Persistent poverty and informal credit*

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Abstract

This paper explores the consequences of nonlinear wealth dynamics on the formation of bilateral credit arrangements. Building on recent empirical work that finds evidence consistent with the hypothesis of poverty traps, and using original primary data on expected wealth dynamics, social networks and loans, we find that the threshold at which wealth dynamics bifurcate may serve as a focal point at which transfers are concentrated and that, as a consequence, asset loans respond to recipients' losses but only so long as the recipients are not "too poor".

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Our results suggest that, when shocks can have long term effects, asset transfers may aim to insure the permanent component of income generation, rather than the transitory component. The persistently poor are excluded from social networks and do not receive transfers in response to shocks.

1 Introduction

Risk is a central feature of life in rural areas of developing countries and therefore has appropriately attracted much attention in the economics literature. The focus of much of this literature has been on how households smooth consumption in the face of idiosyncratic variations in income, either by analyzing how specific actions – most commonly, credit, insurance or savings – contribute to that objective,[1] or by asking how well the complete set of available instruments performs in stabilizing consumption.[2] The consumption smoothing literature uniformly starts, however, from a key assumption that shocks have only transitory consequences, in other words that the income generation process is stationary. Coate and Ravallion (1993, p.4), for example, justify their focus on symmetric insurance arrangements with the assumption that "either player could end up 'rich' or 'poor' in any period" with equal probability. However, the assumption that income generation processes are stationary and thus that all poverty is transitory does not easily square with the empirical evidence, which suggests that a substantial share of poverty in many low–income countries is persistent (Baulch and Hoddinott, 2000, Barrett, Carter, and Little, 2006) and that rates of intergenerational earnings transmission are high even in high income countries (Solon, 2002).

As is widely recognized, uninsured risk and persistent poverty may be linked, either because poorer individuals choose safer investment portfolios that prove, on average, less profitable (Rosenzweig and Binswanger, 1993, Morduch, 1995, Dercon, 1996, Bardhan, Bowles, and Gintis, 2000), or because negative shocks have a disproportionately detrimental impact on poor people's investments, perhaps especially with respect to the formation of human capital (Jacoby and Skoufias, 1997, Dasgupta, 1997, Alderman, Hoddinott, and Kinsey, 2006, Carter et al., 2007). Whether due to the former, ex ante effects or the latter, ex post ones, risk and shocks may have long-

[1] See Alderman and Paxson (1994), Besley (1995) or Lim and Townsend (1998) for useful reviews.

[2] Deaton (1992) and Townsend (1994) are key contributions in a large literature that tests for the presence of full insurance or risk pooling in developing countries.

lasting effects on welfare status. But while the link from risk to persistent poverty has been probed extensively, the link from persistent poverty back to risk management options remains underdeveloped. This paper aims to contribute to filling that void.

Theoretical models in which poverty is a stable dynamic equilibrium suggest two key conditions under which short-term shocks can have longer-term consequences. First, a non–convexity in some technology generates a critical threshold, an unstable dynamic equilibrium at which wealth dynamics bifurcate. This causes the mapping from current to future wealth to exhibit multiple stable dynamic equilibria. When at least one of them associated with consumption below the poverty line, a (stochastic) poverty trap emerges. Second, some sort of market imperfection, on average, prevents those initially below the unstable dynamic equilibrium from moving themselves above the threshold so as to jump onto a path that converges on a higher welfare level. In such a world, even a transitory shock associated with a stationary stochastic process can have permanent effects. This has been well-recognized in the literature (Azariadis and Stachurski, 2005, Carter and Barrett, 2006). What has not yet been recognized is that the first condition above – the existence of an unstable dynamic equilibrium wealth level – might induce the market imperfection that is the second condition for risk to cause persistent poverty. Multiple equilibria might lead to credit (and insurance) rationing that excludes the poorest, those who most need financial instruments to manage risk. In this paper we empirically explore this possibility that nonconvex wealth dynamics might induce exclusion of the very poor from informal credit markets that might facilitate their escape from poverty.

The extensive literature on equilibrium credit rationing focuses largely on adverse selection and moral hazard may cause the poor to be disproportionately rationed out of credit markets.[3] Poverty matters because it leads to “desperation” (Banerjee, 2000): the poor are not creditworthy because, having too little to loose, it may be prohibitively costly for a lender to punish them in case of default (see also Banerjee and Newman (1993)). This paper suggests an additional plausible explanation. If the lender has an interest in the results of the project because informal loans bundle an insurance or equity element with the loan – as Udry (1994) finds in studying northern Nigeria – then the presence of non–convexities may turn the unstable dynamic equilibrium (or its neighborhood) into a focal point for loans, since

[3]See Stiglitz and Weiss (1981) or Carter (1988) for early contributions to this literature and Banerjee (2001) for an excellent recent synthesis.

this is the point at which the expected gains to the borrower are greatest. In this context, those who are not too poor (the "middle class") become preferred borrowers, while both poorer individuals and the very rich are excluded from such credit arrangements. Observing such behavior in informal credit arrangements would reinforce a key long-recognized policy implication of non–convexities: small transfers can have large, long-term welfare impacts if they lift an ex ante poor recipient onto a path of sustained accumulation towards a higher level equilibrium.

The remainder of the paper proceeds as follows. Section 2 introduces the setting we study and the data we use, collected from Boran pastoralists in southern Ethiopia, drawing partially on previous work (Lybbert et al., 2004, Santos and Barrett, 2006) that has documented nonlinear wealth dynamics and the presence of an unstable dynamic wealth equilibrium in this system and explained the apparent sources of this structure. In this paper, we take the existence of such phenomena as given in order that we can focus on the implications of prospective multiple equilibria on informal lending relationships. In section 3 we study how informal credit networks form among Boran pastoralists. We find that the decision to extend credit (in kind) to an individual is better explained by the expected gains due to the transfer than by the recipient's expected capacity to repay the loan. This result is robust to a series of additional controls for individual ability, correlation in asset returns between borrower and lender, and the ex ante network of the lender. These findings imply a "middle class" bias in informal lending of the sort we study, in which the poorest members are rationed out of informal credit markets in equilibrium due to the existence of an unstable dynamic wealth equilibrium. In section 4 we then study patterns of social acquaintance (hereafter, social networks) and find that wealth plays a role in explaining who is known within a community. Being destitute (i.e., having no wealth in cattle) has a strong, negative impact on the probability of being known within the community. And since credit networks are nested within social networks, social invisibility further reinforces the exclusionary process associated with credit rationing. Finally, section 5 discusses the policy implications of our findings.

2 Nonlinear wealth dynamics: evidence from southern Ethiopia

Lybbert et al. (2004) analyze wealth dynamics among Boran pastoralists, a poor population in southern Ethiopia. Using herd history data for 55 households over a 17 year period, they show that herd dynamics follow a S-shaped curve with two stable equilibria (at approximately 1 and 35–40 cattle), separated by an unstable threshold (at 12–16 cattle), consistent with stylized poverty traps models. Drawing on prior ethnographic research and extensive direct field observation, the authors suggest that this threshold results from a minimum critical herd size necessary to undertake migratory herding to deal with spatiotemporal variability in forage and water availability. Those with smaller herds are forced to stay near their base camps, where pasture conditions soon get degraded, leading to a collapse of herd size towards the low-level stable equilibrium, while those with bigger herds can migrate in search of adequate water and pasture, enabling them to sustain far larger herds.[4]

These authors present two other findings that help motivate the present paper. First, they show that asset risk is predominantly idiosyncratic. This creates conditions conducive to the implementation of welfare-improving insurance or lending contracts among pastoralist households. Nevertheless and second, inter-household gifts and loans of cattle are conspicuously limited.[5] The purpose of this paper is to understand whether such paucity of prospectively welfare-improving informal financial transactions might be a direct consequence of the apparent poverty trap faced by these pastoralists.

