underline{k}$ converging to the higher one, k_H^*. Intuitively, we could have expected that there will be a poverty trap in this situation, even without examining the equations. Individuals that pay more emphasis on smoothing consumption than on smoothing bequests would be more likely to spend their resources on ensuring that their consumption does not fluctuate substantially, thus leaving them with less resources to pass forward as bequests. However in this case, the gap between the two steady states is substantially larger than in the two preceding cases. When smoothing consumption is a higher priority, the capital-poor are likely to be left far behind the capital-rich. Since the capital-rich face lesser constraints, they have to worry less about shocks that may affect their consumption and are able to divert more of their resources to bequests. Our assumption about the value of the (η/ν) ratio is a key element in determining the size of the gap again.

Anusandhanvallari
Vol 2024, No.1
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ISSN 2229-3388

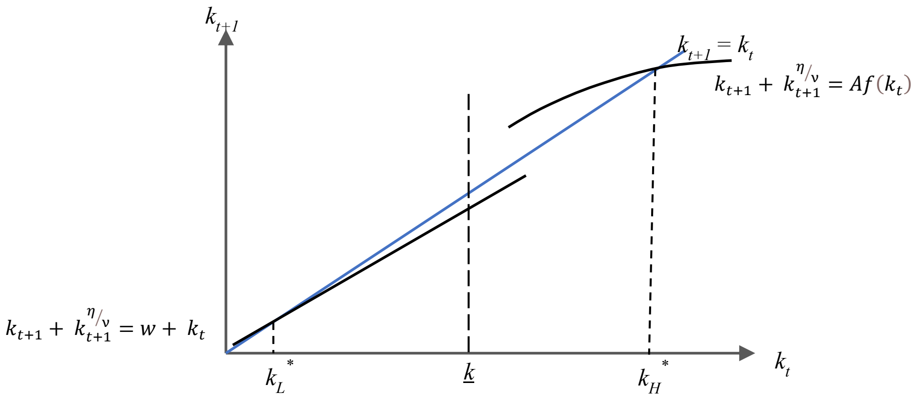

Figure 3. Poverty trap when η > ν.

Another interesting point to note is the behaviour of the transition equation for the subsistence activity as the value of (η/ν) approaches 0.

$$\lim_{\frac{\eta}{\nu} \to 0} k_{t+1} + k_{t+1}^{\eta/\nu} = k_{t+1} + 1$$

Thus, as (η/ν) approaches 0, the transition equation becomes:

$$k_{t+1} + 1 = w + k_t$$

For small values of *w*, this approximates the 45° line, and for *w* extremely close to 1, the transition equation coincides with the 45° line. This would imply the existence of a continuum of steady states when the subsistence wage is sufficiently low, as seen in figure 4. Thus people engaged in a subsistence activity at extremely low wages would not accumulate any capital at all, and would stay at the same level of capital stock. Capital transfers of the appropriate size could help lift these agents out of the poverty trap and place them on the high technology transition equation, leading them to the higher steady state. However, in the absence of such policies and interventions, people working on extremely low subsistence wages will continue to be stuck in a poverty trap at the lowest levels of capital. Since (η/ν) is close to zero, ν is much larger than η in magnitude, and these agents value consumption smoothing substantially more than smoothing bequests. When such agents are receiving extremely low wages, their resources are highly strained and the basic minimum level of consumption takes the priority in terms of resource allocation. Thus these agents devote all of their wage income to consumption, leaving nothing as bequests. This is true even for higher levels of initial capital endowment, as long as the agent continues to be employed in the low wage subsistence activity. As compared to the previous case of extremely high relative risk aversion for bequests over consumption, this case of extremely high relative risk aversion for consumption over bequests seems more realistic and possible. At very low levels of income, survival is the pressing issue, not bequests for future generations. In such dire circumstances, we could expect agents to be much more risk averse for consumption than for bequests, which could lead to this multiplicity of steady states at very low wages. This is more likely to be the case in countries that do not have stringent minimum wage laws or worker protection laws. Not only should this be addressed by capital transfers that lift people out of the poverty trap, but also by laws and policies that ensure that workers are not being exploited at dismal wages.

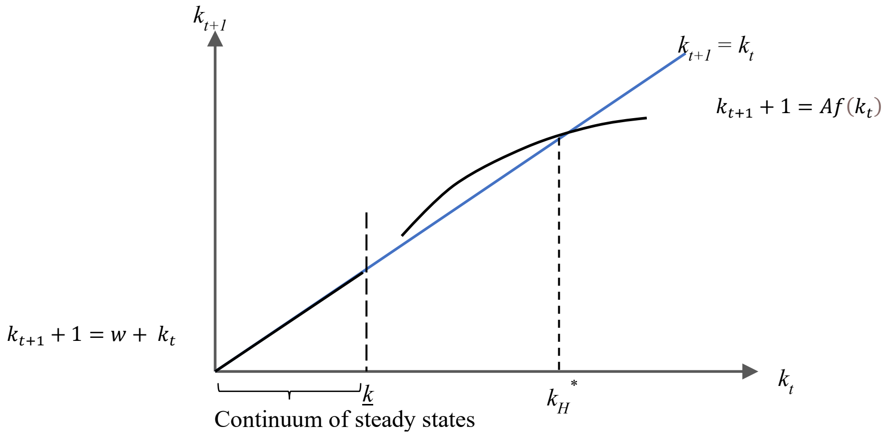

Figure 4. Poverty trap when $\eta < \nu$.

