Poverty Traps and the Social Protection Paradox*

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Abstract

Progressively targeted food aid and cash transfers to the poorest of the poor remain the dominant responses to chronic poverty in developing countries. This paper uses a dynamic stochastic programming model of households that confront a non-convex production technology and missing financial markets to demonstrate the potentially large returns to an augmented social protection policy that establishes a productive safety net below vulnerable, but not indigent, households that keeps them from slipping into a poverty trap in the wake of a shock that would otherwise rob them of key productive assets. By mitigating the *ex ante* effects of risk and crowding in additional investment by vulnerable households, the productive safety net reduces the rate of unnecessary deprivation that occurs when agents able to attain a high-level equilibrium fail to do so for want of adequate capital. But if there simultaneously exists a subpopulation that is inevitably poor, then a tradeoff arises between allocating resources to progressively-targeted versus vulnerability-targeted social protection. We use this model to illustrate the tradeoffs among subpopulations and over time that arise from the use of different social protection mechanisms in societies where multiple poverty trap mechanisms co-exist.

Keywords: Poverty traps, Targeting transfers, Dynamic modeling

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Poverty Traps and the Social Protection Paradox

Cash transfer programs, progressively targeted at the poorest, have become a predominant policy for addressing poverty in developing countries. While pioneered by middle income developing countries (notably Mexico, South Africa and Brazil), cash transfer programs have spread more broadly across the developing world, including the risk-prone pastoral regions of eastern Africa (*e.g.*, Northern Kenya and Southern Ethiopia) whose economic reality underwrites the analysis in this paper. While cash transfers may indeed break the liquidity constraints that Loury (1981) argues propagate poverty intergenerationally by limiting investments in child health and education, there is little evidence that these programs enhance the earned incomes of their recipients (the Gertler et al. (2012) study is an important exception). Indeed policymakers Latin America now confront the conundrum of former cash transfer recipients who revert to their pre-transfer living standards when their transfer eligibility ends (typically because their children are no longer of school age).[1] In northern Kenya, the Hurrell and Sabates-Wheeler (2013) impact evaluation of the Hunger Safety Net Program (HSNP) cash transfer scheme found that while transfers allowed recipient households to economically tread water even as their untreated neighbors sunk under the weight of continuing shocks, it did nothing to help recipient households to craft a pathway from poverty. Similar to Latin American countries, Kenya is now looking to augment its HSNP cash transfer program with a "poverty graduation program."[2]

This apparent failure of cash transfer programs to fundamentally alter poverty dynamics in at least the medium run has particular salience in regions characterized by (multiple equilibrium/risk driven) poverty traps.[note to types of traps?] If cash transfers do little to promote upward mobility in general, their impact on poverty dynamics may be further blunted in risky environments because they do not protect the assets of those who are not poor, but who are vulnerable to falling into poverty. This omission has two potential effects. First, the conventional cash transfers do not stem the downflow of the poor into poverty driven by shocks (Krishna (2006)). Second, by not protecting the assets of the vulnerable non-poor, cash transfers in turn do little to enhance the investment incentives of the already poor.[3] Given these two effects, then the population of future poor grows and either (a) per capita benefits have to shrink with the same pool of social protection resources, or (b) the social protection budget has to grow in order to maintain real per capita benefits (creating an aid trap).

These observations raise the question as to whether an alternative targeting of a given social protection budget might be more effective in reducing the extent and depth of poverty in the medium term compared to the purely progressive targeting standard cash transfer programs. Using a dynamic stochastic programming model meant to capture key features of a risky rural landscape like that of Northern Kenya and Southern Ethiopia, this paper explores the poverty reduction potential of a hybrid social protection system that combines means-tested cash transfers with state of the world-contingent social protection transfers targeted at the vulnerable, non-poor. Absent social protection, the model a high and a low (poor) equilibrium with agents gravitating in probability to one or the other based on their initial position in the two-dimensional spaced defined by intrinsic ability and productive assets.

Our findings include what we call the paradox of social protection. Assuming initially that transfers

[1] Worse yet is the concern of second generation beneficaries who obviously were helped little by program meant to enhance their human capital.

[2] The current generation of graduation programs take their inspiration from BRAC's ultra-poor program that recognizes that more than liquidity increments to reduce poverty. Such programs involve a mix of cash transfers, financial education, confidence building and coaching, and culminate with a discrete asset transfer. Bannerjee et al. (2015) summarize evaluations of graduation programs that span both middle and low income countries. These programs prove to be quite expensive.

[3] Indeed, if anything, it might be expected that means-tested cash transfers would discourage accumulation as successful accumulation could lead to loss of benefits.

are unanticipated (*i.e.*, that households do not alter their accumulation strategies in anticipation of social protection benefits), we show that for a given government budget, targeting the vulnerable with state of the world contingent transfers in preference to conventional cash transfers to the already poor results in a lower levels of poverty in the medium term (although higher rates in the short term). Conventional cash transfer programs thus implicitly make an intertemporal tradeoff between the well-being of the poor today versus the well-being of the poor in the future.

We then explore the impacts of hybrid social protection when contingent transfers are anticipated. We show first that anticipation crowds in additional accumulation by the poor, who are incentivized by the fact that contingent transfers protect assets when they join the ranks of vulnerable non-poor. This *ex ante* accumulation effect might be termed positive moral hazard as it is induced risk taking that lessens the overall rate of poverty. At the same time, when contingent transfers are sharply targeted at the vulnerable, a new equilibrium appears in the system at which a subset of agents stay in the ranks of the vulnerable non-poor. This new equilibrium reflects what might be termed as negative moral hazard (as those at this equilibrium make choices that increase the probability of insurance-like contingent social protection payments).

Finally, we draw on companion work (Janzen et al. (2016)) to show that replacing the purely publicly provisioned contingent transfers with an explicit insurance mechanism (whose cost is split between the public sector and the individual) eliminates the negative moral hazard while preserving the positive moral hazard and other benefits of contingent transfers.

The semi-arid pastoral region of Northern Kenya, which helps motivate this work, is an area of widespread, extreme chronic poverty in the pastoral regions of northern Kenya has long motivated food aid, and more recently cash transfers targeted towards the poorest of the poor. While humanitarian assistance is obviously necessary, the apparent lack of progress in reducing predictable case loads has motivated development agencies to consider alternative policy designs that might help break cycles of chronic poverty. In 2009, The Kenyan government, with financial support from the United Kingdom's Department for International Development (DfID), created a social protection scheme, the Hunger Safety Nets Program (HSNP), built around regular cash transfers targeted at the chronically poor and indigent in the country's poorest northern districts. By regularizing progressively-targeted cash assistance, HSNP had hoped to put households on a pathway from poverty by enabling asset accumulation and sustained investment in child health and education so as to avert future chronic poverty arising due to economic disability (DfID, 2007).

As already mentioned, the evidence to date indicates that HSNP has had little impact on poverty. This finding is perhaps not surprising given that multiple studies, using different data sets, have found evidence of bifurcated asset dynamics in the pastoral regions of East Africa, with households above a critical level tending to a high equilibrium and those below it tending to a low level (Barrett et al. (2006); Lybbert et al. (2004); McPeak and Barrett (2001); Santos and Barrett (2011, 2016)). Such a tipping point may have important implications for the impact of progressively-targeted policies on aggregate poverty rates. If the underlying stochastic process continues to drive vulnerable but non-indigent households below the critical herd size threshold, then the ranks of the transfer-eligible indigent will swell over time unless the HSNP-style cash transfers are sufficient to alter accumulation strategies and lift some of the poor above the poverty line. This observation suggests that targeting some assistance on vulnerability criteria, in an effort to brake the poverty dynamics that generate indigence, could dominate purely progressive targeting for some classes of welfare measures.

To explore this intuition, we specify a parsimonious dynamic stochastic programming model of individual asset accumulation in the presence of innate ability differences, heterogeneous initial asset endowments,

risk and missing financial markets.[4] The model admits two quite different sorts of poverty traps: one in which individuals with low innate ability face a unique, low-level dynamic equilibrium and another in which higher ability individuals face multiple equilibria based on their capital holdings due to borrowing constraints and non-convexities in production (*i.e.*, fixed costs of investment and innovation). Specifically, the model generates a "Micawber Frontier" which divides the innate ability-asset space into multiple regions of distinct, dynamically optimal behavior.[5] Individuals located above the Micawber Frontier find it feasible to accumulate assets, adopt the improved production technology and eventually climb out of poverty. Those below the frontier do not. Because the frontier is infinite for individuals below a minimum ability level,[6] there is a region of what might be termed intrinsic chronic poverty. Intermediate ability individuals in the model are potentially upwardly mobile, and will or will not be poor over the long-run depending on their initial endowments and their luck. Their poverty might be termed unnecessary deprivation in the sense that these individuals have the capacity to be non-poor given the structure of the economy and are only poor due to misfortune. **something on conundrum here when have this coexistence of multiple types of chronic poverty**

The remainder of the paper proceeds as follows. Section 1 presents the stochastic dynamic programming model of individual asset accumulation. Section 2 then uses this framework to analyze a stylized model of a village economy comprised of 300 households distributed randomly over the ability-initial asset space that defines the intertemporal choice model. As a baseline for later analysis of alternative policy regimes, we simulate the stylized economy over a sixty year time horizon, tracking the evolution of growth, poverty and a new unnecessary deprivation measure.

