The Sisyphean Pursuit of Evidence for Poverty Traps

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Abstract

Much of development economics, both micro and macro, posits theories and explores the empirics of poverty traps. A common theory centers around asset-threshold poverty traps in which marginal returns to capital increase sharply over a certain threshold and financial markets are incomplete. This combination leads households above this threshold to prosper while those below continuously fall back, trapped in poverty. Yet in economics, as best as we can tell, far more papers assume such thresholds than empirically demonstrate them. In a key recent exception, Balboni et al. (2022) (hereinafter "BBBGH") argues that data from Bangladesh identifies clear evidence of such a threshold at slightly above the cost of a cow for recent recipients of a big push transfer program. We apply this analysis to data from seven other similar programs in low-income countries and find no evidence of an asset-threshold poverty trap. We then return to BBBGH and argue that their data do not support the identification of a poverty trap, with the point of disagreement being a log-transformation challenge and a potential geographic confound. In long-term representative rural panel data from Bangladesh and Ghana we find no evidence of divergence away from any particular threshold. While the threshold theory is undoubtedly true for some households, we argue that the pursuit of clear evidence of an asset-threshold poverty trap for a broad population is likely an aspirational goal rendered unachievable by the intersection of a multitude of possible mechanisms as well as heterogeneous agents.

Keywords: poverty, poverty traps, analysis replication, transfers, Graduation programs
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I. Introduction

Poverty traps are a central organizing idea of development economics. If there is a poverty trap, then poverty can generate conditions that perpetuate poverty. Prosperity, likewise, can provide the foundation for continued prosperity. An intervention or policy change that permits an escape from a poverty trap can generate long-term prosperity. Similarly, a negative shock can induce persistent poverty. Self-reinforcing mechanisms that keep the poor poor (and the not-so-poor out of poverty) come in many flavors, operating at different scales over different time periods. All poverty trap theories depend on market failures of some type, with borrowing, saving, or insurance market frictions either central to, or a necessary complement to, the core story. All are difficult to identify in data.

An underlying challenge for empirical analysis of poverty traps is posed by the diversity of mechanisms that could generate a trap and what each mechanism predicts empirically. As reviewed in Kraay and McKenzie (2014) and Ghatak (2015), mechanisms vary by scale (individual, household, firm, market, sector, country), by timing (days, weeks, months, years, generations), and by nature (nutrition, human capital, technology, institutional, investment indivisibility, etc.). Each of these has implications for the empirical identification strategy, as well as the unit, object, and timing of the needed data.

From a broad array of possible mechanisms for poverty traps, development economics has focused attention on physical capital and nonconvex technologies generated by locally increasing returns or fixed costs. A family of multi-faceted transfer interventions (hereinafter "Graduation Programs"), modeled on a program designed by the Bangladeshi non-governmental organization BRAC, has achieved remarkably positive and persistent long-run impacts by both BRAC and other institutions (Bandiera et al. (2017); Banerjee et al. (2015, 2021), although Barker et al. (2024) finds fading treatment effects in Ethiopia). The programs' impacts are observed in trials randomized at the household or community level (rather than industry or region) and over a time frame of years (rather than days or generations). These are the kind of impacts that one might observe if the asset transfer typically at the center of the Graduation program is sufficient to move recipient households from a low-level stable equilibrium to or across the unstable threshold of an asset-threshold poverty trap with investments that yield returns within months or years rather than decades[1].

Balboni et al. (2022, hereinafter "BBBGH") studies the Bangladesh implementation by BRAC of the Graduation program and argues that the long-term pattern amongst those that receive this big push is evidence of a threshold slightly above the cost of a cow. We start our empirical analysis in Section III by examining seven other implementations of the Graduation program to see if we draw similar conclusions in the other settings. Six of the seven cases are from Ethiopia, Ghana, Honduras, India, Pakistan, and Peru (reported in Banerjee et al. (2015)) and the seventh is from another BRAC-implementation in Bangladesh, but in a different year and location than BBBGH (Beam et al., 2025). We do not find persuasive evidence in any of the seven. In each case, we focus on post-transfer asset dynamics of the treatment group that received a large productive asset transfer. This failure does not imply the absence of a poverty trap: we may lack sufficient power to detect a trap, or the threshold could be outside the range of the post-transfer assets of these programs.

We next show our reexamination of the BBBGH analysis. Due to a combination of two issues, functional form assumptions associated with a log transformation of assets (Section IV) and omitted geographic confounds (Section V), we come to a different conclusion about the strength of the evidence for an asset-threshold poverty trap[2]. We conclude that geography, more so than the households' starting asset levels, drives the observed divergence in asset growth (Section VI).

[1]Other mechanisms could explain this success, as the Graduation program includes a rich array of components designed to complement the asset transfer, and an active research community is examining their complementarity as well as the treatment effect with and without cash transfers. For example, Banerjee et al. (2022) finds that, in Ghana, an arm transferring only indivisible assets (goats) fails to produce long-run effects without the other components; Bossuroy et al. (2022) finds that a strong psycho-social component without lump-sum cash transfers generates effects similar to the full program; and Mahmud and Riley (2025) finds that a universal-within-the-village program focused on savings and behavior change– with de minimis transfers– generates strong results.

[2]However, we do confirm the strong conclusion that the program generates large, economically-important average treatment effects on asset holdings, income and consumption, estimates consistent with those reported in Bandiera et al. (2017), see Appendix Table 1.

We then examine wealth transition functions and the predictive power of geography for later wealth in a broader sample of households from the BBBGH villages, and in long-term representative rural panel data collected in Bangladesh and Ghana (Section VII). We find no evidence for a threshold-based asset poverty trap in any of the time periods we examine in these representative data, nor do we detect a strong pattern of geographical clustering of asset growth.

We conclude with a discussion of this Sisyphean challenge, and in particular point to critical lacking information: better understanding of the returns, risks, and required inputs to livelihood options for low income households.

II. The Challenge of Identifying Asset-Threshold Poverty Traps

An important subset of theories of poverty traps concerns capital – physical, financial or human, and has the common feature of increasing marginal returns to capital over some range, often with a kink or discontinuity. We focus on a particularly common model for the study of low-income households: an asset threshold in which there is an indivisible asset that generates higher returns than achievable without that asset, combined with capital market frictions that prevent acquisition of the more productive indivisible asset. Put forward by Banerjee and Newman (1993), this could apply to both households and firms, since capital market frictions could affect either. This model also has clear implications for policies that promote household livelihood and enterprise development, such as cash transfer and multi-faceted social protection programs. It also at first glance appears to provide cleaner empirical predictions. There would be a canonical "S-curve" transition function of assets on future assets that crosses the 45 degree line from below, thus indicating multiple equilibria with units above some threshold prospering and those below that threshold worsening. And the equilibrium distribution of assets could have multiple modes at the stable equilibria outside the poverty trap.

Increasing marginal returns to capital also underlies several human-capital led trap models (see Loury (1981); Azariadis and Drazen (1990); Galor and Zeira (1993)). Barham et al.

(1995) also puts forward a human-capital led model, but one driven by the opportunity cost of acquiring education for subsistence households. Durlauf (1996) extends these human capital centric models geographically, pointing to community-level traps driven by local externalities combined with locally-financed public education.

Last within the individual and household models, the original literature on traps focused on nutrition-based models in which poverty led to low nutrition which led to low labor productivity which led to low wages, thus a self-enforcing trap (Leibenstein 1957; Mazumdar 1959; and, extended by Dasgupta and Ray (1986) to understand the consequences in equilibrium).

For firms, other mechanisms beyond increasing marginal returns to capital could generate traps. For example, the matching of tasks to workers when there are complementarities in production can generate increasing returns to worker skill, and the matching process generates a self-reinforcing pattern of investment in worker skill (Kremer 1993). This applies to firms large enough to be hiring people, but then has a noticeably different empirical implication than the threshold-based trap model. An environment in which both models had elements of relevance would be difficult to tease apart and find clear evidence for either in the presence of the other. Continuing upward in scale, entire sectors of an economy can be caught in a technological poverty trap (Buera et al. (2021)). This can occur when there are fixed costs to adopting a technology in one sector, and the productivity in that sector of the modern technology depends on the extent to which the inputs required by that sector are produced with the modern technology. This can trap entire sectors in the traditional technology, and the economy as a whole in a low-level equilibrium.

Boundaries for traps could be at the market or community level. For example, the "Social Tax" studied by Carranza et al. (2025) operates to pool risk in environments characterized by missing formal insurance markets, at the cost of depressing productivity. Poverty increases the insurance value of local institutions that generate and enforce the social tax, which in turn reduces incentives for investment. Similarly, Platteau (2000) and Hoff and Sen (2011) put forward models that predict traps at the community level.

Lastly along the scale-dimension, analogous “trap” theories in macroeconomics aim to understand persistently low growth at the country level. Rosenstein-Rodan (1943), even earlier than the individual-level theories, posited that poor country demand for industrial goods was too small to justify the fixed costs of investment in manufacturing (Murphy et al. (1989) and Matsuyama (2004) provide formalizations of the idea). This mechanism exemplifies a coordination failure at the national level: if all (monopolistic) firms and the state can coordinate to invest simultaneously, wages will increase sufficiently to generate the demand required for the investments to be profitable. But no firm individually can make a profit by investing. Naturally, other theories in the growth literature also predict traps, such as institutionally-driven traps through differential power structures (Bowles, 2011).

The timing varies widely across these models. A calorie-based poverty trap might be observable in daily or even hourly data, while a trap originating in education or training might require data that span generations. One empirical approach even for the long-run theories is to validate the short-run implications of a longer-run theory. This may then confirm a necessary– but not sufficient– condition for the model to be widely applicable.

Aside from the challenges posed by varying scale, scope, and timing, models also differ on a key empirical prediction: is the trap in absolute levels, or relative pathways? Persistent inequality of households, firms, countries, may occur far more often than an equilibrium with absolute gains and losses. Most models focus on– and predict– poverty traps in absolute levels. The seminal work on nutrition, or on asset indivisibilities are set in static worlds without ongoing growth. In these models, the poor remain absolutely poor. Absolute poverty traps disappear with background growth. However, instead of absolute declines in assets of the poor and increases for others, a relative poverty trap (or “inequality trap”) theory could imply persistent (or growing) inequality depending on initial levels and distributions of assets in an overall growing economy (Azariadis and Drazen, 1990; Mookherjee and Ray, 2003). For example, the mobility of poorer households could be hindered by low equilibrium wages. As suggested by Genicot and Ray (2017) and Rigolini (2004), Ghatak and Newman (2025) show that even without nonconvexities in production, capital and insurance market imperfections can generate a self-reinforcing inequality trap with high inequality and low productivity, where with the same technology and preferences but a different initial distribution of wealth there is an equilibrium with less inequality and higher productivity. No individual is permanently trapped, but inequality is persistent.

The search for absolute gains and losses– versus relative– exacerbates empirical challenges due to measurement error and shocks. Measurement error could be due to use of the wrong inflation adjustment or just simpler measurement error from surveys. In theory these could be mitigated by tracking the quantities of assets and consumption rather than monetary value (thus avoiding the problem of noisy inflation information). Shocks pose a more difficult challenge and can obscure signs of a poverty trap. Data over a sufficiently long period (in units of production cycles) and from a sufficiently dispersed population (relative to the spatial correlation of shocks) are extremely valuable. For example, Arunachalam and Shenoy (2017) gains much by making use of a 30 year panel of rural households in India to test for the existence of a critical threshold.

Without substantial shocks, however, if a simple asset-threshold poverty trap exists no household can escape (or fall into) the trap. The distribution of wealth would be concentrated around the stable equilibria; no households would be observed near the threshold of the trap. To detect a poverty trap, shocks must be small enough that the nonconvex transition function and bimodal density of wealth can still be found, but large enough to put a sufficient number of households near the threshold to be identifiable. The large asset transfer in a graduation program may provide that kind of shock.

Given the plethora of "trap" theories– and their varying scale, scope, timing, and absolute versus relative predictions, one is left with a simple point: identifying, and validating, any one particular theory as "the" theory is ultimately a Sisyphean task, one that expects too much of both data and theory. Many of these mechanisms (like coordination failures) can operate at different scales; and at any scale multiple mechanisms can be at play (like health-productivity and aspirations at the individual level). A poverty trap may be operating and yet invisible if examined at an inappropriate scale or at the wrong time horizon: for example, it will be difficult to use variation across households within economies to identify poverty traps that are operating at the economy-wide level. And persistent or increasing inequality in a growing economy demands different data for examination than does a static poverty trap.

A major theme of empirical research in development economics has been careful exploration and validation of necessary components of theories of poverty traps, rather than looking for equilibrium evidence of the full theory. For example, the large literature showing evidence of credit market constraints is necessary– but obviously not sufficient– to support several of the theories. Another example is on labor: does labor productivity increase following income shocks? Kaur et al. (2025) and Banerjee et al. (2020) examine this in the short-run using fairly controlled settings in order to obtain clean measures of labor productivity. Similarly, Strauss (1986) finds that better nutrition raises farmer productivity. But these merely validate the presence of a key relationship (income's effect on labor productivity) rather than the presence of a poverty trap in equilibrium as a by-product of that relationship.

III. Presence of Asset-Threshold Poverty Traps in Eight Graduation Transfer Studies

We narrow our focus to poverty traps based on indivisible assets or other technologies that generate non-convexities in asset dynamics. In its simplest form an asset-threshold poverty trap has a single level of wealth (associated perhaps with a single indivisible, highly productive asset) denoted $\hat{K}$.[3] Households with assets below $\hat{K}$ in period t will see their wealth decline in $t+1$, while those above will see their wealth increase. There are two stable steady states at $K_P^* < \hat{K} < K_R^*$. In the cross-section, we would expect the distribution of wealth to be bimodal with peaks at those stable equilibria. These two features of the asset-threshold poverty trap model have attracted the bulk of empirical research: the bifurcation of asset accumulation paths at some critical wealth threshold and the bimodality of the distribution

[3]This simple model may be close to the reality in the pastoral economy studied by Lybbert et al. (2004).

of wealth.[4]

If we use multi-year household panel datasets to estimate the transition function $K_{i,t+1} = \phi_{i,t}(K_{i,t})$ of productive assets owned by i in $t+1$ if i held $K_{i,t}$ in t, do we find evidence of the non-convexities and multiple steady states required to generate an asset-threshold poverty trap? Much is buried in $\phi_{i,t}$. The transition function is an equilibrium outcome of consumption and production decisions and thus depends on preferences, relative prices, abilities, knowledge, market access and the distributions of shocks as well as on technology. To make progress, it is necessary to make assumptions about how heterogeneity shifts the transition equation. Conditional on observed heterogeneity, $\phi_{i,t}$ and therefore $\hat{K}_{i,t}$ depend on the realizations of random shocks to output, asset holdings and preferences.

BBBGH provides the model for this analysis. It uses 11 years of panel data on households that received an asset transfer as part of the BRAC program in Bangladesh. The asset transfer from BRAC for 91% of households was a cow. This transfer was relatively large, equaling the 93rd percentile of the pre-transfer distribution of wealth among the ultra-poor. It is plausible that the transfer shifted recipients from wealth near K_L^*, the lower steady state of a poverty trap to wealth in the area of $\hat{K}$, making it possible to test for the existence of a threshold level of wealth. Variation in pre-transfer wealth or variation in the value of the BRAC transfers serve to identify households with post-transfer wealth just above and just below the critical threshold. Concretely, for BBBGH these small differences could correspond to ownership of assets complementary to livestock ownership, such as a cart, a plough or a shed. Households with post-transfer wealth below this level "lack such complementary assets ... and the absence of rental or credit markets generates a poverty trap that locks the poorest in the worst occupations.... Although we believe this to be the most plausible mechanism, we cannot rule out that alternative mechanisms also reinforce it" (BBBGH, p.

[4] An additional lens into the consequences of an asset-threshold poverty trap is provided by the consumption decisions that are jointly made with investment/production choices. Buera (2009); Carter and Lybbert (2012) and Jee (2025) model the interactions between consumption-smoothing and wealth accumulation with indivisible assets or other technological nonconvexities. This is a rich and promising agenda, but outside the scope of this paper.

810). Thus, only those who can afford (for example) a cart escape poverty; those who receive a cow but have no additional resources for complementary assets remain trapped.

The BBBGH analysis of poverty traps, like ours, relies mainly on non-experimental comparisons of transitions over time of households within the treatment group. Summarizing broadly the BBBGH empirical analysis and findings in two steps: (1) Treatment households exhibit an S-shaped transition function between assets at the baseline immediately post-transfer and four years later. Thus, those with initial assets below a certain threshold were likely to lose assets and those above the threshold were likely to have accumulated more. They estimate this threshold value (i.e., the crossing of the 45 degree line from below in the transition function, or the increase in the probability that assets grow) as 9309 BDT (504 PPP USD)[5], approximately the same as the value of a cow.[6] (2) Using this 9309 BDT threshold, they find that households above the threshold at baseline (including the value of the asset transfer from BRAC) grow at both year 7 and 11 along many economic dimensions (productive assets, consumption, earnings, and hours worked), whereas households below threshold worsen over time.

We start our empirical analysis by examining the transition function for productive assets from the treatment arms of eight graduation studies in Figure 1: a Bangladesh BRAC-implemented study (Beam et al. (2025), hereinafter "Bangladesh-Beam"), the six sites reported in Banerjee et al. (2015) from Ethiopia, Ghana, Honduras, India, Pakistan, and Peru[7]; and a re-reporting and analysis of the BBBGH Bangladesh study (with one key change: we start with the function in levels versus the modified-log transformation reported in BBBGH).

[5]Throughout all analysis, currency converted from BDT to PPP USD at the baseline PPP exchange rate of 18.46 BDT to 1 PPP USD.

[6]BBBGH cross-validates the selection of this specific threshold by examining the distribution of log(baseline pre-transfer assets/1000 + 1). This generates a distinct bimodality with a local minimum of the wealth density proximate to the threshold $\hat{K}$. Within the BBBGH data the bimodality is generated in distributions of logs but not in distributions of levels and the bimodality is not commonly found in other data from Bangladesh nor in data from other countries. While we consider this re-analysis of the bimodal distributions interesting, we note that failure to find a bimodal distribution is not at odds with the conclusions drawn by BBBGH.

[7]Productive assets analyzed using an index of wealth in terms of goat-equivalents, measured at baseline and again approximately three years later.

The threshold-based asset poverty trap theory predicts that a specific threshold $\hat{K}$ exists such that those below the threshold will worsen (hence be in a trap) and those above the threshold will grow. Presence of a threshold implies that the non-parametric graph (Figure 1 Column A) will have segments in which the function crosses the 45 degree line from below. Column D reports the distribution with respect to baseline assets (both pre and post transfer) in order to see where the support is mostly coming from with which to estimate the transition function. In none of the eight sites do we observe convincing evidence of the transition function crossing the 45 degree line from below. We find the function entirely above the 45 degree line in both Bangladesh studies and Peru (i.e., the average wealth of households grew for all levels of baseline wealth); entirely below in Ghana and India; and crossing from above to below in Ethiopia, Honduras (but mostly tracking the 45 degree line), and Pakistan.

An alternative representation is based on the observation that if the transition function is concave and has a single stable steady state, then the probability of positive asset growth is monotonically decreasing with baseline wealth. If on the contrary there is a poverty trap threshold, then the probability of positive asset growth will increase sharply around that wealth threshold. Arunachalam and Shenoy (2017) propose a series of binary tests: sort and divide the data into bins based on baseline assets, and then examine whether for the n^{th} bin a higher proportion of households grows than for the $(n-1)^{th}$ bin. Figure 1 Columns B and C show the bin-wise proportion of households with positive asset growth and the p-value from the binary tests. The bins can be constructed in a multitude of ways, e.g. deciles (Column B) or by equally spaced bins (Column C). Asymptotically it should not matter how the bins are created, and indeed similar inference is drawn from the two columns.

In seven of the eight sites (Bangladesh-Beam, Ethiopia, Ghana, Honduras, India, Pakistan and Peru), judging from both the non-parametric transition function (Column A) and the binary analysis by bins (Columns B and C), there is no evidence that the likelihood of increasing wealth increases with baseline assets anywhere in the range of our data. For Bangladesh-BBBGH, both binning methods lead to a rejection of the null, i.e., a rise in the likelihood of a household's wealth increasing as baseline wealth increases over certain ranges. The jump seems to be between the third and fourth bins (Column C) (in the next section we will explore this jump more, and conclude that this is likely driven by geographical differences, not starting household asset levels). However, the non-parametric function in Column A presents no range of baseline assets for which an increase leads to an upward crossing of the 45 degree line: the entirety of the function lies above the 45 degree line, i.e., for all levels of baseline assets, we observe on average an increase in assets four years later.

Thus in none of these eight samples does the exercise detect evidence of an asset-threshold poverty trap consistent across these two types of test, the transition function 45-degree line-crossing and the discrete asset growth analyses. This does not rule out asset-threshold poverty traps in these populations. The statistical noise may be sufficiently large to obscure a trap. Or the transfers might not have been sufficiently large to move the wealth of the treated to the neighborhood of the threshold. Nor do the results exclude the possibility of other forms of poverty traps operating at different scales or longer periods than covered by our data.

The Figure 1 analysis is in levels, and contrasts with the log transformation transition function reported in BBBGH. BBBGH transformed the data to log(assets/1000+1) because 8.4% of households at the four-year follow-up reported zero for all assets questions (no households are coded with zero assets at baseline because baseline assets were computed as the assets reported in the survey plus the value of one cow). This log transformation matters, so we turn to understanding it more in order to see how this is affecting the graphical identification of an asset-threshold poverty trap.

IV. BBBGH Transition Function and the Log(0) Conundrum: What are the true assets for a household reporting zero assets?

We start by re-examining the transition functions that lie at the heart of the determination of a potential threshold. BBBGH log-transforms assets and adds a constant to accommodate households *reporting* zero assets in post-baseline surveys, thus transforming the asset variable

(x) to log(x/1000 + 1). The results are sensitive to the details of this transformation. We first describe the problem, then propose two solutions: use levels (as well as binary analysis for growing vs shrinking) or determine a minimum amount of assets that even the poorest household is likely to have.

