Mechanism 4: Dynamics and Resilience in Natural Resources and Agriculture

Comments on “Heterogeneous Wealth Dynamics: The Role of Risk and Ability” (Santos and Barrett) and “Agro-Ecosystem Productivity and the Dynamic Response to Shocks” (Chavas)

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Geographic poverty traps

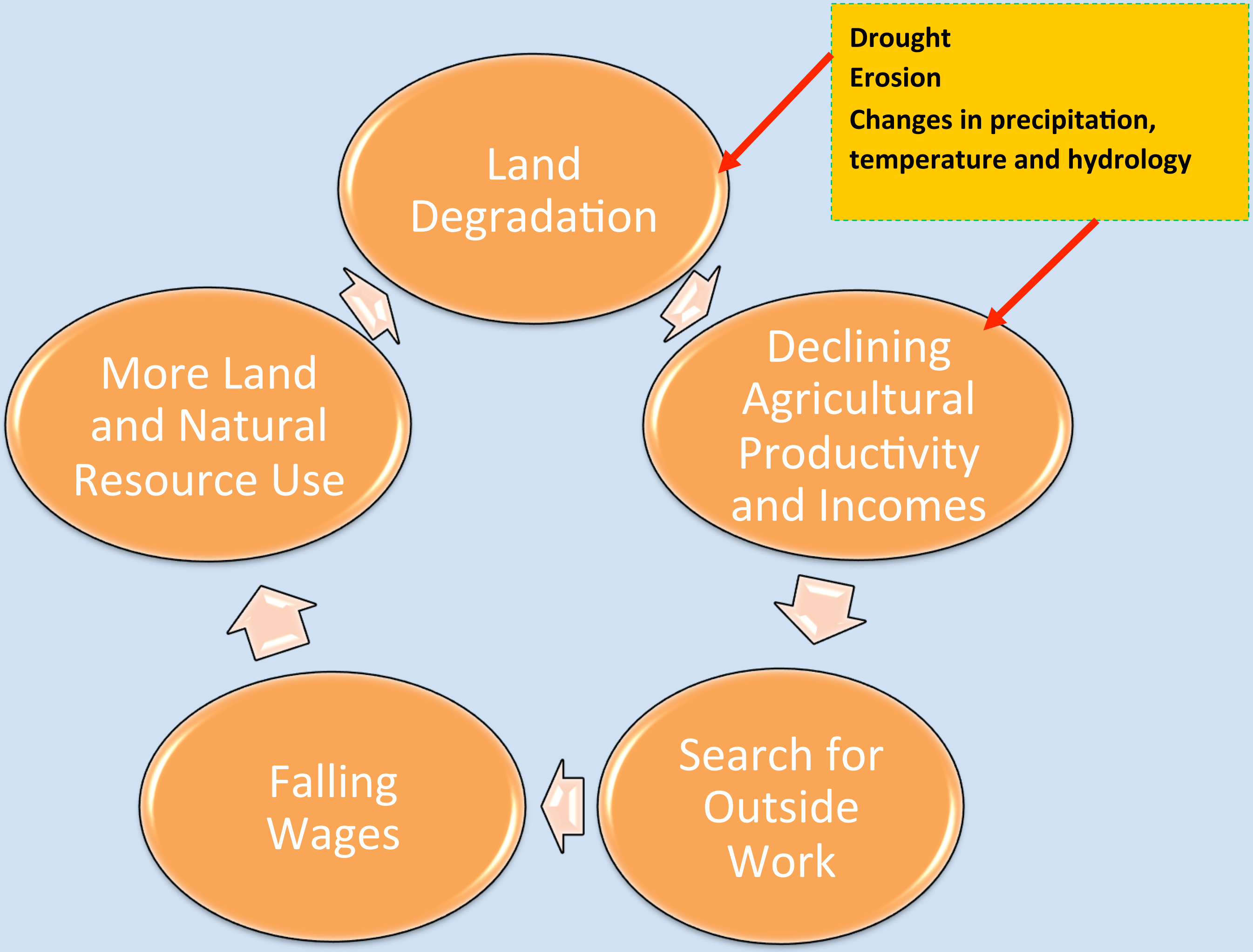
- **Remote less-favored agricultural lands**
  - face severe biophysical constraints on production (e.g. difficult terrain, poor soil quality, or limited rainfall)
  - have limited access to markets (e.g. five hours or more travel to a market town with a population of at least 50,000)
- World Bank (2008, p. 49): "the extreme poor in more marginal areas are especially vulnerable" and "one concern is the existence of geographical poverty traps".
- Kraay and McKenzie (2014, p. 143): "The evidence most consistent with poverty traps comes from poor households in remote rural regions".