Section 3 then explores the impact of alternative social protection schemes, one that targets relief in a purely progressive fashion, and another in which the available budget is targeted according to a triage protocol that prioritizes transfers households that are vulnerable to slipping into chronic poverty over transfers to already poor households. It is here where the paradox of social protection emerges: by preventing collapse into poverty by agents vulnerable to asset risk, the regressive triage scheme ultimately reduces poverty and leads to greater transfers to and higher welfare for poor households in later years.

Section 4 then relaxes the strong, artificial assumption of unanticipated social protection to explore what happens when agents fully anticipate contingent transfers provided to the vulnerable under the triage scheme. We show that anticipation of these transfers has both positive and negative effects, and that implementing the contingent transfers as a partially subsidized insurance contract (with co-pays required of beneficiaries) eliminates the negative while preserving the positive effects of contingent protection. Section 5 concludes the paper.

[4] Model in part inspired by the non-stochastic model of Buera (2009a).

[5] Zimmerman and Carter (2003) pinched the term Micawber from Lipton (1993) who uses the term somewhat differently to evoke a level of poverty below which virtuous Victorian savings strategies cannot be implemented. Lipton labeled this level 'Micawber' in honor of the Charles Dickens character Wilkens Micawber, who told David Copperfield: 'Annual income twenty pounds, annual expenditure nineteen nineteen and six, result happiness. Annual income twenty pounds, annual expenditure twenty pounds nought and six, result misery'.

[6] We take ability as exogenous here, explicitly abstracting from human capital that might be accumulated by adults, for example through educational or health care investments. Carter and Janzen (2015) develop an intergenerational model that endogenize ability, specifying it as a function realized early life nutrition.

1 Assets, Ability, Risk and the Multiple Dimensions of Chronic Poverty

Azariadis and Stachurski (2005) define a poverty trap as a "self-reinforcing mechanism which causes poverty to persist." A robust theoretical literature has identified a variety of such mechanisms that may operate at either the macro level–meaning that an entire country or region is trapped in poverty–or at the micro level–meaning that a subset of individuals become trapped in chronic poverty even as others escape (Barrett and Carter, 2013, Kraay and McKenzie, 2014, and Ghatak, 2015 provide recent review papers). In this paper, we explore the implications of a micro poverty trap mechanism for the design of social protection programs, employing a variant of what Barrett and Carter (2013) call the "multiple financial market failure" poverty trap model, which can generate multiple equilibria in the sense that a given individual may end up at the high or the low equilibrium depending on initial conditions and stochastic realizations. As mentioned in the introduction above, there is empirical support for this model in the particular case of pastoral regions of Eastern Africa.[7]

In what follows we build on Buera (2009b) non-stochastic model of asset accumulation with two production technologies under credit constraints and heterogeneous agent ability.[8] We extend Buera's model by adding asset shocks to allow for the importance of both *ex ante* awareness of risk and the *ex post* experience of shocks as key determinants of poverty dynamics (Elbers and Gunning (2005)). We show that multiple poverty trap mechanisms emerge in this setting. Low ability households are innately poor, as they never find the high-return technology attractive and thus they endure low incomes indefinitely. Meanwhile, intermediate ability households dramatically change asset accumulation and production choices in response to ex ante asset risk and ex post realization of asset shocks. This cohort faces multiple equilibrium poverty traps of the sort on which the literature has long focused. Finally, there is a high ability group that may start poor but will inevitably take up the high-return technology and graduate out of poverty and remain non-poor (in expectation) indefinitely. We intentionally develop and employ the most parsimonious model that can capture tremendous heterogeneity in welfare dynamics in order to illustrate the inherent tension between policies aimed at addressing different mechanisms underlying poverty traps.

1.1 A Model of Asset Dynamics and Heterogeneous Ability

Consider an economy in which each individual j is endowed with a level of innate ability (α_j) as well as an initial stock of capital (k_{j0}). Preferences are unrelated to the individual's innate ability. In what follows, we treat α_j as fixed. We conceptualize the agents in this economy as adults and α_j as capturing the effectively immutable physical stature, cognitive development and educational attainment with which they enter adulthood and thus the economy. This obviously ignores the origins of such innate ability. [9]

Exploring the multigenerational extension to the present model, by endogenizing α_j, seems a promising topic for future research, not least of which because it would directly address the economic growth and poverty reduction effects of early childhood nutrition, health and education interventions. In this paper,

[7]Note, these findings do not generalize globally. Broad-based empirical evidence of poverty traps has been mixed (Subramanian and Deaton, 1996; Kraay and McKenzie, 2014), although Kraay and McKenzie (2014) conclude that the evidence for the existence of structural poverty traps is strongest in rural remote regions like the arid and semi-arid lands of East Africa.

[8]Related previous papers include Becker and Tomes (1979), Loury (1981), Banerjee and Newman (1991, 1993), Galor and Zeira (1993), Ray and Streufert (1993), Aghion and Bolton (1997), Piketty (1997), Carter and Zimmerman (2000), Ghatak, Morelli and Sjostrom (2001) and Ghatak and Jiang (2002).

[9]***more here on Carter-Janzen paper with endog HK**

however, we set those questions aside in order to concentrate on exploring social protection policy design in the presence of poverty traps.

Each period the individual has to choose between two alternative technologies for generating income. Both technologies are capital using and skill-sensitive (*i.e.*, for both technologies, more able people can produce more than less able people). One technology (the "high "technology) is subject to a fixed cost, E, such that the technology is not worth using at low amounts of capital. Specifically, we assume that income, f, for individual j in period t is given by

$$f(\alpha_j, k_{jt}) = \alpha_j \max[f_H(k_{jt}), f_L(k_{jt})]$$

where $f_L(\alpha_j, k_{jt}) = \alpha k_{jt}^{\gamma_L}$, $f_H(\alpha_j, k_{jt}) = \alpha k_{jt}^{\gamma_H} - E$, $E > 0$ and $0 < \gamma_L < \gamma_H < 1$. We denote as $\hat{k}(\alpha)$ as the value of capital where it becomes worthwhile to switch to the more productive technology (i.e., $\widehat{k}(\alpha_j) = \{k | f_L(\alpha_j, k) = f_H(\alpha_j, k)\}$).[10]

If an individual had access to only one technology, she or he would accumulate capital up to a unique steady state values $k_L^*(\alpha_j)$ for the low technology or $k_H^*(\alpha_j)$ for the high technology. The key question is then what happens when the individual has access to both technologies. In particular, will an individual whose initial capital stock is below $\widehat{k}(\alpha_j)$ gravitate toward the high or the low technology and, relatedly, toward the higher or lower income level associated with the different technologies? Consider the case of an individual who begins life with $k_L^*(\alpha_j) < k_{j0} < \widehat{k}(\alpha_j)$. Note that because this individual is beyond the low level steady state, incremental returns to further investment are low and discourage further investment. Will this individual optimally accumulate assets over time, and ending up at $k_H^*(\alpha_j)$ and a non-poor standard of living? Alternatively, will the individual settle into a poor standard of living with capital stock $k_L^*(\alpha_j)$? More formally, is there an initial asset threshold, which we will denote $\widetilde{k}(\alpha_j)$, below which individuals stay at the low equilibrium (remaining chronically poor), and above which she or he will move to the high equilibrium (eventually becoming non-poor)?

We analyze this question with a dynamic model of consumption and investment choice. We rule out borrowing and hence consumption every period can be no more than available wealth, or what Deaton (1991) calls cash on hand:

$$c_{jt} \leq k_{jt} + f(\alpha_j, k_{jt}),$$

The household's stock of accumulated capital evolves over time according to the following rule:

$$k_{jt+1} = (k_{jt} + f(\alpha_j, k_{jt}) - c_t)(\theta_{t+1} - \delta).$$

where δ is the natural asset depreciation rate and $\theta_t \in [0, 1]$ is a random asset shock realized at the beginning of every period t. Note that $\theta = 1$ indicates that there is no shock, whereas $\theta < 1$ indicates an unfavorable shock that destroys some fraction of assets. While in principal $\theta > 1$ might be allowed, such events seem unlikely and we will restrict the analysis to the case where only negative shocks are possible. The cumulative density function of θ_t is denoted by $\Omega(\cdot)$ and we assume that every household knows $\Omega(\cdot)$.