In order to answer that question, in 2004 we collected new data on expected wealth dynamics and on bilateral credit relations within the same communities (but not the same individual respondents) studied by Lybbert et al. (2004). This effort took place within a larger research project that has repeatedly surveyed these same households since 2000, generating a data set that includes rich detail on household composition, migration histories and herd changes, among other relevant characteristics.[6] The data on expected wealth dynamics are discussed and analyzed in detail in Santos and Barrett (2006). Here we only briefly present key elements of that discussion that

[4]During migration only part of the household moves, mainly young men, who are physically strong enough to undertake arduous, long treks to move herds between distant water points and to protect them against (human and animal) predators. Hence the need for a sufficiently large herd that can be split and still feed both the migrant herders and the remaining (largely child, aged, infirm and female) members of the household who are left at the base camp.

[5]Several recent studies from semi-arid African systems confirm the relatively small importance of gifts and loans, both of income (Lentz and Barrett, 2004) and assets (McPeak, 2004, Kazianga and Udry, 2006, McPeak, 2006)

[6]The data were collected by the Pastoral Risk Management (PARIMA) project of the USAID Global Livestock Collaborative Research Support Program. Barrett et al. (2004) describe the location, survey methods and available information.

are necessary to understand our two key explanatory variables: borrowers' expected gains from a loan and their expected future wealth.

We first asked each respondent about his/her expectation regarding weather conditions for the coming year. We then assigned each respondent four initial (hypothetical) herd sizes, randomly selected from the interval 1–60 animals, and then elicited their subjective herd size distribution one year ahead, given the state of nature just elicited and the seed herd size. These data equipped us to model the relation between initial and expected future wealth - herds are the lone non-human form of wealth in the study area - for each of the four states of nature considered (drought, bad year, good year, very good year). Combined with meteorological information on rainfall histories, these estimates were enabled us to simulate the empirical distribution of herd size several periods (up to ten years) ahead. Motivated by the large dispersion of expected herd size under conditions of bad rainfall, we then investigated how latent ability to deal with shocks affected wealth dynamics.[7] Using the estimated herding ability for each respondent, we classified respondents into two categories: low ability (those in the 4$^{\text{th}}$ quartile) and a residual higher ability category. We then redid the herd growth simulations described above to establish the relation between expected wealth and initial herd size for each state of nature and each ability category. The results, presented in figure 1, suggest a complex growth mechanism that combines both club convergence (defined by herders' ability) and, for the higher–ability club, multiple equilibria.

Our data on the willingness to extend credit to an individual follows an approach introduced by Goldstein and Udry (1999). We randomly matched each respondent with other respondents from the sample and asked two types of questions. The first about (real) social networks, through the question "Do you know (the match)?". The other on the possibility of transferring cattle as a loan if the match asked for it.[8] The latter question provides information on potential credit networks and is the subject of study in the next section. Our approach to data collection offers one major advantage relative

[7] More precisely, we used the 2000-3 panel data to estimate a herd growth function frontier using a composed error term that includes a symmetric random component reflecting standard sampling and measurement error and a one-sided term reflecting herder-specific, time-invariant inefficiency, which we assumed follows a truncated normal distribution. The results are available upon request and are discussed at length in Santos and Barrett (2006).

[8] We asked also about the possibility of transferring cattle as gifts but the pattern of answers is virtually identical and loans and gifts seem empirically indistinguishable. Out of 561 matches, in only 13 (2.3%) does the decision differ between loans and gifts. We therefore concentrate on transfers deemed "loans" in what follows.

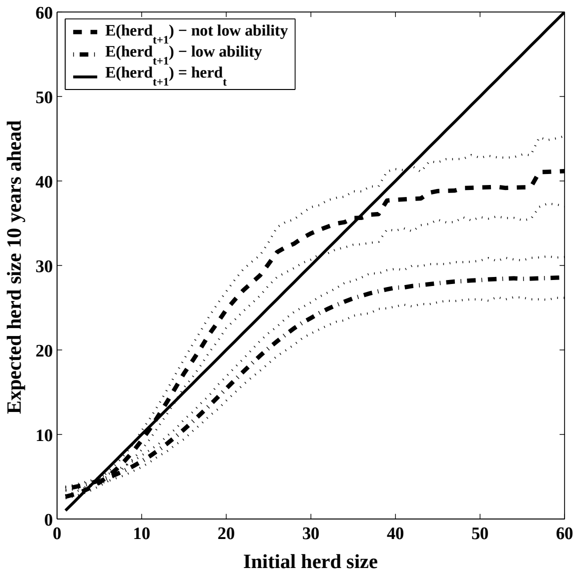

Figure 1: Heterogeneous wealth dynamics

to previous studies of informal transfers. Because we know the characteristics of both lender and borrower, we can avoid concerns of biased estimates due to lack of knowledge about one end of this relation (Rosenzweig, 1988, Cox and Rank, 1992).

However, there are two prospective problems with this approach. First, by studying links between individuals rather than the transfers themselves, one risks errors due to excessive discretization. This does not seem to be a problem in our data because informal asset transfers among Boran pastoralists are quite small. In our sample, over the period 2000–03, there were 15 such transfers, out of which 12 (i.e., 80%) were of 1 or 2 cattle.[9] For that reason, and with only a slight abuse of language, we use the terms "credit network formation" and "loans" interchangeably in what follows.

Second, one might reasonably wonder how well potential credit networks elicited in this manner reflect the decision process underlying the formation of real credit networks. In a separate paper Santos and Barrett (2007) we show that the inferred determinants of insurance networks derived from the

[9]A separate survey of cattle transfers motivated by shocks, conducted in 2004, in the same geographical area but with different respondents, suggests even greater dominance of small transfers: out of 112 transfers, 102 (or 91%) were of 1 animal, 8 (or 7%) were of 2 cattle and the remaining less than 2% were more than 2 cattle.

approach used in this paper closely match those obtained from analysis of real insurance relations among the same population. The appeal of using randomly matched respondents thus seems to outweigh the prospective pitfalls of using discrete data on hypothetical transfers.[10]

3 Nonlinear wealth dynamics and credit networks

The basic pattern of answers to the credit link questions is described in Table 1. Three key facts emerge clearly. First, not everyone knows everyone else, even in this rural, ethnically homogeneous setting in which households pursue the same livelihood and there is very little in– or out–migration. Although most people know the random match presented to them, almost 14% of the matches were unknown by the respondent. Second, social acquaintance is, for our respondents, clearly a necessary condition for willingness to make a loan: in only 2/69 cases did a respondent indicate that they would be willing to lend livestock to someone they did not know. The sequential structure of these answers carries consequences for our econometric strategy – in particular, it leads us to estimate the determinants of insurance networks only on the subsample of those who know their matches (Amemyia, 1975, Maddala, 1983) – and raises the additional question of identifying the correlates of exclusion from social networks, one that we explore in section 4. Finally, knowing people is by no means a sufficient condition for pastoralists to be willing to transfer animals to a match. In just under one quarter of the cases where the respondent knew the match was he or she willing to lend an animal to the match. The acquaintance between lender and borrower seems therefore to be necessary but insufficient for obtaining credit.

3.1 Understanding exclusion from credit contracts

The intuition behind the analysis of these responses is that respondents evaluate the expected benefits and costs of each potential link/loan, answering "yes" if their evaluation of the benefits exceeds the costs. Two motives may enter this calculus: the possibility that the borrower may not repay the loan and the value of the compensation for parting with an animal.

The first motive is the one usually emphasized in the literature that explores the relation between wealth and exclusion from contracts (see Banerjee (2001) for a review), usually concluding for a monotonically positive

[10] The benefits of using experimental data in the study of social capital (a concept closely related to that of social networks) is emphasized by Durlauf and Fafchamps (2005). Barr (2003) also concludes that experimental evidence is mirrored by reality.

Table 1: Knowing and lending: a sequential process

Lend Know	Yes	No	Total
No	67	2	69
Yes	367	144	511
Total	434	146	580

relation between borrower's wealth and its creditworthiness. If informal credit were strictly a textbook debt instrument, this might be the end of the story.

