Persistent poverty and informal credit*

Paulo Santos† The University of Sydney

Christopher B. Barrett‡ Cornell University

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Abstract

This paper explores the consequences of nonlinear wealth dynamics for the formation of bilateral credit arrangements to help manage idiosyncratic risk. Building on recent empirical work that finds evidence consistent with the hypothesis of multiple equilibrium poverty traps, and using original primary data on expected wealth dynamics, social networks and informal loans among southern Ethiopian pastoralist households, we find that the threshold at which wealth dynamics bifurcate serves as a focal point at which lending is concentrated. Informal lending responds to recipients' losses but only so long as the recipients are not "too poor". Our results suggest that when shocks can have long term effects, loans are not scale-neutral. Furthermore,

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†Lecturer, The University of Sydney. Correspondence address: 107 Watt Building, Science Road, The University of Sydney. Sydney NSW 2006, Australia. Email: p.santos@usyd.edu.au .

‡S.B. and J.G. Ashley Professor, Department of Applied Economics and Management.

the persistently poor are excluded from social networks that are necessary to obtain loans given 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 instruments 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 the 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.

The assumption that all poverty is transitory seems to be contradicted by the empirical evidence, which suggests that a substantial share of poverty in many low–income countries is persistent. [3] It also seems to be at odds with a large literature that emphasizes how uninsured risk can reinforce poverty, either because negative shocks have a disproportionately detrimental impact on poor people's investments, (Jacoby and Skoufias, 1997, Dasgupta, 1997, Alderman, Hoddinott, and Kinsey, 2006, Carter et al., 2007) or because poorer individuals choose safer investment portfolios that prove, on average, less profitable (Rosenzweig and Binswanger, 1993, Morduch, 1995, Dercon, 1996). Curiously, the link from persistent poverty back to risk management options other than self–insurance remains underdeveloped in the literature. This paper aims to contribute to filling that void.

[1]Most commonly, credit, savings or insurance. 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.

[3]See Baulch and Hoddinott (2000) and Barrett, Carter, and Little (2006) for recent reviews.

Theoretical models in which poverty is a stable dynamic equilibrium suggest two key conditions under which short-term shocks might have longer-term consequences (Azariadis and Stachurski, 2005, Carter and Barrett, 2006). First, if a nonconvexity in some technology generates a critical threshold, an unstable dynamic equilibrium at which wealth dynamics bifurcate, the mapping from current to future wealth will exhibit multiple stable dynamic equilibria, poverty may persist if one of these stable equilibria lies below the poverty line. Second, if some market imperfection (e.g., in the credit market) 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, then persistent poverty can result from either meager initial endowments or an adverse shock that drives one beneath the unstable equilbirium and onto the path dynamics that converge towards the low-level stable equilibrium. In such an economy, small transfers can have large welfare impacts if they succeed in putting a recipient in a path of sustained accumulation towards a higher level equilibrium.

What seems not to have been recognized yet 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 lead to persistent poverty. 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 how adverse selection and moral hazard may cause the poor to be disproportionately rationed out of credit markets. The poor are not creditworthy because, having too little to lose, it may be prohibitively costly for a lender to punish them in case of default (Banerjee and Newman, 1993). An assumption underlying this result is that borrower's payment does not depend on the project realized returns (Banerjee, 2001). If that is not the case, either because informal loans bundle credit and insurance (Udry, 1994) or because loans bundle an element of equity, as in the context we study below, then the presence of non–convexities may turn the unstable dynamic equilibrium (or its neighborhood) into a focal point for loans, since this is the point at which the expected gains to the borrower are greatest. In this context, those who are not "too poor" – the economy's "middle class" – become preferred borrowers, while both poorer individuals and the very rich may be excluded from such credit arrangements.