Key characteristics

- If remote less favored agricultural lands in developing countries are prone to such traps, we should observe a high incidence of poverty in such regions.
- We should also be able to show, both analytically and empirically, how their unique environmental characteristics and remoteness affect household consumption growth.
- These two papers highlight a third characteristic:
  - the instability of these agro-ecosystems to withstand, or be resilient, in the fact of external environmental shocks, such as changes in rainfall, temperature or drought (Chavas)
  - the resulting impact of these environmental risks on wealth accumulation of affected households (Santos and Barrett)

The geographic poverty trap and environmental shocks

Barbier, E.B. 2010. "Poverty, development, and environment." *Environment and Development Economics* 15:635-660.



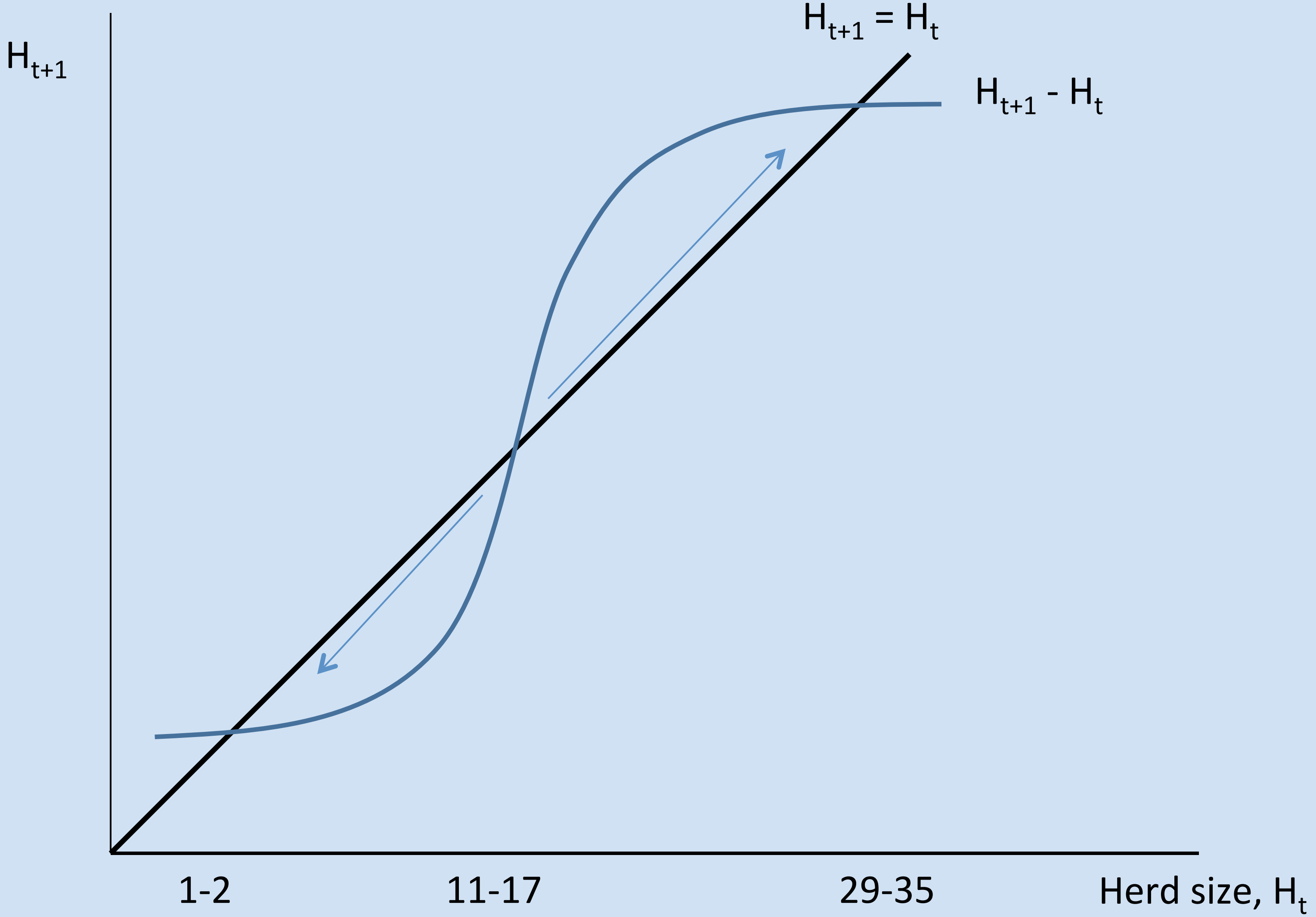
Comments on Santos and Barrett

- Santos and Barrett take a pragmatic asset-based approach to analyzing poverty traps among Boran pastoralists in southern Ethiopia.
- As the probability of moving out poverty is quite low (less than 12%), a poverty trap is defined as "a high probability that agents will remain at lower levels of welfare" (p. 18).
