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*Risk Responses to Dynamic Asset Thresholds**

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A recurring theme in development economics is that risk affects individual production, consumption, exchange, and investment behaviors in ways that ultimately shape income and wealth distributions. Arrow's Decreasing Absolute Risk Aversion conjecture implies that the poor prefer low return, low risk activities, while the rich more quickly adopt higher return, higher risk activities. The resulting divergence in microlevel growth rates may create a risk-aversion-induced poverty trap. This risk aversion-to-asset dynamics logic has fueled decades of research.

In this thought piece, we casually explore the possibility of the opposite causality: might underlying patterns of asset dynamics affect risk-related behaviors? Suppose (*a*) that asset dynamics in a particular context are nonconvex for reasons unrelated to risk and (*b*) that individuals accurately perceive the location and severity of key dynamic thresholds. Should not we expect individuals to adjust their behavior, including their risk responses, near these thresholds accordingly? We hypothesize that, relative to static risk preferences as commonly captured by the concavity of contemporaneous utility function, the rational adjustment involves greater risk avoidance just above the dynamic asset threshold and greater risk taking just below it. After a brief literature review, we sketch out a conceptual model and discuss suggestive empirical evidence before concluding with a few thoughts on possible extensions of this line of research and its relevance to policymaking.

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Background

The notion of threshold-induced risk responses is not entirely new. But these behavioral responses have typically been buried in preferences and therefore, have remained a largely implicit analytical feature. In their classic article, Friedman and Savage motivated their double inflection, "wiggly" utility curve with a loose reference to implicit wealth dynamics that make it difficult for individuals to move to higher socioeconomic classes and hence, induces risk seeking when upside payoffs would allow them to move to a higher class. In their words, "the segments of diminishing marginal utility correspond to socioeconomic classes, the segment of increasing marginal utility to a transitional stage between a lower and a higher socioeconomic class" (p. 304).

Others subsequently explored these underlying dynamics slightly more explicitly, but continued to embed them in preferences. In these earlier models, deviations from conventional concave utility functions are attributed to indivisible human capital investments (Yew Kwang), credit market imperfections (Hakansson), or nutritional subsistence constraints (Kunreuther and Wright)—features that reappear in the more modern literature on asset dynamics and poverty traps. The role thresholds play in decision making under risk is most explicit in safety-first formulations (Roumasset), but even these embed threshold effects in preferences rather than in the structure of the decision problem.

Recent work on asset poverty and wealth dynamics allows us to bring these dynamic effects out of the black box of preferences. Theoretical research on wealth dynamics made significant progress in the 1990s, while more recent econometric work using detailed panel datasets provides supporting evidence of nonconvex asset dynamics associated with multiple equilibrial systems (Barrett et al.; Hoddinott; Lybbert et al.).

The core insight of these models and empirical findings on poverty traps is that in some settings, there may be asset levels at which investment behavior naturally bifurcates, with decumulation occurring (on average) below the threshold, and accumulation above it. This may be due to physiological processes associated with child growth and undernutrition, to indivisibilities associated with particular production technologies or other exogenous factors. But the key feature of such multiple equilibrial systems is the existence of at least one dynamic asset threshold. Banerjee draws on this feature to contrast the nature of poverty above dynamic asset thresholds—which he labels "vulnerability" to being shocked into the basin of attraction of the low-level equilibrium—with that of poverty below these thresholds—which he refers to as "desperation" associated with expected chronic poverty in the low-level equilibrium.