The remainder of the paper proceeds as follows. Section 2 introduces the population we study, Boran pastoralists in southern Ethiopia, drawing partially on previous work that has documented 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 dynamics as given in order that we can focus on the implications of prospective multiple equilibria on informal lending relationships. In section 3 we study the decision to extend informal credit among Boran pastoralists. We find that this decision 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 correlation in asset returns between borrower and lender, and for the ex ante credit network of the lender. These findings imply a "middle class" bias in informal lending, in which the poorest members are rationed out of informal credit markets in equilibrium due to the existence of an unstable dynamic wealth equilibrium and the richest members are rationed out due to diminishing returns to wealth. 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 informal 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

analyze

Nonlinear wealth dynamics consistent with stylized poverty trap models were analyzed by Lybbert et al. (2004) among a poor population in southern Ethiopia, the Boran pastoralists. 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 (Desta, 1999), 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.[4] Those with smaller herds are forced to stay near their base camps, where spatial concentration of herds quickly leads to localized rangeland degradation, leading to a collapse of herd size towards the low-level stable equilibrium. Meanwhile, those households with bigger herds can migrate in search of the many areas with adequate water and pasture, enabling them to sustain far larger herds, free of the constraints imposed by localized range degradation.

These authors present two other findings that are important for this 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, as in other societies in semi-arid Africa (Lentz and Barrett, 2004, McPeak, 2004, Kazianga and Udry, 2006, McPeak, 2006). A central purpose of

[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.

this paper is to understand whether such paucity of prospectively welfare-improving informal transactions might be a direct consequence of the wealth dynamics faced by these pastoralists. Do the system's multiple equilibria reinforce the credit market failures that help underpin the poverty trap?

In order to answer that question we collected new data on expected wealth dynamics and on bilateral credit relations in the same communities – although not from the same individual respondents. [5] The data on expected wealth dynamics are discussed and analyzed in detail in Santos and Barrett (2008a). Here we only briefly present key elements of that discussion that 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 hypothetical initial herd sizes, randomly selected from the interval 1–60 animals, after which we elicited their subjective herd size distribution one year ahead, given the state of nature just elicited and the initial, random, herd size. These data equip us to model the relation between initial and expected future wealth for each of the four states of nature considered (drought, bad year, good year, very good year). Combined with historical information on rainfall, these estimates enabled us to simulate the empirical distribution of herd size up to ten years ahead. The results, presented in figure 1, suggest that the wealth dynamics revealed in the historical data studied by Lybbert et al. (2004) are in fact understood by pastoralists, as evidenced by the existence of multiple dynamic equilibria and the location of each of the different equilibria.

In order to understand the decision to extend credit to potential borrowers we randomly matched each respondent with five other respondents from the sample and asked two types of questions. The first question identified (real) social networks through the question "Do you know (the match)?"

[5]This took place within a larger research project, the Pastoral Risk Management (PARIMA) 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. Barrett et al. (2004) describe the location, survey methods and available data.

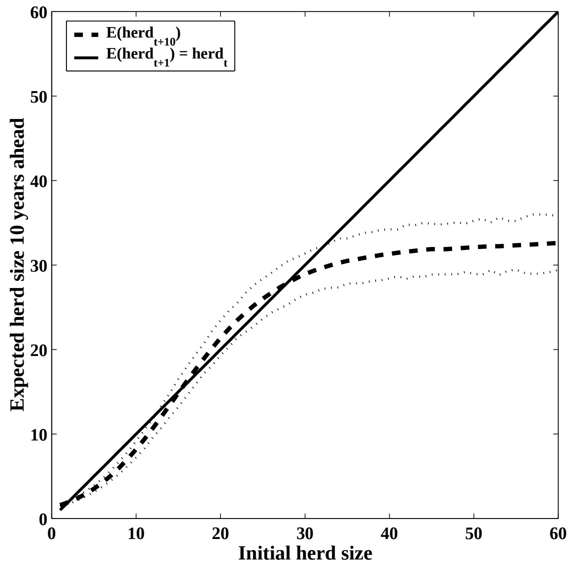

Figure 1: Expected wealth dynamics

The other question inquired about the possibility of transferring cattle as a loan if the match asked for it.[6] This 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 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 bilateral relation (Rosenzweig, 1988, Cox and Rank, 1992, Ackerberg and Botticini, 2002).

There are, however, two prospective problems with this approach. First, by studying links between individuals rather than the transfers themselves, we could err due to excessive discretization. However, 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

[6]We also asked about the possibility of transferring cattle as gifts. The pattern of answers is virtually identical; loans and gifts seem empirically indistinguishable in this sample. In only 13 (2.3%) of 561 matches did the decision differ between loans and gifts. We therefore concentrate solely on transfers deemed "loans" in what follows.

were 15 such transfers, out of which 12 (80%) were of 1 or 2 cattle. [7] For that reason, and with only a slight abuse of language, we use the terms "credit network" 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 approach used in this paper closely match those obtained from analysis of real insurance relations among the same population. [8] The appeal of using randomly matched respondents thus seems to outweigh the prospective pitfalls of using discrete data on hypothetical transfers.