In Figure 2(a) we present the 2007 to 2011 BBBGH productive asset transition figure and alternative transformations. The solid line presents the BBBGH transformation, i.e. log(x/1000+1), that generates an S-curve that upwardly crosses the 45 degree line at 9309 BDT. This crossing point becomes the focus of the ensuing poverty trap tests in BBBGH. We present four alternative specifications: log(x/10000+1); log(x/100+1); log(x+1); and levels. None of the alternatives generate a function that crosses the 45 degree line. We note that changing the divisor in the log transformation for any one observation cannot change whether 2011 assets are higher or lower than 2007 assets since the transformation is monotonic. But, the choice of divisor shifts the local polynomial log graph up or down because the estimated function is a localized mean (not a collection of individual data points) and the divisor affects the relative influence of extreme shifts in assets within each localized mean calculation[8]. This choice drives a key interpretation: with both levels and a transformation of log(x/10000+1) one would conclude that for all starting asset levels on average everyone improves, whereas with a transformation of log(x+1) one would conclude that for all starting asset levels on average everyone worsens[9].

[8]More specifically: a divisor of 1000, relative to 1, pulls the non-zero values closer to the transformed zero, reducing the transformed zeros' influence on the local mean. Hence the curve with divisor=10,000 has the highest local mean, with 1000 lower and 1 the lowest. As an example, consider a household with post-transfer baseline assets of 10,000 BDT that falls to zero after four years: dx/x = -1 but dlog(x/10000+1) = -0.7, dlog(x/1000+1) = -2.4, and dlog(x+1) = -9.2. The left end of the graph is more sensitive to this than its right end because households on the left are more likely to have zero assets after four years.

[9]Turning to linear estimates of the transition function, Appendix Table 2 Panel A, Column 1 replicates the BBBGH short-run analysis, whereby households below the threshold experienced negative asset growth and those above positive asset growth. We then examine four alternative specifications in Columns 2-5. First, motivated by the discussion above with respect to the differentially large influence large drops in assets receive depending on the divisor, Column 2 presents results with the dependent variable censored from below at -1. This generates positive estimates of asset growth both above and below the threshold, albeit higher growth above the threshold. Column 3 employs a median regression, and similarly finds growth both above and below the threshold, again with higher growth above the threshold. Column 4 uses the growth rate of assets in an OLS specification and Column 5 a median regression of growth rates, and both find again positive growth above and below the threshold, but only the median specification finds statistically significantly higher

Estimating in logs does have a potentially important advantage: the difference in log(x) approximates the growth rate. The decision to divide by 1000 BDT and add 1 is equally a decision to add 1000 BDT (54 PPP USD) to every household's assets.[10], This decision may seem arbitrary, but it need not be. We believe it is reasonable to consider a measure of zero assets as a by-product of (likely non-classical) measurement error, for example due to some small assets either not being included in the survey (due to the understandable time constraints of any household survey) or not reported by households.

If zero is a by-product of such measurement error, one could argue for determining a likely minimum value of assets that even the poorest household owns, and adding that to all households' assets. We examine two sources of data to try to determine a reasonable amount to add. A 2008 survey of poor households[11] in rural Bangladesh collected more granular farm asset data than in BBBGH. In these data, the median value of small farming tools (weeder and "sickle/dao/axe/spade") is 110 BDT among households with non-zero holdings of these assets, which is roughly the 20th percentile of total productive assets in that date. Second, in the representative rural 2011 Bangladesh Integrated Household Survey, the 10th percentile of the total productive assets distribution is 100 BDT. Triangulating these two sources, we re-estimate the transition functions after adding 100 BDT, hence log(x/100+1). This transition function (the short-dashed line in Figure 2(a)) does not cross the 45 degree line. In Appendix Figure 1, we present figures for values between 200 and 1800, in steps of 200, to show how the transition function changes with different assumptions.

growth for those above versus below the threshold. Thus, across columns 2-5, we find evidence of divergence - faster asset growth above the threshold - but not of a poverty trap, since households below the threshold also experience positive asset growth on average.

[10] Choosing a divisor D inside the log is equivalent to choosing an additive constant in the same units as x. Algebraically, log(x/D + 1) = log(x + D) - log(D), so dividing by D inside the log is equivalent to adding D inside the log: because the same transformation is applied to assets on both axes, the -log(D) term cancels out. This equivalence is between log(x/D + 1) and log(x + D); the choice of the divisor/additive constant D still affects the shape and the position of the estimated transition function.

[11] The inclusion criteria in this survey was households in which "a household member was forced to miss meals during the prior (2007) monga season" (Bryan et al., 2010, p. 1677)

V. Bangladesh Analysis and the Role of Geography: Local Cow Prices, not Household Assets, Predict Direction of Household Productive Assets Stock

While the log transformations just discussed are critical for the vertical placement of the transition function relative to the 45 degree line, the slope of the function is also important for the asset-threshold poverty trap story. Any section of the transition function with a slope greater than one is an indication of heightened separation in growth rates (in logs) or changes in assets (in levels) over that range of asset values (only near the 45 degree line does this imply a separation between accumulation and decumulation). Figure 2a shows that regardless of the specific transformation in the BBBGH data, the transition function seems to steepen around 9309 BDT (504 PPP USD). Similarly, Figure 3a shows that about 55% of households with baseline post-transfer wealth just under the BBBGH threshold increase their asset holdings four years later, whereas for households just above the threshold about 75 percent increase their asset holdings.

However, this divergence is at least partly a by-product of a shifting composition of villages as you move along the x-axis. Specifically, wealthier households at the post-transfer baseline (x-axis) are more likely to be from villages with high cow prices. In this section we show that the apparent threshold pattern is strongly related to branch-level cow prices, which enter mechanically into post-transfer baseline assets. This matters because branch cow prices both classify many households as above or below the threshold and proxy local economic conditions. The evidence therefore cannot cleanly distinguish a household-level asset threshold from location-specific differences in transfer valuation, livestock returns, or local growth opportunities.

To understand why this is important, we start by examining the distribution of cow prices. This is critical because post-transfer baseline asset value is the sum of: (1) the median cow price in each BRAC branch catchment area, and (2) the household's total asset value as measured in their baseline survey. BBBGH then categorizes post-transfer baseline assets as above or below a threshold of 9309 BDT (504 PPP USD). However, the branch-level median cow price varies considerably, and we show here that cow price variation drives the sorting above or below the threshold considerably more so than baseline (pre-transfer) household assets.

Table 1 Panel A documents the core variation driving this determination, the branch-level median cow prices. An almost equal number of households are assigned cow values below and above the threshold. We find this variation striking. Nearly half of the households live in branches for which the median cow price is above the BBBGH threshold, thus rendering baseline household assets irrelevant for the determination of whether a household is above or below the threshold (nobody is recorded as having negative assets). Furthermore, of households with zero baseline household assets reported in the survey, they are split evenly above and below the threshold (769 vs 780, respectively) because of the variation in the branch-level median cow price (1549 out of 3292 report zero baseline household assets). Thus, the complementary pre-transfer asset story seems potentially at odds with the raw data distribution. Table 1 Panel C presents a simple variance decomposition of the categorization of a household into above or below the poverty trap threshold, showing that the branch-level median cow price accounts for four times as much of this variation as does the baseline (pre-transfer) value of household assets.

Next we return to the transition function, and examine the same graph but separately for low-cow-price and high-cow-price villages, in order to remove the extent to which the steepening effect was driven by the change in village sample composition. Figure 2b and 2c present these results, and there is no longer any discernible slope increase for either the low-cow price villages (2b) or high-cow-price villages (2c).[12,13]

[12] The linear estimates of the transition equation presented in Appendix Table 2 Panel B are consistent. These regressions include a control for high-cow-price-village and indicate that it is residence in a high-cow-price village that is strongly associated with divergence in log(x/1000+1). This remains the case in all four alternative specifications discussed at the end of Section III. In each case the coefficient for a household having above threshold post-transfer assets turns negative, thus reinforcing the inference that geography is driving divergence.

[13] Appendix Figure 2 plots the transition functions without any variation in cow price. Instead of using branch-level cow prices, we use the median cow price in the full sample of 9000 BDT. Doing so, we find no evidence of an S-curve.

Figure 3a shows that the sharp rise in the probability of asset growth near the threshold for the full sample is attributable to the changing composition of villages across levels of baseline wealth. We then examine the relationship using the binary analysis discussed above, and observe the same pattern: when examining the full sample one would conclude that a poverty trap exists right around the threshold identified in BBBGH (the left column of sub-figures B, E, and H). The evidence of a threshold is not robust to separately analyzing low-versus high-cow-prices (sub-figures in the middle and right column). If bins are defined by asset decile (3c), we reject the null ($p<=0.01$), but if bins are defined with equal spacing (3f), we do not ($p=0.78$ and $p=0.13$ for high- and low-cow-price, respectively). However, Figure 2 does not find a crossing of the 45-degree line at the points indicated in 3c and 3f. Hence, we do not infer the presence of a poverty trap from these results.

Figure 4 returns to the transition function, and examines the same analysis but with the Bangladesh-Beam data (hence a different implementation, but the same implementer and same country). Here we find no evidence of an upward crossing of the 45 degree line, but also we note we do not observe cow price variation.

Similarly, the long-term (7 or 11 year) pattern of asset growth does not provide consistent evidence that households are in an asset-threshold poverty trap, once we account for differences in asset growth across high- versus low-cow-price regions. In Table 2, we first replicate the BBBGH Table IV specification and results, for comparison. The core difference-in-difference specification for this long-term asset dynamics analysis takes the following form:

$$Y_{i,t} = \beta_0 I(k_{i,1} > \hat{k}) + \sum_t \beta_{1,t} \mathbb{I}(k_{i,1} > \hat{k}) S_t + \sum_t \beta_{2,t} S_t + Subdistrict_i + \epsilon_{i,t} \quad (1)$$

where k denotes post-transfer baseline assets, $\hat{k}$ denotes the threshold value, S denotes the survey wave, and *Subdistrict* stands for subdistrict fixed effects (equivalent to branch fixed effects because there is one treatment branch per subdistrict).

Panel B then restricts the sample to just households with *zero* reported assets at baseline, thus removing all individual-household level variation; the only variation in baseline post-transfer wealth is generated by the cow price. Yet the estimates remain quite similar to the primary BBBGH specification, thus showing that local cow prices (or, more likely, something that local cow prices reveal about villages) drive the long-run dynamics, at least for households that report zero assets at baseline.

The large, positive point estimate for increase in land ownership, a fairly rare transaction, led us to examine the tails of the raw data (shown in Appendix Figure 3); we observe that the land ownership result is largely driven by three outliers in Year 11, all three of which had baseline assets just above the threshold.[14] Naturally, these three observations may be a by-product of exactly the theory being put forward regarding investment thresholds, but also could be a by-product of inheritance, mismeasurement, or a myriad of other causes. Table 2 Panel C reports the analysis without these outliers: the point estimate reduces to 3548 (se=3034), compared to 9758 (se=4878) and 13580 (se=8667) in Panels A and B, respectively. BBBGH's long-run effects on productive assets and land value are cut slightly more than half and lose statistical significance without the three outlying households; however, other outcomes, such as consumption (no change relative to Panel A), net earnings (33% lower than Panel A), labor supply (no change relative to Panel A), remain statistically significant. Thus we infer that the three outliers do matter for estimates of the determinants of productive assets (specifically via land) but are not driving the bulk of the results in BBBGH.

Next, in Table 3, we estimate with the full sample of treated households a "horserace" specification of the long-run dynamics by taking the primary BBBGH specification and adding four indicator variables for year interacted with a binary variable equal to one if the branch-level median cow price is above the threshold. These four variables use no household level variation. And then the key test is to examine whether after including these controls, the coefficients for years 7 and 11 interacted with whether the household is above the threshold post-transfer remains large, positive, and statistically significant.

[14]The three data points increase their landholdings from 0 to 2 million BDT (108k PPP USD), 0 to 3.1 million BDT (167k PPP USD), and 0 to 5 million BDT (270k PPP USD) over 11 years, which situates them 12, 18, and 30 standard deviations above the mean in the year 11 asset distribution.

Specifically, we run the following regression:

$$\begin{aligned} Y_{i,t} = & \sum_t \alpha_{1,t} \mathbb{I}(CowPrice_{i,1} > \hat{k}) S_t \\ & + \sum_t \beta_{2,t} S_t + \beta_0 \mathbb{I}(k_{i,1} > \hat{k}) \\ & + \sum_t \beta_{1,t} \mathbb{I}(k_{i,1} > \hat{k}) S_t + Subdistrict_i + \epsilon_{i,t} \end{aligned} \tag{2}$$

where $CowPrice$ denotes the branch-level median cow price, k denotes post-transfer baseline assets, $\hat{k}$ denotes the threshold value, S denotes the survey wave, and $Subdistrict$ stands for subdistrict fixed effects (equivalent to branch fixed effects because there is one treatment branch per subdistrict).

Table 3, Panel A shows that all of the coefficients on Year 11 X above $\hat{k}$ are no longer statistically significant except for hours self-employed, although that is now negative and statistically significant (-111 with se=27, compared to the BBBGH estimates of 74 with se=17, replicated in Table 2, Panel A). The key outcome for productive assets, however, actually increases but with a standard error that increases even more (14806, se=11235); thus we cannot reject the null but we also cannot reject equality with the BBBGH estimate of 10686 (se=5003). The increase is driven by a large increase in land, not cows. The growth in cow assets in the BBBGH specification in years 7 and 11 attenuates considerably, from 2522 (se=408) and 2239 (se=374) in the BBBGH estimate to -889 (se=446) and 359 (se=639). Instead, growth in cow assets is in villages with high cow prices: 4305 (se=425) and 2274 (se=645) in years 7 and 11. Panel B then shows the same analysis, omitting the three outliers discussed above. Now the large but imprecise point estimate on land shrinks from 14966 to 5424, similar to what we observed in Table 2. However, whereas in Table 2 many of the other outcomes (consumption, earnings, labor supply) remained strong after removing the three outliers, here in Table 3 we are unable to reject the null of no effect for all outcomes (except for hours self-employed, which is negative).

We find that the predictive power for long-run outcomes shifts from the household-level threshold variables to the regional cow price variables. There are many observed and unobserved variables that may be correlated with the cow price and with long-run outcomes, so caution is warranted. Our interpretation is that the main long-term divergence is driven by regional differences, not household-level asset thresholds, and that cow prices encapsulate local information that predicts regional trends.

VI. Bangladesh Geography: Comparing Branches with High versus Low Cow Prices

Patterns of asset accumulation vary dramatically across low- and high-cow price branches, revealing a spatial dimension to wealth accumulation (Kraay and McKenzie (2014)). Returning to Table 3, with or without the outliers, we see that households in high-cow-price branches have higher holdings of cows in every followup wave relative to those in low-cow-price branches. In parallel, in every followup wave after year 2, households spend more hours in self-employment in high-cow-price branches than in low-cow-price branches. In the long-run (years 7 and 11) households in high-cow-price branches have higher net earnings from self-employment than those in low-cow price branches. These patterns are not repeated for total holdings of productive assets, neither in the full sample nor when outliers are removed. There is a clear tendency to shift the portfolio of assets towards livestock in high-cow-price branches. Higher prices and higher quantities together suggest higher demand for cows in these branches, all else equal.[15]

To further examine the importance of geography, we examine whether the same high- vs low- cow price proxy drives long-run trends for those in the control group (although

[15] One further hypothesis, which did not prove explanatory, was that branches with higher cow prices were correlated with higher prior cow ownership, and that it was prior cow ownership that was underlying the observed results. If the assets which shifted households above the threshold were carts and sheds, i.e., assets complementary to cow-rearing, then perhaps the above threshold households were more likely prior cow-owners and thus also more knowledgeable and skilled at maximizing productivity of a cow. Whereas being below the threshold implies virtually no productive assets, little to no farm equipment, and none of the assets that might be complementary with cow ownership. In Appendix Table 4, we explore this possibility by adding interactions with prior ownership of a cow to the primary BBBGH specification. We do not find evidence that prior cow ownership is driving the observed results. This null effect can be rationalized with the fact that the treatment households received an initial classroom training and then home visits for up to two years for the chosen asset bundle, thus helping households with no prior cow rearing experience overcome the knowledge and skill gap.

the program was rolled out after the four-year survey to the control group, hence we can only examine the trend up until that point). This is a critical test of the asset-threshold poverty trap theory since these households received no asset transfer pushing them over the hypothesized threshold. We find the same pattern in the control: Table 4 shows that branch cow price drives a similar divergence in productive asset accumulation within the control group, i.e. the ultra-poor living in communities that did not receive a transfer. The productive assets of control group households living in high-cow-price branches grew significantly faster than the assets of similar households living in low-cow-price branches. There are differences in the timing and pattern of asset accumulation: relative to control group farmers in low-cow-price branches, control group farmers in high-cow-price branches accumulate mainly land with little evidence of cattle accumulation, while the opposite is true for treatment group farmers.

Table 5 Panel A pools the samples of treated and control ultra-poor households. The strong and rising treatment effect on productive assets is visible in column 1. There is no statistically significant difference in the value of year 1 assets in the control group (who do not own cows) between households in high- versus low-cow-price branches. However, there is much larger growth in productive assets of both treatment and control households in high-cow price branches in years 2 and 4. Heterogeneity of treatment effects is limited mainly to the portfolio of assets in year 4, and to patterns of employment in year 2. Hence geography – or specifically regions with low versus high cow prices – shapes overall growth in the wealth of the poor.

Assets of the less poor (non-eligible for the BRAC program) also evolve differently in high- and low-cow-price branches. Table 5 Panel B, column 1 shows that the productive wealth of non-eligible households increases faster in high-cow-price than low-cow-price branches. Most of this additional growth is in land rather than cows. This is especially true in treatment branches, in which the eligible poor received transfers of cows.

Villages in BRAC branches with median cow prices over the threshold of 9309 BDT are different from other villages along many dimensions we observe, and undoubtedly many that we do not. Figure 5 presents a map of Bangladesh, where visually it is clear that cow prices are correlated with geography: six out of eight of the branches with low cow prices are clustered in the north, specifically in the northeast part of Rangpur, one of the poorest areas of Bangladesh and also an area more likely to face river erosion. Table 6 compares some basic descriptive statistics from a census conducted by BRAC prior to the intervention. Although some exceptions exist, in general villages with higher cow prices are wealthier and more educated.

Table 6, Columns 1-3 show that high-cow-price villages have households with less exposure to river erosion (branch/sub-district level), higher participation in NGO activities, fewer members working for a daily wage, fewer remittances from abroad, fewer members, smaller houses, more electricity access, more highly educated household heads, greater values of household assets and (unsurprisingly) greater livestock values. They also have higher childhood mortality and slightly lower probability of all children being in school. Columns 4-6 compare villages with river erosion versus those without. Households in villages unaffected by river erosion have higher participation in NGO activities, fewer members working for a daily wage, more remittances from abroad, more members, bigger houses, more electricity access, more highly educated household heads, greater values of household assets, greater livestock values, and lower childhood mortality.[16]

Next, motivated by the clustering on the map in the northeast of six of the eight low-cow-price branches, we examine the extent to which river erosion is a key mechanism. We use the

[16]Appendix Table 5 Panel A, reports a similar comparison, but using the baseline survey (weighted to account for different sampling probabilities). Here we find that high-cow-price villages (which may indicate higher cow quality) have higher female schooling rates, higher earnings from household business activities and (again unsurprisingly) higher value of livestock assets. BBBGH presents a measure of cow earnings potential, and this is substantially larger in high-cow-price villages. There are no statistically significant differences in landholdings, non-business assets, consumption or total hours worked across these villages. Amongst the poorer residents included in the BBBGH analysis, the divergence in business earnings remains strong, and there are more total hours worked and higher levels of anxiety in the high-cow-price villages. These differences are reflected in the comparison of places with versus without river erosion as well, with households in villages without river erosion having higher levels of anxiety, higher earnings, greater livestock values, higher consumption, and more hours worked. Village-level cow earnings potential does not differ between places with and without river erosion, however.

District Statistics 2011 publications of the Bangladesh Bureau of Statistics (BBS) for data on river erosion, which is a binary variable that indicates the occurrence of river erosion in a sub-district in each year between 2008 and 2011.[17] We prefer to use administrative data on river erosion because Guiteras et al. (2015) finds alternative measures such as rainfall or self-reported exposure in household surveys to be weak proxies for true exposure in Bangladesh. The BBBGH research team shared the geo-coordinates of the BRAC branches and villages with us. We used these and Bangladesh's political boundaries maps to determine the sub-district to which the BRAC branches belong. In the resulting sample, a sub-district either did not experience river erosion in 2008-2011 or experienced river erosion in all four years between 2008-2011, with one exceptional sub-district that experienced river erosion in three out of four years. Therefore, the main variation we have is whether the sub-district had or did not have river erosion, and so in the analysis, we will use a binary No River Erosion variable that equals 1 if the sub-district did not have any occurrence of river erosion and equals 0 if the sub-district had river erosion in three or more years during 2008-11. River erosion is correlated with the cow price: 74% of low-cow price villages are coded as having river erosion whereas only 42% of those in high-cow price villages are. The composition of the main analysis sample reflects this: 83% of the below-threshold households were in a river erosion-affected village while only 46% of the above-threshold households were so.

We estimate a difference-in-difference specification taking the primary BBBGH specification detailed above and adding four indicator variables for each year interacted with a binary variable equal to one if the branch was unaffected by river erosion. Specifically, we run the following regression:

[17]The reports, available on the BBS website as separate PDF files for each district and also in the replication folder, cover several statistics at the sub-district and/or district level. The meteorology section captures the following variables at a yearly level between 2008 and 2011: maximum and minimum temperatures, rainfall in millimeters, humidity percentage, storm occurrence (binary, sub-district-level), and river erosion occurrence (binary, sub-district-level).

$$
\begin{aligned}
Y_{i,t} = & \sum_t \alpha_{1,t} \mathbb{I}(\text{No River Erosion} = 1) S_t \\
& + \sum_t \beta_{2,t} S_t + \beta_0 \mathbb{I}(k_{i,1} > \hat{k}) \\
& + \sum_t \beta_{1,t} \mathbb{I}(k_{i,1} > \hat{k}) S_t + Subdistrict_i + \epsilon_{i,t}
\end{aligned}
\tag{3}
$$

where $NoRiverErosion$ equals 1 if the branch (sub-district) did not experience river erosion between 2008-2011, k denotes post-transfer baseline assets, $\hat{k}$ denotes the threshold value, S denotes the survey wave, and *Subdistrict* stands for subdistrict fixed effects (equivalent to branch fixed effects because there is one treatment branch per subdistrict).