Going back to the question of whether risk aversion can keep people stuck in poverty, the above analysis demonstrates that when an agent's preferences follow the CRRA formulation, poverty traps do exist for most values of $(^{\eta}/_{\nu})$, excluding a few special cases. The analysis also showed that the disparity between the two steady states depends on the $(^{\eta}/_{\nu})$ ratio. An important implication of this is that two individuals, starting with the same initial level of capital and equal values of all parameters except $(^{\eta}/_{\nu})$, could end up at different steady states. The extent to which the agent prioritises consumption smoothing or bequest smoothing has an impact on the long run capital levels that the agent will converge to.

Another important point to note is that the adoption of technology was not modelled in any way. In a more complex model, the take-up rates of technology could be interacted with the relative risk aversion displayed by agents in such a way that more risk averse agents were less likely to adopt the technology than their less risk averse counterparts, for the same initial level of capital. This could help capture how risk aversion may keep people stuck in poverty by discouraging them from trying new technologies that involve risk. In the model analysed in this paper, the take-up of the better production technology was determined merely by the capital level of the individual. Yet, we find that relative risk aversion for bequests versus consumption plays an important role in determining what level of capital stock the agent converges to. For agents who value consumption smoothing more, the low steady state is far below that for agents who value bequest smoothing more. Thus, even without incorporating the effect of risk attitudes on the take-up of technology, it is observed that risk attitudes can keep agents stuck in poverty.

Policy Implications

Depending on what the policymakers believe about the risk attitudes of the concerned individuals, this analysis could imply several distinct policy implications, in addition to the usual capital transfers that can be used to lift people out of the traps. If the agents have a substantially larger coefficient of relative risk aversion for consumption, as seen in case II previously, the need of the hour would be to put in place policies that inspire confidence among the agents. Providing financial education, training, and information about various saving options could be a good way to encourage agents to save more as bequests. However, this must be coupled with ensuring that these agents receive a minimum wage that enables them to meet their day to day needs. Unless the agents can be reassured that they have sufficient resources for their daily expenses, any amount of information provision about savings options is going to be unlikely to convince them to save their extra resources. This form of two-pronged policy could have large benefits in rural areas and the informal sector of developing nations, since agents in those settings are most vulnerable to exploitation on low wages and also more likely be less financially educated than their urban counterparts working in the formal sector.

If the agents display time inconsistency in terms of their savings decisions, choice architecture and 'nudges' might be the way forward (Thaler & Sunstein, 2009). For agents who say they want to save more, but inevitably end up consuming the amount they intended to save, it might be an appropriate policy response to put in place "opt-out" savings schemes. Under such a scheme, the agents would by default be enrolled in savings plans and they would have the option of exiting those plans. This way, only those agents who really do not want to save will opt out, and the rest who want to save but end up not saving because of time inconsistency, would remain enrolled in the scheme and thus end up saving more. However, there is a caveat: this would usually require the agents to be in some form of formal employment, which is not the case for a large proportion of the population that we are concerned with.

It is imperative to note that while using policy to try to influence the agents' degrees of relative risk aversion may have an impact on the severity of the poverty trap they could potentially face, as long as the combination of capital market frictions and technological non-convexities exists, they will inevitably face poverty traps at lower levels of capital, no matter what their degrees of relative risk aversion are. Even in the case of equal degrees of relative risk aversion for consumption and bequests, a poverty trap did exist. Thus, while the policies mentioned above could help agents escape poverty by creating an upward shift in their transition equations, these policies do not get rid of the existence of the poverty trap, and any agent who falls to sufficiently low capital levels, perhaps due to unexpected shocks, will find himself trapped in poverty again. Thus to truly eliminate the poverty trap and ensure that no one's economic aspirations are limited solely due to the initial capital level they start off with, it is crucial to ensure that either the capital market frictions or the non-convexities are addressed. In reality, it may be difficult to address technological non-convexities using policy, since that is a feature of the production process itself. On the other hand, capital market frictions might be more feasible to tackle. There are several tools to partially alleviate the information problems that restrict the capital-poor from accessing the capital market. Arguably one of the most effective ways is implementing joint liability in microcredit, which has been proven to be massively successful in Bangladesh (Chowdhury, 2016; Ghatak & Guinnane, 1999).