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.

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

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; almost 14% of the matches were

[7] 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.

[8] This is not an entirely surprising result. An extensive literature on stated choice methods suggests that when properly contextualized, elicitation of hypothetical behaviors can provide an accurate view of actual behaviors (Arrow et al., 1993). 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).

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 has consequences for our econometric strategy. In particular, we must estimate the determinants of credit networks only on the subsample of those who know their matches (Maddala, 1983). This also raises the question of who is excluded from social networks, which we explore in section 4. Third, 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 informal credit rationing

The intuition behind the analysis of respondents' willingness to extend a cattle loan to a random match from the sample 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 key considerations enter this calculus: the possibility that the borrower may not repay the loan and the value of the compensation provided for parting with an animal.

The first, default risk consideration is heavily emphasized in the literature that explores the relation between wealth and exclusion from contracts,[9] usually finding a monotonically positive relation between a borrower's wealth and her creditworthiness. If informal credit were strictly a debt instrument, this might be the end of the story and willingness to extend credit should be a monotonically increasing function of the prospective borrower's ex ante wealth, and thus capacity to repay.

In our setting, however, as in many other developing country settings, loans often come bundled with insurance (Udry, 1994) or, in this case, an element of equity investment. Among the Boran, informal lending traditions

[9] See Banerjee (2001) for a comprehensive analysis.

hold that the loan of a cow[10] 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 affects the expected returns to the lender, reflecting an equity component to informal livestock loans in this setting.

Clearly, these motives are non–exclusive. We can conceive of an individual Boran pastoralist (indexed by i) making lending decisions as if maximizing the net expected returns (ER) on a loan of one cattle to another herder (indexed by j):

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

Here, $\mathrm{EG_j}$ stands for j's Expected Gains from a loan, σ stands for the lender's 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, is a strictly increasing function of borrower's Expected Wealth (EW), both evaluated at some relevant repayment horizon T. Let

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

where $\mathrm{W_{jt}}$ is borrower's wealth at time t, $\mathrm{l_{ij}}$ is the binary decision reflecting the lender's decision regarding the loan, and $\phi(\theta)$ is the distribution function of the production shocks, θ. The growth function $\mathrm{F}(\bullet)$ allows for the possibility of a threshold as in Azariadis and Drazen (1990).

Finally, we define the Expected Gains from lending as

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

Both EG and EW are a function of the same variable, namely borrower's initial wealth. In the empirical application, these variables were created using the simulation procedure briefly described in section 2 and developed

[10] Even money to be used to buy animals, which is becoming less rare.

in detail in Santos and Barrett (2008a). The results from that exercise, for specific definitions of "expected wealth" and "expected gains" ten years ahead are presented in figure 2, with expected wealth the dot-dashed line (read against the lefthand vertical axis) and expected gains the dotted line (read against the righthand vertical axis). [11]