In our setting, however, as in many developing country settings, loans often come bundled with quasi–insurance (Udry, 1994) or an element of equity investment. Among the Boran, as we show below, lending is overwhelmingly in response to shocks, thus it functions much like insurance. Furthermore, informal lending traditions in this culture hold that the loan of a cow (even money to be used to buy animals, which is becoming less rare) entitles the lender not only to the original animal (the conventional loan component) but also to its male offspring, with female calves kept by the borrower. This introduces a second channel through which a borrower's wealth may matter: the borrower's expected herd growth drives the expected returns to the lender.

Clearly, these motives are non–exclusive and we can think that they jointly lead Boran pastoralists (indexed by i) to make lending decisions as if maximizing the net expected returns (ER) on a loan of one cattle to another herder (indexed by j):

$$\mathrm{ER_{ij}} = \sigma \mathrm{EG_j} \times \mathrm{r(EW_j)} - 1 \tag{1}$$

Here, $\mathrm{EG_j}$ stands for j's Expected Gains from a loan, σ stands for the lenders' share in the gains from the loan, which is set by social convention (the male offspring hence, on average, half the gains), and r(EW) is the repayment function, which we assume, following the extant literature, to be a monotonically strictly positive function of borrower's Expected Wealth (EW), both evaluated at some relevant horizon T. Let

$$\mathrm{EW} \equiv \mathrm{E_0}\ \{\sum_{\mathrm{t=0}}^{\mathrm{T}} \mathrm{F(W_{jt} + l_{ij}) \times \theta_{jt}} |\ \phi(\theta), \mathrm{W_0}, \alpha_{\mathrm{j}}\} \tag{2}$$

where $\mathrm{F(\bullet)}$ is a growth function, $\mathrm{W_{jt}}$ is borrower's wealth at time t, $\mathrm{l_{ij}}$ is the binary decision reflecting the lender's decision regarding the loan, $\phi(\theta)$ is the distribution function of the production shocks, θ, and α_j defines borrower's ability. Before we discuss the characteristics of the growth function, we define Expected Gains as

$$\mathrm{EG} \equiv (\mathrm{EW}|\, \mathrm{l_{ij}} = 1) - (\mathrm{EW}|\, \mathrm{l_{ij}} = 0) \tag{3}$$

Clearly, both EG and EW are a function of the same variables, namely borrower's ability and initial wealth, raising important empirical questions regarding the identification of the importance of each motive.

The growth function, F(•), in its most general form incorporates two possibilities, identified in earlier work in this environment (Santos and Barrett, 2006) and represented in figure 1. First, household characteristics (e.g., intrinsic ability, α_j) may sort cross–sectional units into distinct cohorts or clubs, c. Second, within each club, agents might face nonlinear dynamics – in particular, the possibility of a critical threshold value, γ_c, at which the welfare dynamics bifurcate, with one path, subscripted l , leading to a low-level equilibrium and another, subscripted h, leading to a high-level equilibrium. These possibilities imply that for each individual j, belonging to the club c=1, . . . , C, the growth function can be written as[11]

$$\mathrm{F^c_t} = \begin{cases} \mathrm{F^c_l(W_{jt} + l_{ij})} & \text{if } \mathrm{j \in c,\ W_{jt} \leq \gamma_c} \\ \mathrm{F^c_h(W_{jt} + l_{ij})} & \text{if } \mathrm{j \in c,\ W_{jt} > \gamma_c} \end{cases} \tag{4}$$

The empirical relevance of the different variables has important implications for our understanding of informal bilateral credit relations and for related policy interventions. If only matches' expected wealth drives credit access, it would signal that, although persistent poverty plays a role, the wealth threshold *per se* does is not important. In this case, we would expect the wealthiest herders to be the primary beneficiaries of these loans.

Given the small size of these loans, expected growth, even after the loan, is low or even negative for those in the vicinity of the stable equilibria (that is, the wealthiest or the poorest members of the community). On the other

[11]Borrowing the terms from the growth literature, this specification can be simplified into a club convergence approach (as in Quah (1997)) if there are no asset thresholds at which asset dynamics bifurcate (that is, γ_c=0, ∀ c), or into a threshold model (as in Azariadis and Drazen (1990)) if there is only one club (that is, C=1). In the more standard case, one would assume that F(•) is concave, and that there are no convergence clubs or thresholds. Several approaches have been recently suggested to identify convergence clubs (for example, Canova (2004)) and thresholds (for example, Hansen (2000)) but not, to our knowledge, both. In the empirical section we'll build on previous work (?Santos and Barrett, 2006) to identify both convergence clubs and accumulation thresholds.

hand, and in expectation, they enable those below and "sufficiently close" to the unstable equilibrium to recover onto a growth path leading to a higher level equilibrium.[12] If expected gains guide the allocation of transfers, it might then induce a bias that favors herders of intermediate wealth. Such a pattern, if it exists, would suggest that the effects of informal lending (or equivalent insurance arrangements) in the presence of nonconvexities might be best understood as a mechanism to prevent participants from falling into persistent poverty.

Although in the empirical part of this paper we'll mainly focus on the analysis of these two considerations – expected wealth with its standard effect on likelihood of repayment and expected gains – several other explanations of rationing of credit or insurance contracts merit attention. The closest study, empirically, to our analysis is McPeak (2006). The author explores different motives for livestock transfers in an environment quite similar to ours (the rangelands of Northern Kenya) and finds that transfers are targeted to wealthier pastoralists, which he interprets as reflecting differential capacity to reciprocate the original transfer, essentially our r(EW) function. More surprisingly, he finds support for an interpretation of asset transfers as a form of precautionary savings (his term) as transfers do not seem to be triggered by recent wealth shocks. We differ from this study in that we analyze the formation of credit networks through which such transfers occur and can condition our analysis on expected gains thanks to our analysis of the wealth dynamics. Omission of this term from McPeak (2006) could explain the difference in our results.

Hoff (1997) analyzes the relation between insurance arrangements, the erosion of investment incentives and the persistence of poverty, and predicts matches along wealth levels. Individuals with high enough expected wealth may not invest in insurance relations because the expected benefits may not

[12]Given the standard transfer of one animal from one household to another, individual transfers can clearly serve this safety net purpose only for those herders quite close the unstable equilibrium. One needs to recognize, however, that this limitation is purely an artifact of the two person, dyadic model we employ. Anecdotal evidence from a survey of life histories collected during fieldwork suggests that coordinated transfers are commonly sought and obtained, raising the potential for transfers to perform such a role over a wider herd size range although, unfortunately, not so wide as to catch the very poor or the destitute: the maximum size of a transfer such as this was 5 cattle. This is further corroborated by anthropological work among the Boran (Dahl, 1979, Bassi, 1990) on the functioning of *busa gonofa*, an institution through which such coordination is achieved. Similar institutions have been analyzed among other east African pastoralist societies (for example, Potkanski (1999)). Coordination of transfers raises a separate set of questions – e.g., how are the obvious free rider problems resolved? – that cannot be pursued here.

compensate for expected net contributions to the insurance pool. This result implicitly depends on the lack of convergence in incomes between agents (i.e., some have higher expected income than others) and relies heavily on the impossibility of separating insurance from redistribution due to egalitarian sharing rules, an environment quite different from the one that we study. In the empirical section we test Hoff's model as well, since we use data from both sides of the credit contract and control for the lender's wealth.

Given that informal transfers can insure only against idiosyncratic shocks, asset covariance between potential insurance partners should matter to contracting choices, as the literature on peer selection in micro-credit arrangements suggests (Ghatak, 1999, Sadoulet and Carpenter, 1999). Agents might therefore rationally opt out of insurance contracts with those whose wealth covaries strongly with their own wealth. We'll address this possibility below as well, as an additional check on our results.