A Conceptual Model of Asset and Risk Thresholds

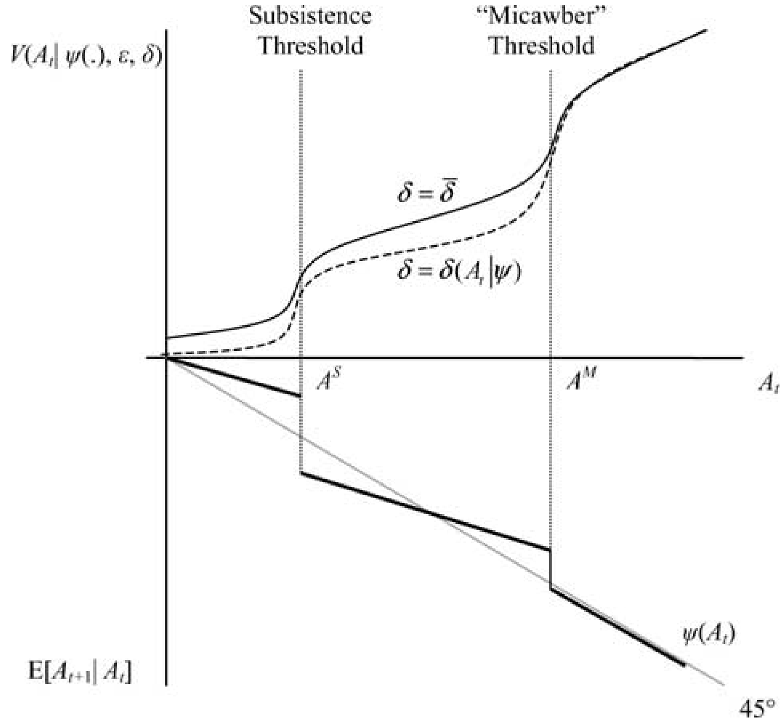
As a stylized illustration of how nonconvex asset dynamics might affect risk-related behavior, consider a system with two distinct dynamic asset thresholds. The first is a nutritional subsistence threshold. Those who fall below this threshold suffer weakened immune, muscular, and nervous systems that invite illness, injury, and cognitive impairment, thereby increasing the likelihood of degradation in human capital. Those who remain above the threshold can accumulate productive human capital, both cognitively and physically. One example of such a threshold emerges from basic micronutrient deficiencies early in life, such as iodine deficiency, a leading cause worldwide of intellectual impairment.

The second dynamic asset threshold defines a point at which the accumulation process of physical (nonhuman) assets bifurcates. This "Micawber" threshold (Zimmerman and Carter) evokes the Dickensian travails of Wilkins Micawber, the perpetually insolvent debtor in *David Copperfield* who moves in and out of different jobs and debtor's prison, unable to advance. Lybbert et al. and Santos and Barrett (2006a), for example, use different data sets from southern Ethiopia to describe how wealth dynamics shift markedly as pastoralists' livestock holdings fall below a minimum herd size necessary to sustain migratory herding, forcing collapse into sedentarized livestock keeping. That herd size threshold results in distinct wealth equilibria that pastoralists themselves recognize and to which they respond (Santos and Barrett 2006a, 2006b).

Consider a graphical depiction of these asset dynamics. Let A_t represent a composite asset stock reflecting some index of human, physical and financial capital. Assume this asset index follows some exogenous, nonconvex dynamics such that subsistence and Micawber thresholds exist and people accurately perceive these dynamics. For simplicity, let the dynamics be described by the piecewise linear recursion function $\psi(A_t) = E[A_{t+1} \mid A_t]$ and a stochastic shock $\varepsilon_t \sim N(0, \sigma^2)$ such that the realized asset stock in a period $t + 1$ is given by $A_{t+1} = \psi(A_t) + \varepsilon_t$. The bottom panel of figure 1 shows these exogenous asset dynamics where the 45° line represents the locus of dynamic equilibria. Consider the present value of an asset stock conditional on these dynamics across a range of initial asset levels. The top panel of figure 1 shows such a value function, $V(.)$ where δ is the discount rate. Since perceived asset dynamics may affect time preferences, this value function is shown for both a constant discount rate $\bar{\delta} \geq 0$ and an endogenous discount rate $\delta = \delta(A_t \mid \psi)$ where $\delta(A_t < A^S \mid \psi) > \delta(A_t \in [A^S, A^M) \mid \psi) > \delta(A_t \geq A^M \mid \psi) \geq 0$ (Becker and Mulligan).