Table 7, Panel A presents these results. Compared to those affected by river erosion, households in branches unaffected by river erosion have higher levels of productive assets, cows, land holdings, and earnings in all survey waves. The long-run coefficients on being above $\hat{k}$ are no longer economically or statistically significant for cows (column 3), productive assets and earnings, but are so for consumption and hours worked.

In Table 7 Panel B, we add four indicator variables for year interacted with a binary variable for whether the branch-level median cow price is above the threshold (this is an extension of Table 7 Panel A). The river erosion coefficients remain largely unaffected by the inclusion of the cow price controls, but the above $\hat{k}$ results for cows, consumption and hours worked fall and are not statistically significant. However, we are puzzled by the negative coefficients on NoRiverErosion in Years 4 and 11 for consumption since households in NoRiverErosion=1 branches earn more and have more assets.[18]

We conclude that geography, as proxied by high or low cow price, is an important influence on the divergence in wealth observed across households in the BBBGH data. The apparent threshold is not robust to observed differences across branches defined by cow price or river

[18]Appendix Table 6 replicates the analysis without dropping the three outliers discussed in Section V (see footnote 14) and the results remain largely unaffected, except for productive assets (which is driven by land holdings). For productive assets, the coefficient on Year 11 X NoRiverErosion = 1 increases to 22201 (se=6647) in Panel A and to 24204 (se=7290) in Panel B, and the coefficient on Year 11 X above $\hat{k}$ increases to 2438 (se=4115) in Panel A and to 11752 (se=10741) in Panel B.

erosion.

VII. Geography and Wealth: Long-Term Panel Data from Bangladesh and Ghana

The BBBGH data, and the seven other samples of treatment groups from Graduation programs discussed above are more homogeneous, by design, than a random sample of the rural areas from which each sample is drawn. The very poor– those targeted by the Graduation program– are most likely to be affected by a poverty trap, and the asset transfers associated with Graduation programs were often calibrated specifically to support a viable livelihood that requires an indivisible investment good (such as livestock or equipment). However, perhaps this homogeneity is obscuring an otherwise visible asset-threshold poverty trap. In a sample of the very poor, measurement error may be large relative to actual differences, and the distribution of observed wealth may not be sufficiently broad to cover the (likely heterogeneous) asset thresholds. Thus the added variation in actual wealth in a representative sample may reveal an asset-threshold poverty trap that is latent in analysis restricted to just those in extreme poverty.

To examine this, we turn to three representative long-term rural panel samples. The first is the full sample from BBBGH. The survey includes all of the poor identified in the BRAC-led participatory wealth assessment in each village, plus a 10 percent sample of all other households. The second and third are two nationally-representative long-term panel sample surveys: the Bangladesh Integrated Household Survey (BIHS) and the Ghana Socioeconomic Panel Survey (GSPS), which track clustered random samples of households across eight and twelve years, respectively[19]. We restrict the samples in the nationally representative surveys in both Bangladesh and Ghana to rural residents at baseline.

Figure 6 rows 1-2 show the transition functions in levels between baseline and successive follow-ups for the full distribution of households in the BBBGH villages. As in Figure 1, the transition function lies entirely above the 45 degree line and there is no evidence at this scale

[19]Bangladesh data and documentation available from Ahmed (2021) and Ghana data from Osei et al. (2022).

of the nonlinearities that might generate an asset-based poverty trap. The wealth transition functions between waves are plotted in levels for the rural BIHS in rows 3-4 and for Ghana in rows 5-6 in Figure 6. In BIHS, as in the BBBGH villages, each of the transition functions lies above the 45 degree line for at least the bottom 80 percent of the wealth distribution. For larger levels of wealth, the transition function is noisily estimated to approximately follow the 45 degree line. In Ghana, both transitions show striking convergence to a single steady state equilibrium.[20]

Columns B and C of Figure 6 depict the binary tests for the direction of asset changes in BBBGH full sample, BIHS, and GSPS across bins of starting wealth. In the BBBGH full sample, both the decile and evenly-spaced binning schemes show a sharp increase in the share of households with rising assets at intermediate levels of baseline wealth, mirroring the steeper slope visible in the levels transition function over that range, and replicating the findings in Figure 3 (a, b, e and h). But the levels transition function does not exhibit an S-shape and remains above the 45-degree line throughout. In BIHS, for the decile binning algorithm, there is evidence of non-monotonicity between the 6th and 7th deciles in transition from 2011-12 to 2015, but the wealth transition function is above the 45 degree line at that wealth and this jump vanishes in the longer-run transition from 2011-12 to 2018-19. There is no evidence of any threshold above which the probability of growth increases sharply in any of the transitions in Ghana.

Next we examine the predictors of future wealth in the BBBGH villages (for both the treated sample and the representative sample), in rural Bangladesh as a whole and rural Ghana. We use rich baseline family background and human capital characteristics.[21] We

[20]In Appendix Figure 4, we plot the graphs in log form for the BBBGH, BIHS and GSPS data. The BBBGH and BIHS data (but not the GSPS data) have many households with zero recorded assets, and thus we have to use functional form transformations of log(Assets/1000 +1), log(Assets/100 + 1), and log(Assets+1) to assess the robustness under different transformations. BIHS and GSPS show strikingly smooth and linear transition functions, thus no areas of increasing returns that would be indicative of a potential asset-threshold poverty trap. The BBBGH transition functions exhibit an S-shape in logs, replicating (and extending) Figure 2A.

[21]Controls include: household composition (number of children and adults), head characteristics (age, female, married), and religious/ethnic identity (Hindu/Tribal in Bangladesh; Christian/Muslim/Traditional in Ghana). Human capital is measured by the head's education in Bangladesh and parental education in Ghana.

examine the importance for prediction of community random effects and baseline wealth in linear regression, partial linear model[22], and two machine-learning algorithms to future wealth from the baseline wave of each survey. We compare predictive performance across models using out-of-sample (OOS) R^2.[23] We report the results starting from models with one set of covariates, successively adding more variables to the specifications with the full model with all variables presented at the end.

Table 8 Panels A and B report the results for the sample of the treated ultra-poor and the full sample of those villages in Bangladesh over 7 years; Appendix Table 7 Panels A and B show the 4-year results. The results show extremely low predictive power for any of the models within the ultra-poor sample over either time range. The full model with linear wealth effects has zero OOS R^2 in predicting assets after 4 years or after 7 years. There is no gain from permitting nonlinear wealth effects. As expected, the explanatory power of baseline wealth is much larger in the full sample from the BRAC villages. A linear prediction from baseline wealth provides an OOS R^2 of 0.49 for 4-year ahead and 0.45 for 7-year ahead wealth, and the full model has very similar predictive power for the same time spans (0.55 and 0.49, respectively). Predictive power for 4- and 7-year ahead wealth improves further when nonlinear effects are permitted for wealth: The OOS R^2 improves to 0.53 – 0.57 for the models with wealth entering nonparametrically via PLM or either a random forest or EGB.

Social capital includes local government and religious leadership, plus Bangladesh-specific nongovernmental organization/microfinance participation. Economic controls include owned agricultural land in Ghana, and indicators for government safety net receipt and current loan status in Bangladesh. Ghana models also include plot-area-weighted measures of mild, moderate, and severe agricultural shocks.

[22]The partial linear model estimates the relationship between baseline and future wealth non-parametrically, while allowing for linear demographic controls and community random effects. Specifically, we use generalized additive models available through the MGCV package in R, which use a penalized spline regression for the non-parametric estimation.

[23]We calculate OOS R^2 via 5-fold cross-validation with 50 repetitions to account for the ML models' inherent instability and the randomness of the fold splits. In each repetition, we divide the sample into five folds and then train the model five separate times: each time leaving out a different fold and testing the trained model on and computing its out-of-sample R^2 in the left-out fold. This approach provides a more stringent criterion for "explanation" than in-sample R^2/Adjusted R^2, which can be susceptible to overfitting in high-dimensional settings or with complex estimators like random forest. For instance, in the limit, a nonparametric estimator with a bandwidth of one observation can achieve a perfect in-sample R^2 by "memorizing" each data point, yet may offer zero predictive validity for unseen data. Negative OOS R^2 means predictions are worse than using the training set mean.

An asset poverty trap with heterogeneous thresholds could generate results such as these, so in Figure 7 we depict the shape of the nonparametric relationship between baseline and 4- and 7-year ahead wealth from the PLM estimates.[24] There is a strong, concave relationship between baseline and future wealth and thus this does not provide evidentiary support for an asset-threshold poverty trap.

Table 8 Panels C and D present parallel results for predicting eight-year-ahead wealth in the nationally-representative rural samples of Bangladesh and Ghana; Appendix Table 7 Panels C and D show the 4-year results. Baseline wealth alone has an OOS R^2 of 47% in a nonparametric regression in Bangladesh (BIHS); the corresponding OOS R^2 for Ghana (GSPS) is 13%. The full model accounts for about 49% of the variation in eight-year-ahead wealth levels in Bangladesh and 17% in Ghana. Thus, in each of these rural samples, baseline wealth is the main contributor to predicting future wealth. However, unlike BBBGH, in both national samples very little is gained by permitting nonlinearities in current wealth. In Bangladesh BIHS, in the simple univariate case, moving from linear regression to a nonparametric estimator improves the OOS R^2 by 0.01. In the full model, the effect of moving from the linear specification to a partial linear model remains similarly small at 0.01. None of the machine learning models successfully detects sufficient nonlinearities or interaction effects to improve predictive power over linear regression or a partial linear model. In Ghana as well, the relationship between current and future wealth is well-characterized by linearity. Using the full set of covariates, moving from a linear model to a partial linear model has a trivial effect. In neither Bangladesh nor Ghana does the out-of-sample performance of an ML estimator improve notably on the corresponding linear regression. Appendix Figure 5 depicts the nonparametric estimates from the PLM of 4- and 8-year ahead asset predictions for BIHS and GSPS, and as foreshadowed in Table 8 the estimates are close to linear.

One pattern found in each of these datasets is that location alone has little OOS explanatory power for future wealth: in the BIHS the OOS R^2 is 0.04 and in Ghana it is 0.01. In the

[24] In this partial linear model, the y-intercept of the estimated function varies with household characteristics; these figures are drawn for a household with mean values of the characteristics.

BBBGH full sample data, the R^2 is only 0.02 and 0.05 for the 7-year and 4-year ahead predictions, respectively. Recall from Section VI that using the BBBGH data, Table 5 Panels A and B report a related specification on the same samples of ultra-poor and non-ultra-poor households (both treatment and control), respectively. Column 1 shows that households in villages with high cow prices whether treatment or control and whether ultra-poor or not, have much higher asset holdings four years after baseline. The results in Table 8 (and Appendix Table 7) supply important nuance to that result. There are large and statistically significant effects of geography (at the BRAC branch level) on the path of asset accumulation, but predictive performance is low.

The conclusion of this exercise is straightforward: in the full rural population, current wealth and family background are predictive of future (seven or eight year ahead) wealth in the general population of the BBBGH villages, and in nationally-representative rural samples from Ghana and (especially) Bangladesh. Conditional on community and/or on family background, the effects of baseline wealth on future wealth are well-approximated as linear in the national samples, and concave for the BBBGH representative data. The limited variation in baseline wealth among the poorest implies that baseline wealth is far less predictive of future wealth among this subpopulation. Asset growth varies across location (both in the full samples and in the subsamples of the poorest), but this explains only a small share of overall variation.

VIII. Conclusion

We do not interpret our re-analysis as evidence against asset-threshold poverty traps. Direct empirical validation of these theories is extremely challenging.

Any specific threshold undoubtedly depends on preferences, productivity, local market conditions, local access to finance (formal and informal), complementary human capital, household structure, and many more factors. Maybe a narrowing of contextual factors would generate clearer evidence of an asset-threshold poverty trap, but this seems like a Catch-

22 exercise[25]: Doing so will inevitably require narrowing the context, the population, the investment possibilities, so as to render the result only right in that particular instance and not a generalized and applicable description of transition dynamics for low income households and markets.

The BBBGH data and the BRAC graduation context show important variation in the dynamics of wealth accumulation. The local village environment is apparently important, with much more rapid growth over 11 years in holdings of cows for households receiving a cow transfer in high-cow-price villages than in other villages. This resonates with a large and growing literature on the importance of location for socioeconomic mobility. Cow prices are likely a mere proxy for village characteristics that are essential for increasing economic opportunities and outcomes. Understanding why and how location drives outcomes is a large and growing literature (e.g., in the United States, see Chetty and Hendren (2018a,b); in India, examining both geography and how marginalized groups suffer more from geography effects, see Asher et al. (2024) which documents how district of residence drives father-son mobility gap; and similarly, see Asher et al. (2023) which documents geography driving unequal access to public services and educational outcomes).

However, even generalizing from this geography finding is elusive. While there are important differences in wealth accumulation across villages that have high and low cow prices, we do not find that village is a strong predictor of long-run asset growth for households. Perhaps for some of the same reasons that poverty traps may be present but challenging to identify empirically, the geography results may be driven by a complex combination of underlying mechanisms so as to render any specification that "works" in one setting unlikely to work elsewhere unless aligned perfectly with a complex theoretical model that incorporates all relevant contextual factors. For instance, even the simplest decision of how to draw geographic boundaries and model their interactions, or heterogeneity in the household data quality, could render a test that finds geographic effects in one context not able to find them in another.

[25]For a discussion of this external validity point with respect to enterprise, see Fischer and Karlan (2015)

Where to? We believe there is a key set of empirical inquiries that remains substantially unexplored. At the heart of the asset-threshold poverty trap theory is the premise that there is a region over which there are increasing returns to capital and a threshold: that one cow is actually more profitable than four smaller animals that add up to the value of a cow, that a refrigerator increases profits for a corner store more than the equivalent expansion in inventory, that a trader operating at a larger scale has a higher return on investment than one operating at a smaller scale. For the theory to be applicable in a given community and manifest itself in the data at any specific threshold, there must be barriers to both borrowing and saving that could reach that threshold *and* marginal returns must increase as in these examples. Economics has made much progress identifying liquidity constraints and imperfections in credit markets, and more recently exploring behavioral and social impediments to saving. If a threshold is to exist there must be both a region of increasing returns and also be no "bridge" investments that are incrementally viable to use to build up to the threshold investment. Thus, as argued by Kraay and McKenzie (2014), the characteristics of the full set of investments open to households determine the existence of a poverty trap. Yet there is little direct evidence on the array of assets available in local economies and their costs, risks, and achievable rates of return.

It is not a trivial exercise to measure the returns to different kinds of investments that could be made in any given locality. Lybbert et al. (2004) succeeds in mapping the pattern of returns to cattle in an economy (in rural southern Ethiopia) in which cattle are the sole available productive asset. In environments with a wider array of investments available, the empirical task is more difficult. In Kenya and Mali, we learn the returns to specific amounts of fertilizer in Duflo et al. (2008) and Beaman et al. (2013). But in these settings there are many alternative assets, and in neither case is there evidence of increasing returns to fertilizer. Udry and Anagol (2006) discusses the returns to adopting a new crop, and Kremer et al. (2010) calculates the rate of return to inventory investment for Kenyan retailers. There are minimum required investments in both these cases, but many alternative investment opportunities exist.

Examples could be multiplied – there is research on rates of return and investment costs for agricultural trade in Madagascar (Fafchamps and Minten, 1999), small enterprises in Sri Lanka (Mel et al., 2008) and Mexico (McKenzie and Woodruff, 2008). The farming systems research tradition in agricultural economics provides a rich set of estimates of costs and returns to specific investments in crop enterprises; the studies cited in the meta-analyses in Sánchez et al. (2022) and Himmelstein et al. (2017) provide examples. Many of the underlying papers cited in these meta-analyses report on enterprises that require fixed investments or minimum viable scales, and it is these detailed reports that are relevant for understanding the possibility of nonconvex returns to assets in specific economies. However, we know of no literature that addresses the full set of potential investments in any environment.

Comprehensive surveys of both households and enterprises in a local economy could provide a framework for understanding the portfolio of available productive investments. For example, Townsend's long-term panel Thai data is used to construct the rate of return on assets or wealth for individual households (Samphantharak and Townsend, 2009, Section 4 and especially 5.2). But households in rural Thailand are commonly engaged in multiple enterprises. In principle, it would be possible to disaggregate further to describe the returns to specific assets, and to measure the fixed costs or minimal scales at which the activities take place.[26] Such information about potential thresholds and returns to different livelihoods could then be complemented with experimental variation in transfer sizes, transferring below versus at or above hypothesized thresholds. But as the complexity of the local economy increases and the set of investment choices multiplies, enumerating the returns and costs for each livelihood becomes more burdensome. At the same time, the likelihood of a simple asset-threshold poverty trap existing in aggregate declines.

The idea of poverty traps remains a central organizing principle for development economics. However, the very idea of a fixed threshold may not be appropriate in a model incorporating

[26]Even with their rich data, Samphantharak and Townsend hesitate to disaggregate, noting the challenges of allocating assets and labor to specific activities, and valuing the outputs of one activity used as inputs for another.

background growth, which raises additional complexities. Would a finding that wealth grows more rapidly as one moves up the wealth distribution constitute a poverty trap, even if all households are increasing their wealth? We think it might, with an appropriate definition of "poverty" being relative, not absolute and a set of mechanisms. There is abundant evidence of such mechanisms that can reinforce each other to reproduce poverty. Indeed, the syllabi of our development economics courses largely consist of research that examines these mechanisms.

Whether absolute or relative, the identification of any specific asset threshold requires systematic evidence on the full array of locally-available productive investments — their costs, returns, and indivisibilities — and on how those returns vary with the contextual and individual-level heterogeneity in preferences, endowments, and market access. Without that prior mapping of the investment landscape, an asset-threshold poverty trap, however real it may be as a structural feature of a specific economic environment, remains noumenal.

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Table 1: Determination of Household Status Relative to Threshold
Contribution of Local Cow Prices versus Baseline Assets

Panel A: Distribution of Branch-Level Median Cow Prices and Above Threshold Household Proportions

(1) Branch-level median cow price, in BDT	(2) #HHs	(3) #Branches	(4) Proportion of HHs above the 9309 BDT threshold used in the BBBGH analysis
7500	92	1	0.15
8000	311	2	0.32
8333	209	1	0.08
8500	282	1	0.18
8785	402	1	0.27
9000	63	1	0.25
9083	318	1	0.18
10000	1346	10	1
10500	147	1	1
12000	122	1	1
Total	3292	20	0.60

Panel B: Regression Analysis of Factors Predicting Above Threshold Placement

	(1) Above Threshold (=1 if Yes)
Branch-level Median Cow Price ('000 BDT)	0.36***
	(0.01)
Pre-transfer Baseline Assets ('000 BDT)	0.11***
	(0.00)
Constant	-2.84***
	(0.06)
N	3292
adj. R^2	0.60

Panel C: Variance Decomposition of Above Threshold Placement
(Displaying Partial Sums of Squares of the Explanatory Variables)

	(1)	(2)	(3)	(4)	(5)
	=1 if HH is Above Threshold				
Pre-Transfer Baseline Assets	74***			99***	74***
Branch-level Median Cow Price		371***		396***	
Branch Fixed Effect			514***		514***
Adjusted R-squared	0.09	0.47	0.65	0.60	0.74
Total SS	789	789	789	789	789
N	3292	3292	3292	3292	3292

A household is classified as "Above Threshold" if the sum of its pre-transfer baseline assets and the branch-level median cow price ≥ 9,309 BDT (504 PPP USD). Panel A reports the distribution of branch-level median cow prices across the 20 BRAC treatment branches and the proportion of households in each branch classified as above threshold; the red line indicates BBBGH's threshold of 9,309 BDT. Panel B reports OLS coefficients from a regression of the above-threshold indicator on the branch-level median cow price and pre-transfer baseline assets. Panel C reports partial sums of squares from regressions of the above-threshold indicator on combinations of pre-transfer baseline assets, branch-level median cow price, and branch fixed effects. The sample is restricted to ultra-poor treatment households with post-transfer baseline assets below 19,000 BDT (93rd percentile), as per the original BBBGH data filter. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Long-Run Dynamics

Panel A: Replication of BBBGH's Table 4
Sample: Ultra-Poor Households in the Treatment Group

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × above $\hat{k}$	260	514	-840**	1018	-2298**	-1878***	-803***	-211***	-110***
	(897)	(365)	(366)	(770)	(976)	(329)	(253)	(39)	(15)
Year 4 × above $\hat{k}$	3374**	3346***	1991***	1178	-847	-443	-242	84**	99***
	(1658)	(452)	(452)	(1531)	(1078)	(346)	(265)	(41)	(18)
Year 7 × above $\hat{k}$	2302	2522***	1188***	821	1561	2151***	1817***	21	-15
	(2570)	(408)	(408)	(2470)	(1120)	(426)	(353)	(42)	(19)
Year 11 × above $\hat{k}$	10686**	2239***	894**	9758**	3534***	1462**	864**	87**	74***
	(5003)	(374)	(374)	(4878)	(1267)	(703)	(424)	(41)	(17)
N	15713	15713	15713	15713	14988	15713	15713	15713	15713
adj. R^2	0.02	0.19	0.10	0.01	0.08	0.07	0.05	0.12	0.30

Panel B: Sample Restricted to Ultra-Poor Treatment Households with Zero Assets at Baseline

