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Abstract

This paper demonstrates that there are potentially large returns to social protection policy that stakes out a productive safety net below the vulnerable and keeps them from slipping into a poverty trap. Much of the value of the productive safety net comes from mitigating the ex ante effects of risk and crowding in additional investment. The analysis also explores the implications of different mechanisms of targeting social protection transfers. In the presence of poverty traps, modestly regressive targeting based on critical asset thresholds may have better long-run poverty reduction effects than traditional needs-based targeting.

JEL classification: D91, I30, O12

Keywords: Poverty traps, Targeting transfers, Dynamic modeling

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Poverty Traps and Social Protection

Poverty traps caused by the existence of multiple dynamic equilibria attract ever-growing attention, among both economic researchers and development policymakers.³ In this paper, we focus not on why or if poverty traps exist, but rather on the implications of poverty traps for the design and performance of poverty reduction policies. This topic remains remarkably underexplored even though the poverty traps concept underpins much current development policy discourse.⁴ As we explore, multiple equilibria can create stark tradeoffs between helping those who are currently poorest versus preventing descents into poverty among an initially non-poor, middle class group. Not only is there a tradeoff between preventing and responding to poverty, but because benefit levels associated with transfer programs operating on a fixed budget are determined endogenously as people descend into or graduate from poverty, the most progressive transfer policies may trade off greater reductions in near-term poverty for higher future poverty rates. Over time, today's poor may actually benefit from policies that protect the assets of a vulnerable but somewhat better-off middle class if such social protection stimulates investment by the poor and eventually reduces the size of the poor subpopulation needing support from transfer programs with a fixed budget. Ultimately, we demonstrate that poverty traps can have a pronounced effect on the performance and appropriate design of poverty reduction policies. This fundamental point appears to have gone unnoticed in the literature to date.

This paper explores these issues with a stochastic dynamic programming model of individual asset accumulation in the presence of innate ability differences, heterogeneous asset endowments, multiple production technologies and risk. As in many such models, multiple equilibria and an associated poverty trap are generated by assumptions of missing financial markets and non-convexities in production (*i.e.*, fixed costs of investment and innovation). These assumptions create a 'Micawber Frontier' which divides the innate ability–initial asset space into multiple regions of distinct, dynamically optimal behavior.⁵ Individuals located above the Micawber Frontier find it feasible to accumulate

³ Azariadis and Stachurski (2005), Bowles et al. (2006) and Carter and Barrett (2006) provide excellent overviews of the relevant literature.

⁴ For example, Sachs (2005) relies heavily on the poverty trap idea in making a case for massive increases in international development assistance to low-income countries, but without directly teasing out specific design implications.

⁵ As discussed by Carter and Barrett (2006), the phrase Micawber Threshold was first used by Michael Lipton to describe a point below which it is difficult for agents ever to accumulate assets. The idea was subsequently adopted by Zimmerman and Carter (2003) who give it a meaning similar to that used here. The image echoes the travails of Wilkins Micawber, the perpetually insolvent debtor in Dickens' *David Copperfield*.

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, there is a region of what might be termed “intrinsic chronic poverty.” The model thus captures the ability differences that figure prominently in some empirical discussions of chronic poverty (Chronic Poverty Research Centre 2005, Santos and Barrett 2006), as well as the bifurcated wealth dynamics that figure prominently in the theoretical poverty traps literature.⁶

In addition to making clear the complex nature of chronic poverty, the model also shows that exposure to risk and shocks play especially pernicious roles when poverty traps exist. *Ex post*, realized shocks can have irreversible consequences for agents who get pushed below the critical threshold. In addition, the *ex ante* anticipation of shocks shifts out the endogenous threshold, making escape from poverty less likely as agents become less willing to sacrifice current consumption to accumulate risky assets. Policies that compensate individuals for the effects of realized shocks or insure them against future losses can crowd-in investment and have a major effect on the incidence of chronic poverty, even taking into account agents’ natural behavioral response to insurance (*i.e.*, moral hazard).

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 form a stylized model of a poverty trap economy. 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 GDP, technology adoption, inequality and standard Foster-Greer-Throbecke (FGT) poverty measures, as well as a new measure of unnecessary deprivation.

Section 3 explores the design of programs intended to aid the poor, either by making progressive, needs-based transfers, or by offering a productive social safety net that offers insurance against potentially catastrophic asset losses. These experiments are perhaps best characterized as relief programs in that they are *ex post* and they are assumed to be unanticipated by agents in the economy.⁷ In the presence of poverty traps needs-based allocation rules can lead to a long-run “relief trap” for development assistance because agents fall into a poverty trap due to asset shocks, swelling the ranks of the poor and thereby ultimately reducing assistance to the poorest due to increased

⁶ This finding suggests that much of the empirical literature on poverty traps (including our own) has been misguided in imposing a single model of welfare dynamics on data generated by heterogeneous agents. Santos and Barrett (2006) is an exception.

⁷ This does not strictly require that agents are ignorant of the possibility of transfers, merely that assistance is sufficiently unreliable that agents behave as if such policies do not exist.

competition for scarce relief resources. While in the near term the productive safety net implies regressive targeting among the subpopulation of poor and vulnerable agents, by preventing collapse into poverty by agents vulnerable to asset risk, it reduces poverty and leads to greater transfers to and higher welfare for the intrinsically poor in later years.

Section 4 then explores what happens when a program of sporadic, unanticipated relief is replaced with a a systematic program of fully anticipated social protection. While anticipation of social protection creates an element of standard, output-reducing (and indemnity payment-increasing) negative moral hazard, it can also create what we term positive moral hazard, wherein individuals are induced to take on more risk and invest more. But rather than increasing the likelihood of subsequent indemnity payments, this induced risk taking behavior reduces that likelihood of indemnity payments and stimulates output growth. While the effects of negative moral hazard appear potentially substantial under a naive program design, we show how modest changes in program structure can markedly shift the balance between negative and positive moral hazard. Section 5 concludes the paper with implications for further research and for social protection policy design.

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

The growing literature on poverty traps offers a range of theoretical models that generate multiple dynamic welfare equilibria, at least one of which falls beneath a poverty line. Dercon (2003), Banerjee and Duflo (2004), Azariadis and Stachurski (2005) and Bowles et al. (2006) provide excellent summaries of that literature. Our focus in this paper is on micro-(household-)level poverty traps, especially forward-looking agents' asset accumulation and welfare dynamics in an economic environment characterized by credit constraints, a non-convex production technology set, heterogeneous agent ability and initial asset endowments, and non-existent labor and asset rental markets. Our model thus resembles other models of poverty traps in the sense that some households do not invest – nor choose the more profitable technology – because the current cost of investment is large compared to the future returns to investment for those with low initial wealth when they cannot borrow against future expected earnings.⁸

In what follows we build on Buera's (2005) non-stochastic model of asset accumulation with two production technologies under credit constraints and heterogeneous agent ability. 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 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 section and that result help motivate our focus in subsequent sections on prospective safety net policies and associated moral hazard concerns.