The explicitly dynamics-driven "wiggles" in the value function induce a risk response near each dynamic asset threshold—a response that is magnified under endogenous discounting (figure 1). Consider the associated behavioral implications above and below a dynamic threshold. Just above the subsistence threshold, "households may manage their assets primarily to avoid ever falling below a certain consumption-minimum, and only secondarily to smooth consumption" (Zimmerman and Carter, p. 238). Note (*a*) that this risk-averse response is due to concavity in an intertemporal value function caused by asset dynamics and should emerge even among households with risk neutral contemporaneous utility functions, and (*b*) that asset smoothing is conceptually indistinguishable from the safety-first, lexicographic preferences popular in the 1970s. Indeed, assuming lexicographic preferences among Philippine rice farmers, Roumasset realized that a minimum caloric intake subsistence threshold was irrelevant for most farmers. Instead, Roumasset (foreshadowing the concept of asset smoothing) defined the relevant threshold as the level of

Figure 1. Asset recursion function (bottom) and an implied intertemporal asset value function (top)



income "sufficient so that families would not sell non-liquid assets to finance what they considered to be necessary household expenses" (p. 161).

With respect to changes in assets, the relevant threshold definition is not a consumption level per se, because forward-looking agents make dynamic adjustments *before* pure subsistence thresholds bind. Empirical tests find strong evidence of asset smoothing above perceived dynamic asset thresholds among the rural poor in Africa (Barrett et al.; Hoddinott). Analogously, with incentives to grow their funds, mutual fund mangers know that net inflows fall when calendar year returns relative to the market are negative. Fund managers tend to decrease the riskiness of their portfolio in the fourth quarter when their relative performance in the first three quarters is positive (Chevalier and Ellison).

Those just below a dynamic threshold are threatened with further decline into a poverty trap and may take excessive risks to escape this inertia. That "desperate circumstances call for desperate measures" is widely substantiated in both wild animals and humans. For animals (especially cornered ones), the response is likely an evolutionary adaptation that maximizes fitness. For humans, desperation ranks with thrill seeking as perhaps the most common motives for risky behavior. Victor Hugo writes of the powerful motivation desperation creates in the character Jean Valjean in *Les Miserable*. As a starving, illiterate, orphaned, unemployed peasant with a sister and seven starving nieces and nephews to feed during an especially hard winter, Valjean broke a baker's window to steal a loaf of bread and subsequently spent 19 years in prison.

Such stories of desperation-driven behavior are common in literature but largely absent from economists' explanations of human behavior. In drier economic language, the convex portions of the value function just below the thresholds in figure 1 capture such desperate risk taking when the perceived dynamics to which individuals feel subject are represented by the function $\psi(.)$. Again, this local convexity is created by perceived dynamics rather than preferences. Allowing for endogenous discounting—imagine Jean Valjean's discount rate the night he stole the bread—magnifies this convexity and, with it, desperate risk taking. Lastly, notice that in this two threshold model the risk taking of those just below the A^M threshold is naturally bounded by the presence of the yet lower threshold A^S. In contrast, those just below this lowest threshold face more dire circumstances, and their degree of risk taking may be bounded by their limited assets rather than by the threat of a deeper poverty trap.

It is worth citing a few examples of excessive risk taking below dynamic thresholds. Subsistence farmers, both our contemporaries in poor countries and those in the U.S. south during the early nineteenth century, may devote relatively large shares of their land to risky cash crops (Kunreuther and Wright). In arid regions of Kenya and Ethiopia, pastoralists often resort to cattle raiding as a strategy to secure bride wealth in order to marry, accumulate labor through marriage (and reproduction), and/or reconstitute herds decimated by drought, disease, or others' raids (Hendrickson, Mearns, and Armon; Markakis). Also in Kenya, women appear to take on risky sex work in response to shocks such as a family illness (Robinson and Yeh).