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × above $\hat{k}$	3252**	1508***	-168	2869**	-2115*	-2583***	-1069***	-219***	-102***
	(1284)	(499)	(500)	(1150)	(1247)	(448)	(330)	(58)	(20)
Year 4 × above $\hat{k}$	4410	3397***	1720***	2263	-1152	-872*	-128	131**	179***
	(2861)	(585)	(586)	(2730)	(1490)	(502)	(390)	(61)	(24)
Year 7 × above $\hat{k}$	1960	2296***	619	632	2469	644	810**	-11	21
	(3412)	(634)	(635)	(3269)	(1635)	(583)	(413)	(63)	(28)
Year 11 × above $\hat{k}$	15151*	2411***	729	13580	6646***	689	1139	120*	121***
	(8751)	(509)	(511)	(8667)	(1759)	(905)	(814)	(62)	(24)
N	7380	7380	7380	7380	6966	7380	7380	7380	7380
adj. R^2	0.01	0.20	0.10	0.01	0.09	0.08	0.04	0.10	0.33

Panel C: Panel A but removing three outlier HHs

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × above $\hat{k}$	233	514	-841**	992	-2292**	-1879***	-806***	-211***	-110***
	(881)	(365)	(366)	(754)	(976)	(328)	(253)	(39)	(15)
Year 4 × above $\hat{k}$	3211*	3349***	1993***	1016	-860	-472	-245	83**	100***
	(1644)	(452)	(452)	(1516)	(1079)	(344)	(265)	(41)	(18)
Year 7 × above $\hat{k}$	2178	2513***	1178***	703	1488	2171***	1814***	20	-15
	(2559)	(408)	(408)	(2460)	(1118)	(425)	(353)	(42)	(19)
Year 11 × above $\hat{k}$	4383	2206***	860**	3548	3490***	976*	858**	86**	73***
	(3181)	(373)	(374)	(3034)	(1268)	(539)	(425)	(41)	(17)
N	15698	15698	15698	15698	14974	15698	15698	15698	15698
adj. R^2	0.02	0.19	0.10	0.02	0.08	0.09	0.05	0.12	0.30

Panel A replicates the BBBGH Table IV specification: the dependent variable in each column is regressed on indicators for each survey wave interacted with a binary variable equal to one if the household's post-transfer baseline assets exceed the 9,309 BDT threshold, with sub-district fixed effects included as per the original BBBGH specification. Panel B restricts the sample to treatment households with zero reported pre-transfer baseline assets, so that the only variation in post-transfer baseline wealth comes from branch-level median cow prices. Panel C removes three outlier households that increased their landholdings from 0 to approximately 2, 3.1, and 5 million BDT over 11 years ($\approx$ 108k, 167k, and 270k PPP USD respectively; see Appendix Figure 3 for a data plot). The baseline survey was conducted prior to the asset transfer; hence BBBGH add the cow transfer value to baseline productive assets in Column 1 for ultra-poor treatment households so the diff-in-diff baseline reflects post-transfer holdings, but do not do so for the cow variable. Column 2 shows BBBGH's original cow variable; Column 3 includes the transfer value in baseline, for ease of comparing to the productive asset Column 1. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Long-Run Dynamics: Adding Control for High-Cow-Price Branch

Sample: Ultra-Poor Households in the Treatment Group

Panel A: Add 1{Branch Cow Price Above 9309 Threshold} X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2	6325***	10755***	2222***	2261***	3660***	3691***	3236***	503***	679***
	(672)	(269)	(270)	(566)	(775)	(255)	(203)	(30)	(11)
Year 4	9325***	10222***	1689***	5515***	9490***	4805***	3577***	306***	492***
	(1203)	(301)	(302)	(1101)	(832)	(258)	(199)	(32)	(13)
Year 7	8528***	4623***	-3908***	9882***	7578***	2841***	2235***	513***	432***
	(1824)	(327)	(328)	(1758)	(835)	(253)	(179)	(33)	(15)
Year 11	11239***	4343***	-4187***	12882***	13429***	4915***	3125***	83***	214***
	(2188)	(267)	(268)	(2081)	(897)	(341)	(222)	(31)	(12)
Year 2 × CowPrice above $\hat{k}$	1440	1627***	-52	69	-2016	-2438***	-1756***	-142**	8
	(1413)	(474)	(475)	(1299)	(1658)	(502)	(384)	(59)	(27)
Year 4 × CowPrice above $\hat{k}$	3206	5715***	4036***	-1478	-1706	-605	37	154**	287***
	(2641)	(642)	(642)	(2494)	(1828)	(591)	(418)	(64)	(31)
Year 7 × CowPrice above $\hat{k}$	5457	4305***	2634***	1553	883	2131***	1990***	-8	211***
	(6849)	(425)	(426)	(6756)	(1853)	(595)	(494)	(63)	(31)
Year 11 × CowPrice above $\hat{k}$	-5393	2274***	599	-6671	3430	-1733	1320**	79	230***
	(11838)	(645)	(646)	(11440)	(2194)	(2311)	(514)	(61)	(28)
Year 2 × above $\hat{k}$	-915	-814*	-798*	961	-669	112	630	-95	-117***
	(1414)	(463)	(464)	(1291)	(1715)	(513)	(402)	(61)	(27)
Year 4 × above $\hat{k}$	757	-1318**	-1302**	2384	540	51	-272	-42	-135***
	(2596)	(590)	(591)	(2444)	(1863)	(593)	(418)	(65)	(32)
Year 7 × above $\hat{k}$	-1848	-889**	-882**	-256	896	592	307	26	-183***
	(6969)	(446)	(446)	(6880)	(1868)	(547)	(434)	(65)	(31)
Year 11 × above $\hat{k}$	14806	359	367	14966	872	2819	-174	26	-111***
	(11235)	(639)	(640)	(10822)	(2173)	(2279)	(410)	(61)	(27)
N	15713	15713	15713	15713	14988	15713	15713	15713	15713
adj. R^2	0.02	0.20	0.10	0.01	0.08	0.07	0.05	0.12	0.31

Panel B: Panel A but removing three outlier HHs

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2	6325***	10755***	2222***	2261***	3661***	3691***	3236***	503***	679***
	(658)	(269)	(270)	(550)	(775)	(254)	(203)	(30)	(11)
Year 4	9325***	10222***	1689***	5515***	9489***	4805***	3577***	306***	492***
	(1194)	(301)	(302)	(1092)	(832)	(258)	(199)	(32)	(13)
Year 7	8548***	4625***	-3906***	9900***	7561***	2849***	2236***	513***	432***
	(1819)	(327)	(328)	(1754)	(835)	(251)	(179)	(33)	(15)
Year 11	11047***	4340***	-4190***	12701***	13423***	4832***	3123***	83***	214***
	(2154)	(267)	(268)	(2048)	(897)	(331)	(222)	(31)	(12)
Year 2 × CowPrice above $\hat{k}$	1414	1640***	-38	27	-2077	-2419***	-1737***	-143**	7
	(1366)	(475)	(476)	(1255)	(1661)	(501)	(385)	(60)	(27)
Year 4 × CowPrice above $\hat{k}$	3170	5687***	4009***	-1500	-1775	-441	57	158**	285***
	(2619)	(642)	(643)	(2469)	(1829)	(573)	(419)	(64)	(31)
Year 7 × CowPrice above $\hat{k}$	5177	4287***	2617***	1277	1127	2140***	1983***	-7	211***
	(6857)	(426)	(426)	(6766)	(1832)	(594)	(495)	(64)	(30)
Year 11 × CowPrice above $\hat{k}$	-821	2371***	698	-2400	3566	369	1370***	78	230***
	(6786)	(639)	(640)	(6507)	(2191)	(915)	(513)	(62)	(28)
Year 2 × above $\hat{k}$	-921	-825*	-811*	970	-614	95	612	-94	-115***
	(1363)	(463)	(465)	(1242)	(1718)	(511)	(402)	(61)	(27)
Year 4 × above $\hat{k}$	624	-1293**	-1279**	2241	582	-113	-292	-46	-133***
	(2575)	(590)	(591)	(2422)	(1863)	(575)	(419)	(65)	(32)
Year 7 × above $\hat{k}$	-1819	-886**	-880**	-218	639	574	308	24	-183***
	(6977)	(446)	(447)	(6889)	(1847)	(546)	(434)	(65)	(31)
Year 11 × above $\hat{k}$	4934	249	256	5424	720	689	-219	25	-112***
	(6734)	(633)	(634)	(6455)	(2169)	(866)	(409)	(62)	(27)
N	15698	15698	15698	15698	14974	15698	15698	15698	15698
adj. R^2	0.02	0.20	0.10	0.02	0.08	0.09	0.05	0.12	0.31

Panel A extends the BBBGH Table IV specification (replicated in Table 2 Panel A) by adding interactions between survey wave indicators and a binary variable equal to one if the branch-level median cow price exceeds the 9,309 BDT threshold (Equation 2 in the text). Panel B removes three outlier households that increased their landholdings from 0 to approximately 2, 3.1, and 5 million BDT over 11 years (≈ 108k, 167k, and 270k PPP USD respectively; see Appendix Figure 3 for a data plot). Regressions include sub-district fixed effects as per the original BBBGH specification. The baseline survey was conducted prior to the asset transfer; hence BBBGH add the cow transfer value to baseline productive assets in Column 1 for ultra-poor treatment households so the diff-in-diff baseline reflects post-transfer holdings, but do not do so for the cow variable. Column 2 shows BBBGH's original cow variable; Column 3 includes the transfer value in baseline, for ease of comparing to the productive asset Column 1. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Dynamics Through Year 4 for Control Group Households

Panel A: Sample Restricted to Ultra-Poor Households in the Control Group

	(1) Productive assets	(2) Cows	(3) Land	(4) Consumption	(5) Net earnings	(6) Net earnings self-employed	(7) Total hours	(8) Hours self-employed
Year 2	1470***	544***	729***	-2024**	185	247*	-136***	-3
	(313)	(107)	(272)	(912)	(330)	(148)	(46)	(15)
Year 4	2142***	622***	1303**	1686*	3364***	324*	171***	23
	(582)	(130)	(559)	(1004)	(349)	(178)	(47)	(18)
Year 2 × CowPrice above $\hat{k}$	2497***	124	1922***	2173**	954**	607***	182***	70***
	(605)	(133)	(563)	(1086)	(380)	(198)	(55)	(18)
Year 4 × CowPrice above $\hat{k}$	3629***	313*	3027***	2558**	-987**	279	-68	68***
	(1050)	(161)	(1018)	(1252)	(403)	(222)	(55)	(20)
Observations	7380	7380	7380	6859	7380	7380	7380	7380
Adjusted R^2	0.02	0.04	0.01	0.04	0.08	0.03	0.05	0.05

Panel B: Panel A but removing four outlier HHs

	(1) Productive assets	(2) Cows	(3) Land	(4) Consumption	(5) Net earnings	(6) Net earnings self-employed	(7) Total hours	(8) Hours self-employed
Year 2	1470***	544***	729***	-2024**	185	247*	-136***	-3
	(313)	(107)	(272)	(912)	(330)	(148)	(46)	(15)
Year 4	2142***	622***	1303**	1686*	3364***	324*	171***	23
	(582)	(130)	(559)	(1004)	(349)	(178)	(47)	(18)
Year 2 × CowPrice above $\hat{k}$	2371***	126	1794***	2245**	946**	605***	183***	70***
	(590)	(134)	(547)	(1086)	(380)	(198)	(55)	(18)
Year 4 × CowPrice above $\hat{k}$	2393***	308*	1806**	2561**	-987**	279	-68	67***
	(840)	(161)	(806)	(1252)	(403)	(222)	(55)	(20)
Observations	7368	7368	7368	6847	7368	7368	7368	7368
Adjusted R^2	0.02	0.04	0.01	0.03	0.08	0.03	0.05	0.05

In Panel A, the sample consists of ultra-poor control group households who did not receive the BRAC asset transfer and had productive assets worth less than 10,000 BDT at baseline (to be consistent with BBBGH's restriction for treatment HHs in its analysis sample). Panel B drops four outlier households from the Panel A sample that had roughly 780k, 600k, 450k, and 450k BDT (42k, 32k, 24k, and 24k PPP USD) worth of assets at year 4. The specification regresses each outcome on survey wave indicators interacted with a binary variable equal to one if the branch-level median cow price exceeds the 9,309 BDT threshold, with sub-district fixed effects. The control group was offered the program after the four-year survey, so only years 2 and 4 are available. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Dynamics of Heterogeneity in Treatment Effects by Cow Price

Panel A: Ultra-Poor Households in the Treatment and Control Groups

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Treat=1	9933***	646	9106***	928	3761***	-853*	-429	-203*	2
	(1820)	(747)	(776)	(1079)	(934)	(472)	(449)	(107)	(33)
CowPrice above $\hat{k}$	1740	262	182	1712*	1070	274	-289	39	-22
	(1297)	(616)	(605)	(855)	(1224)	(560)	(367)	(103)	(34)
Year 2	1470***	544***	544***	729***	-1978	185	247*	-136	-3
	(285)	(101)	(101)	(183)	(1532)	(805)	(144)	(132)	(20)
Year 4	2142***	622***	622***	1303***	1698	3364***	324*	171	23
	(413)	(216)	(216)	(339)	(1109)	(549)	(166)	(130)	(35)
CowPrice above $\hat{k}$ × Treat=1	136	-725	1030	-1092	-877	111	779	47	-9
	(2088)	(900)	(922)	(1395)	(1501)	(591)	(539)	(128)	(46)
Year 2 × Treat=1	4617**	10047***	1515	1695	5505***	3519***	3115***	620***	659***
	(2174)	(841)	(949)	(1110)	(1647)	(940)	(616)	(140)	(48)
Year 4 × Treat=1	7204**	9338***	807	4596***	7848***	1444	3188***	124	441***
	(2692)	(1289)	(1330)	(1553)	(1452)	(878)	(791)	(143)	(55)
Year 2 × CowPrice above $\hat{k}$	2497***	124	124	1922**	2045	954	607***	182	70**
	(919)	(200)	(200)	(754)	(1980)	(901)	(216)	(140)	(31)
Year 4 × CowPrice above $\hat{k}$	3629**	313	313	3027**	2479	-987	279	-68	68*
	(1377)	(317)	(317)	(1168)	(1516)	(650)	(246)	(142)	(40)
Year 2 × CowPrice above $\hat{k}$ × Treat=1	-1726	852	-814	-1037	-4561*	-3291***	-1863***	-400**	-157**
	(2502)	(990)	(1093)	(1683)	(2403)	(1078)	(685)	(162)	(67)
Year 4 × CowPrice above $\hat{k}$ × Treat=1	340	4351**	2685	-2474	-3594	413	-460	190	112
	(3232)	(1674)	(1728)	(2119)	(2406)	(1076)	(872)	(169)	(73)
Observations	17259	17259	17259	17259	16181	17259	17259	17259	17259
Adjusted R^2	0.08	0.36	0.34	0.01	0.06	0.09	0.09	0.08	0.42

Panel B: Spillovers among Non-Ultra-Poor Households in the Treatment and Control Groups

	(1) Productive assets	(2) Cows	(3) Land	(4) Consumption	(5) Net earnings	(6) Net earnings self-employed	(7) Total hours	(8) Hours self-employed
Treat=1	10968	-275	15106	-2824	-503	-779	-68	-67
	(40442)	(702)	(39268)	(3014)	(1119)	(1120)	(83)	(58)
CowPrice above $\hat{k}$	-22535	838	-18593	3540	-323	-810	-42	-43
	(50799)	(632)	(49406)	(3110)	(1261)	(1276)	(78)	(54)
Year 2	92455***	-1886***	94313***	-3739	-273	111	-184**	-112**
	(14300)	(478)	(13675)	(2781)	(873)	(639)	(88)	(45)
Year 4	199571***	-1042***	202757***	3834	-332	-1919	31	-49
	(44274)	(195)	(44156)	(5928)	(1242)	(1410)	(86)	(59)
CowPrice above $\hat{k}$ × Treat=1	-12046	1058	-17309	3837	-296	515	32	48
	(59276)	(1224)	(57804)	(4059)	(1584)	(1494)	(102)	(68)
Year 2 × Treat=1	-1560	1413**	-3476	2805	3209***	2300**	281***	163***
	(18820)	(692)	(18265)	(3097)	(1066)	(914)	(96)	(54)
Year 4 × Treat=1	56603	946	51236	5827	2899**	3426**	21	96
	(60695)	(593)	(59962)	(6279)	(1386)	(1565)	(105)	(74)
Year 2 × CowPrice above $\hat{k}$	68635**	983	65300**	-129	1601	1214	254**	148**
	(32533)	(618)	(31834)	(3494)	(1212)	(1014)	(104)	(61)
Year 4 × CowPrice above $\hat{k}$	188398**	1419***	182163**	6722	3948*	4512*	143	173**
	(72260)	(480)	(71626)	(6512)	(2060)	(2264)	(94)	(71)
Year 2 × CowPrice above $\hat{k}$ × Treat=1	14112	-2300**	4179	-1668	-3541**	-2662**	-339***	-172**
	(45523)	(916)	(42690)	(4089)	(1454)	(1292)	(115)	(73)
Year 4 × CowPrice above $\hat{k}$ × Treat=1	-42808	-1644*	-37938	-9055	-5553**	-5991**	-82	-105
	(106377)	(938)	(105297)	(7593)	(2204)	(2440)	(121)	(88)
Observations	49933	49933	49933	46969	49933	49933	49933	49933
Adjusted R^2	0.02	0.02	0.02	0.01	0.05	0.03	0.07	0.06

Panel A pools ultra-poor treatment and control households that had productive assets worth less than 10,000 BDT at baseline (to be consistent with BBBGH's restriction for treatment HHs in its analysis sample), and regresses each outcome on treatment status, a binary variable for whether the branch-level median cow price exceeds the 9,309 BDT threshold, survey wave indicators, and all two- and three-way interactions. Panel B estimates the same specification for non-ultra-poor (program-ineligible) households. Standard errors are clustered at the BRAC branch level, the level at which treatment was assigned. The baseline survey was conducted prior to the asset transfer; hence BBBGH add the cow transfer value to baseline productive assets in Column 1 for ultra-poor treatment households so the diff-in-diff baseline reflects post-transfer holdings, but do not do so for the cow variable. Column 2 shows BBBGH's original cow variable; Panel A Column 3 includes the transfer value in baseline, for ease of comparing to the productive asset Column 1. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Comparison of Households in Low-Cow-Price vs High-Cow-Price Branches
Source: BRAC Census Data

	(1) Low-Cow-Price	(2) High-Cow-Price	(3) Difference (2)-(1)	(4) RiverErosion	(5) No RiverErosion	(6) Difference (5)-(4)
=1 if branch affected by river erosion	0.75	0.44	-0.3***			‘
	(0.0028)	(0.0026)	(0.0038)			
=1 if all children attend school	0.66	0.65	-0.013***	0.64	0.66	0.02***
	(0.0038)	(0.0032)	(0.005)	(0.0033)	(0.0037)	(0.0049)
=1 if any member of HH participate in any NGO	0.3	0.32	0.025***	0.26	0.39	0.13***
	(0.0029)	(0.0025)	(0.0038)	(0.0024)	(0.003)	(0.0038)
=1 if any member of HH work for daily wage	0.5	0.43	-0.069***	0.47	0.45	-0.017***
	(0.0032)	(0.0026)	(0.0042)	(0.0027)	(0.0031)	(0.0041)
=1 if HH receives remittances from abroad	0.023	0.0095	-0.013***	0.0091	0.023	0.013***
	(0.00096)	(0.00052)	(0.0011)	(0.00052)	(0.00092)	(0.0011)
# HH members	4.4	4.3	-0.15***	4.3	4.4	0.045***
	(0.013)	(0.01)	(0.016)	(0.011)	(0.011)	(0.016)
# rooms in house	1.8	1.6	-0.16***	1.6	1.7	0.14***
	(0.0066)	(0.0051)	(0.0083)	(0.0051)	(0.0065)	(0.0083)
=1 if HH has separate kitchen	0.8	0.72	-0.075***	0.74	0.77	0.031***
	(0.0026)	(0.0024)	(0.0035)	(0.0024)	(0.0026)	(0.0035)
=1 if HH has electricity	0.18	0.2	0.026***	0.15	0.25	0.1***
	(0.0025)	(0.0021)	(0.0033)	(0.0019)	(0.0027)	(0.0033)
=1 if No child mortality in last 5yrs	0.99	0.99	-0.0039***	0.99	0.99	0.00078
	(0.00046)	(0.0005)	(0.00068)	(0.00048)	(0.00052)	(0.0007)
HH head's # years of education	2.4	2.7	0.33***	2.3	3	0.6***
	(0.024)	(0.021)	(0.032)	(0.021)	(0.025)	(0.032)
Livestock value	8380	14356	5976***	9331	15341	6010***
	(114)	(142)	(182)	(115)	(163)	(199)
Shop/vehicle/boat value	2445	2783	338**	2333	3056	723***
	(136)	(104)	(172)	(109)	(128)	(168)
Non-business assets value	1400	1597	196***	1261	1852	591***
	(27)	(24)	(36)	(22)	(30)	(37)
N	24222	35497	59719	24222	35497	59719

Data are from a census conducted by BRAC prior to the intervention, covering all households in BRAC branch areas. Columns 1–3 compare households in branches with median cow prices below versus above the 9,309 BDT threshold. Columns 4–6 compare households in branches (sub-districts) that experienced river erosion in three or more years during 2008–2011 versus those that did not, based on District Statistics 2011 data from the Bangladesh Bureau of Statistics. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 7: Long-Run Dynamics of Branches Without and With River Erosion