1.1 A Model of Asset Dynamics and Heterogeneous Ability

Consider an economy in which each individual i is endowed with a level of innate ability (α_i) as well as an initial stock of capital (k_{i1}). Preferences are unrelated to the individual's innate ability. In what follows, we treat α_i as fixed. We conceptualize the agents in this economy as adults and α_i 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. Exploring the

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).

multigenerational extension to the present model, by endogenizing α_i , 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, 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 fixed costs, E , such that the technology is not worth using at low amounts of capital. Specifically, we assume that expected income, f , for individual i in period t is given by

$$f(\alpha_i, k_{it}) = \begin{cases} f_L(\alpha_i, k_{it}) = \alpha k_{it}^{\gamma_L} & \text{under the low technology} \\ f_H(\alpha_i, k_{it}) = \alpha k_{it}^{\gamma_H} - E & \text{under the high technology} \end{cases}$$

where $0 < \gamma_L < \gamma_H < 1$. The individual interested in maximizing income will optimally employing the high technology if and only if k_{it} equals or exceeds the critical level $\hat{k}(\alpha_i) = \{k | f_L(\alpha_i, k) = f_H(\alpha_i, k)\}$.⁹

If an individual had access to only one technology, she or he would accumulate capital up to a unique steady state values $k_L^*(\alpha_i)$ for the low technology or $k_H^*(\alpha_i)$ 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 $\hat{k}(\alpha_i)$ 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 $k_L^*(\alpha_i) < k_{i0} < \hat{k}(\alpha_i)$. 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 $k_H^*(\alpha_i)$ and a non-poor standard of living? Alternatively, will the individual settle into a poor standard of living with capital stock $k_L^*(\alpha_i)$? More formally, is there an initial asset threshold, which we will denote $\tilde{k}(\alpha_i)$, 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 model of dynamic choice. Given the income

⁹ 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.

generation process shown above, assume that in every period individuals allocate the income they earn between consumption and the accumulation of productive assets:

$$c_t + i_t \leq f(\alpha_i, k_{it}),$$

where c_t is household consumption in period t and i_t is household investment in period t . The household's stock of accumulated capital evolves over time according to the following rule:

$$k_{it+1} = \theta_t[i_t + (1 - \delta)k_{it}],$$

where δ is the asset depreciation rate and θ_t is a random variable realized every period t .¹⁰ Individuals cannot borrow against future earnings to build up capital and can only pursue autarchic accumulation strategies. Note that $\theta = 1$ indicates that there is no shock, whereas $\theta < 1$ indicates a negative shock that destroys some fraction of assets. While in principle $\theta > 1$ might be allowed, such events seem unlikely and we will restrict the analysis to the case where only negative shocks are possible, i.e., $\theta_t \in [0, 1]$. The cumulative density function of θ_t is denoted by $\Omega(\cdot)$ and we assume that every household knows $\Omega(\cdot)$. The decision-maker's allocation choice at period τ is therefore represented by the following problem:

$$\begin{aligned} \max E_\tau \sum_{t=\tau}^{\infty} \beta^{t-\tau} u(c_t) & \quad (1) \\ \text{s.t. } c_t + i_t \leq f(\alpha_i, k_{it}) & \\ k_{it+1} = \theta_t[i_t + (1 - \delta)k_{it}] & \\ k_{i\tau} \text{ given} & \end{aligned}$$

where E_τ is expectation at the start of period τ , 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

¹⁰ This asset shock is the only source of stochasticity considered here. Incorporating income shocks would make the choice of technology more complicated, but will not fundamentally change the nature of our results as long as the income risk is stationary.

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

$$\begin{aligned} V(k_t) &\equiv \max_{i_t} \{u(f(\alpha, k_t) - i_t) + \beta E[V(k_{t+1}|k_t, i_t)]\} \\ \text{where } E[V(k_{t+1}|k_t, i_t)] &= \int V(\theta_t[i_t + (1 - \delta)k_t])d\Omega(\theta_t) \end{aligned}$$

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

1.2 The Micawber Frontier and the Two Dimensions of Chronic Poverty

As in Buera (2005), this model identifies a critical asset level, denoted $\tilde{k}(\alpha)$, for each level of skill or ability. An individual with ability level α_i will attempt to accumulate the assets needed to adopt the high technology if she enjoys capital stock $k_{i\tau} > \tilde{k}(\alpha_i)$. 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 $\tilde{k}(\alpha)$ the Micawber Frontier.

Figure 1, created through numerical analysis of the dynamic programming model, illustrates the Micawber Frontier.¹² Along the horizontal axis are innate ability or skill levels, ranging from least to most able. The vertical axis measures the stock of productive assets. The solid curve is the Micawber Frontier for the basic model.

To ease discussion and link it to more conventional poverty analysis, Figure 1 also includes an “asset poverty line,” illustrated as the dashed downward sloping line. For each ability level, this asset poverty line 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 this poverty line as the level of income that a reference middle ability person ($\alpha = 1.12$) would produce were she in steady state equilibrium at the *low* technology. 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

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. The piece-wise linear shape of the Micawber Frontier arises from the discretization of α . The finer grained α , the smoother the frontier.

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.

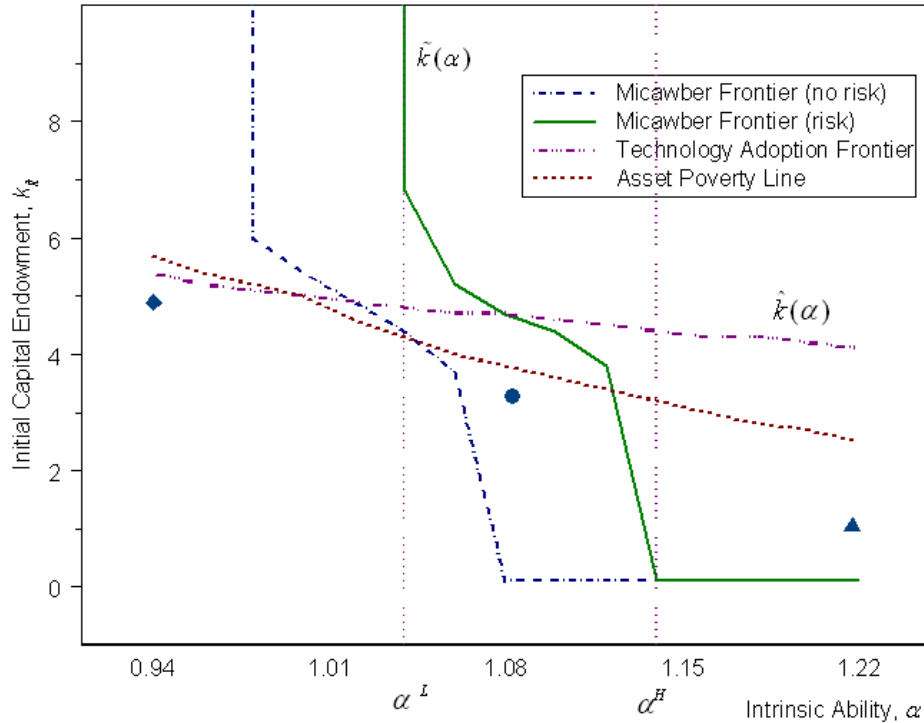


Fig. 1. Risk and the Micawber Threshold

ability-asset endowment places them above the Micawber Frontier but beneath the asset poverty line will be initially but only temporarily poor as they naturally accumulate their way out of poverty. By contrast, those whose initial ability-asset endowment 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 1, the numerical analysis identifies three distinct re-

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

gions in the space of ability and initial asset holdings. Irrespective of their capital endowment, high skill individuals with $\alpha_i > \alpha^H$ will always move toward the high equilibrium as $\tilde{k}(\alpha) = 0 \forall \alpha_i > \alpha^H$. When they reach the technology shift asset threshold $\hat{k}(\alpha_i)$ they will optimally switch to the higher technology. Irrespective of their starting position, 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..