Finally, Murgai et al. (2002) suggest that the costs of establishing insurance links may limit the domain of equilibrium contracting. Genicot and Ray (2003) likewise suggest that insurance groups may be bounded because risk-sharing arrangements need to be robust to deviations by sub–groups. Although these authors do not explicitly model wealth as a source of friction that might prevent insurance links from forming, they offer complementary explanations for the behavior that we observe. In our empirical work, we therefore control also for covariates that may reflect differences in the degree of enforcement of such contracts or of monitoring of other agent's activity and, less perfectly, for the degree of alternative insurance ex ante of the link formation decision.[13]

3.2 Econometric model

We study respondents' decision (to lend or not) using a model that nests the different explanations/motives for asset transfers under the reduced form

$$\mathrm{Prob}(\mathrm{l_{ij}} = 1) = \Lambda(\mathrm{EG_j}, \mathrm{EW_j}, \mathrm{L_j}, \alpha_\mathrm{j}, \mathrm{W_i}, \mathrm{X_{ij}}) \tag{5}$$

where $\mathrm{l_{ij}} = 1$ denotes that a credit link is formed between i (the respondent) and j (the match), EG_j is the match's expected gains from the loan of 1

[13]Unlike Genicot and Ray (2003), we address network formation rather than group formation. Groups differ from networks because the latter lack common boundaries. If A establishes a link with B, the fact that B already has a link with C does not mean that A will also have a (direct) link with C. Hence considerations about sub-group deviations may be less of a concern here than in more formalized institutions such as, for example, the funeral insurance groups studied by Bold (2005).

animal, EW_j is the match's expected wealth after the same transfer, L_j indicates whether the match lost cattle in the recent past (in practice, the period 2000/03 for which we have data), α_j is a classification of the respondent as being of low or higher ability, W_i is the respondent's wealth and the X_{ij} vector captures a range of covariates describing the distance, in both the physical and socio-economic space, between i and j. Finally, Λ is the logit cumulative distribution function and we assume that relations are nested within respondents:

$$E(\varepsilon_{\mathrm{ij}}, \varepsilon_{\mathrm{ih}}) \neq 0 \text{ if } \mathrm{j} \neq \mathrm{h} \tag{6}$$

$$E(\varepsilon_{\mathrm{ih}}, \varepsilon_{\mathrm{jh}}) = 0 \text{ if } \mathrm{i} \neq \mathrm{j} \tag{7}$$

where ε_{ij} is the error term of the regression. Taking advantage of having multiple matches for each respondent, we can then estimate equation 5 using a random effects specification of the logit model. Three issues need to be addressed before we present our estimates: (1) the way we construct our two central variables, expected gains from a loan and expected wealth, and how is identification obtained, (2) the way we express the distance between respondent and match (the vector X_{ij}), which differs from the formalization of social distance presented in Akerlof (1997) and used in much of the empirical work, and (3) how to address the inferential problems that may arise if, contrary to our assumptions regarding the error term, unobserved heterogeneity across individuals is important for the network formation decision.

Both the expected gains and expected wealth variables were created following the simulation procedure briefly described above and in detail in Santos and Barrett (2006). We define borrower's "expected wealth" as the probability that future herd size ten years hence, post transfer of one animal, will be larger than a specified value – 30 cattle – given actual (2003) herd size. [14] We define "expected gains" of a loan as the difference in expected herd size, 10 years ahead, due to the transfer of 1 cattle given actual herd size. Both variables are graphically represented in Figure 2, with expected wealth the solid line (read against the righthand vertical axis) and expected gains the dashed line (read against the lefthand vertical axis). Two features merit particular attention. First, the probability that a recipient's herd size will reach the high-level asset equilibrium (more than 30 cattle) is S-shaped, with values less than 1% below 7 head and reaching a plateau in the 35-45% range beginning roughly at 22 head. Second, that initial herd size interval of 7-22 cattle – the neighborhood of the threshold at which wealth dynamics

[14] Other herd sizes (10, 15, 20, 25, 35) lead to similar conclusions. We also experimented with the *change* in the probability of having a herd size above 30 due to the transfer of one animal. The results are qualitatively similar to the ones discussed below.

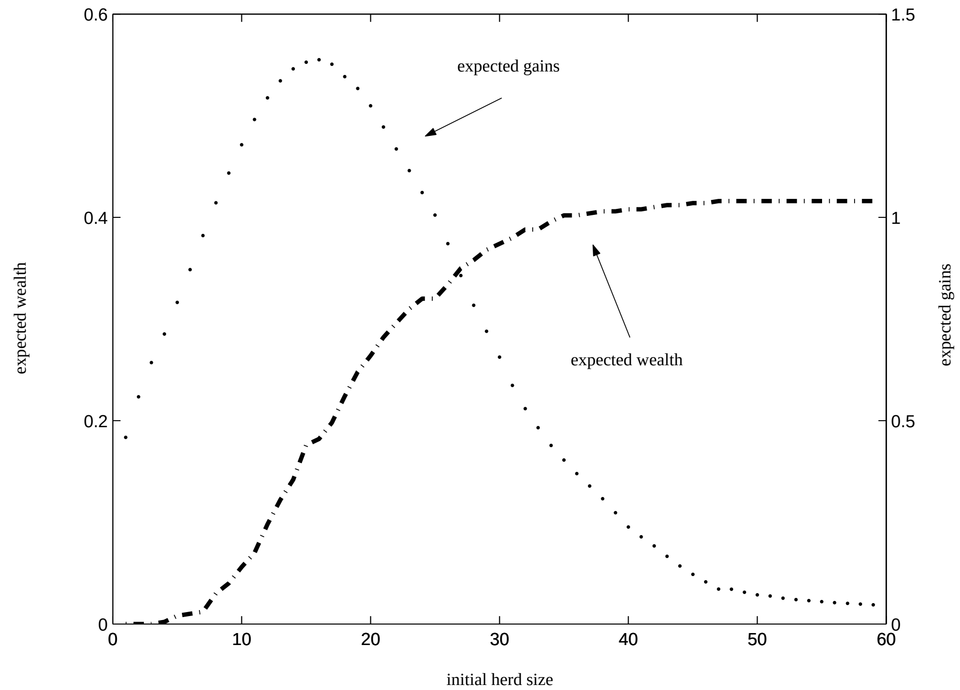

Figure 2: Expected consequences of a loan of 1 cattle

bifurcate – is the only asset range over which expected gains exceed the 1 cattle transfer.[15]

The elements of the X–vector – clan membership, gender, age, land holdings, and household size – are expressed not as the Euclidean distance between the pair but rather using a measure of distance that allows for ordinal differences in the relative position of the respondent and match to play a role in explaining the respondent's decision. To be more concrete,

[15]Because our simulation procedure only considers initial herd sizes between 1 and 60 cattle, we face a problem in assigning values to these variables outside of that interval. We chose not to assign any values to these variables when herd size in 2003 is bigger than 60 given that we only lose 9 of 463 observations and the degree of arbitrariness in that decision would be unacceptable. The decision on what values to assign to the case when the match has no cattle is much more straightforward. For expected wealth, we assumed that Pr(herd size10 years ahead $\geq$ 30| match has no cattle, gift of 1 cattle)= Pr(herd size10 years ahead $\geq$ 30 | match has 1 cattle) = 0. For expected gains, we assumed that (expected herd size after 10 years | match has no cattle, gift of 1 cattle) = (expected herd size 10 years ahead | match has 1 cattle) = 1.612, and that, in case they receive no gift, 10 years ahead their herd size will remain 0.

consider the case of a categorical variable such as gender. If the match and respondent share the same gender we can either control for a dummy variable "same gender" - implicitly imposing that the effect of a female–female match is the same as that of a male–male one – or we can consider the set of all possible matches (female–female, female–male, male–female and male–male) and incorporate a dummy variable for each specific combination. *Mutatis mutandis*, the same reasoning applies to continuous variables.[16]This approach offers an intuitively more appealing interpretation of the effects of social and economic distance than the more conventional Euclidean measure of social distance that (implicitly) imposes symmetry in the effect of these variables upon the dyad formation decision.