Sample: Ultra-Poor Households in the Treatment Group Removing Three Outliers

Panel A: Without 1{Branch Cow Price Above 9309 Threshold} X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × No RiverErosion = 1	3568***	1144***	1318***	1606*	-678	-21	872***	-21	18
	(1003)	(402)	(402)	(863)	(1110)	(387)	(313)	(43)	(17)
Year 4 × No RiverErosion = 1	2420	619	794	1223	-2283*	1184***	432	161***	71***
	(2183)	(557)	(557)	(2049)	(1172)	(394)	(317)	(45)	(20)
Year 7 × No RiverErosion = 1	9817**	353	520	9577**	-959	1008**	1139***	-165***	-77***
	(3834)	(581)	(580)	(3720)	(1232)	(498)	(432)	(45)	(20)
Year 11 × No RiverErosion = 1	13872***	1373***	1548***	11243***	-1975	2217***	1345***	40	17
	(4254)	(440)	(440)	(4046)	(1443)	(670)	(516)	(46)	(20)
Year 2 × above $\hat{k}$	-1110	84	-1338***	388	-2038*	-1871***	-1134***	-203***	-116***
	(915)	(384)	(385)	(763)	(1103)	(368)	(306)	(42)	(16)
Year 4 × above $\hat{k}$	2300	3116***	1694***	556	8	-918**	-408	22	73***
	(1970)	(540)	(540)	(1819)	(1150)	(372)	(303)	(45)	(20)
Year 7 × above $\hat{k}$	-1434	2374***	976*	-2800	1852	1795***	1393***	79*	12
	(3372)	(553)	(553)	(3254)	(1190)	(389)	(313)	(45)	(20)
Year 11 × above $\hat{k}$	-770	1695***	284	-627	4228***	153	357	71	66***
	(3612)	(406)	(407)	(3418)	(1355)	(519)	(366)	(45)	(18)
N	15698	15698	15698	15698	14974	15698	15698	15698	15698
adj. R^2	0.02	0.19	0.10	0.02	0.08	0.09	0.05	0.12	0.30

Panel B: Add 1{Branch Cow Price Above 9309 Threshold} X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × CowPrice above $\hat{k}$	255	1328***	-494	-525	-1943	-2533***	-2125***	-143**	1
	(1415)	(508)	(509)	(1284)	(1692)	(510)	(403)	(61)	(28)
Year 4 × CowPrice above $\hat{k}$	2494	5758***	3936***	-1997	-1068	-871	-89	110*	275***
	(2654)	(728)	(729)	(2474)	(1885)	(592)	(450)	(66)	(33)
Year 7 × CowPrice above $\hat{k}$	2172	4378***	2566***	-1824	1534	1913***	1706***	46	246***
	(6374)	(510)	(511)	(6267)	(1923)	(586)	(486)	(65)	(31)
Year 11 × CowPrice above $\hat{k}$	-5453	2032***	216	-6239	4411**	-345	989**	69	236***
	(6964)	(670)	(670)	(6699)	(2166)	(967)	(475)	(64)	(28)
Year 2 × No RiverErosion = 1	3531***	950**	1390***	1682*	-386	348	1181***	-0	18
	(1046)	(423)	(424)	(894)	(1131)	(394)	(324)	(44)	(17)
Year 4 × No RiverErosion = 1	2058	-218	222	1513	-2119*	1311***	445	145***	31
	(2226)	(605)	(605)	(2076)	(1208)	(408)	(338)	(47)	(21)
Year 7 × No RiverErosion = 1	9450***	-321	118	9836***	-1218	679	855**	-172***	-115***
	(3292)	(625)	(625)	(3151)	(1299)	(496)	(430)	(46)	(20)
Year 11 × No RiverErosion = 1	14726***	1087**	1530***	12197***	-2656*	2269***	1193**	30	-18
	(4392)	(461)	(462)	(4189)	(1419)	(707)	(505)	(48)	(20)
Year 2 × above $\hat{k}$	-1304	-928**	-962**	788	-579	58	484	-94	-117***
	(1337)	(458)	(459)	(1213)	(1731)	(517)	(406)	(61)	(27)
Year 4 × above $\hat{k}$	400	-1269**	-1303**	2077	814	-255	-340	-62	-136***
	(2625)	(590)	(590)	(2471)	(1862)	(572)	(418)	(65)	(32)
Year 7 × above $\hat{k}$	-2925	-838*	-882*	-1392	766	504	212	46	-169***
	(7185)	(479)	(479)	(7093)	(1836)	(539)	(427)	(65)	(31)
Year 11 × above $\hat{k}$	3133	113	70	3935	1040	412	-359	21	-110***
	(6705)	(630)	(630)	(6420)	(2192)	(844)	(407)	(62)	(27)
N	15698	15698	15698	15698	14974	15698	15698	15698	15698
adj. R^2	0.02	0.20	0.10	0.02	0.08	0.09	0.05	0.13	0.31

The sample consists of ultra-poor treatment households, excluding three outlier households (see Table 2 note). Panel A extends the BBBGH specification by adding interactions between survey wave indicators and a binary variable equal to one if the sub-district did not experience river erosion during 2008–2011 (Equation 3 in the text). Panel B further adds interactions between survey wave indicators and a binary variable for whether the branch-level median cow price exceeds the 9,309 BDT threshold. River erosion data are from the District Statistics 2011 publications of the Bangladesh Bureau of Statistics. Regressions include sub-district fixed effects as per the original BBBGH specification. The baseline survey was conducted prior to the asset transfer; hence BBBGH add the cow transfer value to baseline productive assets in Column 1 for ultra-poor treatment households so the diff-in-diff baseline reflects post-transfer holdings, but do not do so for the cow variable. Column 2 shows BBBGH's original cow variable; Column 3 includes the transfer value in baseline, for ease of comparing to the productive asset Column 1. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. See Appendix Table 6 for results including the three outlier households. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Predicting Long-Run Assets: Out-of-Sample R^2 Across Specifications and Models

Panel A: BBBGH Treated Sample: Assets 7 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.00	0.00	-0.03	-0.10
Community	0.01		-0.02	-0.05
Family Background	-0.01		-0.08	-0.36
Assets + Community	0.01	0.01	-0.04	-0.13
Assets + Family Background	-0.01	-0.01	-0.08	-0.39
Community + Family Background	-0.00		-0.10	-0.30
Full Model	-0.00	-0.00	-0.10	-0.31

Panel B: BBBGH Full Sample: Assets 7 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.45	0.54	0.42	0.36
Community	0.02		0.31	0.15
Family Background	0.27		0.32	0.22
Assets + Community	0.47	0.56	0.53	0.47
Assets + Family Background	0.48	0.55	0.54	0.48
Community + Family Background	0.28		0.36	0.31
Full Model	0.49	0.56	0.57	0.53

Panel C: Bangladesh Integrated Household Survey: Assets 8 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.46	0.47	0.38	0.44
Community	0.04		0.00	0.01
Family Background	0.17		0.15	-0.03
Assets + Community	0.46	0.47	0.37	0.38
Assets + Family Background	0.47	0.48	0.48	0.37
Community + Family Background	0.20		0.10	0.13
Full Model	0.48	0.49	0.47	0.43

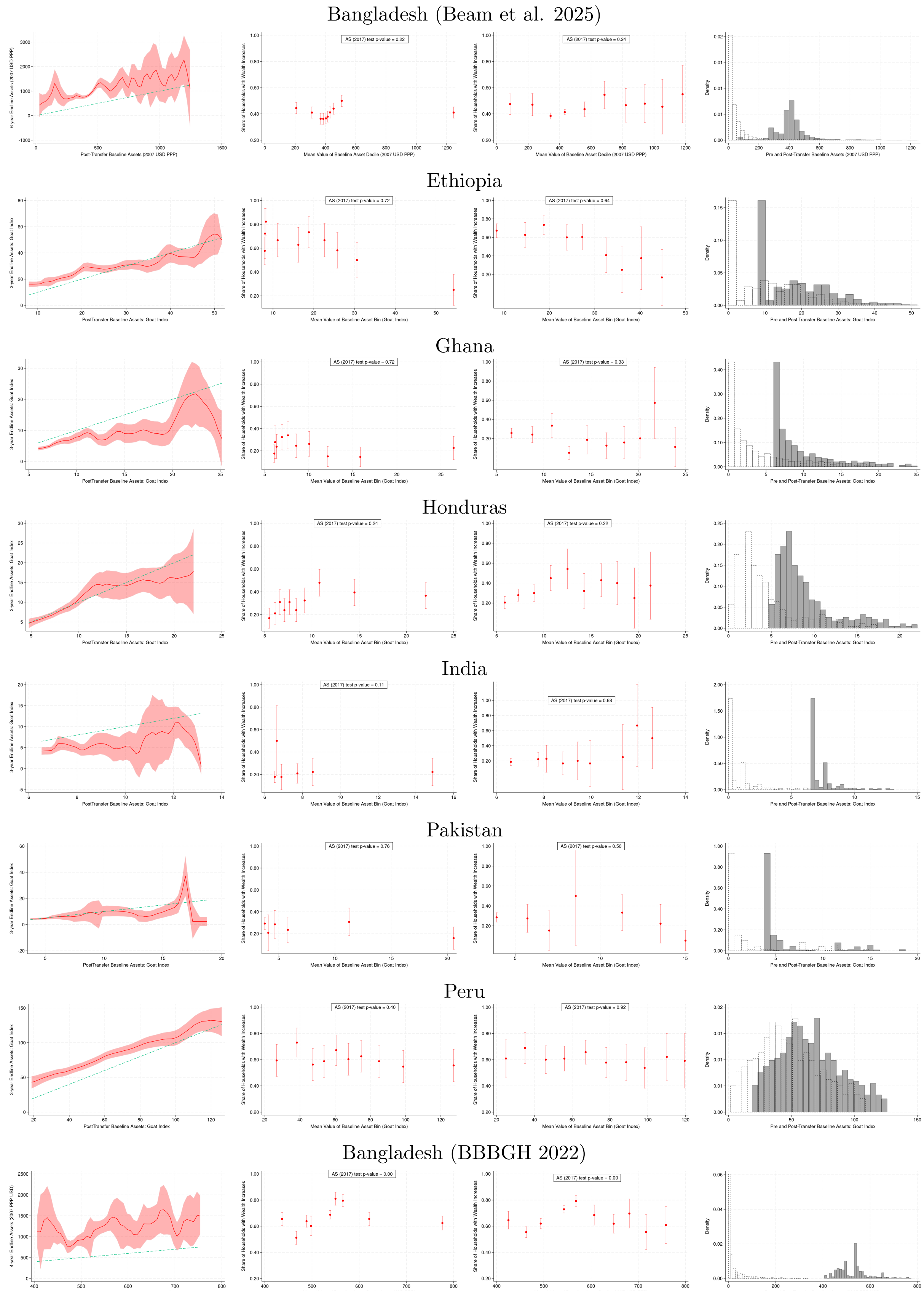
Panel D: Ghana Socioeconomic Panel Survey: Assets 8 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.12	0.13	-0.04	0.03
Community	0.01		-0.07	-0.05
Family Background	0.08		0.06	-0.19
Assets + Community	0.14	0.15	-0.02	-0.01
Assets + Family Background	0.16	0.17	0.16	-0.02
Community + Family Background	0.09		0.08	-0.03
Full Model	0.17	0.17	0.16	0.06

Each cell reports the out-of-sample R2 from predicting productive assets using baseline variables, estimated via 5-fold cross-validation with 50 repetitions. Rows identify combinations of predictor groups. “Family Background”: household composition (number of children and adults), head characteristics (age, sex, marital status), religious/ethnic identity, human capital (head’s education in Bangladesh; parental education in Ghana), social capital (local government and religious leadership; NGO/microfinance participation in Bangladesh), and economic controls (owned agricultural land in Ghana; government safety net receipt and current loan status in Bangladesh); Ghana models also include plot-area-weighted measures of agricultural shocks. “Community”: community random effects (linear regression and partial linear model) or indicators (random forest and extreme gradient boosting). Columns report results for four estimation methods: linear regression with community random effects, a partial linear model that estimates the baseline-to-future-assets relationship non-parametrically with penalized splines while controlling linearly for demographics and community random effects, random forest, and extreme gradient boosting. Blank cells indicate specifications not estimated for the partial-linear model because the nonparametric component is defined over baseline assets. Negative OOS R^2 means predictions are worse than using the training set mean. Results for other waves’ assets are reported in Appendix Table 7.

Figure 1: Transition functions in "Graduation" Programs

(a) Transition Function (b) Binary Analysis (Decile Bins) (c) Binary Analysis (Equally Spaced Bins) (d) Baseline Assets

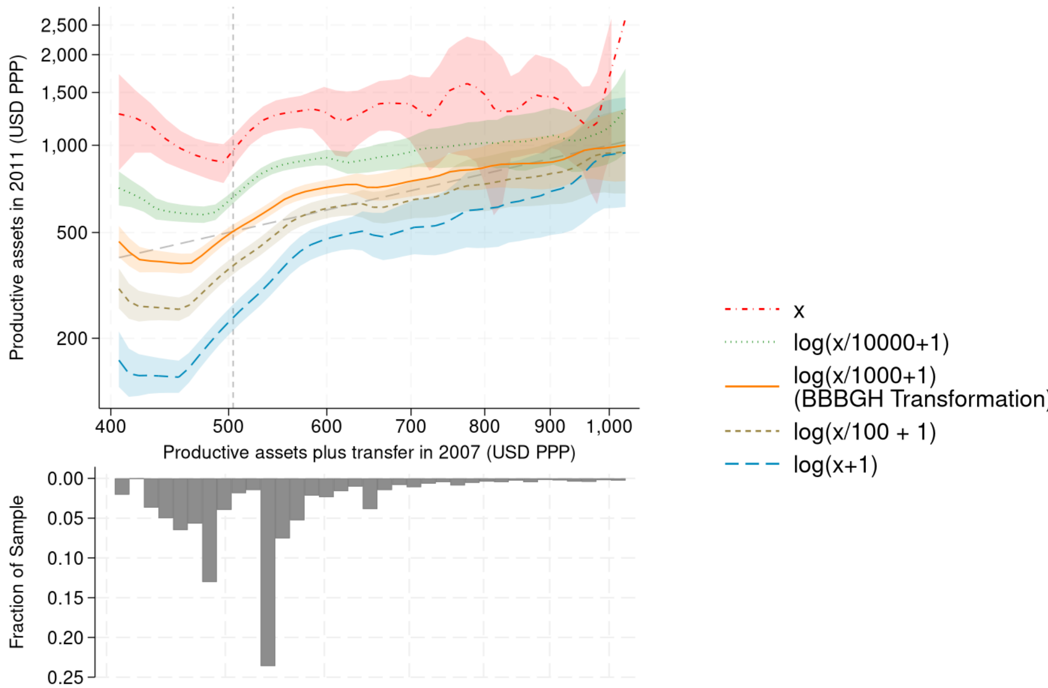


Column (a) plots nonparametric (local polynomial) estimates of the transition function of post-transfer baseline productive assets to productive assets approximately 3-4 years later (6 years for Beam et al.); the dashed line is the 45-degree line and the shaded region denotes the 95% confidence interval. Columns (b) and (c) show the share of households whose assets increased over time, plotted against the mean baseline asset value of the bin. Bins are defined by asset deciles in (b) and by equally spaced intervals over the asset range in (c); P-values report the Arunachalam and Shenoy (2017) test of the null hypothesis of no sharp increase in the probability of asset growth across consecutive bins. Column (d) shows the distribution of pre-transfer (light bars) and post-transfer (dark bars) baseline assets. For the six countries from Banerjee et al. (2015), productive assets are measured in goat-equivalent units. For the two Bangladesh studies, assets are in 2007 PPP USD.

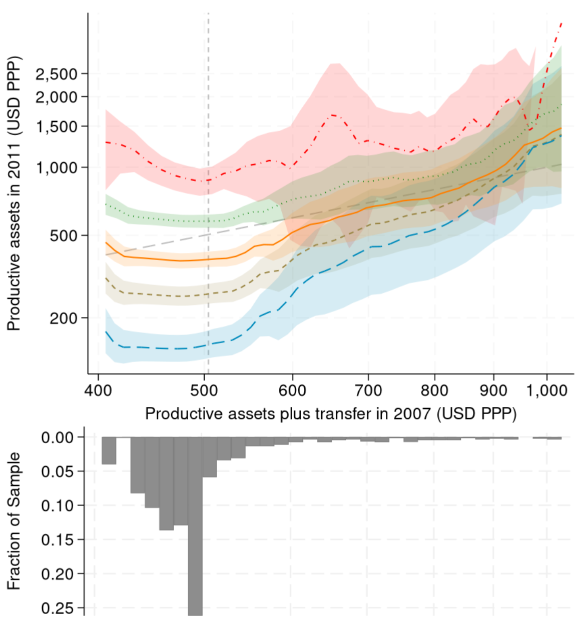
Figure 2: Transition function for assets 2007-2011 (figure 4 in BBBGH)

Sample: Ultra-Poor Households in the Treatment Group

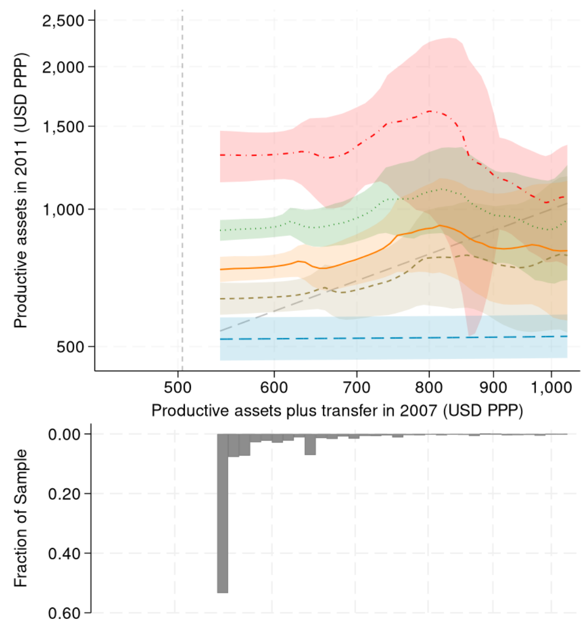
(a) All Branches



(b) Low-Cow-Price Branches



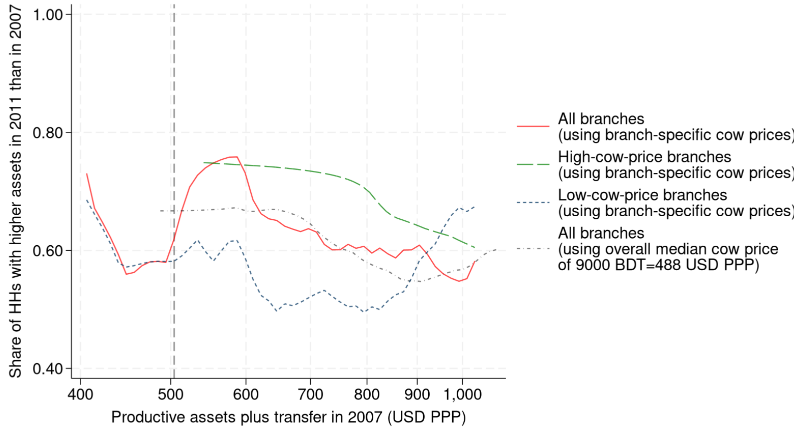
(c) High-Cow-Price Branches



Panel (a) plots nonparametric (local polynomial) estimates of the transition function mapping post-transfer baseline productive assets to productive assets four years later, under five transformations: levels (x), log(x/10000+1), log(x/1000+1) (the BBBGH transformation), log(x/100+1), and log(x+1); the gray dashed line is the 45-degree line and the shaded regions denote 95% confidence intervals. The axes show the equivalent PPP USD amounts of the respective log values. Panels (b) and (c) restrict the sample to low-cow-price and high-cow-price branches, respectively. Consistent with BBBGH, samples are trimmed at post-transfer baseline asset values of roughly 1,000 PPP USD (93rd percentile). In the legend, x denotes asset values in Bangladeshi Taka. The inverted histograms below each panel show the distribution of post-transfer baseline assets.