Assembling these pieces, we can write the decision-maker's intertemporal choice problem as:

[10] By construction, this formulation favors adoption of the high technology by assuming away information problems and all other obstacles to adoption other than financing. These simplifications merely eliminate inessential factors that reinforce this effect.

$$\max_{c_{jt}} \quad E_\theta \sum_{t=0}^{\infty} \beta^t u(c_{jt})$$

subject to:

$$\begin{aligned} & c_{jt} \leq k_{jt} + f(k_{jt}) \\ & f(\alpha_j, k_{jt}) = \alpha_j \max[f_H(k_{jt}), f_L(k_{jt})] \\ & k_{jt+1} = (k_{jt} + f(k_{jt}) - c_{jt})(\theta_{jt+1} - \delta) \\ & k_{jt} \geq 0 \end{aligned} \tag{1}$$

where E_θ is expectation taken over the distribution of the random shock θ, β is the time discount factor, and $u(\cdot)$ is the utility function defined over consumption c_t and has the usual properties. Denote the investment rule in the presence of asset shocks as $i^*(k_t|\alpha, \Omega)$.[11]

1.2 The Micawber Frontier and the Two Dimensions of Chronic Poverty

As in Buera (2009b), this model identifies a critical asset level, denoted $\widetilde{k}(\alpha)$, around which dynamic behavior bifurcates. An individual with ability level α_j will attempt to accumulate the assets needed to reach the high technology equilibrium if she enjoys capital stock $k_{j\tau} > \widetilde{k}(\alpha_j)$. Otherwise, she will only pursue the low technology, accumulating the modest stock of capital that it requires. Note that this frontier, a generalization of what Carter and Barrett (2006) call the Micawber Threshold, divides those who have the wealth needed to accumulate from those who do not. We label $\widetilde{k}(\alpha)$ the Micawber Frontier.

The two graphs in Figure 1, created through numerical analysis of the dynamic programming model 1, present the Micawber Frontier under the parameterization reported in Appendix 1.[12] Along the horizontal axes are innate ability or skill levels, ranging from least to most able. The vertical axes measures the stock of productive assets. Figure 1a graphs the probability that a household occupying each initial endowment position will end up chronically poor, *i.e.*, at the low level equilibrium. Notice that households on west/southwest side of the figure approach the low level equilibrium with probability one, indicating that for these endowment positions it is not worthwhile to even attempt the accumulation of the assets required to reach the high equilibrium. As shown in Figure 1b, we define the Micawber frontier as the locus of skill and assets where the household behaving optimally according to Model 1 where the probability of escaping chronic becomes strictly positive. The solid (green) curve in the figure graphs this locus. Comparing across the two graphs in Figure 1, we can see that for endowment positions far enough east and north of the Frontier, the probability of escaping chronic poverty is essentially one. For middle ability households in the multi-colored band just north and east of the Micawber Frontier, the probabilities of escape are modest.

To ease discussion and link it to more conventional poverty analysis, Figure 1 also includes an "asset poverty line," the dashed downward sloping line, denoted $k_p(\alpha)$. For each ability level, this asset poverty line

[11] More precisely, $i^*(k_t|\alpha, \Omega)$ is the policy function of the following Bellman equation:

$$V(k_t) \equiv \max_{i_t} \{u(f(\alpha, k_t) - i_t) + \beta E[V(k_{t+1}|k_t, i_t)]\}$$

$$\text{where } E[V(k_{t+1}|k_t, i_t)] = \int V(\theta_t[i_t + (1-\delta)k_t]) d\Omega(\theta_t)$$

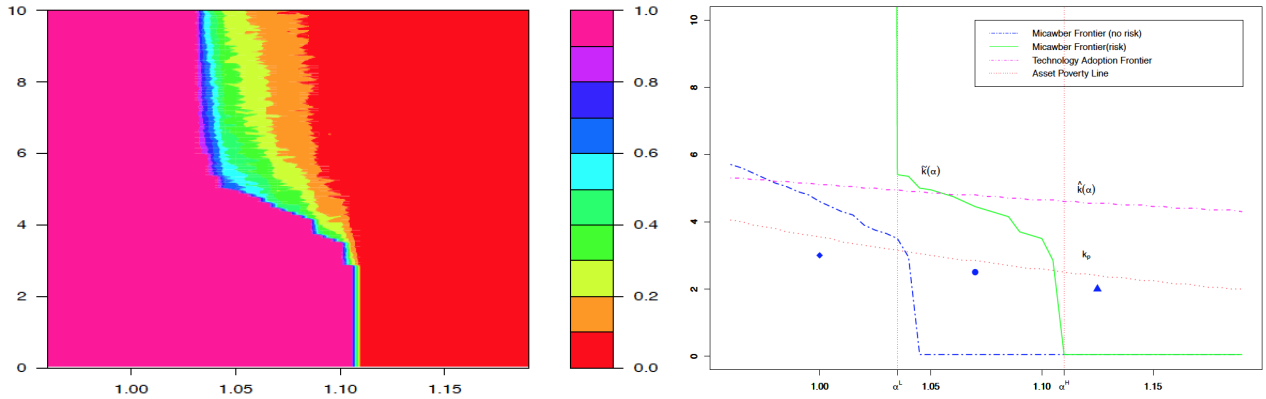
where $\Omega(\cdot)$ is cumulative density function of θ_t.

[12] Buera provides a formal proof for his non-stochastic model. Appendix 1 details the parameterization used to implement the numerical analysis of the stochastic model discussed in the remainder of the paper.

Figure 1: The Micawber Frontier and Chronic Poverty

(a) Probability of Chronic Poverty

(b) Risk and the Micawber Frontier



indicates the stock of assets the individual must have in order to produce a living standard exactly equal to a money metric poverty line, y_p. We define y_p as the level of income that a reference middle ability person ($\alpha_m = 1.12$ **check this number**) would produce were she in steady state equilibrium at the *low* technology ($y_p = f(\alpha_m, k_L^*(\alpha_m))$). This assumption is of course arbitrary,[13] but it has the advantage of rendering most individuals poor unless they craft a pathway to the high technology. This is desirable in our stylized model as it creates a strong linkage between improved technology adoption, income and poverty measures.

Note that the Micawber Frontier has a behavioral foundation and thus differs from from the asset poverty line, which is based on a standard (and therefore somewhat arbitrary) income poverty line.[14] Those agents whose initial ability-asset endowments place them above the Micawber Frontier but beneath the asset poverty line will be initially poor. With the positive probability illustrated in Figure 1a, these individuals will prove to only transitorily poor as they attempt to accumulate their way out of poverty.

By contrast, those whose initial endowments situates them beneath the Micawber Frontier but above the asset poverty line will not be poor initially, but will steadily eat into their asset holdings and will eventually become poor. These movements represent structural transitions across the poverty line. There can also be stochastic movements around the asset poverty line among the subpopulation that finds itself above the Micawber Frontier. For those individuals, small asset shocks may temporarily leave them beneath the asset poverty line without driving them off their growth path toward the high equilibrium. Of course, individuals could find themselves above (below) both the Micawber Frontier and the asset poverty line, in which case they would be always non-poor (poor). This simple depiction of the Micawber Frontier and the asset poverty line thereby captures the full range of conventional static and dynamic poverty measures.[15]

As illustrated in Figure 1b, the numerical analysis identifies three distinct regions in the space of ability and initial asset holdings. Irrespective of their capital endowment, high skill individuals with $\alpha_j > \alpha^H$ will always move toward the high equilibrium as $\widetilde{k}(\alpha_j) = 0 \,\forall\, \alpha_j > \alpha^H$. When they reach the technology shift asset threshold $\widehat{k}(\alpha_j)$ they will optimally switch to the higher technology. Irrespective of their starting position,

[13] Standard poverty lines are of course inherently arbitrary. In contrast, the Micawber Frontier has a behavioral foundation, as well as strong behavioral implications, as Hoddinott (2006) discusses, and can be thought of as a dynamic asset poverty line (Carter and Barrett 2006, Carter and Ikegami 2007).

[14] As discussed by Carter and Ikegami (forthcoming), this characteristic of the Micawber Frontier makes it an interesting candidate as the base for chronic poverty measures.

[15] See Carter and Barrett (2006) for a discussion of distinct generations of poverty analysis that encompass these different ideas.

these upwardly mobile agents steadily converge to the steady state asset value for the high technology. They may be poor over some extended period as they move toward their steady state value, but eventually they should become non-poor by virtue of the optimal accumulation behavior induced by their high ability endowment. Such individuals do not face a poverty trap.

In contrast, those with an innate ability level below the critical level α^L will never move toward the high technology irrespective of their initial asset endowment. This critical skill level defines a region of intrinsic chronic poverty, made up of individuals who lack the ability to achieve a non-poor standard of living in their existing economic context.[16] These individuals face a unique, low-level equilibrium, a very different sort of poverty trap than is confronted by the third and final set of agents.

Those in the intermediate skill group with $\alpha^L < \alpha_j < \alpha^H$ have positive but finite values $\widetilde{k}(\alpha_j)$. If sufficiently well-endowed with assets ($k_{j0} > \widetilde{k}(\alpha)$), these intermediate ability individuals will attempt to accumulate additional assets over time, and will with some strictly positive probability adopt the high technology and eventually reach a non-poor standard of living. However, if these same intermediate skill individuals begin with assets below $\widetilde{k}(\alpha)$, they will no longer find the high equilibrium attainable and will settle into a low standard of living. Like those in the region of intrinsic chronic poverty, intermediate ability individuals initially endowed with less than $\widetilde{k}(\alpha)$ will be chronically poor. Unlike the intrinsically chronically poor, the chronic poverty of the intermediate skilled individuals is needless or unnecessary deprivation in the sense that they could be helped to lift themselves out of poverty with appropriate social protection policies, as we discuss below. The total number of chronically poor in any society will thus depend on the distribution of households across the ability-wealth space.

Finally note that while some authors (e.g., Barrett and Carter (2013) and Kray and McKenize (2014)) often distinguish between single equilibrium poverty trap models, multiple equilibrium poverty trap models and models without poverty traps, our model here admits the coexistence of all three possibilities in a single structure.

