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Comment on Chapters 7 and 8

Edward B. Barbier

There is mounting evidence that remote, less favored agricultural lands, which face severe biophysical constraints on production and are in locations with limited market access, are significant *poverty-environment* traps.[1] Such traps occur when the unique environmental and geographic conditions faced by poor households in such regions are important factors determining the dynamics of the poverty trap.[2] For marginal agricultural areas, the key characteristics are that production is subject to low yields and soil degradation, while lack of access to markets and infrastructure limit improvements to farming systems or restrict off-farm employment opportunities. Consequently, "the evidence most consistent with poverty traps comes from poor households in remote rural regions" (Kraay and McKenzie 2014, 143), "the extreme poor in more marginal areas are especially vulnerable," and "one concern is the existence of geographical poverty traps" (World Bank 2008, 49).

These two chapters highlight another characteristic, which is the vulnerability of agroecosystems on marginal lands to withstand, or be resilient, in the face of external environmental shocks such as changes in rainfall, temperature, or drought (Chavas), and the resulting impact of these environmental risks on wealth accumulation of affected households (Santos and Barrett). Thus, the chapters offer important insights to the burgeoning literature on poverty traps in marginal agricultural areas.

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1. See Barbier (2010) and Barbier, López, and Hochard (2016) for recent reviews.
2. To my knowledge, the first analysis of this phenomenon is by Jalan and Ravallion (2002).

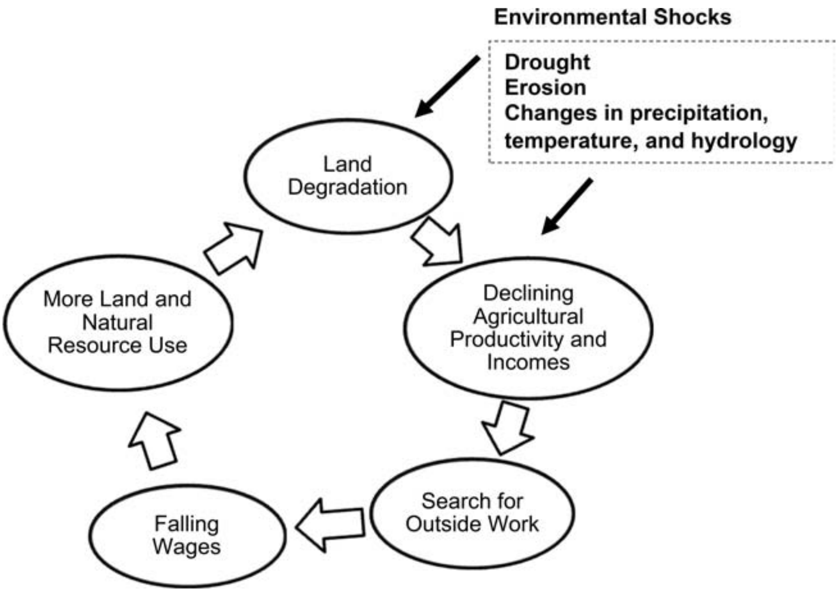

Fig. 7/8C.1 The poverty trap and environmental shocks

Source: Based on Barbier (2010).

Note: In marginal agricultural areas, household responses to land degradation and natural resource dynamics can lead to a downward spiral of poverty. Environmental shocks further tighten the vicious cycle that characterizes this poverty trap.