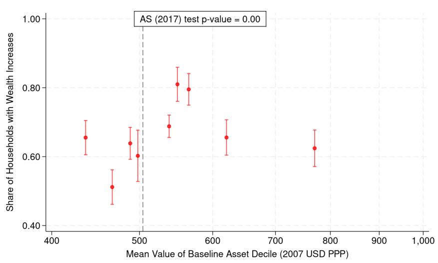
Figure 3: Binary Analysis: Proportion Gaining versus Losing Assets at Four Years in BBBGH Sample: Ultra-Poor Households in the Treatment Group

(a) Local Polynomial Estimation

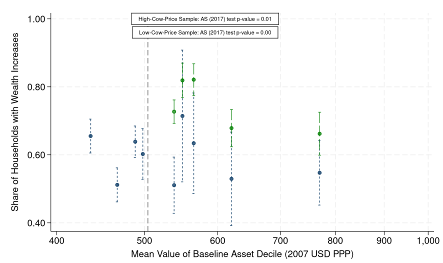


Binscatter Plot by Asset Deciles

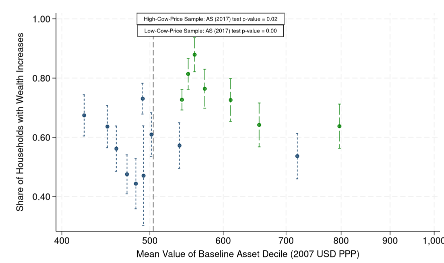
(b) All Branches



(c) Low vs High-cow-price

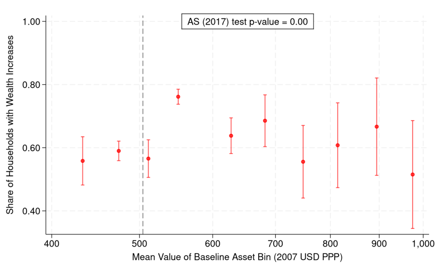


(d) Sample-Specific Deciles

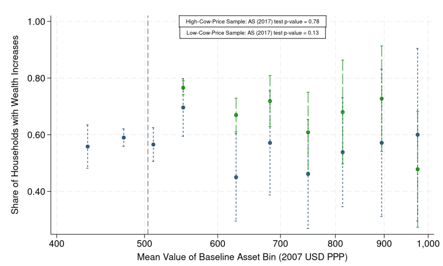


Binscatter Plot by Equally Spaced Bins

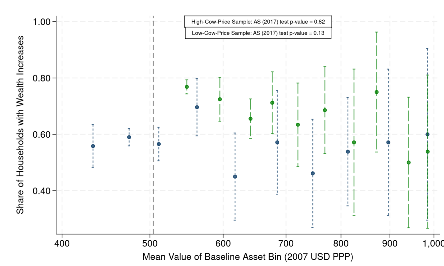
(e) All Branches



(f) Low vs High-cow-price

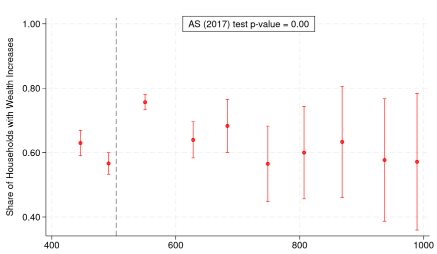


(g) Sample-Specific Bins

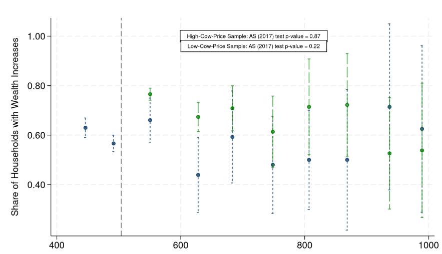


Binscatter Plot by Equally Spaced Bins (Over the levels range, not log)

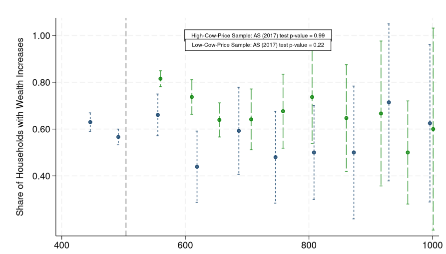
(h) All Branches



(i) Low vs High-cow-price

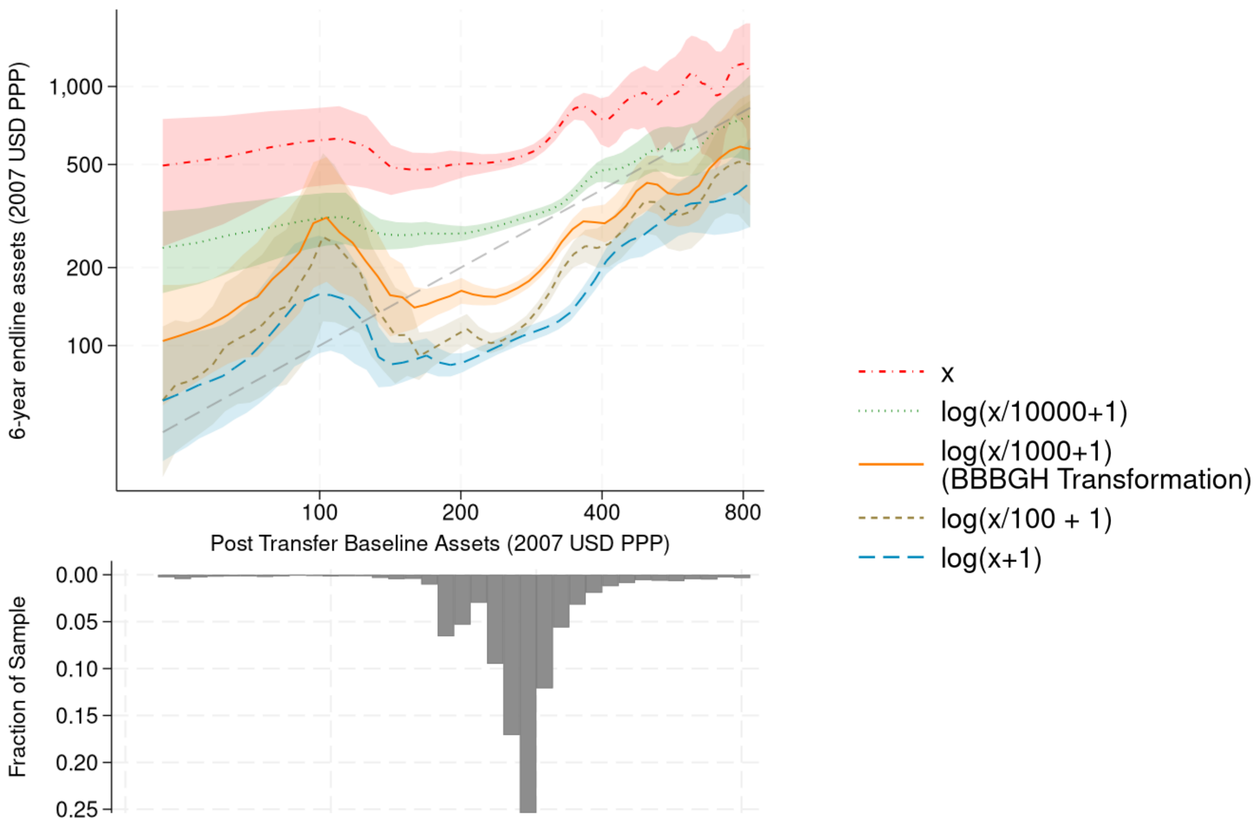


(j) Sample-Specific Bins



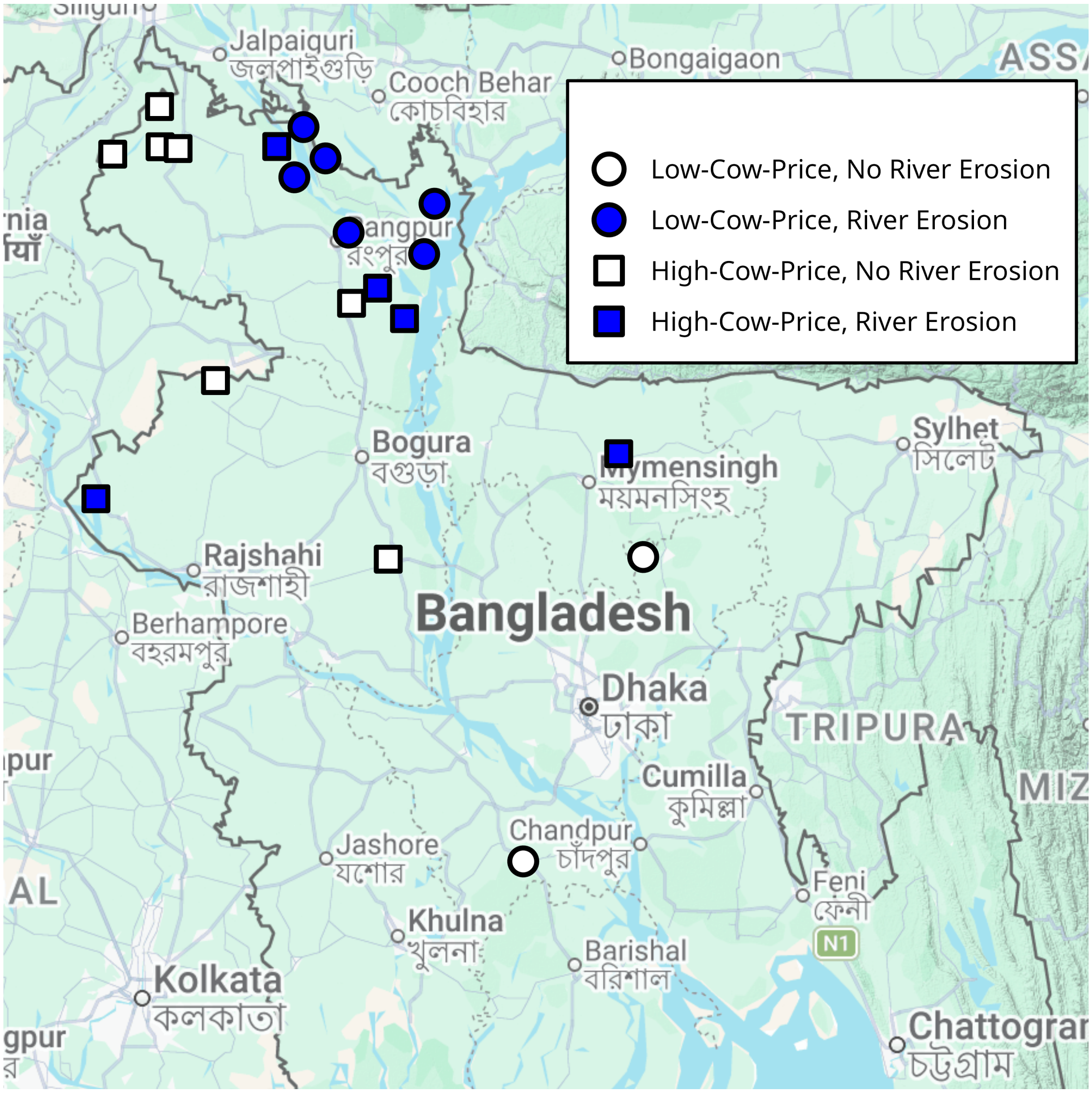
In all panels, the line/bar colors correspond to: all branches using branch-specific cow prices (red solid), high-cow-price branches (green long dash), low-cow-price branches (navy short dash), and all branches using the overall sample median cow price of 9,000 BDT (gray dot-dash). Panel (a) plots local polynomial estimates of the share of households with higher productive assets in 2011 than at baseline, as a function of post-transfer baseline assets (in PPP USD); the vertical dashed line marks the BBBGH threshold of 504 PPP USD. Panels (b)–(j) present binscatter analyses of the share of households whose assets increased. In the left column, bins are constructed over the full sample; in the middle column, low- and high-cow-price branches are plotted jointly using the full-sample bin definitions; in the right column, bins are constructed separately within each cow-price subsample. Rows vary the binning method: asset deciles (b–d), equally spaced bins over the log range (e–g), and equally spaced bins over the levels range (h–j). P-values report the Arunachalam and Shenoy (2017) test of the null hypothesis of no sharp increase in the probability of asset growth across consecutive bins. Following BBBGH, the analysis sample is trimmed at post-transfer baseline asset values of roughly 1,000 PPP USD (93rd percentile).

Figure 4: Transition function for assets 2016-2022 in Beam et al. (2025)
Sample: Treatment Group



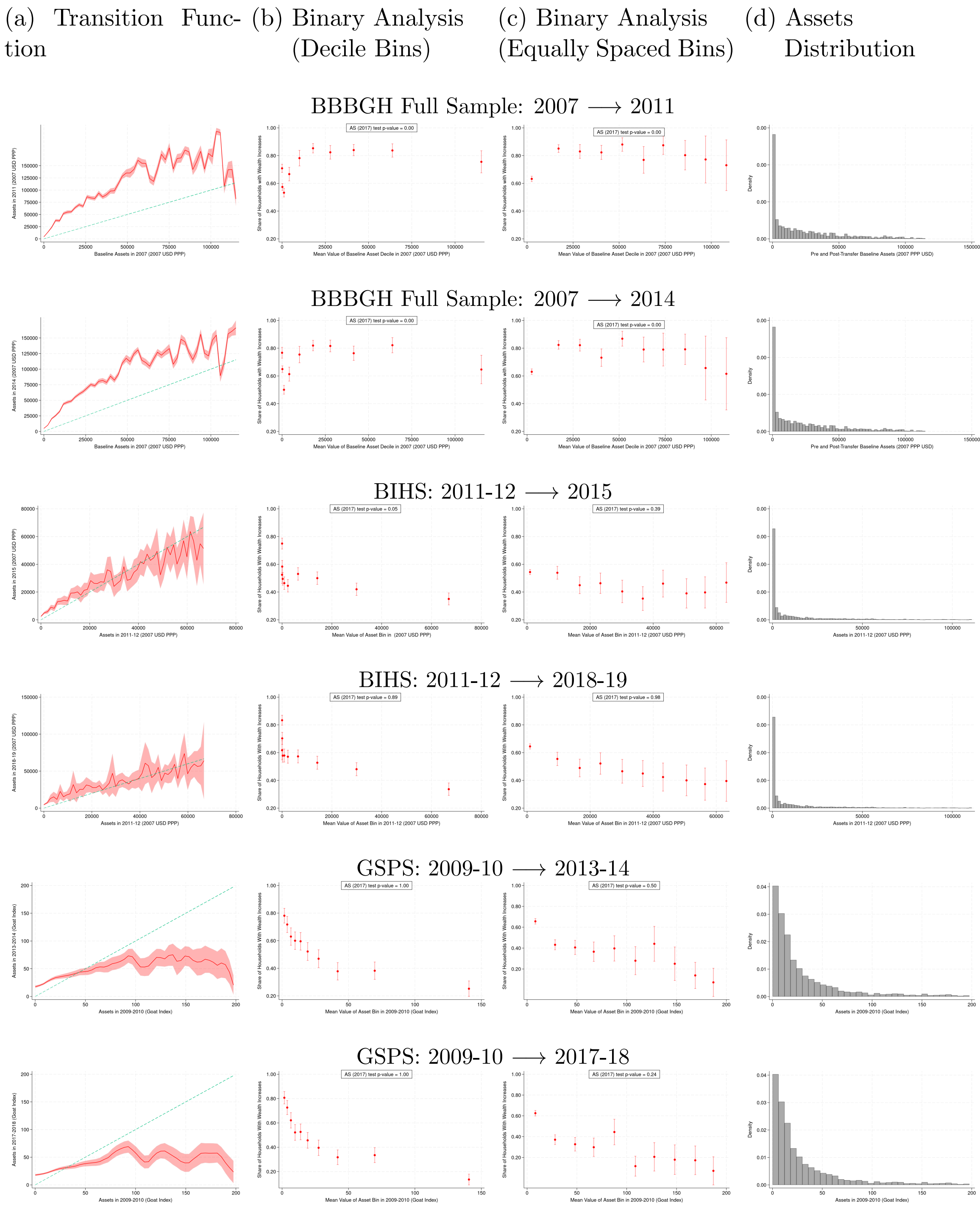
The graph plots nonparametric (local polynomial) estimates of the transition function mapping post-transfer baseline productive assets to productive assets six years later, using data from the Beam et al. (2025) Bangladesh Graduation study, a different implementation from BBBGH but by the same implementer (BRAC) in the same country. Five transformations are shown: levels (x), log(x/10000+1), log(x/1000+1), log(x/100+1), and log(x+1); the gray dashed line is the 45-degree line and the shaded regions denote 95% confidence intervals. The axes show the equivalent PPP USD amounts of the respective log values. In the legend, x denotes asset values in Bangladeshi Taka. The inverted histogram shows the distribution of post-transfer baseline assets.

Figure 5: Map of Treatment Group BRAC Branches in BBBGH



Each marker represents a BRAC branch in the BBBGH treatment sample. Shape indicates whether the branch-level median cow price is below (circle) or above (square) the BBBGH threshold of 9,309 BDT (504 PPP USD). Fill indicates whether the sub-district experienced river erosion in three or more years during 2008–2011 (filled) or not (hollow), based on District Statistics 2011 data from the Bangladesh Bureau of Statistics.

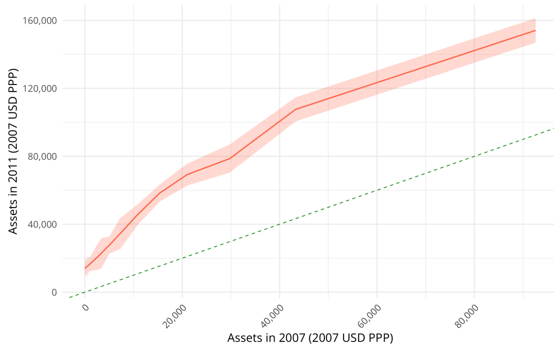
Figure 6: Transition functions in Bangladesh (BBBGH, BIHS) and Ghana (GSPS) Household Surveys



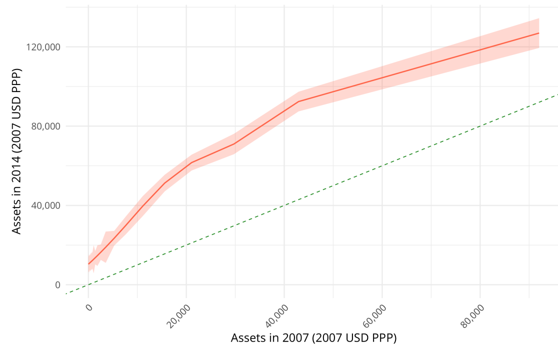
BBBGH Full Sample (first two panels) refers to household survey data from Balboni et al (2022). BIHS (third and fourth panels) refers to Bangladesh Integrated Household Survey, which is a nationally representative survey of rural households in Bangladesh. GSPS (last two panels) refers to Ghana Socioeconomic Panel Survey, a nationally representative survey in Ghana; we restrict its sample to rural households present in all four waves of the survey. For each survey, its first panel presents results at the four-year wave and the second panel at the seven/eight-year wave. Column (a) plots nonparametric (local polynomial) estimates of the transition function mapping productive assets (in PPP USD for BBBGH and BIHS, and in goat-equivalent units for GSPS) at the start of each period to productive assets at the end; the dashed line is the 45-degree line and the shaded region denotes the 95% confidence interval. Columns (b) and (c) present analyses of the share of households whose assets increased over time, plotted against the mean baseline asset value of the bin. Bins are defined by asset deciles in (b) and by equally spaced intervals over the asset range in (c); P-values report the Arunachalam and Shenoy (2017) test of the null hypothesis of no sharp increase in the probability of asset growth across consecutive bins. Column (d) shows the distribution of baseline productive assets for each transition.

Figure 7: Partial Linear Model Estimates of the Transition Functions in BBBGH

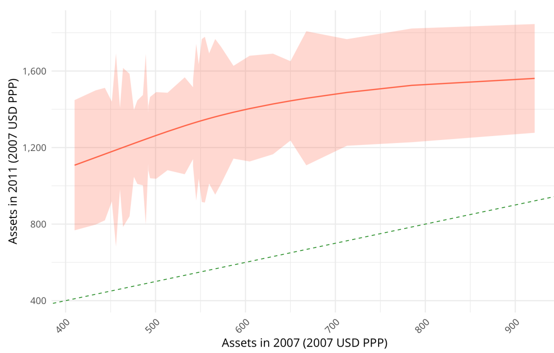
(a) BBBGH Full Sample: 2007 ⟶ 2011



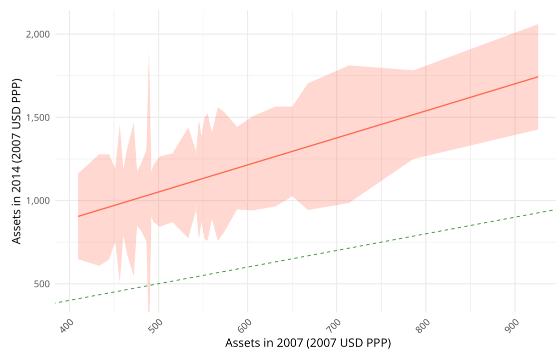
(b) BBBGH Full Sample: 2007 ⟶ 2014



(c) BBBGH Treated Sample: 2007 ⟶ 2011



(d) BBBGH Treated Sample: 2007 ⟶ 2014



BBBGH Full Sample refers to the full household survey data from Balboni et al (2022). BBBGH Treated Sample refers to the sample of ultra-poor households that received the Graduation package treatment. For each sample, the left figure presents results at the four-year wave and the right figure at the seven-year wave. The figures plot estimated transition functions from baseline productive assets to future productive assets, measured in 2007 PPP USD. Estimates come from partial linear models that fit the asset transition non-parametrically using penalized splines, while controlling linearly for demographics and, where included, community random effects. The dashed line is the 45-degree line; shaded regions are point-wise 1.96-standard-error bands based on variation in binned predictions across repetitions/folds.