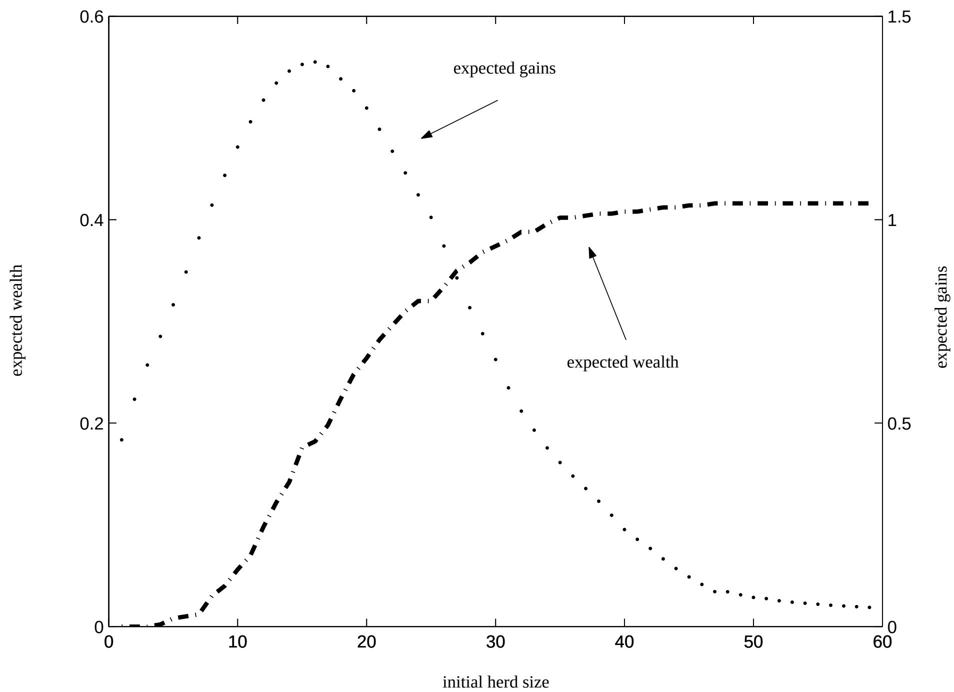

Figure 2: Expected consequences of a loan of 1 cattle

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

[11]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 herd size. 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. As explained in the text, 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.

plateau in the 35-45% range beginning roughly at 22 head. Second, the only asset range over which expected gains exceed the 1 cattle initially transferred is the interval of 7-22 cattle – that is the neighborhood of the threshold at which wealth dynamics bifurcate.

Given these results, 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 (EW_j) drives credit access, it would signal that the wealth threshold *per se* is not important. In this case, we would expect the wealthiest herders to be the primary beneficiaries of these loans.

If, on the other hand, only expected gains (EG_j) guide the allocation of loans, this might induce a "middle class" bias that favors those nearer the threshold at which wealth dynamics bifurcate. To see this, we must notice that, 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 poorest or the wealthiest members of the community). On the other 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]

And if loans are extended primarily in response to asset shocks that cause borrowers to lose animals, then informal credit serves as de facto insurance (Alderman and Paxson, 1994, Besley, 1995). The existence of such a pattern

[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 but that, together with our evidence, seem to reinforce the existence of a minimal herd size for viable pastoralism.

– lending in response to prospective borrowers' shocks and expected gains more than expected wealth – would suggest that informal lending (or equivalent transfer arrangements) in the presence of nonconvexities associated with multiple dynamic equilibria might be best understood as a mechanism to prevent participants from falling into persistent poverty – that is, loans provide a safety net – rather than as a scale-neutral insurance mechanism ready to be activated whenever the potential borrower suffers a loss, irrespective of his/her wealth after the shock.

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). He explores different motives for livestock transfers in a northern Kenyan environment quite similar to ours 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" 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 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 this implication of Hoff's model as well, since we use data from both sides of the credit contract and thus can 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 defection by sub–groups. [13] Although these authors do not explicitly model wealth as a source of friction that might prevent credit 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 the other agent's activity and, less perfectly, for the degree of alternative credit ex ante of the link formation decision.

3.2 Econometric model

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

$$\mathrm{Prob}(l_{ij} = 1) = \Lambda(EG_j, EW_j, L_j, W_i, X_{ij}) \qquad (4)$$

[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).

where $l_{ij} = 1$ 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 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), W_i is the respondent's wealth and the X_{ij} vector captures a range of covariates describing the distance, in both physical and socio-economic space, between i and j. Finally, Λ is the logit cumulative distribution function and we assume that:

$$E(\varepsilon_{\text{ij}}, \varepsilon_{\text{ih}}) \neq 0 \text{ if j } \neq \text{ h} \tag{5}$$

$$E(\varepsilon_{\text{ih}}, \varepsilon_{\text{jh}}) \neq 0 \text{ if i } \neq \text{ j} \tag{6}$$

where ε_{ij} is the error term of the regression. Two issues need to be addressed before we present our estimates: (1) the way we express the distance between respondent and match (the vector X_{ij}), and (2) how to make accurate inferences as to the statistical significance of our estimates given that unobserved heterogeneity across individuals is likely important for the network formation decision (as in 6).