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

Finally, those in the intermediate skill group with $\alpha^L < \alpha_i < \alpha^H$ have positive but finite values $\tilde{k}(\alpha)$. If sufficiently well-endowed with assets ($k_{i0} > \tilde{k}(\alpha)$), these intermediate ability individuals will accumulate additional assets over time, and would be expected to adopt the high technology and eventually reach a non-poor standard of living. If they begin with assets below $\tilde{k}(\alpha)$, however, these individuals 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 $\tilde{k}(\alpha)$ will be chronically poor. Unlike the intrinsically chronically poor, the chronic poverty of the intermediate skilled individuals is needless 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.

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 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

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

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, 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 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 1. 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, we simulated the income streams generated in three distinct settings:

- A non-stochastic economy in which agents repeatedly apply the optimal investment rule, $i_{nr}^*(k_t|\alpha_i)$ ¹⁷,
- An economy characterized by risk without realized shocks in which agents follow the risk-adjusted optimal accumulation rule, $i^*(k_t|\alpha_i, \Omega)$, 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_i) and the upwardly mobile (high α_i) 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 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.

¹⁷ Subscript *nr* represents no-risk. $i_{nr}^*(k_t|\alpha)$ 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.

2 Accumulation, Growth and the Evolution of Poverty in the Absence of Social Protection

The analysis in the prior section has shown that both the anticipation and the 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 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. Section 3 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 problems (2). 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 100 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.

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 can create another type of poverty trap.

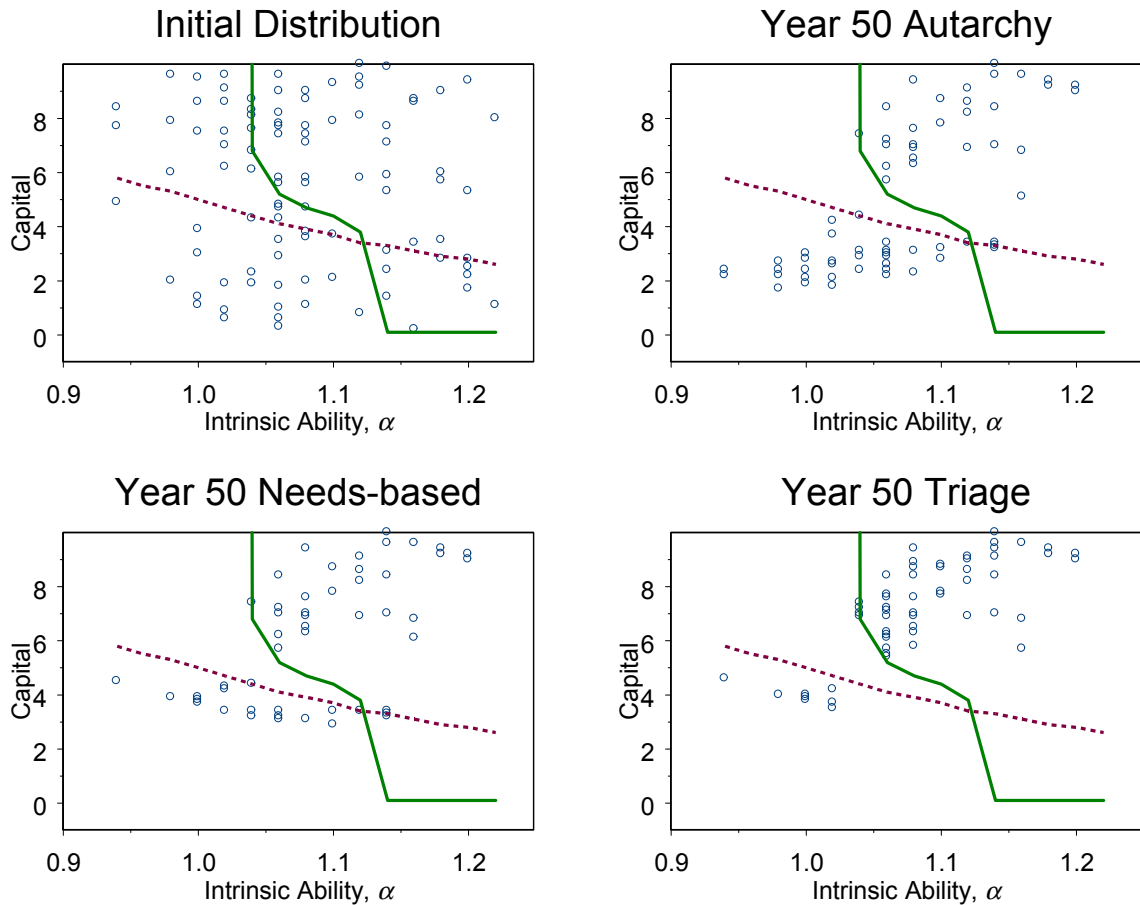


Fig. 2. Asset Evolution with and without Social Protection

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 an individual agent. The solid line is the Micawber Threshold under the stochastic environment, while the dashed line is the asset poverty line.

We employ the following core measures to track economic performance of the stylized economy under alternative social protection regimes:²⁰

- (1) Production Measures, including household income, national income (defined as the sum of the incomes of the 100 agents) and technology adoption (defined as the fraction of agents who adopt the higher yielding

²⁰In 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.

technology). Under the initial asset distribution, the GDP of this stylized economy is 187, with 60% of individuals initially using the high yielding technology.

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

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

where n is total number of individuals, y_p is income poverty line, y_i is individual i '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 high skill individual would produce in steady state if she had access only to the low technology. Under the initial asset distribution, the poverty headcount (FGT(0)) is 33% and the poverty gap (FGT(1)) is 0.07.

- (3) Gini coefficient measures of inequality, for both income and assets, which begin at 0.16 and 0.30, respectively, under the initial asset distribution.
- (4) A new, conceptual measure of unnecessary deprivation, D_γ^y , which measures the "potential gap." 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, $\bar{k}^*(\alpha_i) = \max\{k_H^*(\alpha_i), k_L^*(\alpha_i)\}$, 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 $\gamma=0$ offering a headcount of those who suffer unnecessary deprivation, $\gamma=1$ 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 $\gamma=1$ variant. Thus, define D_γ^y as

$$D_\gamma^y = \frac{1}{n} \sum_{\substack{y_i < y_p \\ y_i < f(\alpha_i, \bar{k}^*(\alpha_i))}} \left(\frac{f(\alpha_i, \bar{k}^*(\alpha_i)) - y_i}{f(\alpha_i, \bar{k}^*(\alpha_i))} \right)^\gamma \quad (3)$$

This measure captures unnecessary deprivation, in that chronically poor individuals who achieve their steady state income level (i.e., $f(\alpha_i, \bar{k}^*(\alpha_i)) = y_i$) realize their full potential and have zero weight in this measure, as do the non-poor (for whom $y_i > y_p$). 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 core, period-by-period measures permit us to capture both the social costs (foregone output and unexploited technological opportunities) and the human costs (low standards of living and unnecessary 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 inherited (or realized) asset levels that lock them below the Micawber Frontier. In this long-run state, the bifurcation is such that there is no transitory poverty – reflected in the absence of observations between the Micawber frontier and the asset poverty line.