- Given that livestock are the main store of wealth, herd size "serves as an excellent proxy for overall wealth" (p. 4)
- *Hypothesis:* a herder's ability conditions wealth dynamics, especially when faced with unfavorable environmental conditions such as low rainfall.

Key findings

- All herders expect their herds to grow in good and normal rainfall years, whereas S-shaped dynamics occurs for herders in bad rainfall years.
- When adverse rainfall conditions occur, lower ability herders appear to converge to a unique low-equilibrium herd size (1-2 head of cattle over time).
- Multiple dynamic equilibria can occur for high ability herders
  - a stable poverty trap equilibrium of 1-2 head
  - an unstable equilibrium at 11-17 cattle
  - a relatively wealthier stable steady state at 29-35 head.
- Additional analysis: "we should expect both an increase in average herd size and a large increase in inequality over time, as low ability herders collapse into destitution and higher ability herders steadily grow their livestock holdings" (p. 27).

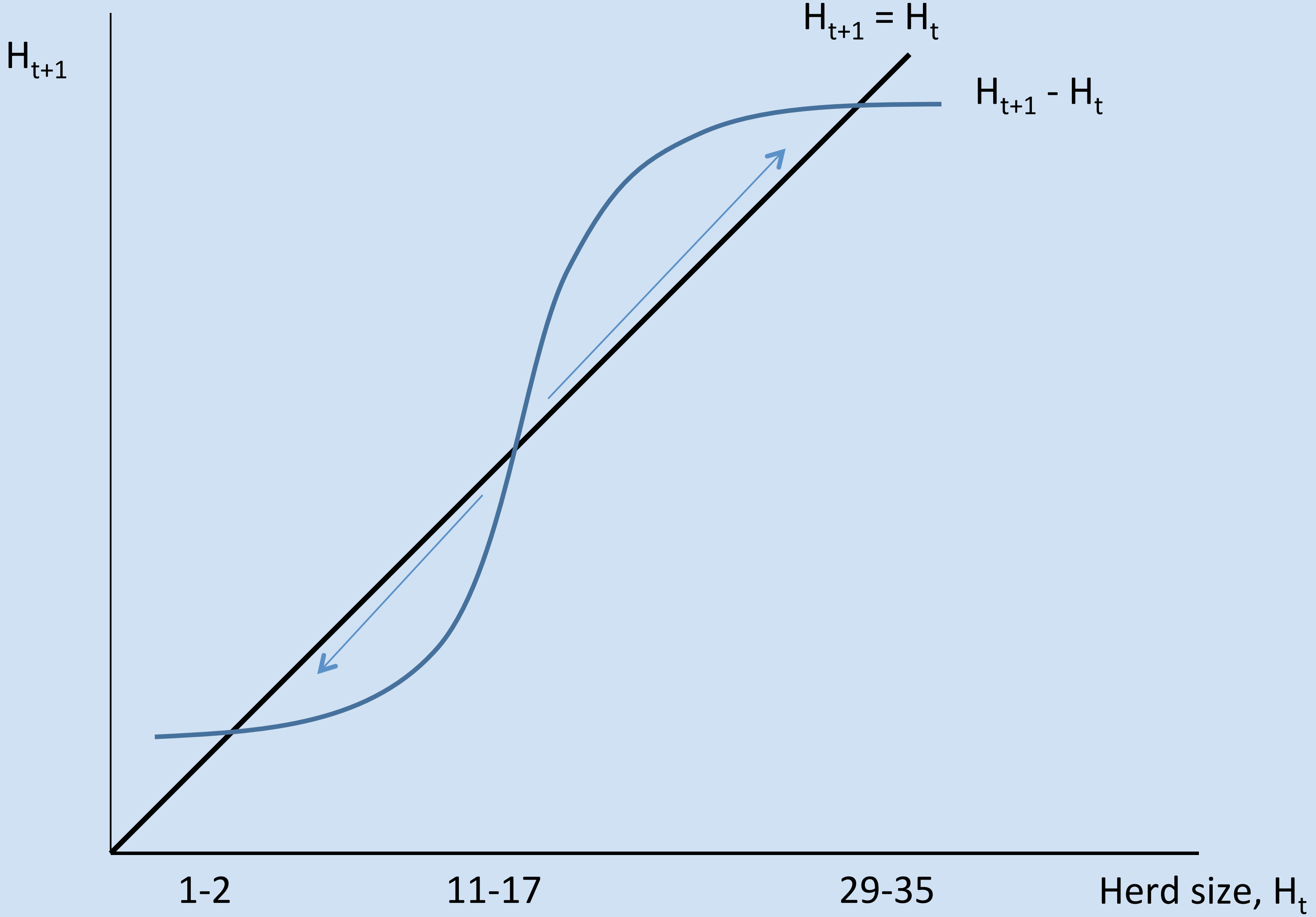
Herd dynamics for high-ability herders under poor rainfall