One alternative way of modeling the error term is to assume that,

$$\mathrm{E}(\varepsilon_{\mathrm{ih}}, \varepsilon_{\mathrm{jh}}) \neq 0 \text{ if } \mathrm{i} \neq \mathrm{j} \tag{8}$$

that is, to incorporate the effect of matches' unobserved heterogeneity on the link formation decision. Just as we assume in equation 6 that (unobserved) lender's capacity do resist demands on his/her assets may drive observed credit access decisions, it may be reasonable to think that (unobserved) borrower's persistence or trustworthiness might play a role in the pattern of answers that we analyze. Both Udry and Conley (2005) and Fafchamps and Gubert (2007) correct the covariance matrices of their estimates for the possible effect of matches' unobservables, using Conley (1999) estimator. Neither study finds large differences due to this correction.[17]

We follow a different strategy for addressing the possibility reflected in equation 8, using a nonparametric permutation test known as Quadratic Assignment Procedure (QAP) (Hubert and Schultz, 1976, Krackhardt, 1987, 1988) to obtain correct p–values. The basic intuition behind this procedure is that the permutation of the data on the dependent variable must maintain its clustered nature. In practice, this means that the same permutation must be applied to respondents and matches. We can then estimate the above model when all correlation between dependent and independent variables is broken through resampling – that is, when the null hypothesis that all slopes equal zero is known to be true – and compare our first estimates with their empirical distribution obtained through the repetition of this exercise (in our case, 200 times), to generate a sampling distribution for the parameter

[16]With a different formalization, the same idea is captured in Fafchamps and Gubert (2007).

[17]Fafchamps and Gubert (2007) mention that their Monte Carlo simulations support the importance given to this issue, as corrected standard errors can be much larger than uncorrected ones.

estimates. Contrary to previous studies, we find that this added control for unobserved heterogeneity across individuals indeed matters to our results with respect to the formation of credit networks. For that reason, and although we'll present both uncorrected and QAP–corrected p–values, we'll focus the discussion on the last, more general results.

3.3 Estimation results

Table 2 presents descriptive statistics of the regressors used in the regressions we now discuss.

Table 2: Variable definitions and descriptive statistics

Variable	Definition	Mean (SD)
EW_j (Expected Wealth)	Probability that the mach will have a herd bigger than 30 cattle, 10 years after receiving a loan of one cattle, given current (2003) herd size	6.5 (0.10)
EG_j (Expected Gains)	Difference in match's expected herd size, 10 years after receiving a loan of one cattle, given current (2003) herd size	1.063 (0.327)
L_j (Loss)	Dummy variable, equal to 1 if the match lost cattle in the period between September 2000 and September 2003	0.21 (0.40)
Match has no cattle	Dummy variable, equal to 1 if the match has no cattle in September 2003	0.15 (0.36)
Physical distance	Absolute value of the distance between respondent and match, in kilometers	37.07 (55.78)
Same clan	Dummy variable, equal to 1 if both respondent and match belong to the same clan	0.190 (0.39)
Both male	Dummy variable, equal to 1 if both respondent and match are male	0.41 (0.49)
Male, female	Dummy variable, equal to 1 if respondent is male and the match is female	0.24 (0.43)
Female, male	Dummy variable, equal to 1 if the respondent is female and the match is male	0.22 (0.41)
Older	Absolute value of the age difference between respondent and match if the respondent is older than the match, 0 otherwise	8.48 (12.92)

Continued on next page...

... table 2 continued

Variable	Definition	Mean (SD)
Younger	Absolute value of the age difference between respondent and match if the respondent is younger than the match, 0 otherwise	8.18 (12.91)
More land	Absolute value of the difference in land cropped be– tween the respondent and match if the respondent cultivates more land than the match, 0 otherwise	0.39 (1.27)
Less land	Absolute value of the difference in land cropped be– tween the respondent and match if the respondent has less land than the match, 0 otherwise	0.37 (1.11)
Bigger family	Absolute value of the difference in family size (in persons) between the respondent and the match if the respondent has a bigger family than the match, 0 otherwise	1.59 (2.40)
Smaller family	Absolute value of the difference in family size (in persons) between the respondent and the match if the respondent has a smaller family than the match, 0 otherwise	1.66 (2.50)
Positive correlation	Absolute value of the correlation in asset levels, be– tween the respondent and the match, if the corre– lation is positive, 0 otherwise	0.26 (0.29)
Negative correlation	Absolute value of the correlation in asset levels, be– tween the respondent and the match,if the corre– lation is negative, 0 otherwise	0.12 (0.21)
Number of brothers	Number of brothers of the respondent	3.04 (2.08)
No cattle since 2000	Dummy variable, equal to 1 if the match has no cattle since 2000	0.04 (0.20)
Poor since 2000	Dummy variable, equal to 1 if the match manages a herd size that is smaller than 5 cattle (but strictly positive) since 2000	0.05 (0.21)
Not poor but below threshold, since 2000	Dummy variable, equal to 1 if the match has a herd of intermediate size but below the threshold (i.e., between 5 and 14 cattle) since 2000	0.22 (0.41)
Above thresh–	Dummy variable, equal to 1 if the match has a herd	0.01

Continued on next page...

... table 2 continued

Variable	Definition	Mean (SD)
old, not wealthy, since 2000	of intermediate size but above the threshold (i.e., between 15 and 39 cattle) since 2000	(0.09)
Wealthy since 2000	Dummy variable, equal to 1 if the match manages a herd that is larger than 40 cattle since 2000	0.01 (0.11)

Table 3 then reports the estimates of the random effects logit regression when the dependent variable is the decision to lend cattle to the match if he/she requests a loan. Before we discuss the effects of our core covariates of interest – the respondent's expected wealth and expected herd growth – let us first note a few results with respect to the X variables, defining relational characteristics between i and$j$. These results reflect possible frictions and associated costs of establishing a credit relation, analogous to the effect of physical distance in driving localized insurance Murgai et al. (2002).

The propensity to lend cattle is strongly and positively influenced by belonging to the same clan, which may reflect closer affinity or, less altruistically, the interest in keeping one's "strength in numbers" when competing with individuals from other clans for the control of natural resources (especially water in this setting). Variables that measure social distance in terms of gender are clearly asymmetric. Men are more willing to lend cattle (either to women or to other men) than are women. Respondents are slightly, but statistically significantly, more willing to lend cattle to matches' who are older than themselves. Differences in household size decrease the probability of a loan, signaling a propesnity to establish links with those in a similar stage of the life–cycle. Physical proximity has no statistically significant effect on credit access patterns in these data, as is perhaps unsurprising among a population that has mobility at the center of its livelihood. Finally, we notice that Hoff (1997) suggestion that wealthier givers would be less interested in entering into such contracts does not seem to find support in these data. The probability of extending an informal loan is modestly increasing in respondent's wealth.

We now turn to the core hypotheses of interest: the relation between credit access and the match's wealth and shocks, holding the respondents' wealth constant. The first point to notice is that our estimates are generally imprecise: after controlling for the effect of unobserved heterogeneity across individuals, only having no cattle and having suffered no loss since 2000

Table 3: Logit estimates of loan giving patterns

Variable	Coefficient	p-value	QAP p-value
$L_j=0 \times W_j=0$	2.038	0.071	0.035
$L_j=0 \times EW_j$	0.031	0.076	0.055
$L_j=0 \times EG_j$	0.313	0.569	0.275
$L_j=1 \times W_j=0$	-2.340	0.129	0.070
$L_j=1 \times EW_j$	-0.206	0.153	0.175
$L_j=1 \times EG_j$	2.006	0.084	0.055
Respondent's wealth	0.030	0.176	0.065
Physical distance	0.001	0.691	0.255
Same clan	3.506	0.000	0.000
Both male	1.172	0.174	0.050
Respondent is male, match is female	1.187	0.172	0.035
Respondent is female, match is male	0.514	0.514	0.145
Respondent is older than match	0.009	0.609	0.145
Respondent is younger than match	0.010	0.543	0.085
Respondent has more land than match	-0.144	0.563	0.440
Respondent has less land than match	-0.140	0.607	0.305
Respondent has a bigger family than match	-0.211	0.048	0.085
Respondent has a smaller family than match	-0.243	0.025	0.030

Note: Village–specific dummies and a constant were included in the estimation but are not reported. W_j=0: Match has no cattle. L_j=0: Match did not loose wealth in the period 2000/03. L_j=1: Match lost wealth in the period 2000/03. EW_j : Match's expected wealth. EG_j : Match's expected gains from a loan

is statistically significant at the conventional five percent significance level, although a few other variables are significant at the ten percent level.