Figure 7/8C.1 (based on Barbier 2010) illustrates the elements of the poverty trap that can occur in marginal areas, and the threat posed by environmental risks. The vicious cycle depicted in the figure is inherently a dynamic process that can lead to a downward poverty spiral for many households in such areas. Because much of the available land has low productive potential, is located far from markets and discourages investment in land improvement, agriculture is prone to topsoil degradation, biomass loss, and low productivity. As agricultural productivity and incomes decline over time, poor households allocate more labor for outside work to boost or supplement incomes. However, with large numbers of households seeking outside employment in these isolated areas, the supply of labor for paid work could exceed demand, causing the market wage to decrease. If the wage rate falls below the reservation wage of households, they are forced to reallocate household labor back to agricultural production and extracting natural resources from the surrounding environment. The result is the self-perpetuating vicious cycle depicted in figure 7/8C.1. Persistent and periodic environmental risks such as drought, erosion, and changes in precipitation, temperature, and hydrology, are shocks to this cycle that may directly affect poor households in marginal areas through causing declining agricultural productivity and income, or indirectly through affecting land and natural resource use (see figure 7/8C.1). Such shocks further tighten the vicious cycle that characterizes the poverty trap. The result affects not only the livelihoods of households, but also their ability to accumulate and maintain key agricultural and natural resource assets. Over the long term, households caught in this poverty trap either remain destitute or must face the difficult choice of migration to other areas.

The key contributions of these two chapters is to determine the conditions that make vulnerable households in marginal areas more "resilient" to the environmental shocks and poverty trap effects depicted in figure 7/8C.1, and whether policy responses may affect the degree of resilience.

Comments on Chapter 8

Exploring the nonlinear dynamic response of agroecosystems in marginal areas to environmental shocks is the key focus of the chapter by Jean-Paul Chavas. He distinguishes between "resilience," which is the probability of escaping from undesirable zones of instability toward zones that are more desirable and stable, and a "trap," which is the low probability of escaping from zones that are both undesirable and stable. Such zones are analogous to the type of vicious cycle depicted in figure 7/8C.1. Chavas uses threshold quantile autoregression (TQAR) to estimate how the dynamics of a specific agroecosystem, and especially how the resilience of the system and the presence of traps, might vary with both current shocks and past states. This approach is applied to wheat yields in the US Great Plains state of Kansas from 1885 to 2012. Over this period, the Great Plains have experienced many periods of severe drought, including the devastating Dust Bowl of the 1930s.

Chavas's findings are inherently optimistic and encouraging. His analysis suggests that successive adverse shocks will lead to a zone of instability, which could reduce the odds of escaping from a "trap." However, this instability might be local, and thus the odds of falling into a trap may not necessarily be inevitable, as implied by the movement away from unstable equilibria to a low-level, long-run equilibrium in conventional poverty trap models. For example, Chavas suggests that the Dust Bowl of the 1930s was an example of an extreme environmental shock that initially induced profound local instability to wheat-farming systems in Kansas, but ultimately induced significant changes in agricultural management and policy that led to improved resilience over the long run. One policy innovation was the creation of the US Soil Conservation Service in 1935, which improved farm practices, increased land values and boosted farm incomes, as well as facilitated a range of continuous innovations that began in Great Plains wheat farming during the immediate post–World War II era.

Overall, the long-run analysis by Chavas of the dynamic conditions leading to resilience as opposed to traps is compelling. Traps are more likely to arise in the absence of management and policy response to adverse shocks, whereas induced innovations in management and policy can be a crucial part of designing a more resilient system. However, there are two important developments that should also be considered in the long-term analysis of the wheat production in the Great Plains and the United States.

First, over the period of analysis 1885–2012, the United States changed profoundly from being an economy dominated by agricultural land expansion through small-scale agricultural smallholdings employing traditional farming methods to an advanced industrialized economy based on mineral wealth exploitation, manufacturing, and commercial services (Barbier 2011, ch. 7). This raises an important question: Can all of the rises in wheat yields in Great Plains agroecosystems be attributed solely to specific policy and management responses to adverse shocks, such as the Dust Bowl, or were economy-wide agricultural innovations leading to total factor productivity increases also relevant? Certainly, there is substantial evidence that from the 1920s onward increased development and use of chemical-based fertilizers, mechanization, and irrigation expansion contributed significantly to the rising productivity and yields of US agriculture (Barbier 2011; Federico 2005; Goklany 2002; Rhodes and Wheeler 1996). The most successful example of such agricultural development occurred in the Great Plains, where beginning in the 1930s the expansion of rural electric cooperatives and low-cost, government-supplied electricity made large-scale, groundwater-based irrigation farming both very productive and profitable, facilitating the remarkable recovery of the region from economic devastation of the Dust Bowl years (Rhodes and Wheeler 1996).