With no exogenous technical change or growth in productive inputs to stimulate growth and modest investment incentives for a large portion of the population, GDP in this baseline economy is relatively stagnant over time (Figure 3, northwest quadrant). 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 new 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

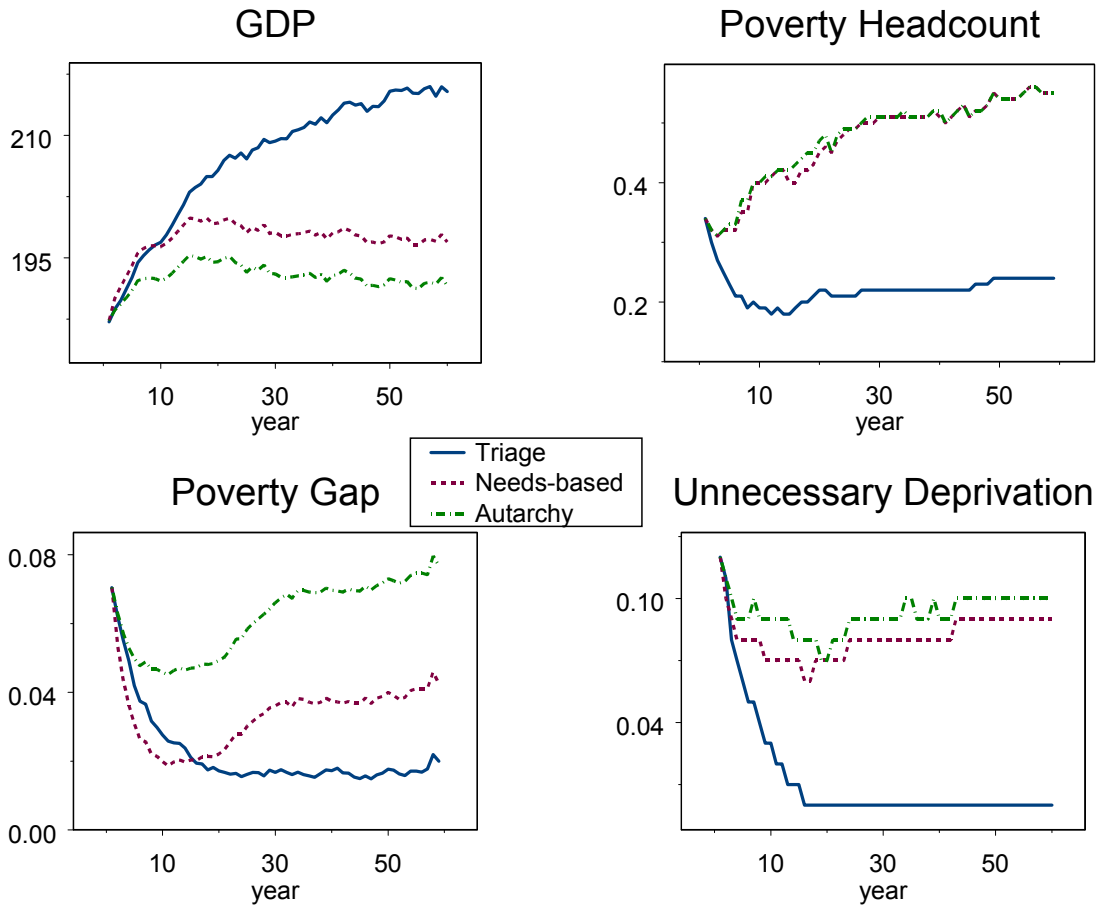


Fig. 3. Evolution of Economy-wide Indicators under Alternative Forms of Relief

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 Designing Unanticipated Social Relief to Manage the Ex Post Effects of Shocks

This section examines the impact of alternative social relief policies on our stylized economy. We use the term "social relief" to signal that these policies are implemented ex post of shocks and we (unrealistically) assume away agents' anticipation of the resulting transfers and the behavioral response that follows from such anticipation. In section 4 we explore "social protection" policies that are properly anticipated by households, who adjust their behaviors accordingly. The purpose of the present, intermediate step is to make clear the value of addressing the purely ex post effects of asset shocks, even if agents

cannot or do not expect transfers.

For all alternatives, we assume that the operational agency²¹ has access to an annual income stream or budget of $B = 5$, which amounts to 2.5% of initial GDP.²² This amount was chosen because it is insufficient to lift all initially poor individuals above the poverty line, though it is enough to substantially close the poverty gap. We further assume that the operational 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 (and underwrite unrealistically perfect targeting), using them to explore targeting of this limited assistance budget helps further illustrate the workings of the poverty trap economy. Based on those findings, we explore alternative regimes that can effectively link relief to development.

3.1 Poverty and Aid Traps under Needs-based Assistance

Under the needs-based scenario, the agency uses its budget only for humanitarian transfers. After each production cycle, it calculates the total poverty shortfall for the economy, $S = \sum_{y_i < y_p} (y_p - y_i)$. 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 method makes the largest transfers to the least well-off. This analysis also artificially assumes that individuals do not anticipate income transfers. That is, once individuals receive the transfer, they make their consumption versus investment decision according to maximization of problem (2) above and (myopically) 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 based on this extreme simplifying assumption.

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, 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

²¹ We use the broad term "operational 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.

poverty headcount and unnecessary deprivation measure under needs-based assistance follows a trajectory nearly identical to that under autarchy. 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. GDP is higher in the economy with needs-based transfer, but purely due to the extra 2.5% of GDP assumed available each year.

In a world where budgets for transfers are available exogenously (e.g., via unrequited transfers associated with overseas development assistance), needs-based transfers 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 not designed to respond to the poverty trap mechanism systematically fail 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 aid budget becomes less and less able to meet the needs of those below the poverty line. If the operational 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. 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. In their analysis of food aid, Barrett and Maxwell (2005) present evidence that such a relief trap may be emerging at a global scale. Current Official Development Assistance (ODA) figures from the OECD show that even though real ODA increased more than 60% since the mid-1970s, the share of ODA devoted to emergency assistance had increased far faster, ten-fold, from only 1% of total ODA to 10% over the same period.

3.2 Triage or Threshold-targeted Social Relief

As the prior simulations make clear, risk in our model poverty trap economy creates an ever increasing amount of unnecessary poverty that eventually overwhelms the capacity of needs-based assistance to provide relief. This observation suggests that a social relief scheme targeted at the threshold defined by the Micawber Frontier – i.e., a safety net designed to stem the increase in needless poverty – can potentially generate a win-win-win scenario, with higher rates of improved technology adoption and GDP growth, reduced poverty (especially for intermediate ability groups), and less stress on the operational agency’s budget.

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

- (1) The budget, B , is first allocated to individuals recently pushed below the Micawber Frontier. Denote these threshold-based transfers as *productive safety net* (PSN) transfers. An individual is eligible for a PSN transfer of $PSN_i = \tilde{k}(\alpha_i) - \theta_{it}[i_{it} + (1 - \delta)k_{it}]$ if $i_{it} + (1 - \delta)k_{it} > \tilde{k}(\alpha_i)$ and $\theta_{it}[i_{it} + (1 - \delta)k_{it}] < k(\alpha_i)$. In words, if an individual was above the Micawber Threshold 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 ($PSN = \sum_{i=1} PSN_i$) 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 $B > PSN$), then those mid-ability individuals already below the Micawber Frontier (due to low initial inheritance or prior bad luck not stemmed by a PSN 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 $CN > B - PSN$, then the budget is again prioritized in order to minimize headcount poverty, by first helping those closest to the Micawber Frontier.
- (3) If $B > PSN + CN$, then the residual budget is allocated according to the needs-based formulation discussed in the previous sub-section.

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.