Second, having suffered losses in the recent past (that is, the period 2000/03, for which we have data) seems to be important in defining the selection criteria of who is creditworthy. Expected gains are important (with a p–value of 0.055) when the borrower lost cattle, while only expected wealth matters (likewise with a p–value of 0.055) for the sub–sample of those who suffered no loss in the recent past.

The identification of the effect of a prospective borrower's wealth on the probability of being given credit requires us to take into account the combined effect of three variables – expected wealth, expected gains and a dummy that accounts for possible discontinuities due to the fact that

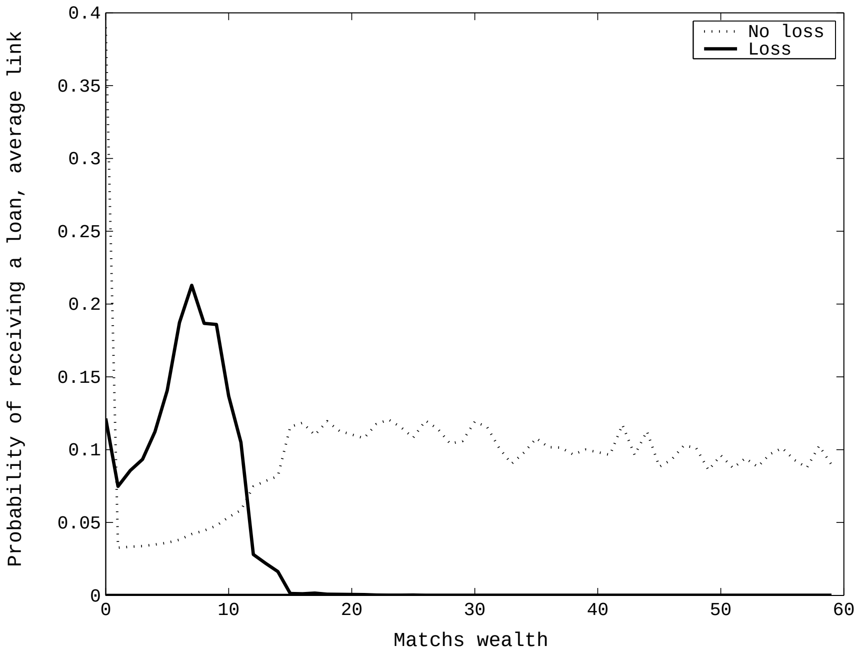

Figure 3: Probability of establishing a credit link: the effect of match's wealth

the borrower has no wealth. This combined effect is graphed in Figure 3 for the "average link" (that is, one characterized by the average value of all other variables), taking into consideration the differences between those who suffered a loss and those who did not.

Credit seems to respond to losses only for those herders who, having cattle, are not "too poor", that is, those with wealth in the neighborhood of 7-10 animals, while those with wealth above 15 animals receive no loans in response to shocks. Recall that the unstable equilibrium is in the neighborhood of 12–16 animals. This suggests that asset transfers may insure the permanent component of income generation (that is, a wealth level that allows them to remain mobile herders able to grow toward the higher herd size equilibrium), rather than the transitory component. Given our earlier discussion, this appears a direct consequence of how gains from informal credit are shared, creating an incentive for lenders to extend credit to prospective borrowers in the neighborhood of the threshold at which wealth dynamics bifurcate. The social convention behind informal lending in this setting seems evolved to provide an effective safety net against collapse into the pastoral poverty trap.

Those herders who did not suffer losses in the recent past seem to be evaluated under different criteria: expected capacity to repay seems to matter most and wealthier herders are preferred borrowers. Here again a wealth level of 15 animals seems to play a role: above this value, the probability of receiving credit does not seem to change much, signaling that all herders above the accumulation threshold seem to be seen as equally desirable/viable, but those with smaller (but non-zero) herd sizes are significantly less likely to receive a loan if they have not suffered a loss.

Finally, those herders who were destitute at the time of our survey had a higher probability of receiving cattle as credit, possibly reflecting the fact that, as with gifts, there is room here for altruism, generating the sharp nonlinearities in the transfer function identified by other authors (Cox, 1987, Cox, Hansen, and Jimenez, 2004). This seems to contradict the historical record, which underscores that cutting off the destitute has traditionally been a standard response to dire poverty among East African pastoralists (Illife, 1987, Anderson and Broch-Due, 1999). In section 4 we revisit this point and show that the exclusionary behavior identified by anthropologists and historians may occur at another level, that of social networks from which credit networks are activated. Conditional on having established social ties, extreme destitution, in the form of stocklessness, appears to induce the highest probability of receiving a loan when the prospective borrower has not experienced a shock, suggesting some space for altruism in informal lending patterns among the Boran.

One must notice see also that the expected probability of giving credit is never above 0.5: in other words, under no conditions is the "average link" expected to correspond to a situation where the lender effectively gives credit to the borrower. Of course, the average link is an abstraction and, given the estimates from Table 3, a good candidate to insert some realism into the analysis of the kind of links that lead to credit being given is to look at links between individuals belonging to the same clan. The results are graphed in figure 4 and can be quickly summarized: credit, now restricted to the situation when both lender and borrower are from the same clan, does not seem to be given to those who didn't loose wealth in the recent past unless they are destitute (that is, with no cattle), while credit within members of the same clan may function as insurance only for those that are not "too poor" – in practice, with wealth below 11 animals.

One must note also that the expected probability of giving credit never exceeds 0.5. In other words, under no conditions is the "average link" expected to correspond to a situation in which the prospective lender extends credit to the borrower. Of course, the average link is an abstraction. Given the estimates reported in Table 3, a good candidate scenario for increased realism is to look at links between individuals belonging to the same clan. Those results are graphed in figure 4. Now restricted to prospective intra–clan lending, the basic pattern of limited credit access in the absence of recent asset losses remains. The destitute enjoy a high probability (greater than 0.8) of receiving an informal loan – reinforcing the impression of altruistic lending to the very poorest – and those with non–zero herd sizes have little prospect for receiving a loan although that probability is increasing in wealth up to the wealth threshold, beyond which it is effectively constant at 0.20-0.25. Intra–clan credit responds robustly to shocks as de facto insurance only for those who are not "too poor" – with wealth of 6–12 cattle – and not at all to shocks for those with herd sizes beyond the critical wealth threshold. The strength of the safety net mechanism remains even within clans, reinforcing the sense that informal lending is directed chiefly toward those who will gain the most from the loan because it tips them into the more desirable basin of attraction, toward the high-level herd size equilibrium.

3.4 The effect of borrower's ability

In section 2 we suggested the possibility that wealth dynamics may be characterized by club convergence as well as by multiple equilibria. Differences in herding ability seem to affect expected herd dynamics; in particular lower ability herders do not exhibit multiple equilibria and are expected to fall into the low–level equilibrium regardless of the herd size with which they start. Transfers to low ability herders are thus ineffective insurance against the permanent effects of shocks irrespective of ex post herd size. By contrast, higher ability herders exhibit multiple stable equilibria and thus positive expected gains from a transfer when made to a borrower in the neighborhood of the unstable equilibrium that appear to drive informal credit patterns in the absence of controls for borrower herding ability.