1.3 The *Ex-post* and *Ex-ante* Effects of Asset Shocks

The Micawber Frontier is a function of the economic environment in which individuals find themselves. In particular, the distribution of the stochastic term θ fundamentally shapes investment behavior. We now explore the impact of *ex ante* risk and *ex post* shocks on investment and the long-term evolution of poverty.

The *ex post* effect of realized shocks comes about simply because negative events may destroy assets, knocking people off their expected path of accumulation. For upwardly mobile individuals, such shocks may delay their arrival at the upper level equilibrium, or knock them down from it, necessitating a period of additional savings and asset reaccumulation. But it does not set them on a different accumulation path. Similarly, realized shocks have no long-term effect on the equilibrium toward which the low ability, intrinsically chronically poor gravitate.

In contrast, the *ex post* consequences of shocks can be rather more severe for households of intermediate ability. Consider the case of a household that is initially slightly above the Micawber Frontier. A shock that knocks it below that frontier will banish the household into the ranks of the chronically poor as in the wake of the shock, the household will alter its strategy and move toward the low equilibrium (divesting itself of assets).

While these *ex post* effects of shocks are important, the anticipation that they might take place would be expected to generate a "sense of insecurity, of potential harm people must feel wary of—something bad can

[16] CPRC (2004) gives examples of individuals who suffer such fundamental disabilities.

happen and 'spell ruin,'" as Calvo and Dercon (2005 p.5) put it. Numerical analysis of the model shows that this sense of impending ruin indeed discourages forward-looking households from making the sacrifices necessary to reach the high equilibrium. The Micawber Frontier shifts to the southwest once asset risk is removed, as shown in Figure 1b. The dashed curve is the Micawber Frontier in the absence of risk. The boundaries marking the critical skill levels at which households move between the different accumulation regimes also shift out, meaning more intrinsically upwardly mobile households and fewer intrinsically chronically poor households when we eliminate the *ex ante* effects of risk.

The most dramatic effects of risk are seen by considering a household whose skill and capital endowments place it between the two frontiers. Consider a household whose skill and initial asset endowments are represented by the solid circle in the middle of Figure 1. Absent the risk of asset shocks, such a household would strive for the upper equilibrium and eventually escape poverty. In the presence of risk, such a household would abandon this accumulation strategy as futile and settle into a low level, chronically poor standard of living. In the face of asset risk, the extraordinary sacrifice of consumption required to try to reach the high equilibrium is no longer worthwhile, and the household will optimally pursue the low level, poverty trap equilibrium. By contrast, the shift has no significant behavioral effect on either intrinsically chronically poor households (represented by the solid diamond on the left side of Figure 1) or intrinsically upwardly mobile households (the solid triangle on the right side of Figure 1).

To explore the differential effects of risk and shocks on these different sub-populations, Carter and Ikegami (2009) used the dynamic choice model above and simulated the income streams it generates in three distinct settings:

- A non-stochastic economy in which agents repeatedly apply the optimal investment rule, $i_n^*(k_t|\alpha_j)$[17],
- An economy characterized by risk without realized shocks in which agents follow the risk-adjusted optimal accumulation rule, $i^*(k_t|\alpha_j, \Omega)$, but never actually experience shocks (a scenario that allows us to isolate the ex ante effects of risk); and,
- A fully stochastic economy, meaning that individuals not only follow the risk-adjusted optimal investment rule but each period they are subject to a random asset shock generated in accordance with the probability structure Ω.

These simulations show that for the intrinsically chronically poor (low α_j) and the upwardly mobile (high α_j) groups, the effects of risk are relatively modest and attributable almost entirely to the disruptive, *ex post* effects of asset shocks. By contrast, for the intermediate ability group, the *ex ante* behavioral (*i.e.*, investment disincentive) effects of uninsured risk account for most of the welfare effects due to asset stochasticity. These effects are also large in magnitude. While the discounted income streams for the other two groups fall only 5-10 percent in the fully stochastic scenario, the drop is approximately 25 percent for the intermediate ability group, with roughly 90 percent of the losses due to the *ex ante* risk effect exclusively.[18] The difference arises because while risk slightly reduces the desired steady state capital stock for low and high ability agents, mainly it forces them to regularly rebuild assets in order to reattain the desired steady state capital stock. In

[17]The subscript n denotes this non-stochastic world and $i_n^*(k_t|\alpha)$ is policy function of the following Bellman equation:

$$\begin{aligned} V_{nr}(k_t) &\equiv \max_{i_t} \{u(f(\alpha, k_t) - i_t) + \beta V_{nr}(k_{t+1}|k_t, i_t)\} \\ &= \max_{i_t} \{u(f(\alpha, k_t) - i_t) + \beta V_{nr}(i_t + (1-\delta)k_t)\} \end{aligned}$$

[18]Details on these simulation results are available from the authors by request.

sharp contrast, intermediate ability agents may fundamentally shift their investment strategy in the presence of risk, eschewing any attempt at trying to reach the high-level equilibrium open to them, creating added avoidable chronic poverty.

Among other things, these simulations show that in the presence of critical asset thresholds, risk takes on particular importance for those individuals subject to multiple equilibria. Social protection policies could in principal generate large returns for such individuals, as the next two sections describe. Furthermore, this response to risk adds an important twist to the moral hazard that naturally results from any policy that attempts to reduce risk exposure, as we discuss in section 4 below.

2 Accumulation and Poverty Dynamics Absent Social Protection

The analysis in the prior section showed that both the anticipation and experience of economic shocks have a fundamental effect on behavior and welfare in the presence of poverty traps, expanding the portion of the endowment space from which people do not escape poverty through their own efforts. This observation suggests that social protection policies have a fundamental role to play in stimulating poverty reduction and economic growth. But how should social protection be designed in a world with multiple sources of poverty traps? As a first step towards answering this question, this section uses the model of individual decisionmaking developed above as the basis for analyzing accumulation, growth and poverty in a stylized economy lacking any social protection policies. Sections 3 and 4 will then take a careful look at the impact of alternative social protection schemes on this economy.

2.1 The Stylized Economy and Measures of Performance

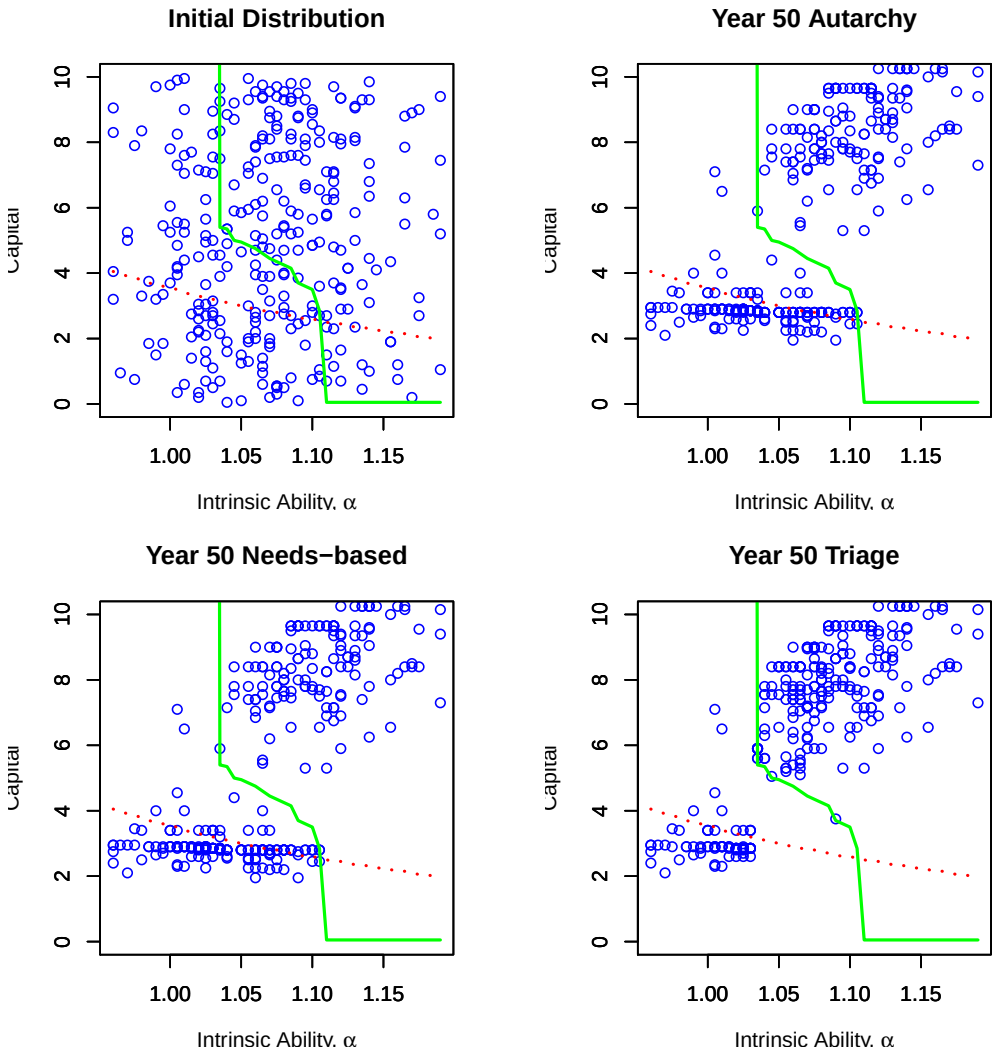
Consider now an economy comprised of agents whose livelihood choices are described by inter-temporal maximization problem 1. To keep things simple, we will assume that all shocks are idiosyncratic and that prices in the economy are unaffected by shocks and by individuals' decisions. While these assumptions are clearly at odds with the real world, they permit us in the first instance to clarify basic principles and tradeoffs in the design of social protection policies.[19]

For purposes of the numerical analysis, we assume that there are 300 agents, each described by a skill and initial capital stock pair. We allocated agents along the skill continuum, with 25% each in the intrinsically chronically poor and upwardly mobile ranges, and half the agents in the intermediate ability range where endowments matter to their accumulation and welfare trajectories. Each agent was then assigned a random initial capital stock drawn from a uniform distribution over the zero to ten range. While in any existing economy we would expect there to be a correlation between skill and observed capital stock, this random assignment of capital creates an experimental environment in which to study asset dynamics under alternative social protection schemes.