Appendix Table 1: Average Treatment Effects of BRAC Graduation Program

Sample: Ultra-Poor Households in Treatment and Control

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × Treatment== 1	3137**	10435***	1083*	700	2753**	1657***	2045***	377***	564***
	(1388)	(535)	(551)	(974)	(1305)	(552)	(373)	(68)	(36)
Year 4 × Treatment== 1	6456***	11403***	2051**	2614**	5446***	1896***	2891***	235***	478***
	(1951)	(1100)	(1007)	(1260)	(1273)	(526)	(443)	(76)	(46)
N	17259	17259	17259	17259	16181	17259	17259	17259	17259
Adj. R^2	0.07	0.35	0.33	0.01	0.06	0.09	0.09	0.07	0.41
Control Group Stats									
Mean at Baseline	673	113	113	24	28946	5392	1161	1105	115
SD at Baseline	1519	901	901	413	15995	5413	3238	903	264
Mean at Year 2	8845	1009	1009	6671	28924	6334	1978	1086	177
SD at Year 2	54784	4324	4324	53558	18134	6635	4216	861	310
Mean at Year 4	9635	1170	1170	7395	33036	8030	1802	1217	204
SD at Year 4	54617	4542	4542	53192	25569	7218	4551	866	360

The sample pools ultra-poor treatment and control households. Each column regresses the indicated outcome on survey wave indicators interacted with a treatment indicator, with sub-district fixed effects. The bottom panel reports control group means and standard deviations at baseline, year 2, and year 4. Standard errors, clustered at the BRAC branch level, are in parentheses. Results may not exactly match Bandiera et al. (2017) because the sample differs slightly from Balboni et al. (2022), which we use in our study. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 2: Asset Growth at Year 4 with Alternative Outcome-Variable Transformations
Regression version of Figure 2, Extension of BBBGH Table II
Sample: Ultra-Poor Households in the Treatment Group

Panel A: Asset Growth at Year 4

	(1)	(2)	(3)	(4)	(5)
	Δ log(x/1000+1) (BBBGH Table II Column 1)	Δ log(x/1000+1) Censored at -1	Δ log(x/1000+1) 50th Quantile	Δ x/x	Δ x/x 50th Quantile
Above $\hat{k}$	0.30***	0.16***	0.09**	0.08	0.13**
	(0.04)	(0.03)	(0.04)	(0.18)	(0.06)
Constant	-0.14***	0.14***	0.30***	1.10***	0.39***
	(0.03)	(0.02)	(0.03)	(0.14)	(0.04)
N	3292	3292	3292	3292	3292
adj. R^2	0.01	0.01		-0.00	

Panel B: Add 1{Branch Cow Price Above 9309 Threshold} to Panel A

	(1)	(2)	(3)	(4)	(5)
	Δ log(x/1000+1)	Δ log(x/1000+1) Censored at -1	Δ log(x/1000+1) 50th Quantile	Δ x/x	Δ x/x 50th Quantile
Above $\hat{k}$	-0.02	-0.06	-0.15**	-0.23	-0.18**
	(0.07)	(0.05)	(0.06)	(0.29)	(0.09)
CowPrice above $\hat{k}$	0.39***	0.27***	0.28***	0.38	0.39***
	(0.07)	(0.05)	(0.06)	(0.29)	(0.09)
Constant	-0.14***	0.14***	0.30***	1.10***	0.39***
	(0.03)	(0.02)	(0.03)	(0.14)	(0.04)
N	3292	3292	3292	3292	3292
adj. R^2	0.02	0.02		0.00	

Panel A Column 1 replicates BBBGH Table II Column 1, regressing the four-year change in log(assets/1000+1) on an indicator for above-threshold post-transfer baseline assets. Column 2 censors the dependent variable from below at -1 to limit the influence of large asset declines. Column 3 estimates a median (quantile) regression using the Column 1 outcome. Column 4 uses the growth rate of assets, Δ x / x, as the dependent variable, and Column 5 estimates a median regression of the same. Panel B adds a control for whether the branch-level median cow price exceeds the 9,309 BDT threshold. Results are robust to BBBGH's second specification that includes a linear control for baseline assets (see Appendix Table 3). Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 3: Asset Growth at Year 4 with Alternative Outcome-Variable Transformations
Add Controls for Baseline Assets to Appendix Table 2 Regressions

Sample: Ultra-Poor Households in the Treatment Group

Panel A: Extension of AT 2 Panel A

	(1)	(2)	(3)	(4)	(5)
	Δ log(x/1000+1) (BBBGH Table II Column 2)	Δ log(x/1000+1) Censored at -1	Δ log(x/1000+1) 50th Quantile	Δ x/x	Δ x/x 50th Quantile
Above $\hat{k}$	0.47***	0.32***	0.32***	0.83***	0.49***
	(0.07)	(0.05)	(0.05)	(0.28)	(0.09)
Baseline assets	-2.20***	-1.83***	-2.22***	-8.72***	-3.50***
	(0.70)	(0.51)	(0.54)	(2.85)	(0.86)
Above $\hat{k}$ × Baseline assets	1.97***	1.52***	1.61***	7.49**	2.57***
	(0.73)	(0.53)	(0.57)	(2.98)	(0.90)
Constant	-0.28***	0.02	0.15***	0.53**	0.16**
	(0.06)	(0.04)	(0.04)	(0.23)	(0.07)
N	3292	3292	3292	3292	3292
adj. R^2	0.02	0.01		0.00	

Panel B: Add 1{Branch Cow Price Above 9309 Threshold} to Panel A (Extension of AT 2 Panel B)

	(1)	(2)	(3)	(4)	(5)
	Δ log(x/1000+1)	Δ log(x/1000+1) Censored at -1	Δ log(x/1000+1) 50th Quantile	Δ x/x	Δ x/x 50th Quantile
Above $\hat{k}$	0.14	0.10	0.08	0.53	0.14
	(0.09)	(0.07)	(0.07)	(0.38)	(0.12)
CowPrice above $\hat{k}$	0.38***	0.26***	0.27***	0.34	0.38***
	(0.07)	(0.05)	(0.06)	(0.29)	(0.09)
Baseline assets	-2.20***	-1.83***	-2.22***	-8.72***	-3.50***
	(0.69)	(0.51)	(0.56)	(2.85)	(0.88)
Above $\hat{k}$ × Baseline assets	2.10***	1.60***	1.74***	7.61**	2.78***
	(0.73)	(0.53)	(0.58)	(2.98)	(0.92)
Constant	-0.28***	0.02	0.15***	0.53**	0.16**
	(0.06)	(0.04)	(0.05)	(0.23)	(0.07)
N	3292	3292	3292	3292	3292
adj. R^2	0.03	0.02		0.00	

This table extends Appendix Table 2 by adding a linear control for baseline assets and its interaction with the above-threshold indicator, following BBBGH Table II Column 2. Baseline assets are centered at the threshold: Baseline Assets = log(baseline assets/1000 + 1) − 2.333, where 2.333 is the log-transformed threshold estimated by BBBGH. Column 1 in Panel A replicates BBBGH Table II Column 2. Column 2 censors the dependent variable from below at -1. Column 3 estimates a median regression. Column 4 uses the growth rate Δ x /x, and Column 5 estimates a median regression of the same. Panel B adds a control for whether the branch-level median cow price exceeds the 9,309 BDT threshold. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses (except Columns 3 and 5, which report quantile regression standard errors). *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 4: Long-Run Dynamics: Adding Controls for Prior Experience with Cow Rearing

Sample: Ultra-Poor Households in the Treatment Group

Panel A: Add Controls for Prior Cow Experience X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × PriorCowExperience	-242	-465	-102	-287	-2058	252	1	-195***	-317***
	(1717)	(1137)	(1133)	(1125)	(1630)	(700)	(422)	(65)	(33)
Year 4 × PriorCowExperience	384	-289	73	-381	-2455	318	582	-169**	-317***
	(2271)	(709)	(701)	(2043)	(1790)	(638)	(516)	(70)	(35)
Year 7 × PriorCowExperience	262	-958	-601	891	-1077	1007	1475	-180**	-252***
	(3523)	(639)	(629)	(3354)	(1985)	(1230)	(1185)	(74)	(41)
Year 11 × PriorCowExperience	-237	284	648	-2340	-1861	-149	686	-209***	-313***
	(8396)	(812)	(805)	(8041)	(2578)	(1385)	(785)	(73)	(38)
Year 2 × above $\hat{k}$	280	551	-832**	1040	-2122**	-1898***	-804***	-196***	-85***
	(934)	(419)	(420)	(782)	(983)	(326)	(255)	(39)	(14)
Year 4 × above $\hat{k}$	3343*	3369***	1985***	1209	-659	-469	-288	98**	125***
	(1712)	(462)	(463)	(1583)	(1094)	(348)	(268)	(41)	(17)
Year 7 × above $\hat{k}$	2287	2615***	1252***	733	1672	2074***	1709***	36	7
	(2574)	(409)	(410)	(2471)	(1137)	(415)	(337)	(43)	(19)
Year 11 × above $\hat{k}$	10708**	2226***	852**	9935*	3700***	1475**	812*	104**	99***
	(5363)	(376)	(377)	(5230)	(1273)	(725)	(440)	(41)	(17)
N	15713	15713	15713	15713	14988	15713	15713	15713	15713
adj. R^2	0.01	0.19	0.10	0.01	0.08	0.07	0.05	0.12	0.31

Panel B: Add Controls for Prior Cow Experience X Survey Wave And Remove Three Outliers

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × PriorCowExperience	-217	-465	-101	-263	-2061	253	4	-195***	-318***
	(1683)	(1137)	(1133)	(1076)	(1630)	(701)	(422)	(65)	(33)
Year 4 × PriorCowExperience	536	-292	72	-230	-2441	345	585	-168**	-317***
	(2247)	(709)	(701)	(2010)	(1790)	(639)	(516)	(70)	(35)
Year 7 × PriorCowExperience	400	-950	-592	1021	-1003	1012	1478	-179**	-252***
	(3519)	(639)	(629)	(3353)	(1984)	(1229)	(1185)	(74)	(41)
Year 11 × PriorCowExperience	5602	314	679	3410	-1812	326	692	-207***	-312***
	(7589)	(811)	(805)	(7212)	(2578)	(1315)	(785)	(73)	(38)
Year 2 × above $\hat{k}$	251	552	-833**	1013	-2116**	-1899***	-806***	-196***	-84***
	(919)	(420)	(420)	(766)	(984)	(326)	(255)	(39)	(15)
Year 4 × above $\hat{k}$	3168*	3372***	1988***	1035	-673	-500	-292	96**	125***
	(1697)	(463)	(463)	(1568)	(1094)	(347)	(268)	(41)	(17)
Year 7 × above $\hat{k}$	2167	2606***	1242***	619	1594	2094***	1706***	35	6
	(2563)	(410)	(410)	(2461)	(1136)	(414)	(337)	(43)	(19)
Year 11 × above $\hat{k}$	3945	2190***	815**	3273	3653***	951*	806*	103**	98***
	(3406)	(376)	(376)	(3251)	(1274)	(539)	(440)	(41)	(17)
N	15698	15698	15698	15698	14974	15698	15698	15698	15698
adj. R^2	0.02	0.19	0.10	0.02	0.08	0.09	0.05	0.12	0.31

This table extends the BBBGH Table IV specification (replicated in Table 2 Panel A) by adding interactions between survey wave indicators and a binary variable for prior cow-rearing experience. Prior Cow Experience equals one if, at the baseline survey, the household reports owning a cow, having transferred out a cow, or rearing a cow it does not own. Panel A includes the full sample; Panel B removes three outlier households that increased their landholdings from 0 to approximately 2, 3.1, and 5 million BDT over 11 years, placing them 12, 18, and 30 standard deviations above the year 11 mean asset distribution. All regressions include sub-district fixed effects following BBBGH's specification. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 5: Comparison of Households in Low-Cow-Price vs High-Cow-Price Branches

Data: Baseline Survey Data from BBBGH Analysis

Panel A: All Households in Baseline Survey Data (With Sampling Weights)

	(1) Low-Cow-Price	(2) High-Cow-Price	(3) Difference (2)-(1)	(4) RiverErosion	(5) No RiverErosion	(6) Difference (5)-(4)
=1 if branch affected by river erosion	0.75	0.44	-0.31***			'
	(0.016)	(0.016)	(0.023)			
# Years of schooling of the main female respondent	2.6	3.1	0.44**	2.8	3	0.17
	(0.16)	(0.13)	(0.21)	(0.15)	(0.13)	(0.2)
Body mass index of the main female respondent	20	21	0.4	20	21	0.52
	(0.19)	(0.5)	(0.54)	(0.15)	(0.65)	(0.67)
=1 if had any mental anxiety that hampered daily activities last 1 month	0.31	0.34	0.025	0.28	0.38	0.095***
	(0.019)	(0.014)	(0.024)	(0.016)	(0.016)	(0.023)
Annual HH earnings from the respondent's business activities	5502	8366	2864***	6081	8642	2560***
	(614)	(661)	(902)	(665)	(599)	(895)
Livestock value	17600	26929	9329***	20041	27988	7947***
	(1047)	(1381)	(1733)	(1160)	(1501)	(1897)
Business assets value (excluding livestock and land)	22028	18396	-3633	22915	17594	-5320
	(5171)	(1726)	(5452)	(4096)	(1395)	(4327)
Land value (excluding homestead land)	508058	491516	-16542	600185	455080	-145106***
	(49303)	(33144)	(59408)	(45980)	(27060)	(53352)
Non-business assets value	24542	22907	-1635	21959	26591	4632
	(3626)	(2768)	(4562)	(2686)	(3649)	(4531)
Annual HH Consumption	87320	85780	-1539	81647	94477	12831***
	(3869)	(2884)	(4826)	(3096)	(3560)	(4718)
# hours worked annually in all occupations	524	548	24	488	607	119***
	(20)	(15)	(25)	(16)	(19)	(24)
Village cow earnings potential (constructed using sampling weights)	-1686	-341	1346***	-1082	-721	362
	(194)	(248)	(314)	(220)	(252)	(334)
N	5061	6316	11377	5061	6316	11377

Panel B: Sample Restricted to Same as in BBBGH Analyses (Ultra-Poor Treatment HHs with post-transfer baseline assets $\leq$ 19000 BDT)

	(1) Low-Cow-Price	(2) High-Cow-Price	(3) Difference (2)-(1)	(4) RiverErosion	(5) No RiverErosion	(6) Difference (5)-(4)
=1 if branch affected by river erosion	0.81	0.4	-0.41***			'
	(0.0095)	(0.012)	(0.015)			
# Years of schooling of the main female respondent	0.55	0.61	0.06	0.48	0.73	0.26***
	(0.038)	(0.044)	(0.058)	(0.033)	(0.052)	(0.062)
Body mass index of the main female respondent	20	20	0.15	20	20	0.46
	(1.1)	(1.5)	(1.9)	(0.96)	(01.9)	(2.1)
=1 if had any mental anxiety that hampered daily activities last 1 month	0.48	0.57	0.087***	0.48	0.6	0.12***
	(0.012)	(0.013)	(0.018)	(0.011)	(0.014)	(0.018)
Annual HH earnings from the respondent's business activities	3961	5319	1358***	4085	5482	1396***
	(104)	(138)	(172)	(101)	(153)	(184)
Livestock value	425	375	-50	242	650	408***
	(32)	(27)	(42)	(17)	(47)	(50)
Business assets value (excluding livestock and land)	288	320	32	269	359	90***
	(21)	(23)	(32)	(19)	(27)	(33)
Land value (excluding homestead land)	30	15	-14	16	32	16
	(11)	(7.5)	(13)	(7.1)	(13)	(15)
Non-business assets value	637	605	-32	599	656	57**
	(17)	(20)	(26)	(15)	(25)	(29)
Annual HH Consumption	32319	31447	-872	30937	33398	2462***
	(407)	(406)	(575)	(352)	(487)	(601)
# hours worked annually in all occupations	872	972	100***	883	980	97***
	(21)	(22)	(31)	(20)	(24)	(31)
N	1677	1615	3292	1677	1615	3292

Data are from the BBBGH baseline survey. Panel A includes all households with sampling weights applied to account for different sampling probabilities. Panel B restricts to the BBBGH analysis sample: ultra-poor treatment households with post-transfer baseline assets $\leq$ 19,000 BDT. Columns 1-3 compare households in branches with median cow prices below versus above the 9,309 BDT threshold. Columns 4-6 compare households in sub-districts with versus without river erosion during 2008–2011. The village cow earnings potential variable follows BBBGH's methodology (using sampling weights): it is the village average of residuals from a regression of households' net livestock earnings on a constant and a second-order polynomial of the number of cows owned. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 6: Long-Run Dynamics of Branches Without and With River Erosion

Sample: Ultra-Poor Households in the Treatment Group

Panel A: Without 1{Branch Cow Price Above 9309 Threshold} X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × No RiverErosion = 1	3602***	1143***	1318***	1639*	-685	-19	875***	-21	17
	(1026)	(402)	(402)	(886)	(1109)	(387)	(312)	(43)	(17)
Year 4 × No RiverErosion = 1	2640	615	791	1443	-2260*	1223***	437	163***	71***
	(2202)	(557)	(556)	(2068)	(1171)	(396)	(317)	(45)	(20)
Year 7 × No RiverErosion = 1	10067***	364	533	9815***	-856	1017**	1144***	-163***	-76***
	(3843)	(581)	(580)	(3728)	(1235)	(500)	(432)	(45)	(20)
Year 11 × No RiverErosion = 1	22201***	1415***	1591***	19451***	-1912	2881***	1352***	43	19
	(6647)	(441)	(440)	(6471)	(1443)	(910)	(516)	(46)	(20)
Year 2 × above $\hat{k}$	-1098	83	-1338***	399	-2040*	-1871***	-1133***	-203***	-117***
	(934)	(384)	(385)	(783)	(1103)	(369)	(306)	(42)	(16)
Year 4 × above $\hat{k}$	2378	3114***	1693***	634	15	-905**	-406	23	73***
	(1983)	(540)	(540)	(1831)	(1150)	(373)	(303)	(45)	(20)
Year 7 × above $\hat{k}$	-1438	2378***	981*	-2806	1888	1769***	1394***	79*	12
	(3382)	(553)	(553)	(3263)	(1191)	(391)	(313)	(45)	(20)
Year 11 × above $\hat{k}$	2438	1711***	301	2534	4249***	392	359	72	67***
	(4115)	(406)	(407)	(3934)	(1355)	(565)	(366)	(45)	(18)
N	15713	15713	15713	15713	14988	15713	15713	15713	15713
adj. R^2	0.02	0.19	0.10	0.02	0.08	0.07	0.05	0.12	0.30

Panel B: Add 1{Branch Cow Price Above 9309 Threshold} X Survey Wave

	(1) Productive assets	(2) Cows - w/o transfer value	(3) Cows - w/ transfer value	(4) Land	(5) Consumption	(6) Net earnings	(7) Net earnings self-employed	(8) Total hours	(9) Hours self-employed
Year 2 × CowPrice above $\hat{k}$	276	1316***	-507	-490	-1878	-2552***	-2144***	-142**	3
	(1460)	(507)	(508)	(1322)	(1689)	(511)	(402)	(61)	(28)
Year 4 × CowPrice above $\hat{k}$	2460	5788***	3965***	-2046	-1005	-1055*	-110	106	277***
	(2671)	(727)	(728)	(2493)	(1884)	(614)	(449)	(66)	(33)
Year 7 × CowPrice above $\hat{k}$	2371	4392***	2580***	-1625	1239	1901***	1713***	43	245***
	(6366)	(509)	(510)	(6258)	(1949)	(586)	(485)	(65)	(31)
Year 11 × CowPrice above $\hat{k}$	-12929	1918***	101	-13363	4242*	-2763	936**	69	236***
	(12624)	(676)	(677)	(12193)	(2171)	(2608)	(477)	(64)	(29)
Year 2 × No RiverErosion = 1	3562***	952**	1392***	1710*	-404	351	1186***	-0	17
	(1074)	(422)	(423)	(920)	(1130)	(394)	(324)	(44)	(17)
Year 4 × No RiverErosion = 1	2283	-224	216	1739	-2106*	1376***	453	148***	30
	(2245)	(604)	(605)	(2095)	(1207)	(413)	(337)	(47)	(21)
Year 7 × No RiverErosion = 1	9636***	-311	128	10009***	-1063	679	859**	-170***	-114***
	(3302)	(624)	(625)	(3160)	(1306)	(497)	(429)	(46)	(20)
Year 11 × No RiverErosion = 1	24204***	1147**	1590***	21498***	-2564*	3304***	1208**	32	-16
	(7290)	(462)	(463)	(7080)	(1420)	(1215)	(504)	(48)	(20)
Year 2 × above $\hat{k}$	-1309	-919**	-952**	772	-631	73	499	-95	-119***
	(1377)	(458)	(458)	(1247)	(1729)	(518)	(406)	(61)	(27)
Year 4 × above $\hat{k}$	505	-1293**	-1326**	2192	773	-101	-322	-58	-138***
	(2640)	(590)	(590)	(2487)	(1861)	(589)	(418)	(65)	(32)
Year 7 × above $\hat{k}$	-2962	-842*	-886*	-1437	1008	524	209	48	-168***
	(7182)	(479)	(479)	(7088)	(1853)	(539)	(426)	(65)	(31)
Year 11 × above $\hat{k}$	11752	212	169	12252	1187	2404	-318	21	-109***
	(10741)	(635)	(635)	(10341)	(2195)	(2149)	(408)	(62)	(27)
N	15713	15713	15713	15713	14988	15713	15713	15713	15713
adj. R^2	0.02	0.20	0.10	0.02	0.08	0.07	0.05	0.13	0.31

This table replicates Table 7 without removing the three outlier households (see Table 2 note for details). Panel A regresses each outcome on survey wave indicators interacted with a binary variable for whether the sub-district was unaffected by river erosion during 2008–2011, and on survey wave indicators interacted with the above-threshold indicator, with sub-district fixed effects. Panel B further adds interactions between survey wave indicators and a binary variable for whether the branch-level median cow price exceeds the 9,309 BDT threshold. All regressions include sub-district fixed effects following BBBGH's specification. Figures reported in 2007 BDT. 1 PPP USD = 18.46 BDT in 2007 (baseline year). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix Table 7: Predicting Short-Run Assets: Variation Explained by Baseline Variables

Panel A: BBBGH Treated Sample: Assets 4 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.00	0.00	-0.05	-0.29
Community	0.01		0.04	-0.07
Family Background	-0.01		-0.08	-0.44
Assets + Community	0.01	0.01	0.03	-0.14
Assets + Family Background	-0.01	-0.01	-0.06	-0.45
Community + Family Background	-0.00		-0.01	-0.33
Full Model	-0.01	-0.01	-0.01	-0.36

Panel B: BBBGH Full Sample: Assets 4 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.49	0.56	0.50	0.45
Community	0.05		0.32	0.21
Family Background	0.29		0.33	0.24
Assets + Community	0.51	0.58	0.56	0.52
Assets + Family Background	0.53	0.58	0.57	0.52
Community + Family Background	0.34		0.37	0.34
Full Model	0.55	0.60	0.60	0.58

Panel C: Bangladesh Integrated Household Survey: Assets 4 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.55	0.55	0.47	0.53
Community	0.05		0.02	0.03
Family Background	0.17		0.17	-0.00
Assets + Community	0.56	0.56	0.51	0.51
Assets + Family Background	0.56	0.57	0.56	0.44
Community + Family Background	0.22	0.00	0.14	0.16
Full Model	0.57	0.58	0.58	0.54