A final scenario to be considered is that in which the steady states are too low. Even if the parameters of the economy are such that individuals working in the subsistence employment can save up sufficiently to be able to use the better technology, and thus there is technically no poverty trap, the 'high' steady state reached by using the better technology may itself lie below acceptable living standards. Thus the agents would be living in poverty, without being stuck in a poverty trap, per se. This presents the case of efficiency versus empathy. Given the parameters, this outcome is efficient. However, a considerably large part of the population will be living below the poverty line. In this case, the only way to elevate the level of the steady state is to induce increases in the s and A parameters, which can be achieved by investing in skill enhancement and training in order to increase individuals' productivity, and by providing accessible low-cost savings products (Goldberg, 2014).

Conclusion

In order to understand how risk preferences affect the existence of poverty traps, we modelled the agent's utility from consumption and bequests using constant relative risk aversion (CRRA). The analysis found that poverty traps exist for nearly all ratios of the degrees of relative risk aversion for bequests versus consumption, even when the risk attitudes did not affect the take-up of technology. For extremely high degrees of relative risk aversion for consumption, people working on low subsistence wages face a continuum of equilibria, and will be stuck at their initial capital levels since a considerable part of their wage income is diverted to consumption for survival. Additionally, the degrees of relative risk aversion affect the severity of the poverty traps, and individuals with different degrees of relative risk aversion but the same initial capital could end up at different steady states.

A caveat is that while choosing their optimal savings rates, agents took the income y to be exogenous. They did not take into account how their bequests today, translated into higher capital in future periods, could lead to them having a higher income in the future. In reality, agents will not ignore how capital can increase their future income, especially when they have access to the higher production technology. Additionally, we would expect more risk averse agents to be less likely to take up the technology. A more complex model that could better describe the agents' decisions would ideally include these two aspects.

In practice, when testing what risk attitudes are seen in the real world, preferences of the CRRA form are often rejected in favour of more flexible risk aversion preferences (de Brauw & Eozenou, 2014). The stability of preferences over time is increasingly coming under question, and recent studies have shown that prospect theory might give us a better representation of individuals' preferences and decisions (Sagemüller & Mußhoff, 2020). Incorporating these elements into the traditional poverty trap theory forms an exciting avenue for future research.

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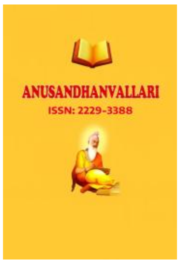

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Appendix I
Derivation of Savings Rate in Basic Model

The agent chooses consumption and bequests to solve the following optimisation problem:

$$\max u(c, b) = \log(c) + \beta\log(b)$$

Subject to $c + b \leq y$

The Lagrangian for this problem can be set up as follows:

$$\mathcal{L} = \log(c) + \beta\log(b) - \lambda(c + b - y)$$

Differentiating this with respect to c, b, and $\boldsymbol{\lambda}$ yields the following first order conditions:

$$\frac{\partial \mathcal{L}}{\partial c} = \frac{1}{c} - \lambda$$

$$\frac{\partial \mathcal{L}}{\partial b} = \frac{\beta}{b} - \lambda$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = -c - b + y$$

Together, the first order conditions imply that:

$$y = \frac{1}{\lambda} + \frac{\beta}{\lambda}$$

Rearranging this gives: $\lambda = \frac{1+\beta}{y}$

Substituting $b = {}^{\beta}/_{\lambda}$, we get: $b = \frac{\beta}{1+\beta} y$

Thus, the fraction of income that is saved as bequests is:

$$s = \frac{\beta}{1+\beta}$$

Appendix II

Derivation of Savings Rate in CRRA Model

The agent chooses consumption and bequests to solve the following optimisation problem:

$$\max u(c,b) = \frac{c^{1-\nu} - 1}{1-\nu} + \frac{b^{1-\eta} - 1}{1-\eta}$$

Subject to $c + b \leq y$

The Lagrangian for this problem can be set up as follows:

$$\mathcal{L} = \frac{c^{1-\nu} - 1}{1-\nu} + \frac{b^{1-\eta} - 1}{1-\eta} - \lambda(c + b - y)$$

Differentiating this with respect to c, b, and $\boldsymbol{\lambda}$ yields the following first order conditions:

$$\frac{\partial \mathcal{L}}{\partial c} = \frac{(1-\nu)c^{-\nu}}{1-\nu} - \lambda$$

$$\frac{\partial \mathcal{L}}{\partial b} = \frac{(1-\eta)b^{-\eta}}{1-\eta} - \lambda$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = -c - b + y$$

The first order conditions for consumption and bequests together imply that:

$$\lambda = c^{-\nu} = b^{-\eta}$$

Rearranging this gives us: $c = b^{\eta/\nu}$

Now, we re-write the budget constraint in the following form: $y = b\left(\frac{b+c}{b}\right)$

Re-arranging a bit, we get $b = \left(\frac{b}{b+c}\right)y$

Substituting in the expression for c that we previously found, and further re-arranging the terms results in:

$$b = \left[\frac{1}{1 + b^{(\eta/\nu)-1}}\right]y$$

Thus, the fraction of income that is saved as bequests is:

$$s = \left[\frac{1}{1 + b^{(\eta/\nu)-1}}\right]$$