Second, environmental shocks, such as drought and the devastating Dust Bowl of the 1930s, were not the only dislocation faced by farming in the Great Plains in the early half of the twentieth century. The region also suffered from the prolonged economic shock of the massive western "farm failure" that was triggered by the fall in crop prices after World War I (Alston 1983; Hansen and Libecap 2004a, 2004b; Libecap 2007). The combination of drought, especially the Dust Bowl, and declining commodity prices changed profoundly the structure of western farming (Libecap 2007). The immediate effect was a large migration of rural households fleeing drought-prone areas. A longer-term consequence was gradual farm consolidation.

In sum, the wheat-farming systems that emerged in Great Plains states such as Kansas during the second half of the twentieth century may have been more resilient than previously thought. But they were fundamentally different systems that were also transformed by economy-wide agricultural developments. Moreover, the farm foreclosures, widespread out-migration, and farm consolidation meant that farm populations and structures were irrevocably changed by the persistent environmental and economic shocks that occurred during the interwar period. As Hansen and Libecap (2004a, 2004b) have shown, the small farms with limited market access that were prevalent in the region were too inefficient as productive units to escape the pressures of natural resource degradation and the loss of wealth from rising debt that precipitated the vicious poverty trap cycle depicted in figure 7/8C.1. For these destitute farming families, the only escape from widespread collapse of smallholder farming across the Great Plains was through massive migration from the region.

Comments on Chapter 7

Santos and Barrett illustrate the asset-based approach to analyzing poverty traps (Carter and Barrett 2006) with a case study of Boran pastoralists in southern Ethiopia. As the authors point out, for these households their livestock herds are their main, and possibly only, nonhuman asset. Even opportunities for employment locally are severely limited. In the remote, less favored semiarid zones that these pastoralists inhabit, the dynamic poverty trap mechanism may be affected by both environment risk, such as sparse rainfall and drought, and differences in herding ability among the various livestock owners, which includes diverse skills such as treating livestock diseases and injuries, protecting cattle against predators, navigating to grazing and water sites, managing calving, and so on. Moreover, risk and ability may be related. Whereas periods of poor rainfall might drive all pastoralists toward a low-equilibrium poverty trap, those with better herding ability may be able to avoid this outcome through more efficient livestock management. Based on these assumptions, the authors investigate the hypothesis that a herder's ability conditions wealth dynamics, especially when faced with unfavorable environmental conditions such as low rainfall.

Overall, their findings confirm this hypothesis. Regardless of any differences in their ability, all herders expect their herds to grow in good and normal rainfall years, whereas S-shaped dynamics occur for herders in bad rainfall years. However, when adverse rainfall conditions occur, lower-ability herders appear to converge to a unique low-equilibrium herd size (one to two head of cattle over time). Instead, multiple dynamic equilibria can occur for high-ability herders; in addition to the stable poverty trap equilibrium of one to two head, there is an unstable equilibrium at eleven to seventeen cattle, and a relatively wealthier stable steady state at twenty-nine to thirty-five head. Thus, even under adverse environmental conditions, higher-ability herders will be able to avoid a poverty trap and accumulate wealth as long as they can maintain herd size above the eleven to seventeen cattle threshold. Moreover, additional scenario analysis suggests that there should be both an increase in average herd size and a large increase in inequality over time, as low-ability herders are unable to escape poverty and higher-ability herders steadily grow their livestock holdings.