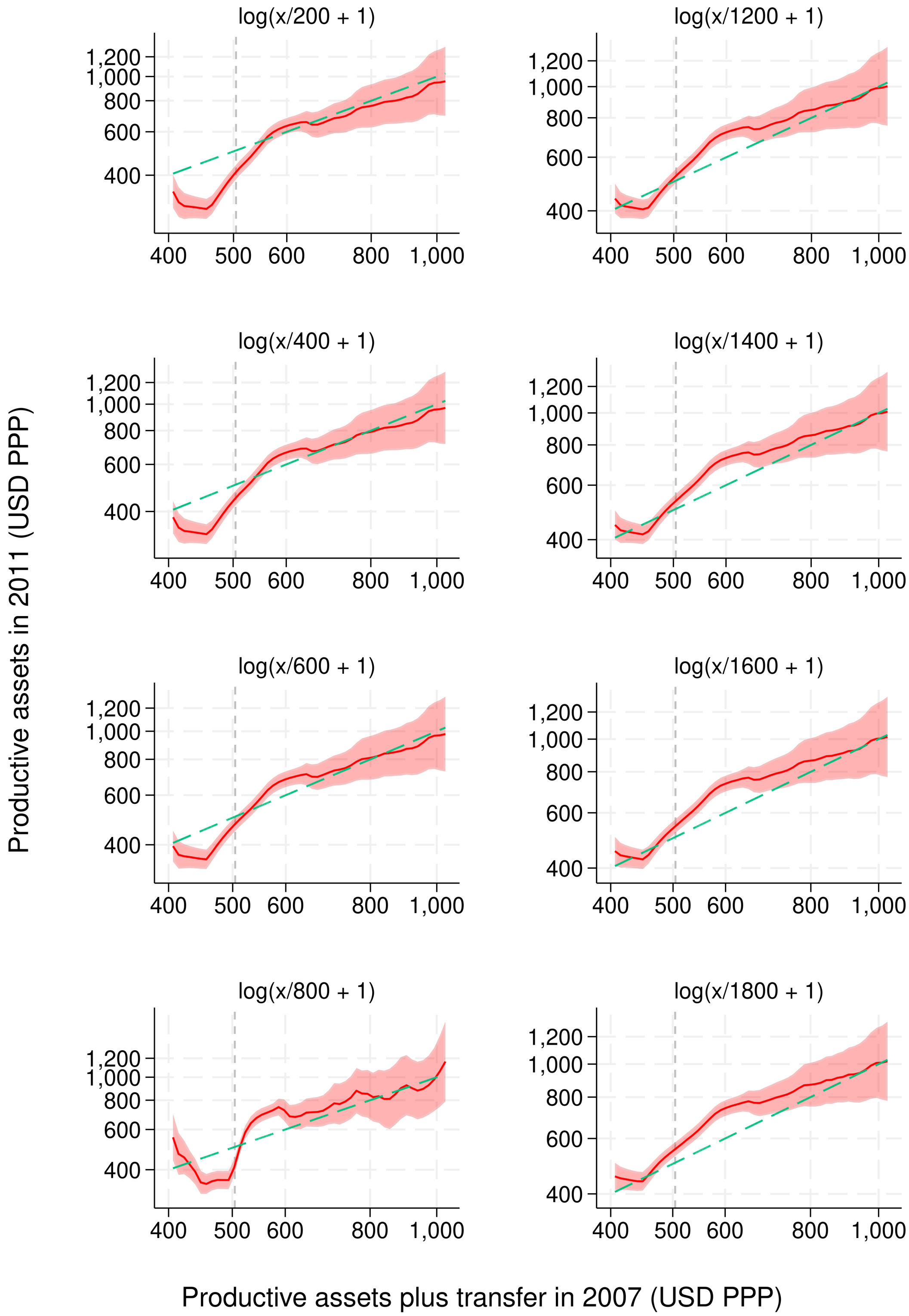
Panel D: Ghana Socioeconomic Panel Survey: Assets 4 Years Later

	Linear Regression	Partial Linear Model	Random Forest	Extreme Gradient Boosting
Assets	0.18	0.18	0.01	0.07
Community	0.02		-0.06	-0.04
Family Background	0.08		0.08	-0.14
Assets + Community	0.20	0.20	0.05	0.06
Assets + Family Background	0.20	0.20	0.20	0.03
Community + Family Background	0.10		0.08	-0.01
Full Model	0.22	0.22	0.21	0.13

Each cell reports the out-of-sample R2 from predicting productive assets using baseline variables, estimated via 5-fold cross-validation with 50 repetitions. Rows identify combinations of predictor groups. "Family Background": household composition (number of children and adults), head characteristics (age, sex, marital status), religious/ethnic identity, human capital (head's education in Bangladesh; parental education in Ghana), social capital (local government and religious leadership; NGO/microfinance participation in Bangladesh), and economic controls (owned agricultural land in Ghana; government safety net receipt and current loan status in Bangladesh); Ghana models also include plot-area-weighted measures of agricultural shocks. "Community": community random effects (linear regression and partial linear model) or indicators (random forest and extreme gradient boosting). Columns report results for four estimation methods: linear regression with community random effects, a partial linear model that estimates the baseline-to-future-assets relationship non-parametrically with penalized splines while controlling linearly for demographics and community random effects, random forest, and extreme gradient boosting. Blank cells indicate specifications not estimated for the partial-linear model because the nonparametric component is defined over baseline assets. Negative OOS R^2 means predictions are worse than using the training set mean.

Appendix Figure 1: Different divisors in the transition function for assets 2007-2011 in BBBGH

Sample: Ultra-Poor Households in the Treatment Group

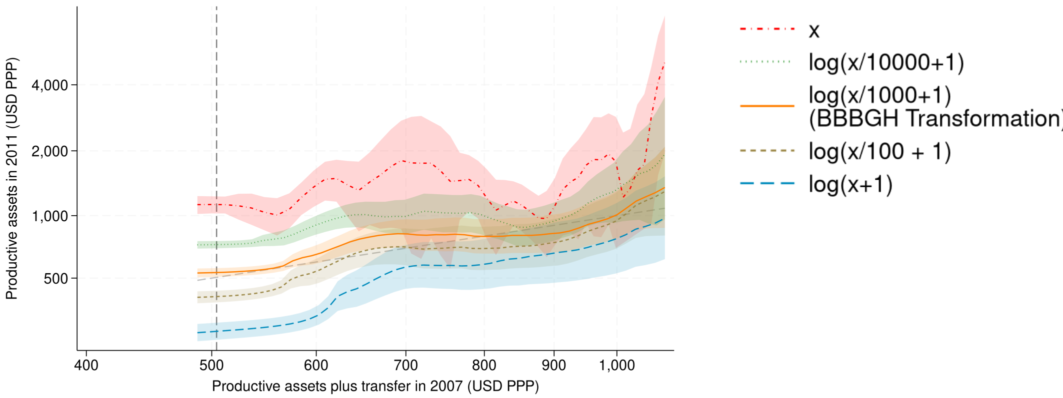


Each panel plots a nonparametric (local polynomial) estimate of the transition function mapping post-transfer baseline productive assets to productive assets four years later, under a different log transformation log(x/d+1) where the divisor d ranges from 200 to 1,800 in increments of 200 and x denotes asset values in Bangladeshi Taka. We do not plot the graph with d= 1000 because that is the BBBGH specification and is shown in Figure 2. The green dashed line is the 45-degree line, the vertical dashed line marks the BBBGH threshold of 504 PPP USD (9,309 BDT), and the shaded region denotes the 95% confidence interval. Consistent with BBBGH, the sample is restricted to ultra-poor treatment households with post-transfer baseline asset values below roughly 1,000 PPP USD.

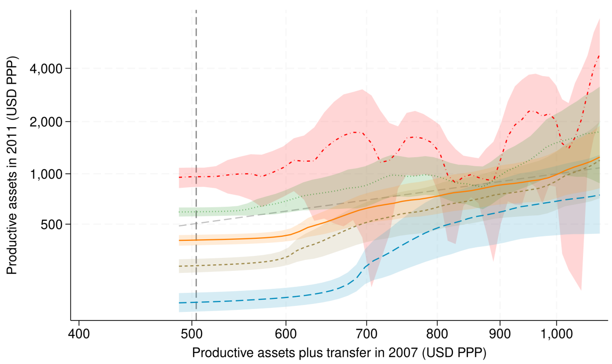
Appendix Figure 2: Transition function for assets 2007-2011
Shutting Down Variation in Cow Price by Using Full-Sample-Median Cow Price of 9000 BDT

Sample: Ultra-Poor Households in the Treatment Group

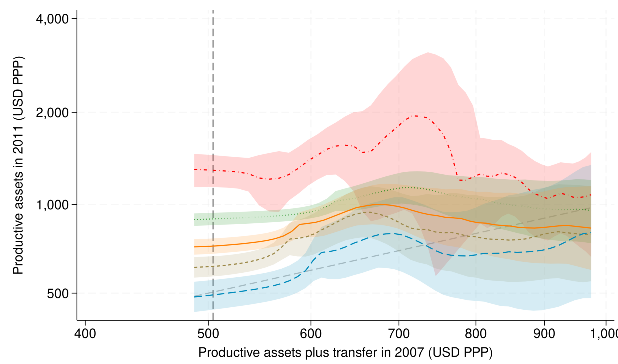
(a) All Branches



(b) Low-Cow-Price Branches



(c) High-Cow-Price Branches

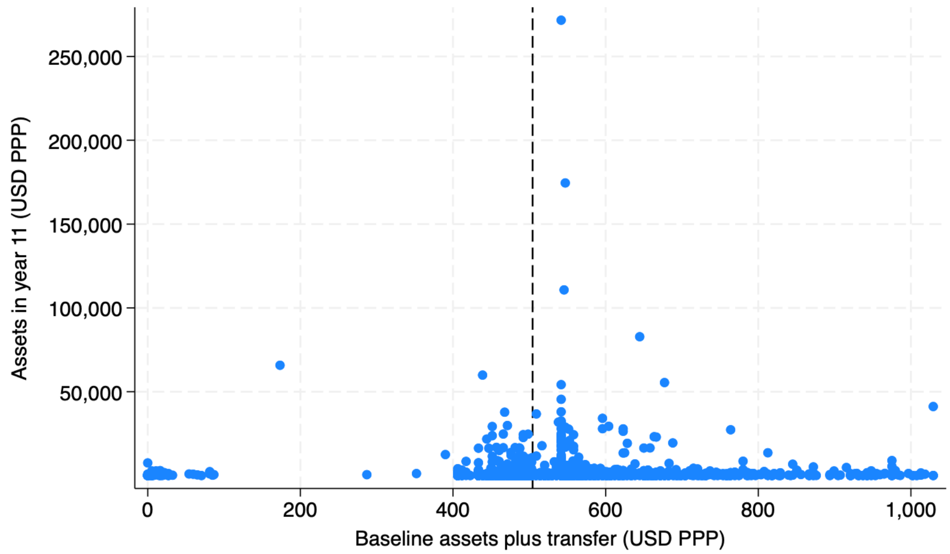


These graphs replicate Figure 2 but shut down variation in the cow component of post-transfer baseline assets by assigning all households the full-sample median cow price of 9,000 BDT, rather than branch-specific median cow prices. Panel (a) plots nonparametric (local polynomial) estimates of the transition function under multiple transformations for all branches; the dashed line is the 45-degree line and the shaded regions denote 95% confidence intervals. Panels (b) and (c) restrict the sample to branches originally classified as low-cow-price and high-cow-price, respectively. The axes show the equivalent PPP USD amounts of the respective log values. In the legend, x denotes asset values in Bangladeshi Taka. Consistent with BBBGH, the sample is restricted to ultra-poor treatment households with post-transfer baseline asset values below roughly 1,000 PPP USD.

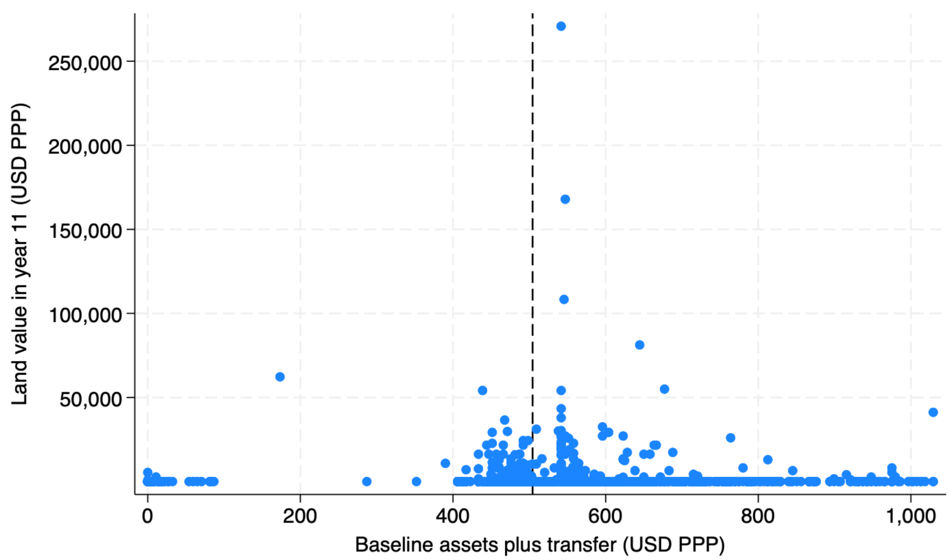
Appendix Figure 3: Outliers in the BBBGH analysis sample

Sample: Ultra-Poor Households in the Treatment Group

(a) Total assets in year 11



(b) Land in year 11

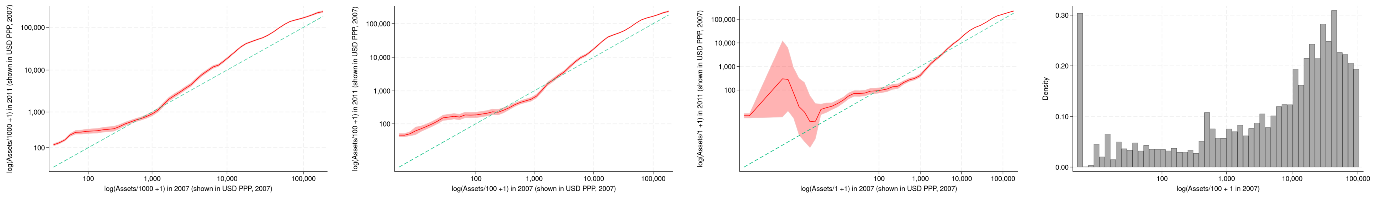


Each point represents an ultra-poor treatment household in the BBBGH analysis sample in year 11 (2018). Panel (a) plots total productive assets in year 11 against post-transfer baseline assets; Panel (b) plots land value in year 11 against the same. The vertical dashed line marks the BBBGH threshold of 504 PPP USD (9,309 BDT). Three households just above the threshold increased their landholdings from 0 to approximately 2, 3.1, and 5 million BDT (≈110,000, 168,000, and 271,000 PPP USD) over 11 years, placing them 12, 18, and 30 standard deviations above the year 11 mean. These are the outliers removed in Panel C of Tables 2 and 3 and in Table 7.

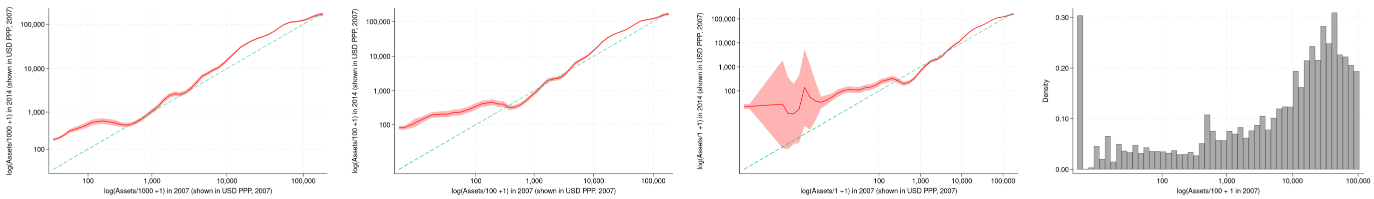
Appendix Figure 4: Log Transition functions in Bangladesh (BBBGH, BIHS) and Ghana (GSPS)

(a) log(x/1000+1) (b) log(x/100+1) (c) log(x+1) (d) Assets Distribution

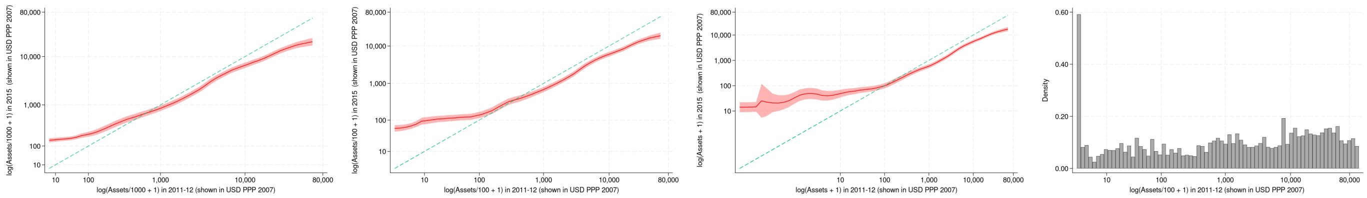
BBBGH Full Sample: 2007 ⟶ 2011



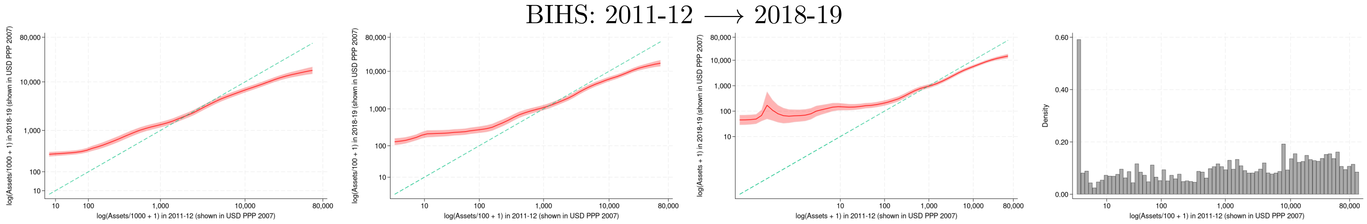
BBBGH Full Sample: 2007 ⟶ 2014



BIHS: 2011-12 ⟶ 2015

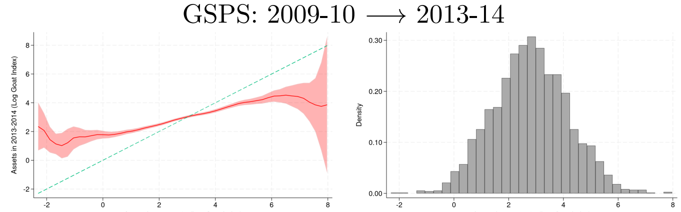


BIHS: 2011-12 ⟶ 2018-19

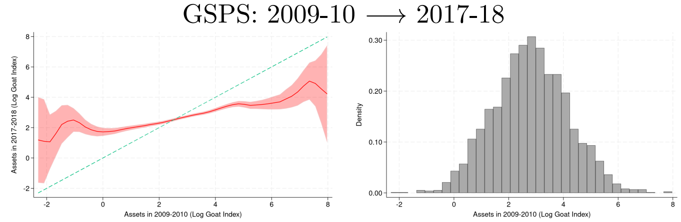


(e) log(x) (f) Assets Distribution

GSPS: 2009-10 ⟶ 2013-14



GSPS: 2009-10 ⟶ 2017-18



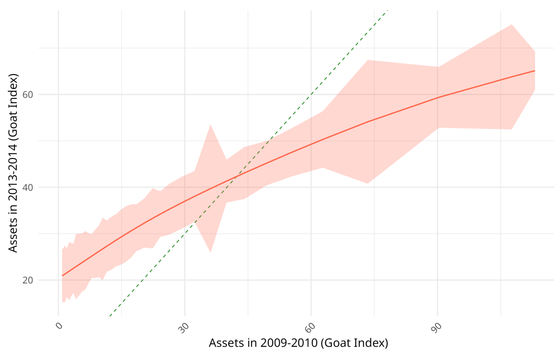
BBBGH Full Sample (first two panels) refers to household survey data from Balboni et al (2022). BIHS (third and fourth panels) refers to Bangladesh Integrated Household Survey, which is a nationally representative survey of rural households in Bangladesh. GSPS (last two panels) refers to Ghana Socioeconomic Panel Survey, a nationally representative survey in Ghana; we restrict its sample to rural households present in all four waves of the survey. For each survey, its first panel presents results at the four-year wave and the second panel at the seven/eight-year wave. For BBBGH and BIHS: Columns (a), (b), and (c) plot non-parametric (local polynomial) estimates of the transition function mapping productive assets (in 2007 PPP USD) at the start of each period to productive assets at the end, under three transformations: log(x/1000+1) (the BBBGH transformation), log(x/100+1), and log(x+1); the sloping dashed line is the 45-degree line, and the shaded region denotes the 95% confidence interval. Column (d) shows the distribution of baseline log productive assets, transformed as log(x/100+1) for each transition. For GSPS: Column (e) plots nonparametric (local polynomial) estimates of the transition function mapping log productive assets (in log goat-equivalent units) at the start of each period to log productive assets at the end; the dashed line is the 45-degree line and the shaded region denotes the 95% confidence interval. Column (f) shows the distribution of baseline log productive assets for each transition. No household in the GSPS reports zero productive assets, so the log transformation is applied directly without any additive constant.

Appendix Figure 5: Partial Linear Model Transition Functions in BIHS and GSPS

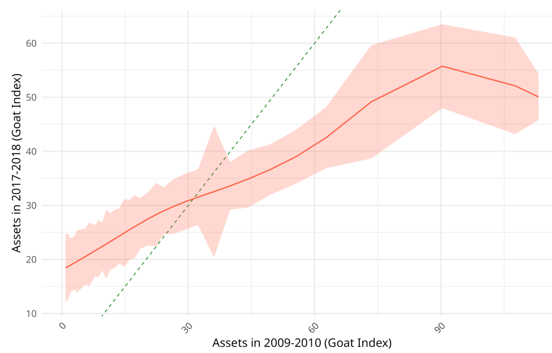
(a) BIHS: 2011-12 ⟶ 2015

(b) BIHS: 2011-12 ⟶ 2018-19

(c) GSPS: 2009-10 ⟶ 2013-14



(d) GSPS: 2009-10 ⟶ 2017-18



BIHS refers to Bangladesh Integrated Household Survey, which is a nationally representative survey of rural households in Bangladesh. GSPS refers to Ghana Socioeconomic Panel Survey, a nationally representative survey in Ghana; we restrict its sample to rural households present in all four waves of the survey. For each survey, the left figure presents results at the four-year wave and the right figure at the eight-year wave. The figures plot estimated transition functions from baseline productive assets to future productive assets, measured in 2007 PPP USD for BIHS and in goat-equivalent units for GSPS. Estimates come from partial linear models that fit the asset transition non-parametrically using penalized splines, while controlling linearly for demographics and, where included, community random effects. The dashed line is the 45-degree line; shaded regions are point-wise 1.96-standard-error bands based on variation in binned predictions across repetitions/folds.