Assuming herders rank the ability of their matches similarly to our estimates, a match's ability should therefore matter to a respondent's likelihood of extending credit to a match if this behavior is indeed heavily influenced by borrowers' expected long–run herd gains. This is effectively what we find in Table 4. As a rule, low ability borrowers' wealth plays no statistically significant role in explaining the decision to give credit. This is true even when the borrower has no cattle. Even seemingly altruistic lending behavior seems to discriminate between those with low and higher ability,

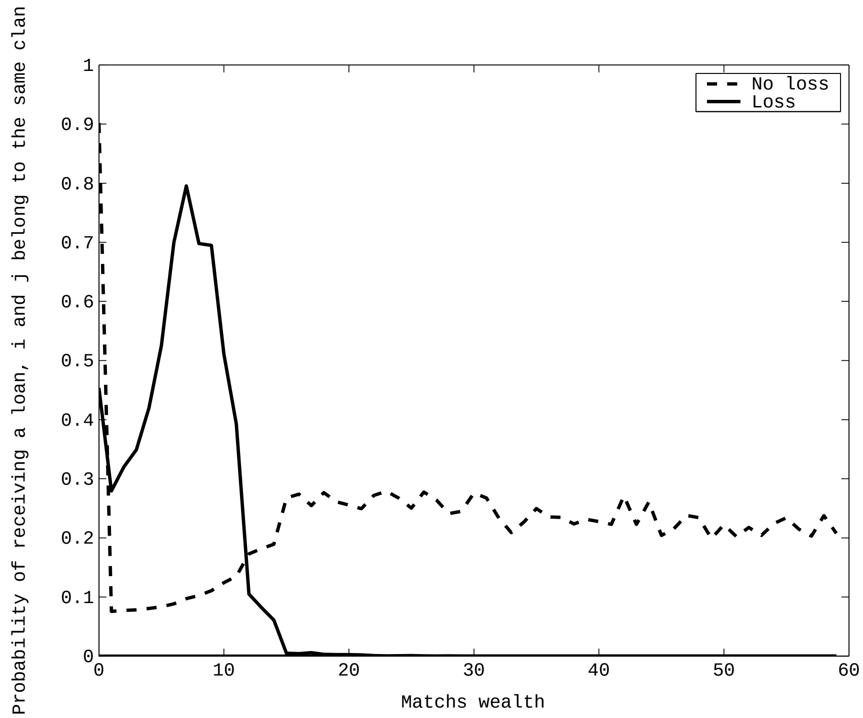

Figure 4: Probability of establishing a credit link: the effect of match's wealth and clan membership

as the latter enjoy a sharply and statistically significantly higher probability of receiving a loan when they have not suffered a recent loss. When our estimates are precise enough to guide some conclusion, as in the case of the variable "low ability × loss × expected wealth", the results do not easily square with conventional models that focus on wealth as guarantee of no default, as our estimate has the "wrong" sign. Credit does not function as insurance to these wealthier herders, who are left to insure themselves. Those who are expected to suffer the greater long-run herd declines (the wealthiest low ability herders) are the least likely to receive informal loans.

On the other hand, the likelihood of granting an informal loan is sharply and statistically significantly increasing in the borrower's expected herd gains for herders of higher ability who lost wealth. They are the most credit worthy members of the community. Introducing borrower ability thus reinforces the patterns already observed: informal credit is concentrated over-

Table 4: Logit estimates of loan giving patterns: the effect of herder's ability

Variable	Coefficient	p-value	QAP p-value
Match is of low ability × L_j=0 × W_j=0	0.030	0.989	0.320
Match is of low ability × L_j=0 × EW_j	0.033	0.272	0.150
Match is of low ability × L_j=0 × EG_j	0.989	0.204	0.110
Match is of low ability × L_j=1 × W_j=0	-4.073	0.411	0.185
Match is of low ability × L_j=1 × EW_j	-14.180	1.000	0.045
Match is of low ability × L_j=1 × EG_j	3.263	0.325	0.130
Match is of high ability × L_j=0 × W_j=0	2.496	0.070	0.020
Match is of high ability × L_j=0 × EW_j	0.026	0.179	0.140
Match is of high ability × L_j=0 × EG_j	0.242	0.675	0.320
Match is of high ability × L_j=1 × W_j=0	-2.963	0.086	0.050
Match is of high ability × L_j=1 × EW_j	-0.224	0.125	0.185
Match is of high ability × L_j=1 × EG_j	2.370	0.050	0.020
Respondent's wealth	0.029	0.157	0.065

Note: Other covariates presented in table 3 were used in the estimation but are not presented here.

whelmingly on those near the threshold who have suffered a wealth loss, thus serving as a safety net, and on high ability destitute herders who have not suffered a loss, signaling altruistic transfers.

3.5 Alternative explanations of exclusion from credit contract

Finally, we check whether our central results are robust to the inclusion of additional controls suggested by the alternative models identified at the close of the section 3. We already addressed the concerns of Hoff (1997) and Murgai et al. (2002) in Tables 3 and 4. In Table 5 we include, as additional controls, the correlation between asset levels of our respondents and their random matches in the nine survey rounds for which we have data. As with other covariates, we allow for the possibility of different effects upon the propensity to transfer cattle as a loan depending on whether this correlation is positive or negative.

Although these additional controls are not statistically significant, their inclusion does change our results in one important way. It is no longer true that belonging to the low ability category leads to being excluded from

Table 5: Logit estimates of loan giving patterns: the effect of correlation in wealth dynamics

Variable	Coefficient	p-value	QAP p-value
Match is of low ability × L_j=0 × W_j=0	-4.749	0.305	0.500
Match is of low ability × L_j=0 × EW_j	0.008	0.854	0.130
Match is of low ability × L_j=0 × EG_j	1.769	0.171	0.050
Match is of low ability × L_j=1 × W_j=0	-21.732	0.280	0.035
Match is of low ability × L_j=1 × EW_j	-32.236	1.000	0.040
Match is of low ability × L_j=1 × EG_j	6.354	0.269	0.040
Match is of high ability × L_j=0 × EW_j	0.028	0.139	0.045
Match is of high ability × L_j=0 × EG_j	0.137	0.799	0.410
Match is of high ability × L_j=1 × W_j=0	-5.721	0.064	0.000
Match is of high ability × L_j=1 × EW_j	-0.324	0.105	0.100
Match is of high ability × L_j=1 × EG_j	2.660	0.042	0.015
Respondent's wealth	0.027	0.177	0.170
Negative correlation in wealth	-0.517	0.635	0.175
Positive correlation in wealth	1.466	0.065	0.245

Note: Other covariates presented in table 3 were used in the estimation but are not presented here. "Match is of high ability × L_j=1 × W_j=0" was dropped due to multicollinearity.

these credit networks, signaling that either matches' ability is not correctly understood by our respondents or that our own classification is somewhat flawed. The likelihood of lending is now statistically significantly increasing in the expected gains from the transfer even for low ability herders who have suffered a loss. Hence, one of our core results remains: informal lending appears concentrated around the unstable wealth equilibrium in response to asset shocks, serving as a safety net against collapse into a poverty trap.

This is likewise true when we include the respondent's number of brothers and its square as a proxy for the size of the ex ante insurance network (Table 6). But just as when we control for correlation in wealth between respondent and match, we now find that expected gains from a transfer post-shock appear to drive informal lending irrespective of the borrower's herding ability.

Table 6: Logit estimates of loan giving patterns: the effect of ex ante credit networks

Variable	Coefficient	p-value	QAP p-value
Match is of low ability × L_j=0 × W_j=0	-5.539	0.230	0.510
Match is of low ability × L_j=0 × EW_j	0.001	0.973	0.435
Match is of low ability × L_j=0 × EG_j	2.019	0.125	0.065
Match is of low ability × L_j=1 × W_j=0	-24.201	0.263	0.030
Match is of low ability × L_j=1 × EW_j	-31.701	1.000	0.040
Match is of low ability × L_j=1 × EG_j	7.052	0.253	0.030
Match is of high ability × L_j=0 × W_j=0	2.500	0.134	0.000
Match is of high ability × L_j=0 × EW_j	0.028	0.157	0.470
Match is of high ability × L_j=0 × EG_j	0.233	0.674	0.390
Match is of high ability × L_j=1 × W_j=0	-5.197	0.104	0.065
Match is of high ability × L_j=1 × EW_j	-0.313	0.116	0.325
Match is of high ability × L_j=1 × EG_j	2.434	0.068	0.000
Respondent's wealth	0.027	0.159	0.475
Number of brothers	-0.437	0.340	0.000
Number of brothers squared	0.063	0.256	0.080

Note: Other covariates presented in table 3 were used in the estimation but are not presented here.