Figure 3 again illustrates the results of this assistance regime for our stylized poverty trap economy. The results stand in strong contrast to autarchy and needs-based assistance simulation. 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 GDP (and GDP 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 one of the major challenges associated with this form of development assistance. The FGT(1) poverty gap measure is lower under needs-based assistance for the first 10-15 years of the simulation because needs-based assistance is targeted to the least well-off while the stylized triage policies are targeted to those nearest the Micawber Frontier. After 10-15 years, the remaining poor are better off under PSN design because it reduces the number of people needing assistance, allowing the fixed budget to provide more generous support to those who inevitably need it. However, 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 relief policy, both over time – do we care for the poor better today or tomorrow? – and across sub-populations of the poor – 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 poverty traps, these tradeoffs become especially sharp. Policymakers need to weigh these tradeoffs and design social relief policy accordingly.²⁴

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 poverty trap economy.

4 Using Safety Nets to Reduce the Ex Ante Effects of Risk in the Presence of Moral Hazard

In the previous section we assumed that households do not react to social relief interventions. However, one would naturally expect agents to adapt their behaviors to a known transfer regime. Indeed, Hubbard, Skinner, and Zeldes (1995) show that social insurance programs discourage precautionary savings in the United States. In this section we therefore relax the previous assumption and consider households' response to safety net transfers and the implication of such endogenous response for the design of productive safety nets. We do not consider households' endogenous response to needs-based transfers, both in the interests of brevity and because the induced behavioral effects are conceptually simpler than those with respect to safety net transfers, for reasons we explain below.

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.²⁵ In this model, accumulation of assets 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 GDP 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 transfers. If the agency 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 that runs counter to social objectives. We therefore label this effect "negative moral hazard".

The trick in designing safety net policy is to maximize the positive moral hazard effects and minimize the negative ones. In the remainder of this subsection,

²⁵ 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.

we explore the behavioral consequences of the simple PSN triage policy outlined in the previous section. We show that awareness of the safety net shifts the Micawber Frontier in a complex way due to the dual effects of positive and negative moral hazard, expanding the share of ability-wealth space from within which lower-intermediate ability households naturally gravitate toward the higher level technology and equilibrium. But it also induces significant negative moral hazard, as households that would otherwise accumulate assets and adopt the high technology become far more likely to settle around the Frontier, maximizing current consumption and the likelihood of indemnity payments from the operational agency's transfer scheme. In the next subsection we modify the safety net design slightly and show how this can substantially mitigate negative moral hazard.

Assume that the productive safety net (PSN) design is as before, with the various strong assumptions about perfect information on agents' ability, wealth and experience of shocks.²⁶ The agency publicly (and credibly) announces that it will insure against potentially catastrophic asset loss by making indemnity payments to any household that experiences a negative shock that drives its asset holdings below the autarchy Micawber Frontier $\tilde{k}(\alpha)$, with the amount of the transfer exactly the amount that restores the household's wealth to $\tilde{k}(\alpha)$.²⁷

As before, each household maximizes its expected lifetime utility given agency policy, that is, given $\tilde{k}(\alpha)$:

$$\begin{aligned} & \max_{c_t} \mathbb{E}_1 \sum_{t=1}^{\infty} \beta^{t-1} u(c_t) \\ & \text{s.t. } c_t + i_t \leq f(\alpha, k_t) \\ k_{t+1} = & \begin{cases} \tilde{k}(\alpha) & \text{if } i_t + (1 - \delta)k_t > k_g \text{ and } \theta_t[i_t + (1 - \delta)k_t] < \tilde{k}(\alpha) \\ \theta_t[i_t + (1 - \delta)k_t] & \text{otherwise} \end{cases} \quad (4) \\ & k_1, \tilde{k}(\alpha) \text{ given} \end{aligned}$$

This is the same as the problem specified in section 1 except for the important change in the law of motion governing k_{t+1} now that households are aware of and respond to the agency transfer policy.²⁸

The main result is that the anticipated safety net transfer induces some house-

²⁶ If the government cannot observe or verify α , an adverse selection problem arises too. We abstract from that possibility here.

²⁷ The existence of anticipated social insurance will of course endogenously change the Micawber Frontier so that the true threshold under insurance will be different than the insured capital stock.

²⁸ The household problem at period t can be represented in Bellman Equation form

holds to change their target capital level, from either the low or the high equilibrium levels, to the threshold at which the agency guarantees them insurance. This insurance equilibrium induces added asset accumulation by those at the low end of the intermediate ability range, but discourages asset accumulation and improved technology adoption by those in the upper end of the intermediate ability range. The northwest diagram in Figure 4 again shows the distribution of households in ability-asset space at $t = 50$ under autarchy and the Micawber Frontier by a solid line. The northeast diagram in Figure 4 shows the distribution under the safety net transfer scheme and adds the new, endogenous Micawber Frontier (the dashed line) to that which arises when agents do not adapt their behavior to the agency transfer policy. More intermediate ability households now move towards $\tilde{k}(\alpha)$ instead of either the low or high equilibrium asset levels. Fewer households with ability in the low-intermediate range, $\alpha \in [1.04, 1.06]$, remain at the low technology equilibrium asset level than under autarchy; they increase their investment following positive moral hazard. However, households in the upper-intermediate range, $\alpha \in [1.08, 1.14]$, become less likely to adopt the improved technology and hold less wealth when they anticipate the safety net transfers than when they do not. This reflects the negative moral hazard created by a guaranteed transfer. For those intermediate ability agents who would, in the absence of the safety net, accumulate capital to the high-level equilibrium, the safety net reduces their need to sacrifice current consumption in order to self-insure, thereby reducing savings and investment. The especially pernicious feature of negative moral hazard in this setting is thus that it not only increases agency indemnity payments by inducing households to choose a steady state capital stock near the payout threshold, but it also reduces household risk-taking via asset accumulation.

Figure 5 gives intuition for the emergence of this new behavior. Note that nature essentially acts as a tax collector in this model, probabilistically taking away a fraction of assets every period. Absent safety nets, the nature's expected marginal tax rate in this model is 1.7%, as shown by the solid line in Figure 5. Under the safety net scheme, individuals exactly at the safety net point ($\tilde{k}(\alpha)$) face a zero marginal tax rate as all asset losses are covered by safety net transfers. However, assets accumulated beyond the safety net trans-

as:

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

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

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

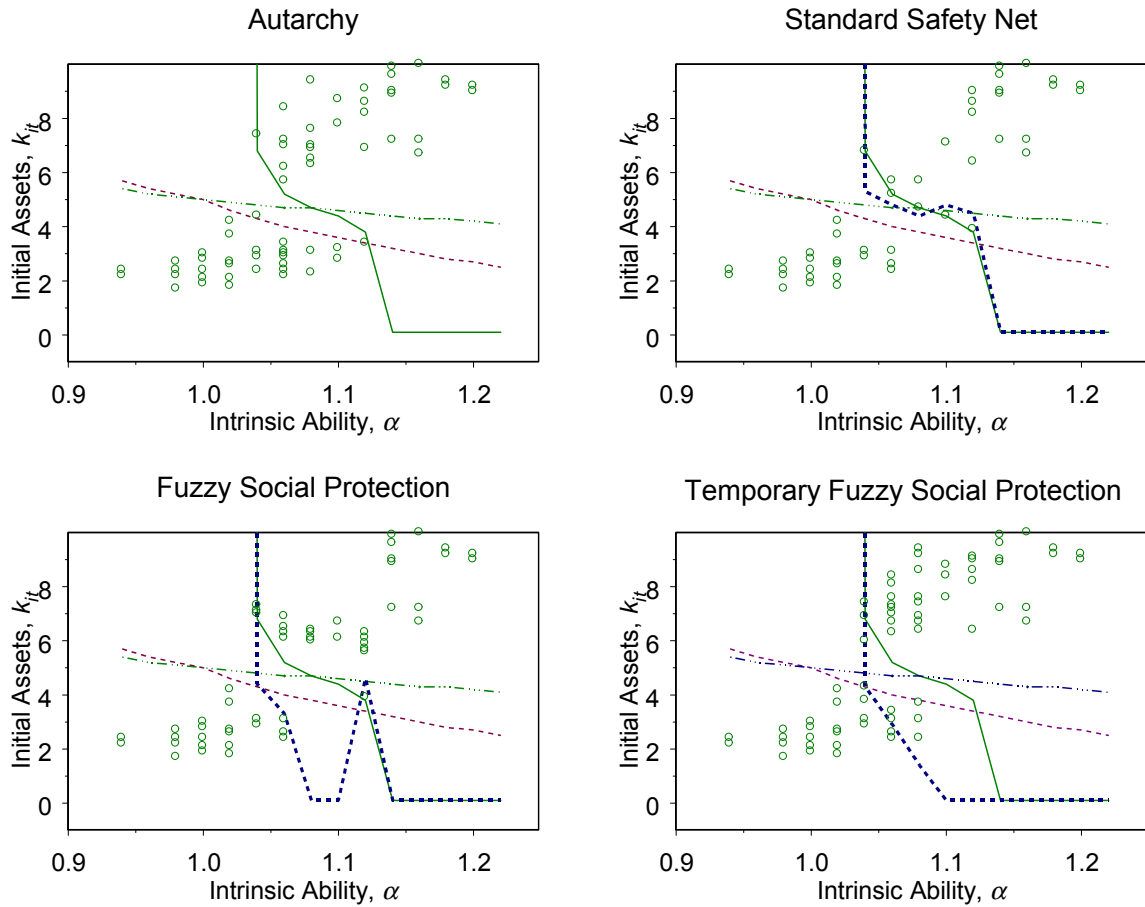


Fig. 4. Moral Hazard with Alternative Social Protection Policies

fer point face a sharply increasing marginal tax rate. As shown by the dotted line in Figure 5, under the standard safety net the marginal tax rate abruptly jumps from zero to 10%, and then slowly decreases to the natural tax rate of 1.7%. It is this sharp and discontinuous elimination of social protection as the individual moves away from the insured point $\tilde{k}(\alpha)$ that discourages accumulation and leads to a class of agents who become welfare dependent. There is an obvious analogy of this problem to that of an earlier generation of US welfare programs whose rapid elimination of benefits when an earned income threshold was crossed created extremely high effective marginal tax rates on earned income. As with those program, a solution can be found by relaxing the rate at which the social protection benefits are eliminated so as to eliminate the sharp jump in marginal tax rates.

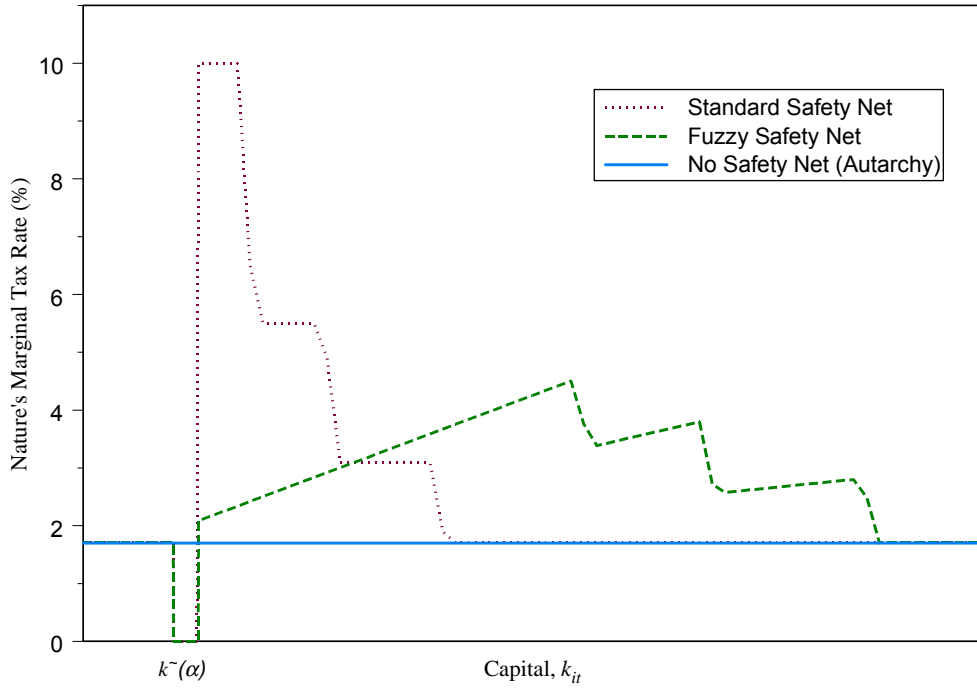


Fig. 5. Nature's Marginal Tax Rates under Alternative Social Protection Schemes

4.2 Fuzzy Safety Nets

The previous subsection demonstrated that when households naturally anticipate and react to the agency's implementation of safety net transfers, the resulting negative moral hazard sharply reduces asset accumulation, GDP, technology adoption and long-run poverty reduction (compared to what can be achieved when agents myopically do not anticipate social protection). This subsection outlines a way to overcome most of the negative moral hazard problem by modifying the simple safety net transfer scheme studied above.

Our modification is two-fold. First, we mitigate the negative effects of the safety net transfer on incentives to accumulate more than the asset threshold the agency uses to determine transfer eligibility by using a "fuzzy" transfer scheme we describe in detail below. Second, the agency announces that safety net transfer scheme is temporary. If the policy period is long enough to permit some households to accumulate assets greater than the Micawber Frontier, before the safety net policy lapses, they move to the high technology equilibrium asset level afterward but are thereafter vulnerable to catastrophic asset shocks against which the safety net previously protected them. This sort of sunset

clause to the policy is of course consistent with the well-known point that in the presence of multiple equilibria, temporary interventions can have permanent effects. Short-lived productive safety nets can stimulate additional asset accumulation and technology adoption by those intermediate ability agents who would otherwise remain chronically poor without inducing dependence on safety net transfers.

Turning to the first modification of the safety net, we can substantially mitigate the distortions created by the high marginal tax rates discussed in the prior section by modifying the productive safety net scheme. We replace the variable transfer to a fixed target asset level with a variable, fuzzy transfer to a variable ex post asset stock. Transfers now return the household to a convex combination of its pre-shock asset holdings, $i_t + (1 - \delta)k_t$, and its post-shock realized wealth, $\theta_t[i_t + (1 - \delta)k_t]$. The technical details are presented in Appendix 2. But the essence of this fuzzy safety net scheme is that expected indemnity payments in the event of loss do not decline one-for-one as agents increase their asset holdings. While expected payments are still declining in wealth, they decline more slowly, thereby attenuating the increase in the implicit marginal tax on investment. The dashed line in Figure 5 depicts the resulting expected marginal tax rate under this fuzzy safety net transfer. As can be seen, the sharp jump in the marginal tax rate is eliminated and the implicit marginal tax rate on investment is now increasing rather than decreasing in wealth beyond the threshold, generating a more progressive scheme.