The diagram in the northwest corner of Figure 2 shows the initial distribution of ability and wealth in this stylized economy. Each symbol on the graph represents the initial position of an individual agent or household dynasty. The (green) solid line is the Micawber Threshold under the stochastic environment, while the dashed (red) line is again the asset poverty line. The other graphs in the figure–to be discussed below–show the evolution of endowment positions under under alternative social protection policies.

[19] When shocks are correlated across households, asset and other prices will begin to covary with household income. The implications of this covariance can be important as Carter, Little, Mogues and Negatu (2007) discuss empirically in the case of Ethiopia. Zimmerman and Carter (2003) theoretically examine the implications of such asset price covariance, showing that it

Figure 2: Asset Evolution with and without Social Protection



While we can simply focus on the trajectories of agents given their initial endowment positions, we also employ a set of summary measures to track the performance of the stylized economy under alternative social protection regimes:[20]

1. GNI defined simply as the sum of the incomes of the 300 agents. Note that this measure will evolve over time based on capital accumulation (or deaccumulation) as well as the shift of households between the low and high productivity regimes.

2. Standard static poverty measures based on the Foster-Greer-Thorbecke (FGT) family of measures:

$$P_{\gamma}^{y} = \frac{1}{n} \sum_{y_j < y_p} \left(\frac{y_p - y_j}{y_p} \right)^{\gamma} \tag{2}$$

   where n is total number of individuals, y_p is income poverty line, y_i is individual j's income, and γ is the usual FGT sensitivity parameter. We will specifically focus on the popular headcount (P_0^y) and poverty gap (P_1^y) measures. As discussed above, we set the poverty line y_p at the level of income that a medium skilled individual would produce in steady state if she had access only to the low technology.

3. A new, conceptual measure of unnecessary deprivation, D_{γ}^{y}. This measure resembles the FGT poverty gap measure, in that it continues to focus just on those with current income beneath the income poverty line, y_p, but with the important refinement that rather than comparing individuals' realized income against y_p, current income is compared instead against the income level associated with the household's optimal capital stock given its innate skill endowment, $\overline{k}^*(\alpha_j) = \max\{k_H^*(\alpha_i), k_L^*(\alpha_j)\}$, if its initial wealth endowment did not constrain equilibrium selection, as it does for some households of intermediate ability. As with the FGT measure, γ is a sensitivity parameter, with γ=0 offering a headcount of those who suffer unnecessary deprivation, γ=1 measuring the money metric gap between potential and current well-being, and $\gamma > 1$ placing greater weight on larger underperformance relative to potential. In our subsequent calculations, we report only the γ=1 variant. Thus, we define D_{γ}^{y} as

$$D_{\gamma}^{y} = \frac{1}{n} \sum_{\substack{y_j < y_p \\ y_j < f(\alpha_j, \overline{k}^*(\alpha_j))}} \left(\frac{f(\alpha_i, \overline{k}^*(\alpha_j)) - y_j}{f(\alpha_i, \overline{k}^*(\alpha_j))} \right)^{\gamma} \tag{3}$$

This measure captures unnecessary deprivation, in that chronically poor individuals who achieve their steady state income level (i.e., $f(\alpha_j, \overline{k}^*(\alpha_j)) = y_j$) realize their full potential and have zero weight in this measure, as do the non-poor (for whom $y_j > y_p$). Instead, the "potential gap" captures mainly those of intermediate skill who are trapped in a low-level equilibrium or those who are presently far from their long-run equilibrium (*e.g.*, upwardly mobile individuals with very low initial endowments). This measure is impractical in empirical work, since it relies on an estimate of steady-state capital holdings conditional on unobservable ability; it is nonetheless helpful as a conceptual tool for distinguishing unnecessary poverty from that which is unavoidable given individuals' immutable endowments and the economic environment in which they operate.

These economic core measures permit us to track over time both the social costs (foregone output and unexploited technological opportunities) and the human costs (low standards of living and unnecessary

can create another type of poverty trap.

[20] In work not reported here, we also analyzed the impacts of the different policies using a conventional Benthamite social welfare function as well as the dynamic poverty measures suggested by Calvo and Dercon (2007). The qualitative story told by these measures is similar to that which can be gleaned from the measures discussed here.

deprivation) of poverty traps.

2.2 Baseline Case of No Social Protection

The northeast panel of Figure 2 shows the asset distribution after 50 years of simulated history for our stylized economy. As can be seen, the asset distribution (which was originally randomly distributed independently of the ability distribution) has bifurcated, with a strong positive correlation between innate ability and wealth. One set of individuals has comfortably settled above the Micawber Frontier at the high technology steady state. The other group is at the low level steady state, below the asset poverty line. There are quite a few poor individuals in the middle ability group whose potential to reach the high equilibrium has been blocked by their low initial asset levels, or realized) asset shocks, that locked them below the Micawber Frontier.

With no exogenous technical change or growth in productive inputs to stimulate growth and modest investment incentives for a large portion of the population, GNI in this baseline economy is relatively stagnant over time as reflected in the "autarchy" line in the northwest quadrant of Figure 2. This reflects the fact that the positive accumulation and associated productivity gains of those above the Micawber Frontier is offset by the lost potential – and wealth deaccumulation and productivity decline – of many of those trapped below it. The decline among some sub-populations is manifest in the disadoption of the high technology, use of which falls from roughly 60% to only 40% of the population. Further reflection of this economic bifurcation is found in the increasing levels of poverty, measured both as a poverty headcount (northeast quadrant) as well as by the poverty gap indicator (southwest quadrant) and our unnecessary deprivation measure (southeast quadrant). Income inequality (not shown) declines modestly over the first decade of the simulations, then increases above the initial level by year 25 as households converge on their α-conditional long-run equilibria. The lackluster performance of the base case poverty trap economy illustrates both the human and aggregate economic costs of poverty traps. The next sections consider alternative policy regimes that might lead to better outcomes.

3 Poverty Dynamics and the Targeting of Unanticipated Social Protection

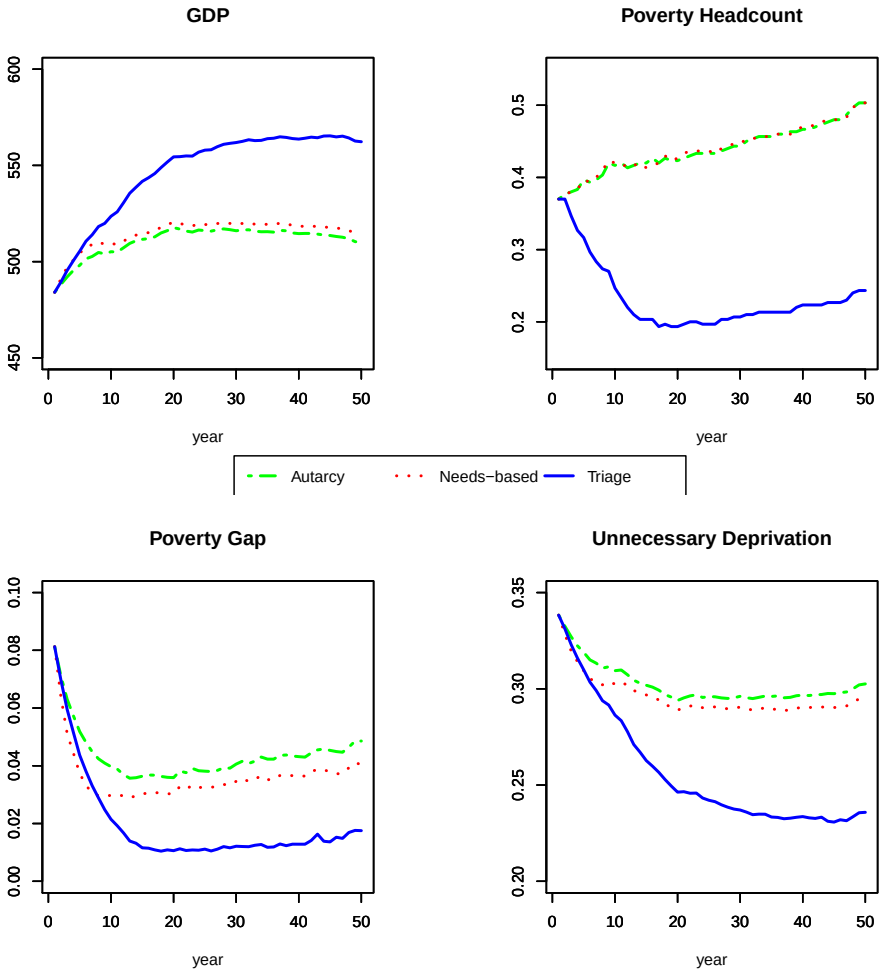
This section examines the impact of reactive food aid or unanticipated social protection policies on the stylized economy studied in the prior section. The label unanticipated signals that these policies are implemented *ex post* of shocks and we assume away agents' anticipation of the resulting transfers and the behavioral response that would follow from such anticipation. This oversimplification is made simply to help understand more clearly how poverty dynamics shift in response to different sorts of social protection policies. In particular, we seek to illustrate clearly the value of addressing the purely *ex post* effects of asset shocks, even if agents do not expect transfers. Section 4 relaxes the assumption that households fail to anticipate and respond to social protection policies.