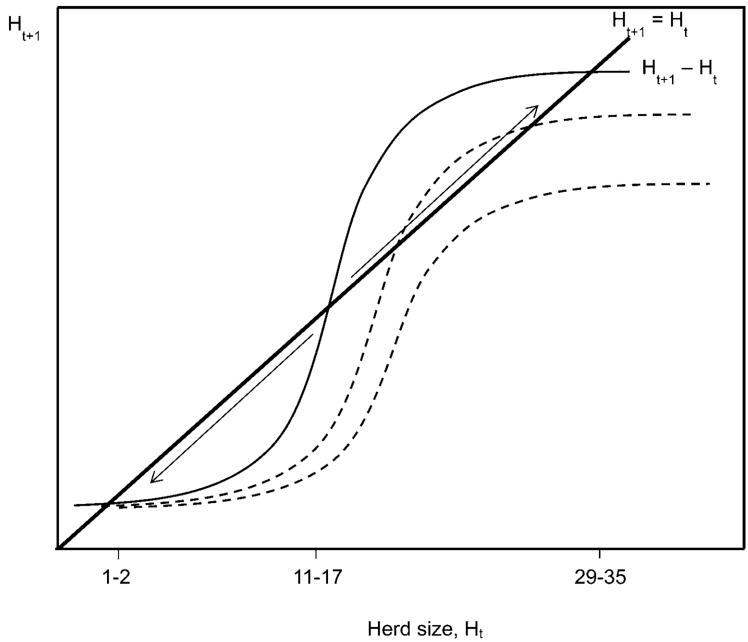

Fig. 7/8C.2 Herd dynamics for high-ability herders under poor rainfall conditions

Note: Prolonged drought and adverse rainfall may also cause the vegetation dynamics of pasture biomass to change, thus causing the herd dynamics curve to shift down (dotted line). Pasture degradation may compound the problem, making high cattle-stocking rates unsustainable. The result over the long run may be a single low-asset stable equilibrium even for high-ability herders.

However, a surprising omission is consideration of another important "natural" asset, which is the pasture biomass that sustains cattle. Since Torell, Lyon, and Godfrey (1991), dynamic economic models of cattle stocking on open rangeland have shown that reduced future forage production, diminished range condition, and reduced performance interact to determine how many cattle can be kept on a given rangeland area, both currently and over time. Such factors are especially relevant for semiarid rangelands that experience uncertain rainfall. For example, Quaas and Baumgärtner (2012, 368) find that "optimal stocking density varies with both reserve biomass and rainfall," although density choices are also affected by the degree of risk aversion of herders.

The impact of poor rainfall on vegetation dynamics, the implications for potential overgrazing in the long run, and the resulting effects on equilibrium herd size could influence the expected herd dynamics portrayed by Santos and Barrett. Not much is likely to change for low-ability herders, who will still converge to the poverty trap herd size of one to two head of cattle when adverse rainfall conditions prevail. However, high-ability herders could be significantly affected, especially if lack of rainfall also leads to changing stocking density and thus greater pasture degradation over the long term as well, as described by Quaas and Baumgärtner (2012). For instance, one possible outcome is for the S-curve for high-ability herders to pivot downward (see figure 7/8C.2). The result is that the unstable equilibrium for herd size is now higher, possibly twenty to twenty-five head of cattle. Higher-ability herders will now only be able to avoid a poverty trap and accumulate wealth if they can maintain herd size above this increased threshold. But if poor rainfall conditions and higher stocking rates on given pasture area also lead to deteriorating vegetation, then the result may be overgrazing. The higher stocking rates above twenty to twenty-five cattle that high-ability herders require to avoid a poverty trap may not be sustainable over long periods of poor rainfall. The ensuing pasture degradation from overgrazing will cause the S-curve to pivot further downward, and the only outcome for all herders is the poverty trap equilibrium of one to two head of cattle (figure 7/8C.2). This is exactly the downward poverty spiral depicted in figure 7/8C.1.

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