Poor rainfall, pasture biomass and degradation

- *Optimal stock density models:* 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.
- "Stocking rates determined to be economically optimal over the single period may not be optimal at all when dynamic forage impacts are considered" (Torell et al. 1991, p. 795)
- Quaas and Baumgartner (2012) show that rainfall conditions affect simultaneously two important jointly determined stocks for herders: livestock and "reserve biomass":
  - "the dynamics of the vegetation is not only influenced by the current precipitation, but also depends on the history of precipitation and grazing" (p. 368)
  - "optimal stocking density varies with both reserve biomass and rainfall", although density choices are also affected by the degree of risk aversion of herders (p. 380).

Herd dynamics for high-ability herders under poor rainfall



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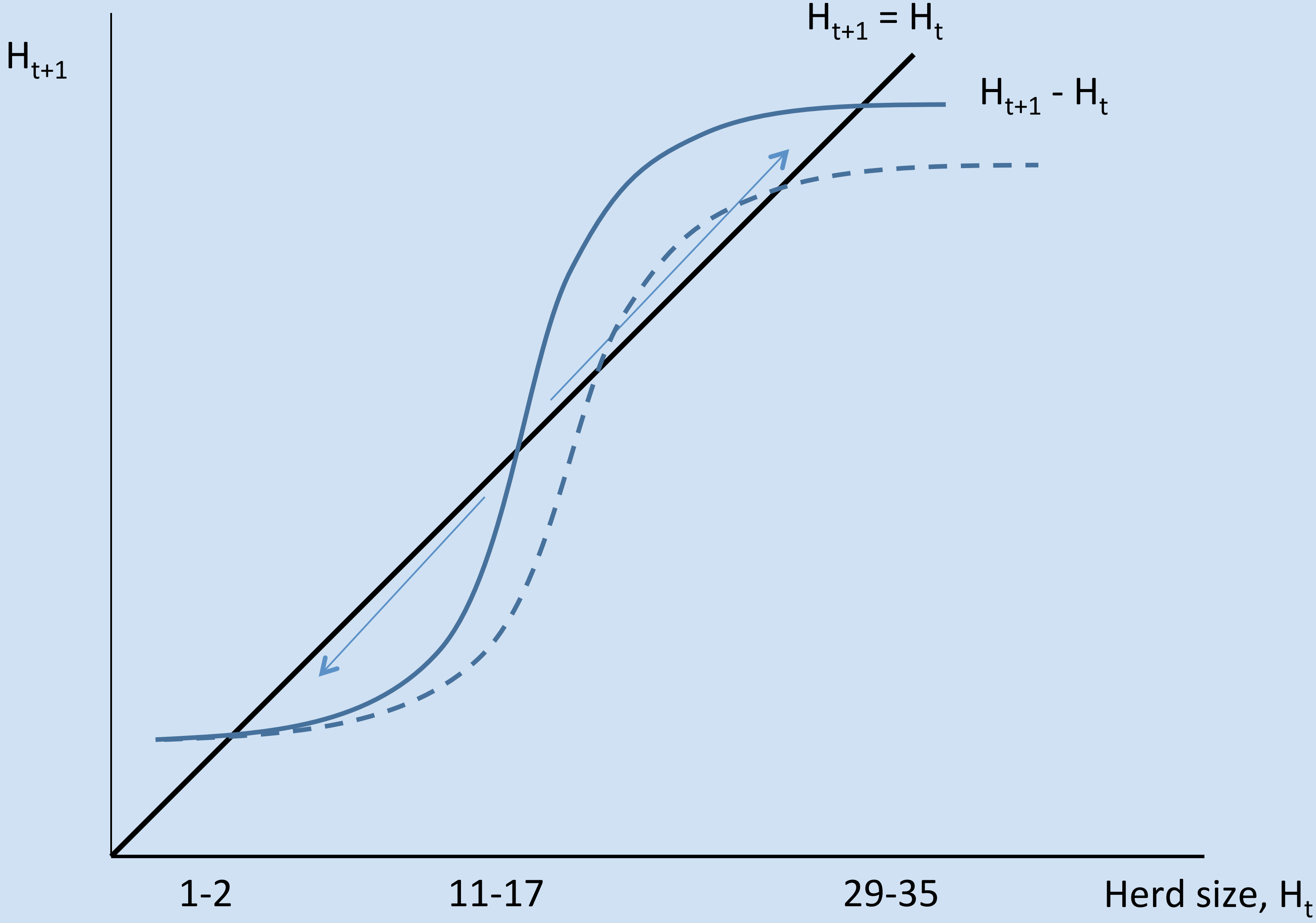

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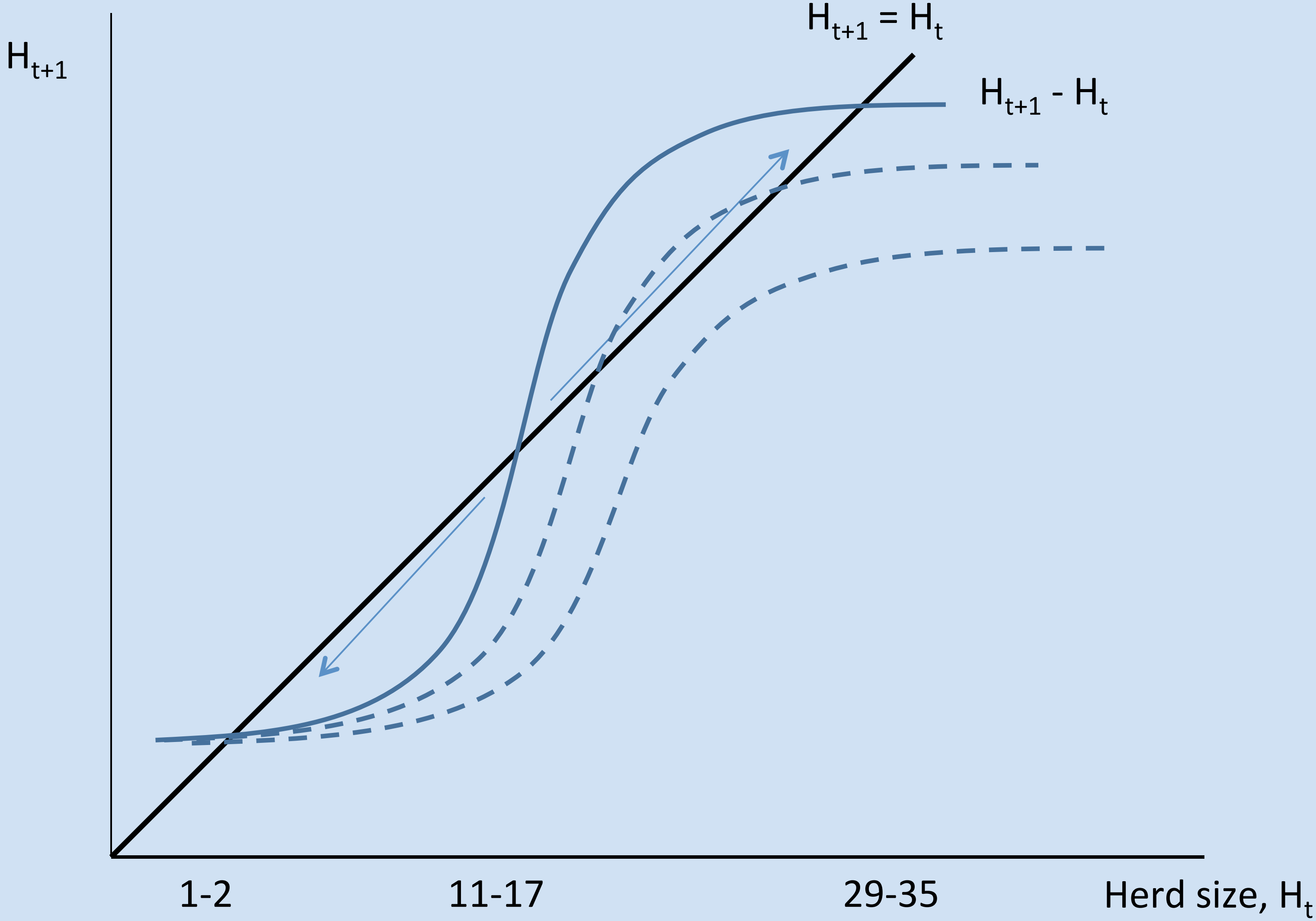