For all alternatives, we assume that the social protection agency[21] has access to an annual income stream or budget of that amounts to 2.5% of initial GNI.[22] This amount was chosen because it is insufficient to lift

[21] We use the broad term social protection agency to encompass local or national government as well as non-governmental organizations (NGOs) that might respond to shocks.

[22] We ignore the source of taxation that generates these resources and the associated distortionary effects on the economy. They could be conceptualized as either external resources (brought in by a donor, an NGO or a relief agency), or as domestic tax resources transferred from another sector of the national economy.

Figure 3: Economic Evolution under Alternative Social Protection Policies



all initially poor individuals above the poverty line, though it is enough to substantially close the poverty gap. We further assume that the social protection agency has access to full information, including household ability and asset holdings, realized shocks and knowledge of the production technology. While these are strong assumptions, using them to explore targeting of this limited assistance budget helps further illustrate the workings of the multiple poverty trap economy.

3.1 Poverty and Aid Traps under Progressive, Means-tested Cash Transfers

Under the progressively-targeted or needs-based scenario, the agency uses its budget only for progressively targeted, humanitarian/cash transfers. After each production cycle, it calculates the total poverty shortfall for the economy, $S = \sum_{y_j<y_p}(y_p - y_j)$. If the available budget exceeds the shortfall ($\frac{B}{S} > 1$), then all poor individuals are given transfers to increase their income to the level of the poverty line. If $\frac{B}{S} < 1$, then each poor individual is given transfers that move them to an income level equal to $\frac{B}{S}y_p$. Note that this targeting methods makes the largest transfers to the least well-off. Once individuals receive the transfer, they make their consumption versus investment decision according to maximization of problem 1 above and assume that future transfers will never occur. Section 4 relaxes this strong assumption, but for now it helps to understand the different effects of alternative designs.

The impact of this needs-based assistance regime on asset distribution can be seen in the southwest diagram in Figure 2. The figure is quite similar to that under autarchy (the northeast panel), except that asset levels are somewhat higher for those below the poverty line, especially among lower ability persons, reflecting a transfer rule based on realized income levels. Turning to Figure 3, we see that the poverty headcount and unnecessary deprivation measures follow a trajectory nearly identical to that which emerges absent social protection. The FGT(1) poverty gap measure is substantially lower under needs-based assistance than without the assistance, reflecting the added resources introduced into the system exogenously. But we can also see that the FGT(1) steadily rises after year 10 of the simulation. GNI is higher in the economy with needs-based transfer, but purely due to the extra 2.5% of GNI assumed available each year.

In a world where budgets for transfers are available exogenously (*e.g.*, via unrequited transfers associated with overseas development assistance), progressively-targeted transfers that flow mainly to the chronically poor of low innate ability plainly reduces income and asset poverty, if only because there are added resources in this scenario. However, these transfers do not fundamentally alter the economy's dynamics. Indeed, the troubling irony is that poverty grows in this economy in spite of these transfers as some agents suffer asset shocks that drop them into poverty but then receive insufficient transfers to enable them to climb back out of poverty on their own. Transfer policies that are designed to respond to one poverty trap mechanism–low innate ability–systematically fail to address the other poverty trap in this economy by failing to prevent more people from inadvertently falling into the trap over time.

These results signal what might be termed a relief trap. By failing to stem the flow of intermediate ability individuals below the Micawber Frontier, the fixed humanitarian assistance budget becomes less and less able to meet the needs of those below the poverty line. If the social protection agency (or the international community) were intent on holding poverty at, say, year 10 levels, then increasing fractions of total public expenditures would need to be devoted to aid budgets to accommodate the inflow of the unnecessarily poor who have suffered severe asset shocks and fallen into the basin of attraction of their low-level equilibrium. We abstract here from the standard public finance problems of raising revenues, but clearly the growing demands for transfers would have to be met either through increasingly distortionary taxation or through reducing funds available for developing new technologies, building schools and infrastructure, or other interventions

(not modeled here) that are aimed at boosting productivity. Poverty traps can thus, in a very direct way, create relief traps for purely progressively targeted social protection programs.

3.2 Vulnerability-targeted Contingent Social Protection

As the prior simulations make clear, in our model asset risk creates an ever increasing amount of unnecessary deprivation that eventually overwhelms the capacity of cash transfers to provide relief. This observation suggests that a social protection scheme targeted at the vulnerable in the vicinity of the Micawber Frontier–*i.e.*, a safety net designed to stem the increase in unnecessary poverty–can potentially generate a win-win-win scenario, with higher rates of improved technology adoption and GNI growth, reduced poverty (especially for intermediate ability groups), and less stress on the social protection budget with which it serves those of low innate ability who are intrinsically chronically poor.

To explore this idea, we initially analyze an admittedly harsh "triage" policy regime in which the social protection agency provides transfers to households according to the following rules:

1. The budget, B, is first allocated to individuals recently pushed below the Micawber Frontier. Denote these threshold-based transfers as *vulnerability-targeted contingent transfers* (VTCTs). An individual is eligible for a VTCT of $VTCT_j = \tilde{k}(\alpha_j) - \theta_t[i_{jt} + (1-\delta)k_{jt}]$ if $i_{jt} + (1-\delta)k_{jt} > \tilde{k}(\alpha_j)$ and $\theta_{jt}[i_{jt} + (1-\delta)k_{jt}] < \tilde{k}(\alpha_j)$. In words, if an individual was above the Micawber Frontier prior to the most recent asset shock, but below it afterward, the agency provides a transfer to move the household back to the Micawber Frontier. If the total budget ($VTCT = \sum_{j=1} VTCT_j$) exceeds the total eligible transfers, then all individuals pushed below the threshold are given an asset transfer to lift them back to it. If the budget is insufficient, then it is allocated first to those closest to the Micawber Frontier so as to minimize the increase in the headcount of needless poverty.

2. If there is any remained budget after step 1 (*i.e.*, if $B > VTCT$), then those mid-ability individuals already below the Micawber Frontier (due to low initial inheritance or prior bad luck not stemmed by a $VTCT$ transfer) are given priority for *cargo net* transfers that lift them over the Micawber Frontier.[23] Analogous to stage 1, total potential spending on cargo net transfers is calculated (denote this total amount as CN). If $CN > B - VTCT$, then the budget is again prioritized in order to minimize headcount poverty, by first helping the most vulnerable, defined as those closest to the Micawber Frontier.

3. If $B > VTCT + CN$, then the residual budget is allocated according to the progressive or needs-based formulation discussed in the previous sub-section.

Figures 2 and 3 illustrate the results of this assistance regime for our stylized poverty trap economy. The results stand in strong contrast to autarchy and needs-based assistance simulations. As shown in the southeast panel of Figure 3, by year 50, all needless poverty is eliminated and the headcount of total poverty levels off at 25%, the share of the population that is intrinsically chronically poor by construction. Technology adoption is high, as is GNI (and GNI growth). In the longer-run, this triage approach to development assistance plainly outperforms needs-based assistance by any of these metrics.

However, the southwest diagram in Figure 3 illustrates a core ethical challenge associated with vulnerability-targeted social protection. The FGT(1) poverty gap measure is lower under progressively-targeted cash

[23]The term "cargo net" was coined by Barrett (2005) and refers to transfers intended to lift people above – or help people climb over – thresholds at which accumulation dynamics bifurcate, as distinct from safety nets, which prevent people from falling beneath those same thresholds.

transfers for the first 8-10 years of the simulation because needs-based assistance flows primarily to the least well-off while the stylized vulnerability-targeted policies are aimed at those nearest the Micawber Frontier. Paradoxically, after 8-10 years, those who are poor are better off under VTCT design because it reduces the number of people needing assistance, allowing the fixed social protection budget to provide more generous support to those who inevitably need it. But, prior to that time, individuals who are poor, and especially the poorest, are better off under needs-based targeting. The results for (asset or income) inequality (not shown) are qualitatively similar, with needs-based transfers generating lower inequality in the economy over the first nine years, but threshold-based transfers generating lower inequality over longer horizons. These results underscore the difficult tradeoffs inherent to the design of social protection policy, both over time and across sub-populations of the poor:

- Do we prioritize reducing the depth of poverty for the poor today or the poor tomorrow?
- Do we focus on helping those who, with a bit of assistance, can then pull themselves out of poverty by their bootstraps, or on those who will suffer low living standards in the absence of assistance of indefinite duration?