A truly global example of risk taking among those trapped in poverty is illegal migration and consensual participation in human trafficking. Such desperate acts bear striking similarity to excessive risk taking associated with skewness seeking in lottery participation (Yew Kwang), at the horse track (Golec and Tamarkin), and among mutual fund managers who gamble with riskier fourth quarter portfolios in order to catch the market or make "best fund" lists (Chevalier and Ellison).

Implications for Research and Policy

The conjecture of risk response as a consequence, not just a cause, of asset dynamics raises two important research questions and at least three key policy implications. First, there may be value to studying agents' perceptions of dynamics more explicitly. In order for dynamic thresholds to induce behavioral responses, individuals must perceive key features of the asset dynamics they face. Relatively simple and discrete asset spaces—as with herd sizes (Hoddinott; Lybbert et al.; Santos and Barrett 2006a)—likely facilitate accurate perceptions of wealth dynamics. Yet people may show unnecessary desperation, insufficient prudence, or excessive caution based merely on (potentially inaccurate) perceptions of feeling trapped, safe, or hopeless about making progress, respectively. Such distinctions between structural and psychological poverty traps raise some fascinating behavioral economic research questions.

A second line of research suggested by this conjecture involves the analysis of risk-taking behavior as an indirect, even allegorical route to identifying dynamic thresholds. Even in contexts where individuals are likely to perceive and respond to dynamic thresholds, estimating these dynamics empirically has proved very challenging, not least because of severe data limitations. Observable risk responses near thresholds may offer an indirect route to studying these dynamics.

Focus group discussions and carefully designed surveys (e.g., Santos and Barrett 2006a) may first suggest asset ranges over which individuals perceive dynamic thresholds. Observable risk taking may then be used to confirm the presence of risk response discontinuities at specific asset ranges. These elicited perceptions and observed risk responses may provide somewhat of a behavioral shadow of a threshold on a given dynamic path. Two examples of such behavioral shadows of dynamic thresholds are worth citing. Kunreuther and Wright posit the existence of subsistence constraints of rice consumption, then translate these thresholds into asset (land) thresholds. They find evidence of risk taking in the form of greater relative allocation of land to cash crops among farmers near these thresholds. Recent work on asset smoothing suggests that individuals typically make asset and investment adjustments before subsistence thresholds become threatening. Thus, instead of positing the existence of relevant subsistence constraints *ex ante*, one might more carefully study land allocation patterns and, in conjunction with other survey evidence, search for discontinuities in land allocated to relatively risky cash crops.

Next, having established that people accurately perceive dynamic thresholds, Santos and Barrett (2006b) find that inclusion in informal insurance networks is partly conditioned on an individual's asset position relative to key thresholds. Those who fall below a commonly perceived threshold are less likely to benefit from informal insurance because their ability to reciprocate in the future is expected to be quite limited. In this way, patterns of inclusion and exclusion in reciprocity networks may reveal behavioral shadows of dynamic asset thresholds.

While the possibility of studying asset dynamics indirectly via risk responses is intriguing, there are at least two important complications to such an approach. There is good reason to expect that dynamic thresholds are conditioned on individual- or household-level traits (Santos and Barrett 2006a). The more difficult it is to observe the variables that condition these dynamics (e.g., ability), the harder it is to identify them precisely, if at all. Another potential complication involves heterogeneous responses to thresholds. In contexts with relatively simple asset spaces, responses are more likely to be similar than in systems with more complex asset spaces, where responses may involve many possible combinations of assets. In such settings, a sharp distinction between consumption and asset smoothing may be misleading since "the true distinction lies in households' choices regarding what type of capital—physical, financial, social, or human (and which human)—that they should draw down given an income shock" (Hoddinott, p. 302).