Comments on Chavas

- Explores the nonlinear dynamic response of agro-ecosystems to environmental shocks, distinguishing between zones of resilience as opposed to traps.
- Uses threshold quantile autoregression (TQAR) to estimate how the dynamics of a specific agro-ecosystem, and especially how the resilience of the system and the presence of traps, might vary with both current shocks and past states.
- Applied to wheat yields in the US Great Plains state of Kansas from 1885 to 2012, which experienced many periods of severe drought, including the devastating Dust Bowl of the 1930s.

Key findings

- The 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.
- "All escape scenarios are about identifying local instability…. our analysis uncovered evidence of resilience as local instability tends to create an escape away from unfavorable events toward improved outcomes" (Chavas, p. 23).
  - The Dust Bowl of the 1930s initially induced profound local instability to wheat farming systems but ultimately induced significant changes in agricultural management and policy that led to improved resilience over the long run.
  - Creation of the U.S. Soil Conservation Service in 1935, which also facilitated profound changes in improving farm practices, increasing land values and boosting farm income as well as a range of continuous innovations.

Economy-wide agricultural development

- Can all of the rises in wheat yields in Great Plains agro-ecosystems be attributed solely to specific policy and management responses to adverse shocks, such as the Dust Bowl?
- Or was there another important factor, such as the long-run "transformation to a more productive and commercial U.S. agriculture from the 1920s onward due largely to economy-wide technological progress? The result was less input required per unit output, fewer and larger farms, lower costs of production, and above all, increased substitution of energy and capital for land and labor" (Barbier 2011, p. 492).
  - increased development and use of chemical-based fertilizers and mechanization, harnessing water resources and irrigation, expansion of rural electrification.

Economic shocks

- During the long-term fall in commodity prices from 1921 to 1940, mortgage debt and foreclosure rates for Western farms were at their highest rate, especially in the northern Great Plains (Alston 1983; Hansen and Libecap 2004a and 2004b; Libecap 2007).
- As pointed out by Libecap (2007, p. 277), "small, Great Plains farms not only were less likely to survive drought, but they were more vulnerable to commodity price fluctuations.
- The immediate effect was a large migration of rural households fleeing drought-prone areas.
- The longer term consequence was gradual farm consolidation and a profound change in the structure of Great Plains farming.

Poverty traps for some, resilience for others

- The wheat farming systems that emerged in Great Plains states such as Kansas during the second-half of the 20th century may have been more resilient than previously.
- 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 that farm populations and structure were irrevocably changed by the persistent environmental and economic shocks that occurred during the interwar period.
- The small farms that predominated 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 (Hansen and Libecap 2004a and 2004b)