In the presence of multiple poverty trap mechanisms, these tradeoffs become especially sharp.[24]

4 Moral Hazard and the Design of Anticipated Social Protection

The analysis in Section 3 revealed the paradoxes and challenges of social protection in an economy characterized by poverty traps that take several forms. That analysis, however was incomplete as it assumed that individuals do not anticipate social protection benefits. This lacunae is especially important for state of the world contingent transfers that are targeted at the vulnerable. Such transfers operate as a form of insurance, and as discussed in the introduction above, might be expected to alter *ex ante* investment incentives for households both above and below the Micawber frontier itself.

In this section we therefore relax the assumption that contingent transfers are unanticipated and consider households' rational response to them. While we could in principle analyze endogenous response to anticipated, progressively-targeted cash transfers, we here limit our attention to anticipated of vulnerability-targeted social protection schemes.[25]

4.1 Positive and Negative Moral Hazard

We expect two kinds of household response to safety net transfers. First, since safety net transfers mitigate asset risk, households are willing to accumulate more assets *ceteris paribus*. This is canonical moral hazard, in that the provision of some insurance induces increased risk taking.[26] In this model, accumulation of assets

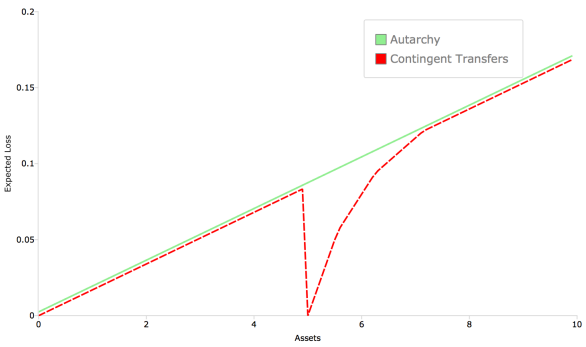
[24] In additional simulations not reported here, we considered whether these tradeoffs could be mitigated by mixing different kinds of transfers and/or by reallocating budgets intertemporally through borrowing. While these alternatives can reduce the magnitude of the tradeoffs reported here somewhat, they cannot be eliminated entirely. This underscores the unavoidable nature of the targeting tradeoffs in both cross-section (between different sub-populations of the poor and vulnerable) and over time in a multiple poverty trap economy.

[25] This analytical choice is primarily made for analytical convenience as under the triage policy developed in Section 3, the magnitude of cash transfer payments is itself uncertain, depending on the vagaries of the weather that dictate the residual budget left for such transfers. Clearly, we would expect cash transfers to discourage private accumulation (Hubbard et al. (1995) give an empirical example showing how means-tested social insurance programs discourage precautionary savings in the United States). By ignoring these disincentive effects, we are thus overerstating the possible efficacy of cash transfers.

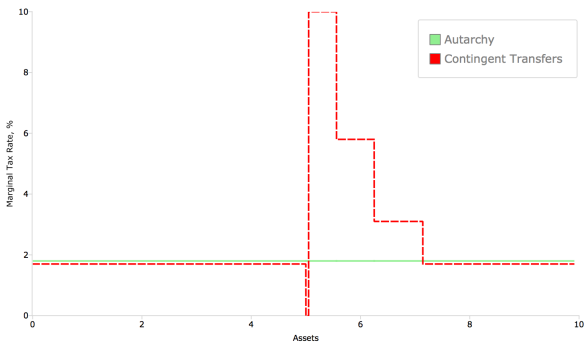
[26] Recognize that risk is increasing in asset holdings because θ is a multiplicative shock and independent of k. Therefore, stochastic losses are greater when k is larger.

Figure 4: Nature's Tax Rates under Contingent Social Protection

(a) Expected Asset Losses



(b) Marginal Tax Rates



subject to stochastic shocks is the only risk-taking behavior available to agents. But asset accumulation is socially desirable in this setting, as it increases productivity and adoption of improved production technologies, increases GNI and reduces poverty. We therefore call this incentive effect "positive moral hazard."

Second, because the safety net transfers are conditional (on pre- and post-shock asset holdings) and given the standard intertemporal tradeoff between current consumption and saving for future consumption, *ceteris paribus* households have an incentive to satisfy the transfer condition as often as possible so as to receive extra resources. If some external agency or government will insure them against falling into a poverty trap, households do not need to self-insure through asset accumulation to the same degree, thereby creating a disincentive to invest–equivalently, reducing the need for precautionary savings–that runs counter to social objectives. We therefore label this effect "negative moral hazard."

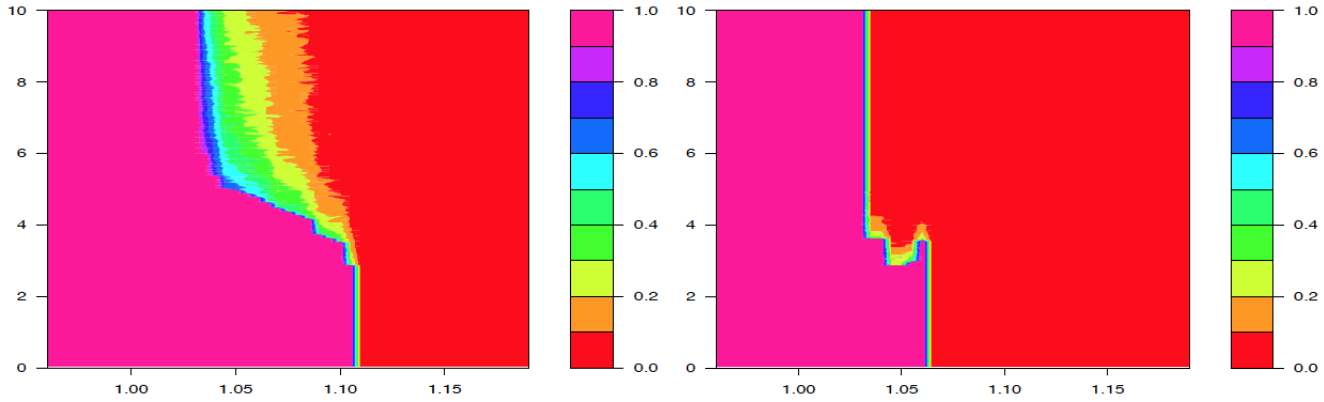
For a middle ability person with $\tilde{k}(\alpha) = 5$, Figure 4a shows expected asset losses as a function of level of capital stock held with (the dashed, red line) and without (the solid, green line) the vulnerability targeted contingent transfer scheme. As can be seen, there is zero chance of asset losses right at this threshold, and expected asset losses above the threshold will always keep the individual at or above $\tilde{k}$. When these contingent transfers of the vulnerability targeted social protection are anticipated, optimization problem 1 can be rewritten as follows:

$$
\begin{aligned}
\max_{c_{jt}} \quad & E_\theta \sum_{t=0}^{\infty} \beta^t u(c_{jt}) \\
\text{subject to:} \quad & \\
& c_{jt} \leq k_{jt} + f(k_{jt}) \\
& f(\alpha_j, k_{jt}) = \alpha_j \max[f_H(k_{jt}), f_L(k_{jt})] \\
& k_{jt+1} = \begin{cases} \tilde{k}(\alpha_j) \text{ if } (f(k_{jt}) - c_{jt}) + (1-\delta)k_t > \tilde{k}(\alpha_j) \text{ and } (k_{jt} + (f(k_{jt}) - c_{jt})(\theta_{jt+1} - \delta) < \tilde{k}(\alpha_j) \\ (k_{jt} + f(k_{jt}) - c_{jt})(\theta_{jt+1} - \delta) \text{ otherwise} \end{cases} \\
& k_{jt} \geq 0
\end{aligned}
\tag{4}
$$

This is the same as the problem specified in Section 2 except for the important change in the law of motion

Figure 5: Ex Ante Impacts of Anticipated Social Protection

(a) Probability of Low Equilibrium under Autarchy (b) Probability of Low Equilibrium under Social Protection



governing k_{jt+1} now that households are aware of and respond to the contingent transfers.[27]

Figure 5 illustrates the impact of the anticipation of contingent transfers on the probability of chronic poverty. For ease of comparison, Figure 5a repeats those probability when these transfers are not anticipated. Comparing 5b with 5a, we can see that substantially fewer endowment positions are likely to end up chronically poor. This additional accumulation induced by the presence of contingent transfers at the (autarchy) Micawber Frontier is precisely represents positive moral hazard.

While the vulnerability-targeted contingent transfers incentive upward mobility, they also have a discouraging effect on further accumulation that takes households beyond the safety of $\tilde{k}(\alpha)$ where assets are fully protected. A large swatch of middle ability agents end up in long-term equilibrium at exactly $\tilde{k}(\alpha)$. This behavior represents class negative moral hazard as the presence of the implicit insurance provided by the contingent transfer lead individuals to undertake behaviors that make contingent payments more likely.