The elements of the X_{ij} 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, 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. [14] This approach

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

offers an intuitively more appealing interpretation of the effects of social and economic distance than the more conventional Euclidean measure of social distance (as in Akerlof (1997)) that (implicitly) imposes symmetry in the effect of these variables upon the dyad formation decision.

Our assumptions about the error term (expressions 5 and 6) formalize the possibility of correlation across matches' unobservables, that is, that the error term is also dyadic. [15] Most of the studies that account for this possibility do so by correcting the covariance matrix using the estimator suggested by Conley (1999). We follow a different strategy, using a nonparametric permutation test known as Quadratic Assignment Procedure (QAP) (Hubert and Schultz, 1976, Krackhardt, 1988, 1987) to obtain correct p–values. [16] 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 estimates. Contrary to most of the previous studies, we find that this added control for unobserved heterogeneity across individuals indeed matters to our results with respect

[15] An alternative way of modeling the error term is to assume that the personal network is a complex attribute of the individual and that relations are nested within individuals (Valente, 2005). This assumption implies a logit model estimated by clustering the observations on the identity of the respondent, that is, that $\mathrm{E}\left(\varepsilon_{\mathrm{ih}}, \varepsilon_{\mathrm{jh}}\right) \neq 0$ if $\mathrm{i} \neq \mathrm{j}$. The record of whether such simplification matters is mixed. Fafchamps and Gubert (2007), Udry and Conley (2005) and Santos and Barrett (2008b) find no significant differences from estimates that do not account for correlation across matches' unobservables. Other studies, for example Arcand and Fafchamps (2007), find that allowing for correlation across matches' unobservables does matter to inference.

[16] Each of our respondents is matched with five other individuals. With such a small number of matches, it does not seem credible that the assumptions for the asymptotic properties of an estimator such as the one introduced by Conley (1999) would hold. In an earlier version of their analysis, Fafchamps and Gubert (2007) used QAP to derive correct p–values. As they mention, inference was similar to using the correction that they ultimately report.

to the formation of credit networks. For that reason, we'll present only the QAP–corrected p–values.

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)	Percent 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 X 100	9.62 (12.29)
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	0.973 (0.383)
Respondent's wealth	Respondent's herd size in 2003	11.31 (13.45)
L_j (Loss)	Dummy variable, equal to 1 if the match lost cattle in the period between September 2000 and September 2003	0.219 (0.414)
Physical distance	Absolute value of the distance between respondent and match, in kilometers	44.65 (61.89)
Same clan	Dummy variable, equal to 1 if both respondent and match belong to the same clan	0.23 (0.42)
Both male	Dummy variable, equal to 1 if both respondent and match are male	0.42 (0.50)
Male, female	Dummy variable, equal to 1 if respondent is male and the match is female	0.25 (0.43)

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... table 2 continued

Variable	Definition	Mean (SD)
Female, male	Dummy variable, equal to 1 if the respondent is female and the match is male	0.19 (0.40)
Older	Absolute value of the age difference between respondent and match if the respondent is older than the match, 0 otherwise	7.40 (11.97)
Younger	Absolute value of the age difference between respondent and match if the respondent is younger than the match, 0 otherwise	7.91 (12.44)
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	0.34 (1.04)
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 (1.28)
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	1.27 (2.04)
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	1.60 (2.37)
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–	0.12 (0.21)

Continued on next page...

... table 2 continued

Variable	Definition	Mean (SD)
	lation is negative, 0 otherwise	
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–old, not wealthy, since 2000	Dummy variable, equal to 1 if the match has a herd of intermediate size but above the threshold (i.e., between 15 and 39 cattle) since 2000	0.01 (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 results of estimating equation 4. 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, simply, the interest in keeping one's "strength in numbers" when competing with individuals from other clans for the control of natural resources (especially

Table 3: Logit estimates of loan giving patterns

Variable	Coefficient	QAP p-value
L_j=0 × EW_j	0.027	0.000
L_j=0 × EG_j	0.092	0.400
L_j=1 × EW_j	-0.112	0.025
L_j=1 × EG_j	1.936	0.040
Respondent's wealth	0.014	0.180
Physical distance	-0.001	0.650
Same clan	2.320	0.000
Both male	0.819	0.050
Respondent is male, match is female	0.959	0.035
Respondent is female, match is male	0.344	0.180
Respondent is older than match	0.014	0.000
Respondent is younger than match	0.009	0.095
Respondent has more land than match	-0.120	0.390
Respondent has less land than match	-0.172	0.260
Respondent has a bigger family than match	-0.136	0.130
Respondent has a smaller family than match	-0.161	0.095
Pseudo–R^2	0.274	

Note: Village–specific dummies and a constant were included in the estimation but are not reported. 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.