4 Nonlinear wealth dynamics and social exclusion

The fact that the poorest members of the community are less likely to receive transfers than those near the accumulation threshold suggests a process of social exclusion. If, as Santos and Barrett (2006) claim, multiple dynamic equilibria arise because of asset shocks, then insurance against asset shocks is critical to maintaining a viable livelihood for those of medium and high herding ability. Yet if the asset poor cannot get transfers, either as gifts or as transfers, their ability to climb out of poverty is negligible. The results reported in the preceding section may even understate this effect because they are based only on credit decisions relating to the subsample of random matches with whom respondents were already acquainted. Given that social acquaintance seems to precede the establishment of a credit network, as shown in table 1, this section explores the possibility of wealth–dependent "social invisibility", which could reinforce the credit rationing mechanism identified in the previous section.

Table 7: Logit estimates of social acquaintance networks

Variable	Coefficient	p-value	QAP p-value
Match is destitute since 2000	-1.106	0.025	0.070
Match has less than 5 cattle since 2000	-0.145	0.736	0.391
Match has between 5 and 14 cattle since 2000	-0.127	0.639	0.379
Match has between 15 and 39 cattle since 2000	-0.581	0.558	0.485
Match has more than 39 cattle since 2000	-1.297	0.287	0.284
Match lost cattle since 2000	0.203	0.466	0.356
Respondent has more cattle than match	-0.014	0.009	0.096
Respondent has less cattle than match	0.040	0.001	0.043
Distance	-0.007	0.323	0.201
Same clan	0.743	0.015	0.033
Both male	0.684	0.081	0.118
Respondent is male, match is female	0.177	0.671	0.359
Respondent is female, match is male	0.618	0.084	0.121
Respondent is older than match	-0.026	0.013	0.005
Respondent is younger than match	-0.000	0.971	0.515
Respondent has more land than match	0.143	0.215	0.193
Respondent has less land than match	0.482	0.001	0.013
Respondent has a bigger family than match	0.042	0.499	0.264
Respondent has a smaller family than match	-0.097	0.088	0.111

Note: Village–specific dummies and a constant were included in the estimation but are not reported here. Being from Qorate predicts being known perfectly – the variable was dropped and 300 observations were not used.

We use the same logit estimation approach from equation 5 to examine patterns of social acquaintance among the individuals in our sample, now using the “know” variable from table 1 as the dependent variable. Because this variable is certainly the result of past processes, we incorporate the effect of past dynamics (in practice, herd size transitions between 2000 and 2003) and not the variables that we previously interpreted as a measure of future herd size or expected gains from a loan. The results are presented in table 7.

Being from the same clan and having less assets (cattle and land) than one’s match increases the probability of knowing the random match, while having more cattle and being older have a negative impact, a clear demonstration of the asymmetric effects of wealth and status on the structure of social networks. This effect is even clearer when we consider the effect of a match being destitute, i.e., having no cattle. Destitution is strongly associated with exclusion from social networks, as reflected in a large, negative, and statistically significant coefficient estimate. A herd size consistently at the low–level equilibrium appears associated with greater likelihood of social invisibility that, recall from Table 1, seems to prevent one from entering into dyadic credit relationships. Informal credit arrangements cannot function for the poorest members of a society if they are not part of the social networks from which credit networks are drawn.

The nature of the channels through which this process operates are not entirely clear, although the anthropological literature on the Boran offers some suggestions. Dahl (1979), for example, mentions that the participation in the social and political life of the Boran is hardly compatible with the daily management of the herd: wealthy herders, who usually occupy these traditional (and highly visible) offices, quite often delegate these tasks to someone else. Lybbert et al. (2004) hypothesize that multiple herd size equilibria result from the involuntary sedentarization of the destitute while those with viable herds migrate. Seasonal migration might thereby create sufficient physical separation and differences in lifestyle that the poorest become invisible to those who remain as herders. Regardless of the precise causal mechanisms by which the greater social invisibility of the poor arises, what seems clear from historical accounts is that exclusion generated by persistent poverty is not something new. For example, Illife (1987, p.42) notes that "[t]o be poor is one thing, but to be destitute is quite another, since it means the person so judged is outside the normal network of social relations and is consequently without the possibility of successful membership in ongoing groups, the members of which can help him if he requires it. The Kanuri [in the West African savannah] say that such a person is not to be trusted". Closer to our study site, a Somali proverb states that "Prolonged sickness and persistent poverty cause people to hate you" (World Bank, 2000, p.16).

We should note, however, that the evidence that we find for the importance of social invisibility in this environment is weakened once we use the QAP to obtain correct p–values for the variables in our model. In particular, persistently having no cattle is no longer significant at the 5% level (although the p–value increases only to 0.07) and the asymmetries in the effects of difference in wealth become less precisely estimated. There are two possible explanations for this. First, knowing one's match may be a less "rational" process than is choosing a loan recipient, leading to a greater role for unobserved heterogeneity for both respondent and match. Second, even if we are using all the relevant variables to eliminate the two–way unobserved heterogeneity concern, we only observe them for a relatively short period and there can be no presumption that the process from destitution to social invisibility takes effect immediately. For example, moving to a larger urban center as a consequence of utter destitution is not quickly or easily undertaken. This raises the theoretically and empirically interesting question of describing the dynamics of these networks, a topic that unfortunately we cannot address with these data.

5 Conclusions and policy implications

This paper presented a simple conceptual model of the implications of multiple wealth equilibria for patterns of informal credit and established that data from a population among which poverty traps have been previously identified support the hypothesis that informal credit conforms to this model. Livestock loans among these herders appear to function largely as safety nets, triggered by herd losses so long as those losses leave the prospective transfer recipient not "too poor" so that the expected gains to the borrower from the loan – and thus to the lender – are relatively high, as compared to loans to poorer or richer prospective borrowers. For the poorest, stockless herders, their destitution induces prospective partners to rationally exclude them from credit–cum–insurance networks, even though they know each other, although informal credit does flow to the destitute altruistically, especially between members of the same clan.

This effect of credit rationing that leaves out poorer (if not necessarily the poorest) members of the community is compounded by the fact that the poor are less socially visible than their somewhat wealthier neighbors. Because being known is, in our sample, a necessary condition for receiving transfers, the greater social invisibility of the destitute compounds their rational exclusion from informal financial transactions effected through social networks, leaving them vulnerable to shocks and largely without credit networks to fall back on in times of need.

The existence of multiple wealth equilibria and the focal role played by the dynamic wealth threshold that we identify in this setting have profound implications for public policies to address problems of persistent poverty and asset loss in a setting characterized by poverty traps. Because transfers can have, literally, life or death consequences in contexts such as the rangelands of southern Ethiopia, it is perhaps unwise to derive conclusions about optimal redistributive policies simply from our econometric results (Cohen-Cole, Durlauf, and Rondina, 2005). Nevertheless, our results speak to the concern that external transfers from governments, donors or international nongovernmental organizations may crowd out existing informal arrangements. Boran pastoralists seem to act in such a way that clearly marginalizes those who are trapped in dire poverty. In this context, worries about the crowding out effect of public interventions seem misplaced, as the poorer members are clearly left uninsured with distressingly high probability. In fact, our empirical results suggest that, up to some wealth level, public transfers may even lead to the crowding-in of private transfers, as a recent analysis of private transfers in the Philippines likewise suggests (Cox, Hansen, and Jimenez, 2004). This result is no surprise in a context where transfers are risk-sharing mechanisms motivated by exchange/reciprocity considerations, in which case there may be a positive correlation between the welfare of the recipient and a private transfer because better-off recipients will be better placed to reciprocate a transfer in the future.

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