Lastly, consider a few policy implications of risk responses to asset dynamics. First, if desperation-driven acts (e.g., crime, sex work) impose negative externalities on society, there may be added merit in asset building (so-called "cargo net") programs—e.g., free public schooling—that reduce one's need to take chances in order to accumulate productive assets. Second, the provision of safety nets to protect the assets of those just above dynamic asset thresholds—e.g., catastrophic health insurance, limited liability laws—can discourage excessive risk avoidance and thereby increase entrepreneurial activity and expected growth. Third, educational campaigns to improve individuals' perceptions of risks and thresholds—e.g., uninsured flood and storm damage to homes and the severe disruption associated with homelessness—may help achieve more socially efficient allocation and levels of risk-taking behaviors.

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References

Arrow, K.J. *Essays on the Theory of Risk Bearing*. Chicago: Markham Publishing, 1971.

Banerjee, A. *The Two Poverties*, S. Dercon, ed. Oxford: Oxford University Press, 2004.

Barrett, C.B., et al. "Welfare Dynamics in Rural Kenya and Madagascar." *J. Devel. Studies* 42(2006):248–77.

Becker, G.S., and C.B. Mulligan. "The Endogenous Determination of Time Preference." *Quart. J. Econ.* 112(1997):729–58.

Chevalier, J., and G. Ellison. "Risk Taking by Mutual Funds as a Response to Incentives." *J. Pol. Econ.* 105(1997):1167–1200.

Friedman, M., and L.J. Savage. "The Utility Analysis of Choices Involving Risk." *J. Pol. Econ.* 56(1948):279–304.

Golec, J., and M. Tamarkin. "Bettors Love Skewness, Not Risk, at the Horse Track." *J. Pol. Econ.* 106(1998):205–25.

Hakansson, N.-H. "Friedman-Savage Utility Functions Consistent with Risk Aversion." *Quart. J. Econ. Aug* 84(1970):472–87.

Hendrickson, D., R. Mearns, and J. Armon. "Livestock Raiding among the Pastoral Turkana of Kenya." *IDS Bulletin* 27(1996):17–30.

Hoddinott, J. "Shocks and Their Consequences across and within Households in Rural Zimbabwe." *J. Devel. Studies* 42(2006):301–21.

Kunreuther, H., and G. Wright. *Safety-first, Gambling, and the Subsistance Farmer*, J.A. Roumasset, J.-M. Boussard, and I. Singh, eds. Laguna, Philippines, Southeast Asian Regional Center for Graduate Study and Research in Agriculture, 1979.

Lybbert, T.J., C.B. Barrett, S. Desta, and D.L. Coppock. "Stochastic Wealth Dynamics and Risk Management among a Poor Population." *Econ. J.* 114(2004):750–77.

Markakis, J. *Conflict and the Decline in Pastoralism in the Horn of Africa*. London: Macmillan, 1993.

Robinson, J., and E. Yeh. *Sex Work as a Response to Risk in Western Kenya*. Princeton University/UC Berkeley, 2006.

Roumasset, J.A. *Rice and Risk: Decision-making among Low-income Farmers*. Amsterdam; New York: American Elsevier Pub. Co., 1976.

Santos, P., and C.B. Barrett. *Heterogeneous Wealth Dynamics: On the Roles of Risk and Ability*. Cornell University, 2006a.

——. *Informal Insurance in the Presence of Poverty Traps: Evidence from Southern Ethiopia*, unpublished manuscript, Cornell University, 2006b.

Yew Kwang, N. "Why Do People Buy Lottery Tickets? Choices Involving Risk and the Individisbilty of Expenditure." *J. Pol. Econ.* 73(1965):530–35.

Zimmerman, F.J., and M.R. Carter. "Asset Smoothing, Consumption Smoothing and the Reproduction of Inequality under Risk and Subsistence Constraints." *J. Development Econ*, 71(2003):233–60.