Figure 4 illustrates the intuition for the emergence of this new insured outcome. Note that nature essentially acts as an unreliable tax collector in this model, probabilistically taking away some fraction of assets every period. Figure 4a shows expected asset losses as a function of level of capital stock held. The solid (green) line shows these expected losses absent the contingent social protection scheme. Under the multiplicative risk specification, this is linear with a constant expected marginal tax rate of 1.7% (under the numerical assumptions used to analyze our model). This marginal tax rate[28] is shown by the corresponding horizontal line in Figure 4b.

Under the precisely targeted contingent transfer scheme, expected losses drop to exactly zero at $\tilde{k}(\alpha)$, as shown by the dashed line in Figure 4a. Beyond that asset level, expected losses begin to increase eventually becoming identical to expected losses absent this form of social protection.[29] Figure 4b shows the implied

[27]The household problem at period t can be represented in Bellman Equation form as:

$$V(k_t) \equiv \max_{i_t} \{u(f(\alpha, k_t) - i_t) + \beta E\left[V(k_{t+1}|k_t, i_t)\right]\}$$

$$\text{where } E\left[V(k_{t+1}|k_t, i_t)\right] = \int V(k_{t+1}(k_t, i_t, \theta_t, k_g, \delta))d\Omega(\theta_t)$$

$$k_{t+1}(k_t, i_t, \theta_t, k_g, \delta) = \begin{cases} k_g \text{ if } i_t + (1-\delta)k_t > k_g \text{ and } \theta_t[i_t + (1-\delta)k_t] < k_g \\ \theta_t[i_t + (1-\delta)k_t] \text{ otherwise} \end{cases}$$

[28]**can add in math of expected marginal tax rates in text here or in a footnote**

[29]With bounded shocks, there will be a capital stock such that even largest shock cannot reduce assets to $\tilde{k}(\alpha)$, the level

marginal tax rates under this scheme. As can be seen, under the discrete probability structure used to analyze the model, the marginal tax rate abruptly jumps from zero to 10%, and then slowly decreases to the natural tax rate of 1.7% as capital stocks accumulate beyond the indemnity payment threshold. This sharp and discontinuous elimination of social protection as the individual moves away from the insured point $\tilde{k}(\alpha)$ discourages accumulation and leads to a class of agents who settle in at the new $\tilde{k}(\alpha)$ equilibrium.

4.2 Using Index Insurance and Co-pays to Implement Contingent Social Protection

Negative moral hazard and the attraction of $\tilde{k}(\alpha)$ as a new equilibrium reflects in part the extremely precise targeting of the contingent transfers (and sharp jump in marginal tax rates) that define the vulnerability-targeted social protection scheme. In addition, this kind of precise targeting is itself of dubious relevance in the real world where neither realized shocks, asset levels, nor individual skills are easy to observe. Together, these observations raise the question as to whether something akin to contingent social transfers can be implemented as an index insurance scheme.[30] Using insurance might have 3 advantages:

1. Cheap to observe index that signals shocks;
2. Rely on self-selection and obviate the need to observe skill;
3. Co-payment, reducing costs and changing incentives; and,
4. Because of cost reduction, may be possible to offer a less-targeted subsidy in order to avoid sharp discontinuities.

In a recent paper, Janzen et al. (2016) show using a dynamic model similar to that developed here[31] 50% insurance subsidy offered across the board to all but the wealthiest agents can induce investment and upward mobility (positive moral hazard), but without the negative moral hazard. Importantly, they show that under their models assumptions, the total social protection budget (defined as funds for the insurance subsidy plus funds for cash transfers needed to close the poverty gap for all poor households) quickly becomes lower under combined insurance-cash transfer scheme than under a pure cash transfer scheme. Total costs are in fact higher under the hybrid scheme, but they become lower as the induced upward mobility eventually reduces the cost of cash transfers. Under their numerical assumptions, the present value of total social protection expenditures is 16% lower under the hybrid scheme.

The feasibility of using index insurance to offer contingent protection has been extensively studied in the semi-arid regions of northern Kenya. Chantarat et al. (2012) and Mude et al. (2009) describe the initial contract design, while impact evaluation results on the ex post and ex ante effects of the insurance are reported in Jensen et al. (2014) and Janzen and Carter (2014). While demand issues remain a problem, the government of Kenya under its Kenya Livestock Insurance Program is currently trying to build on this insurance model to deliver contingent social protection.

where contingent payments kick in.

[30] define index insurance

[31] except no skill heterogeneity and also idio versus covariant, basis risk

5 Conclusions

This paper has put forward a stochastic dynamic programming model of a poverty trap economy (with a non-convex production set and missing financial markets) in which asset risk plays a major role and heterogeneity of individual ability creates two types of chronic poverty. Some people are chronically poor because their innate ability condemns them to a low standard of living. Others suffer unnecessary deprivation simply because they inherit insufficient productive capital to reach the critical asset or 'Micawber' frontier at which it becomes optimal to make the short-term sacrifices necessary to make long-term investments and ultimately escape from chronic poverty. Each of these two poverty trap mechanisms invites a different policy response. When both types of chronic poverty co-exist, therefore, tradeoffs inevitably arise in developing cost-effective poverty reduction strategies.

Using this framework, we show that purely progressively-targeted social relief–such as cash transfers or food aid delivery – can fall prey to an aid trap in which income support to the poorest of the poor – predominantly the intrinsically chronically poor – crowds out asset protection for those of intermediate ability and wealth who are vulnerable to asset shocks. Members of this latter group steadily fall into avoidable chronic poverty, adding to the pool of individuals suffering unnecessary deprivation and needing income support. As a result, while purely progressively-targeted social protection initially reduces the depth of poverty, the lot of the poor deteriorates over time due to increasing competition for limited relief resources. Moreover, an unadorned, purely progressively-targeted system of social protection does not appreciably change the numbers of poor, nor does it enhance wealth accumulation, economic output or adoption rates of improved technologies.

We then show that a triage policy, which in the first instance uses the Micawber frontier to target the vulnerable-but-not-indigent results in a "productive safety net" that largely eliminates unnecessary deprivation, empowers upward mobility and boosts growth through endogenous asset accumulation and adoption of improved technologies. While this triage policy still confronts important tradeoffs among different poor people and over time, this theoretical exercise establishes the potential gains to social protection that targets vulnerability, not just low current well-being, and in so doing creates economic multipliers. However, we show that despite these gains, anticipation of vulnerability-targeted social protection displaces some self-insurance through precautionary savings because it discourages some people from investing beyond the range where they remain eligible for social protection transfers. A key question then becomes whether the balance between positive and negative moral hazard can be altered by changing the mode of delivering contingent transfers. On-going theoretical work suggests that imprecisely targeted partial subsidies for index insurance can cost effectively achieve a better balance between positive and negative moral hazard, encouraging upwardly mobility but not artificially braking it with means-tested cutoffs (Janzen et al. (2016)). Whether this potential can be realized is an on-going object of study under the Index-based Livestock Insurance project in northern Kenya and southern Ethiopia.[32]

Ultimately, the key finding of this paper is that poverty traps characterized by multiple equilibria can have a pronounced effect on the performance and appropriate design of policies intended to stimulate poverty reduction, economic growth and uptake of improved production technologies. There are potentially large returns to developing and using knowledge about critical asset thresholds to target assistance in economies characterized by such poverty traps. The co-existence of populations facing different sorts of poverty traps, however, also raises unavoidable, thorny tradeoffs among distinct cohorts of the poor, as well as difficult

[32] cites here to uptake and other issues

intertemporal tradeoffs between current and future poverty reduction.

Appendix 1: Parameters and Other Details for Numerical Simulation

This section provides additional detail on the formal model used to generate the results discussed in the main body of the paper.

The functional specification for the utility function $u(\cdot)$ is

$$u(c_t) = \frac{c_t^{1-\sigma} - 1}{1 - \sigma}$$

The probability density of θ_t is assumed to be:

$$\text{density of } \theta_t = \begin{cases} 0.90 \text{ if } \theta_t = 1.0 \\ 0.05 \text{ if } \theta_t = 0.9 \\ 0.03 \text{ if } \theta_t = 0.8 \\ 0.02 \text{ if } \theta_t = 0.7 \end{cases}$$

The other structural parameter values are assumed as follows: $\sigma = 1.5, \delta = 0.08, \beta = 0.95, \gamma_L = 0.3, \gamma_H = 0.45, E = 0.45$.

We discretize continuous variables k and α as follows: $k = \{0.1, 0.2, \ldots, 15.0\}$ and $\alpha = \{0.94, 0.96, \ldots, 1.22\}$ <<UPDATE>>.

For the simulation of the stylized economy of 300 individuals we draw α from $\text{N}(1.08, 0.074^2)$, with the mean and variance chosen so that ex ante proportion of low, middle, and high type individuals (defined relative to the stochastic Micawber Frontier) would be 25%, 50%, and 25%, respectively. We draw k_1 from Uniform$[0.1, 10.0]$ and assume that k_1 and α are statistically independent from each other.

We specify poverty line as follows. The asset level which generates income exactly equal to the poverty line satisfies the following equation:

$$y_p = f(\alpha, k_p).$$

where y_p is income-based poverty line. That asset level obviously depends on α and we denote it by $k_p(\alpha)$. We assume that an intermediate ability individual would fall below the income poverty line if he used the low technology and thus set poverty line by $k_p(\alpha = 1.12) = 3.4$ and thus $y_p = 1.62$.

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