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 propensity 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, the suggestion that wealthier givers would be less interested in entering into such contracts (Hoff, 1997) does not seem to find support in these data as the probability of extending an informal loan is modestly increasing in respondent's wealth (although our estimates are not statistically significant at the usual levels of significance).

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. [17]

The first point to notice is that having suffered losses in the recent past (that is, the period 2000/03, for which we have data) seems to be critically important in defining who is creditworthy.

In the case of those herders who suffered no losses in the recent past, only expected wealth seems to be important. This is not true in the case of herders who suffered losses. Both expected wealth and expected gains are statistically significant in explaining this decision (with p–values of 0.025 and 0.040) but, more interestingly, seem to have opposite effects on the propensity to be given a loan: expected wealth (that can be interpreted to reflect one's capacity to stand on one's own after a shock) decreases the propensity of receiving a loan while expected gains has a positive effect on the probability of receiving such a loan.

The second point to notice is that the identification of the net effect of borrower's wealth on the probability of being given credit requires us to take into account the combined effect of the two variables of interest – expected wealth and expected gains. This combined effect is graphed in Figure 3 for the "average link" (that is, one characterized by the average value of

[17] 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 perhaps more straightforward, as we could take the closest herd size - 1 cattle - as a guide, and assume, for example, that

$$\Pr(\text{herd size 10 years ahead} \geq 30 \mid \text{match has no cattle, loan of 1 cattle}) = \Pr(\text{herd size10 years ahead} \geq 30 \mid \text{match has 1 cattle}) = 0$$

The downside of such choice is that we wouldn't be able to clearly interpret our estimates, as they could just as well be reflecting this additional assumption. For that reason, we exclude from the estimation those observations for which the match has no cattle.

all other variables), taking into consideration the differences between those who suffered a loss and those who did not.

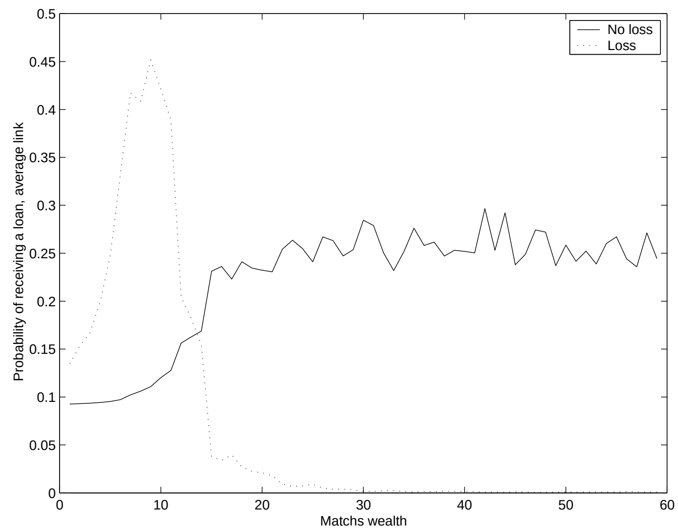

Figure 3: Probability of establishing a credit link: the effect of match's wealth

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 in this economy is in the neighborhood of 12–16 animals. This suggests that credit, in practice, insures that recipients will be wealthy enough to remain mobile herders, able to grow toward the higher herd size equilibrium, rather than insuring all losses, regardless of the beneficiaries' wealth. 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 to have evolved to provide a safety net against collapse into the poverty equilibrium, but not an insurance mechanism.

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 herd sizes are significantly less likely to receive a loan if they have not suffered a loss.

Note 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 an informal lending relationship between the two individuals. Of course, the average link is an abstraction, but alternatives that add more detail (by considering what happens when both parties in this contract are from the same clan, for example) will only shift the probability of establishing a link up or down, without really changing the fundamental message of our results: 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, configuring a safety net and not an insurance mechanism.