The consequence of this change in effective marginal taxation of asset accumulation is striking. The southwest diagram in Figure 4 depicts household distribution in ability-asset space after 50 years and the Micawber Frontier under the fuzzy safety net transfer. By comparing the southwest diagram with the northeast in Figure 4, we see that the positive moral hazard effect is magnified by the fuzzy safety net, relative to the standard safety net, and that negative moral hazard is almost fully extinguished. There are no longer households settling at the insurance threshold $\tilde{k}(\alpha)$, receiving transfers but not adopting the improved technology. A substantial cohort of intermediate ability households now optimally accumulate more wealth, moving them comfortably above the Micawber Frontier, although the asset holdings of intermediate ability households remain below those that obtain in the naive safety nets model under which households act as if the transfer scheme does not exist (depicted in the southwest diagram in Figure 4).

The second refinement we make is to put a sunset clause on the safety net scheme, *i.e.*, the agency announces in the first period that it will terminate safety net transfer scheme at $t = T_g$. We call this the temporary fuzzy safety net transfer policy. The southeast diagram in Figure 4 depicts the resulting household distribution in ability-asset space at $t = 50$ and the Micawber Fron-

tier under the temporary fuzzy safety net transfer with $T_g = 20$.²⁹ By making a credible announcement that the safety net will not persist indefinitely, agency can take advantage of the positive moral hazard (investment-inducing) effects of the transfer scheme and, in the longer-term after T_g has passed, avoid the negative moral hazard effects. The Micawber Frontier expands leftward and down during the life of the fuzzy safety net policy, giving more households an incentive to invest, to adopt improved technologies and thereby to grow their way out of chronic poverty. Of course, after the policy lapses, the Micawber Frontier shifts back, and those who are subsequently shocked beneath the autarchic Frontier then collapse into chronic poverty. The gains of that policy thus become finite-lived.

The termination of the safety net transfer thus inevitably involves a tradeoff. If the agency does not terminate the policy, some households stay at asset levels which are inefficient in the sense that they would accumulate more if the safety net did not attenuate accumulation incentives, in addition to the added costs to the agency of making indemnity payments in additional periods. On the other hand, if the agency terminates the policy, some households with moderate ability may subsequently experience negative asset shocks and be knocked beneath the Micawber Frontier and onto the undesirable path toward the low technology, poverty trap equilibrium.

The northwest diagram in Figure 6 shows the GDP timepaths under the two different policy schemes as well as under autarchy (no safety net policy) and the needs-based social relief policy from section 3. GDP is ultimately markedly higher under either safety net program, as compared to the economy in autarchy.³⁰ But the GDP path under the temporary fuzzy safety net lies significantly above that for the permanent fuzzy safety net transfer, implying that the induced increase in asset accumulation – due to the anticipation of safety net termination as much as by the event itself – more than offsets the decrease in GDP due to households that subsequently suffer shocks. The resulting gap is of course greatest at T_g (year 20) because the added invest-

²⁹ We solve the resulting optimization problem backward: First, solve the problem at $t \geq T_g + 1$ and obtain $V(k_t, t)$ and $i_r^*(k_t, t | \alpha, \Omega)$ for $t \geq T_g + 1$, which are the same as those under autarchy. Second, given $V(k_{T_g+1}, T_g + 1)$, solve the problem at $t = T_g$ and obtain $V(k_{T_g}, T_g)$ and $i_r^*(k_{T_g}, T_g | \alpha, \Omega)$. Third, given $V(k_{T_g}, T_g)$, solve the problem at $t = T_g - 1$ and obtain $V(k_{T_g-1}, T_g - 1)$ and $i_r^*(k_{T_g-1}, T_g - 1 | \alpha, \Omega)$. Iterate this backward until $t = 1$.

³⁰ For almost 15 years, the needs-based relief scheme outperforms the other schemes illustrated here. However, as the southeast graph in Figure 6 shows, the amount of transfers under the needs-based scheme is almost double that under the other schemes. Given this budget difference, it is remarkable that under the fuzzy safety net scheme, GDP catches up and eventually surpasses that under the needs-based scheme. This result clearly illustrates that the former schemes are working by crowding in private accumulation.

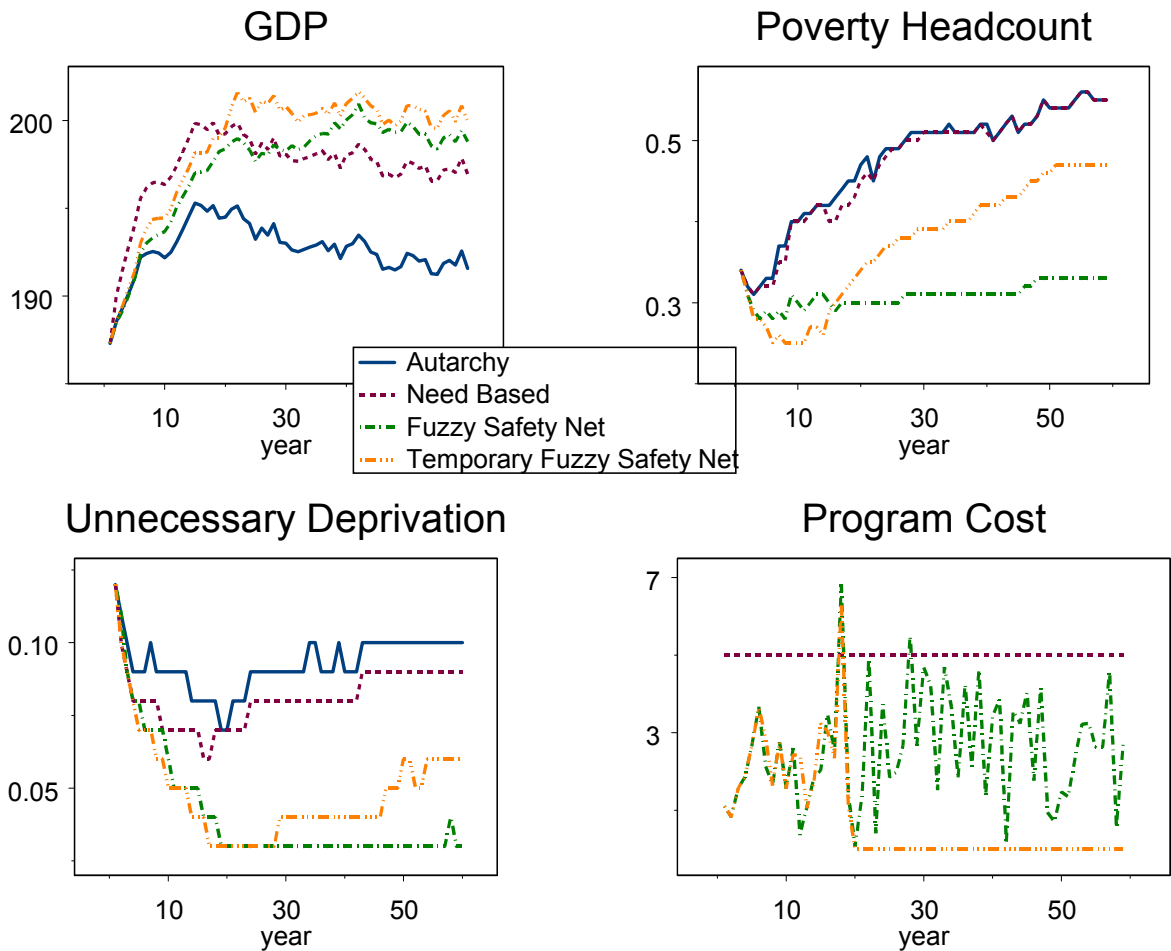


Fig. 6. Evolution of Indicators under Alternative Social Protection Regimes

ment incentives apply throughout the simulation but the absence of the safety net is only felt after that time. The GDP gap between the two safety net schemes steadily narrows thereafter as the loss of asset protection after safety net termination begins to slowly take a toll.