3.4 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 earlier. We already addressed the concerns of Hoff (1997) and Murgai et al. (2002) in Table 3. In Table 4 we include, as additional controls, the correlation between asset levels of our respondents and their random matches in the nine quarterly 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.

The inclusion of these additional controls does not change our results

Table 4: Logit estimates of loan giving patterns: the effect of correlation in wealth dynamics

Variable	Coefficient	QAP p-value
L_j=0 × EW_j	0.021	0.000
L_j=0 × EG_j	-0.264	0.375
L_j=1 × EW_j	-0.153	0.035
L_j=1 × EG_j	2.038	0.070
Respondent's wealth	0.029	0.255
Negative correlation in wealth	1.481	0.185
Positive correlation in wealth	0.042	0.040
Pseudo–R^2	0.289	

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

in any important way. Informal lending appears concentrated around the unstable wealth equilibrium in response to asset shocks, serving as a safety net against collapse into a poverty equilibrium. Somewhat unexpected is the fact that past positive correlation in wealth increases the probability of giving a loan to the respondent – perhaps reflecting more similar livelihoods and the possibility of closer monitoring of the respondents.

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 credit network (Table 5): just as before, we find that expected gains from a transfer post-shock appear to drive informal lending.

Table 5: Logit estimates of loan giving patterns: the effect of ex ante credit networks

Variable	Coefficient	QAP p-value
L_j=0 × EW_j	0.019	0.000
L_j=0 × EG_j	-0.233	0.340
L_j=1 × EW_j	-0.180	0.030
L_j=1 × EG_j	2.100	0.030
Respondent's wealth	0.014	0.240
Number of brothers	-0.183	0.485
Number of brothers squared	0.031	0.365
Pseudo–R^2	0.292	

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 (2008a) claim, multiple dynamic equilibria arise in this setting because of asset shocks, then protection against asset shocks is critical to maintaining a viable livelihood. Yet if the asset poor cannot get transfers, either as gifts or loans, 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.

We use the same logit estimation approach from equation 4 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, variables that characterize herd size transitions between 2000 and 2003, also described in table 2) 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 6.

Table 6: Logit estimates of social acquaintance networks

Variable	Coefficient	QAP p-value
Match is destitute (i.e. has no cattle) since 2000	-1.106	0.070
Match has less than 5 cattle since 2000	-0.145	0.391
Match has between 5 and 14 cattle since 2000	-0.127	0.379
Match has between 15 and 39 cattle since 2000	-0.581	0.485
Match has more than 39 cattle since 2000	-1.297	0.284
Match lost cattle since 2000	0.203	0.356
Respondent has more cattle than match	-0.014	0.096
Respondent has less cattle than match	0.040	0.043
Distance	-0.007	0.201
Same clan	0.743	0.033
Both male	0.684	0.118
Respondent is male, match is female	0.177	0.359
Respondent is female, match is male	0.618	0.121
Respondent is older than match	-0.026	0.005
Respondent is younger than match	-0.000	0.515
Respondent has more land than match	0.143	0.193
Respondent has less land than match	0.482	0.013
Respondent has a bigger family than match	0.042	0.264
Respondent has a smaller family than match	-0.097	0.111
Pseudo–R^2	0.2264	

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. The comparison category is "Match gained cattle since 2000".

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 informal 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. [18]

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 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

[18] Vanderpluye-Orgle and Barrett (2009) find very similar patterns of exclsuion from informal social insurance among socially invisible persons in Ghana.

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 not 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 use all the relevant variables to eliminate two–way unobserved heterogeneity, 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 – and thus to the lender – from the loan are relatively high, as compared to loans to poorer or richer prospective borrowers.

This effect of credit rationing that leaves out poorer members of the community is compounded by the fact that the poorest are less socially visible than their somewhat wealthier neighbors. Because being known is, in this context, a necessary condition for receiving transfers, the greater social invisibility of the destitute compounds their rational exclusion from informal 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 in this economy have profound implications for public policies to address problems of persistent poverty and asset loss in a setting characterized by poverty traps. Because informal loans can have, literally, life or death consequences in contexts such as the rangelands of southern Ethiopia, one must be cautious about deriving strong conclusions about optimal redistributive policies simply from our econometric results (Cohen-Cole, Durlauf, and Rondina, 2005). Our results nonetheless 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 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 gain from loans.

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