That toll is most starkly reflected by the poverty headcount and unnecessary deprivation indicators shown in the northeast and southwest diagrams of Figure 6, respectively. The temporary fuzzy safety net outperforms the permanent fuzzy safety net by both measures up until the former policy terminates. After year 20 (T_g), poverty and unnecessary deprivation remain steadily low under the fuzzy safety net policy but trend upward in the economy whose safety net has lapsed.

We do not impose budget constraints on the fuzzy safety net transfer policy since it is not easy to calculate the equilibrium in which household's expectations of the timing and amount of transfer receipts are consistent with actual

timing and amount of transfer receipts and budgets constraints are satisfied. But as the southeast diagram in Figure 6 indicates, the fuzzy safety net policy tends to cost the operational agency far less than the needs-based transfers under a fixed budget explored in section 3. The time-discounted present value of actual spending for the permanent fuzzy safety net transfers is 43.6, less than half the 95.2 cost of the needs-based transfers. The discounted present value cost of the temporary fuzzy transfer policy is only 27.3 due to its shorter lifespan. Thus in cost-benefit terms using any of our key indicators, social policy based on productive safety nets outperforms either autarchy (no assistance to poor or vulnerable households) or needs-based social relief policy.

5 Conclusions

This paper has put forward a stochastic dynamic programming model of a poverty trap economy 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 are born with insufficient access to productive capital and are below the critical asset threshold needed to make it dynamically optimal to undertake the short-term sacrifices inherent to long-term investment.

Using this framework, we show that needs-based, unanticipated social relief policies 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 shocks. Members of this latter group steadily fall into needless chronic poverty, adding to the pool of individuals needing income support. The result is that while the depth of poverty is initially reduced among the poorest of the poor, their lot deteriorates over time due to increasing competition for limited relief resources. Moreover, the numbers of people suffering poverty do not change appreciably, nor does wealth accumulation, economic output or adoption rates of improved technologies.

We then show that an unanticipated triage policy that prioritizes threshold-targeted social protection for the intermediate wealth and ability group creates a “productive safety net” that largely eliminates needless chronic poverty and boosts growth through endogenous asset accumulation and adoption of improved technologies. While this triage policy still confronts important trade-offs among different poor people and over time, this theoretical exercise establishes the potential gains to threshold-targeted social protection.

As the Lucas critique famously showed, any policy naturally induces a be-

havioral response. We therefore go on to explore what happens when social protection is fully anticipated and demonstrate how safety nets have a complex effect on individuals' investment behavior in the presence of poverty traps. In particular, an anticipated safety net induces some individuals to accumulate more assets than they would otherwise, which naturally stimulates economic activity and reduces poverty. But anticipated social protection also discourages others from investing beyond the range where they remain eligible for transfers, as externally-provided insurance effectively displaces self-insurance through asset accumulation. This effect retards economic growth, technology adoption and progress in the fight against poverty. We term these effects positive and negative moral hazard, respectively. The balance between them is manipulable through the design of the safety net. We show that by altering the payoff scheme slightly and by introducing a credible, known sunset clause to terminate the safety net program after a period of years, the positive effects can be magnified and the negative ones effectively extinguished. Of course, the price of these gains is the loss of safety net protection beyond the expiration of the policy, which leads to later increases in poverty.

Ultimately, the key finding of this paper is that poverty traps can have a pronounced effect on the performance and appropriate design of policy 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 poverty traps. Whatever its analytical complexity, the analysis here has nonetheless massively oversimplified the real world. Improvements to the model are clearly possible, perhaps especially by endogenizing the ability parameter, α . The more substantive research agenda, however, likely involves empirically identifying critical asset thresholds (the Micawber Frontier, as we have called it) and then seeing if threshold-targeted assistance can really liberate human potential to craft pathways from poverty.

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: $k = \{0.1, 0.2, \dots, 15.0\}$ and $\alpha = \{0.94, 0.96, \dots, 1.22\}$.

For the simulation of the stylized economy of 100 individuals we draw α from $N(1.08, 0.074^2)$, 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 $\text{Uniform}[0.1, 10.0]$ 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 $y_p = 1.62$.

Appendix 2: Fuzzy Safety Net Transfers

Denote the safety net insurance threshold as k_g . In order to decrease the negative moral hazard effect of safety net transfers, *i.e.*, the disincentive to accumulate assets beyond k_g , we smooth k_{t+1} in $(i_t + (1 - \delta)k_t, k_{t+1})$ space. The best way to understand the idea is to draw figures in $(i_t + (1 - \delta)k_t, k_{t+1})$ space. Under section 3's assumptions, when a household gets $\theta_t < 1$, the k_{t+1} line is flat in the region $i_t + (1 - \delta)k_t \in (k_g, k_g/\theta_t)$. Thus the expected loss due to a negative asset shock increases rapidly when a household increases $i_t + (1 - \delta)k_t$ from k_g to k_g/θ_t . This is why some households stick at the point where $k_t = k_g$.

In section 4, we modify safety net transfer so that k_{t+1} is increasing in the region $i_t + (1 - \delta)k_t \in (k_g, k_g/\theta_t)$ where $\theta < 1$ and thus the expected loss increases less rapidly when a household increases $i_t + (1 - \delta)k_t$ from k_g to k_g/θ_t than occurs under the previous PSN design. Under the new transfer scheme, k_{t+1} follows the following transition rule:

$$k_{t+1}(k_t, i_t, \theta_t, k_g, \delta) = \begin{cases} [\eta(\cdot) + (1 - \eta(\cdot))\theta_t][i_t + (1 - \delta)k_t] & \text{if } i_t + (1 - \delta)k_t > k_g \\ & \text{and } \theta_t[i_t + (1 - \delta)k_t] > \xi_g k_g \\ \theta_t[i_t + (1 - \delta)k_t] & \text{otherwise} \end{cases} \quad (5)$$

where $\xi_g > 1$ is a constant the agency sets (we let $\xi_g = 1.5$) and $\eta(\cdot) \in [0, 1]$ is a function of $i_t + (1 - \delta)k_t$, more precisely

$$\eta = 1 - \frac{1}{\xi_g \frac{k_g}{\theta_t} - k_g} [i_t + (1 - \delta)k_t].$$

Note that when a household receives a transfer under this smoothed safety net scheme, k_{t+1} is a convex combination of $i_t + (1 - \delta)k_t$ and $\theta_t[i_t + (1 - \delta)k_t]$ and the following:

$$\eta \begin{cases} = 1 & \text{if } i_t + (1 - \delta)k_t = k_g \\ \in (0, 1) & \text{if } i_t + (1 - \delta)k_t \in (k_g, \xi_g k_g/\theta_t) \\ = 0 & \text{if } i_t + (1 - \delta)k_t = \xi_g k_g/\theta_t \end{cases}$$

The household problem at period t is:

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

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

where $k_{t+1}(k_t, i_t, \theta_t, k_g, \delta)$ is defined by (5).

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Summary Findings

This paper demonstrates that there are potentially large returns to social protection policy that stakes out a productive safety net below the vulnerable and keeps them from slipping into a poverty trap. Much of the value of the productive safety net comes from mitigating the ex ante effects of risk and crowding in additional investment. The analysis also explores the implications of different mechanisms of targeting social protection transfers. In the presence of poverty traps, modestly regressive targeting based on critical asset thresholds may have better long-run poverty reduction effects than traditional needs-based targeting.

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