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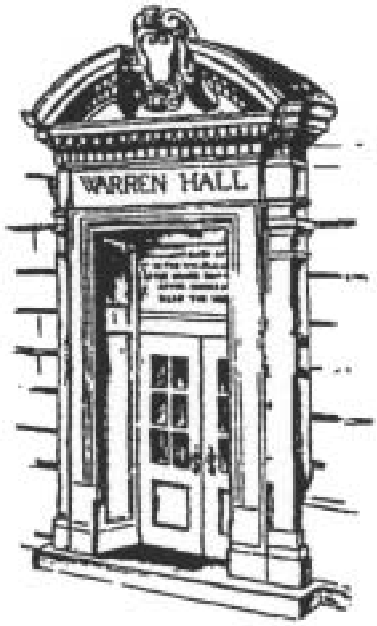

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Department of Applied Economics and Management
Cornell University, Ithaca, New York 14853-7801 USA

Educational Investments in a Spatially Varied Economy

Andrew G. Mude, Christopher B. Barrett,
John G. McPeak and Cheryl R. Doss

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First complete draft. Comments greatly welcomed.

Abstract:

This paper presents a simple two-period, dual economy model in which migration options may affect the informal financing of educational investments. When credit contracts are universally available and perfectly enforceable, spatially varied returns to human capital have no effect on educational investment patterns. But when financial markets are incomplete and informal mechanisms subject to imperfect contract enforcement must fill the breach, spatial inequality in infrastructure or other attributes that affect the returns to education create spatial differentiation in educational lending and consequently, in educational attainment. Although migration options can increase the returns to education, they can also choke off the informal finance on which poorer rural households depend for long-term, lumpy investments like children's education.

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1. Introduction

The positive relationship between education stock and expected future income is well established. The relevant literature provides extensive evidence of high expected relative returns to investment in education throughout the world (Schultz 1988, Strauss et al. 1995, Barro and Sala-i-Martin 1995, Psacharopoulos 1985). Yet, despite clear evidence of strong returns to education, many communities exhibit low rates of educational attainment, especially in rural areas of the developing world. Apparent underinvestment in children's education is commonly attributed to financial market failures that ration poorer households out of the formal market for the long-term credit needed to finance education. In particular, the long-term nature of the loans makes them excessively risky to banks and governments in the developing world typically cannot afford to heavily subsidize education beyond primary level.[1] As Loury (1981) showed, when formal financial markets fail, the logical consequence is not only underinvestment in education but also, derivatively, the propagation of poverty from one generation to the next. Credit market failures, coupled with costly education, limit the poor’s ability to purchase optimal levels of education. The relationship between education and income is thus reversed, generating a perpetual poverty trap whereby the poor attain low levels of education due to financial constraints and consequently can expect meager future earnings due to educational deficiencies.

Why, however, don't informal financial markets spring up to fill the educational financing gap when formal markets fail? Through a complex mix of credit, insurance and gifts, transfers commonly flow between households so as to provide credit and insurance not available through formal financial institutions (Udry 1993, Townsend 1994, Besley 1995, Morduch 1995). Given the high apparent returns to education and widespread anecdotal evidence of informal financing of others' education, one naturally wonders why informal financial transactions do not resolve the educational investment problem in rural areas of developing countries.

This paper offers an answer to that puzzle. We show that in the presence of financial market imperfections associated with imperfect credit contract enforcement, spatial variation in the returns to education can induce migration decisions that rationally choke off the informal financing of education in relatively disadvantaged areas. When financial markets are complete and perfect, spatially varied returns to human capital have no effect on educational investment patterns, which are then Pareto optimal. But when formal financial markets are incomplete and credit contracts must be self-enforcing, spatial inequality in infrastructure and other attributes that increase the returns to education create spatial differentials in educational lending and, consequently, greater geographic and wealth-based variation in educational attainment than would otherwise occur.

The important innovation of this paper is to link the literature on investment in children's education with those on informal finance and migration. The extensive literature on migration emphasizes how spatially varied infrastructure, law enforcement, access to lucrative markets and other attributes creates a gradient across space in real returns to education (Banerjee et al. 1998, Stark 1984, Todaro 1997, Williamson 1988). Migration to areas with greater community endowments is an especially attractive option for educated persons living in relatively disadvantaged rural areas with few opportunities for skilled employment. One of the most consistent findings in this literature is of the positive relationship between educational attainment and rural-urban migration (Todaro, 1997). In a study of migration behavior in Tanzania, Barnum and Sabot (1975) showed that the average educational level of the rural-urban migrant stream varied inversely with the employment opportunities and attributed this to a job market that favored the better educated.

On the other hand, the literature on informal finance identifies the close tight-knit associations of traditional communities as the 'social capital' that allows for the provision of financial services in informal settings (Stiglitz 1991, Besley et al. 1993). Lenders can access relatively cheap information on potential borrowers due to highly personalized intra-community relationships. They can also assure repayment by the credible threat of social sanctions: a borrower who neglects his loan commitment will signal dishonesty, thereby eroding his stock of social capital within the community.

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[1] While governments often subsidize university level education, the number of students obtaining this subsidized higher education, due to space and funding constraints, is much lower than the number of

Contract enforcement, however, becomes more difficult the farther the contracting parties are from each other. Tracking down debtors becomes costly and as their interaction with the community is diminished, the threat of social sanctions loses some of its power. Prospective rural lenders would thus take borrowers' migration options into account when deciding whether to extend an educational loan and, if so, for how much and to whom. Put differently, informal financial market equilibria depend on migration incentives. As a consequence, as the spatial differential in the returns to human capital grows, it may choke off informal financing of education in rural areas as lenders increasingly expect borrowers to migrate, making them greater risks for default.

With perfect financial markets – meaning that all people have access to credit at a unique, exogenously determined interest rate and that all credit contracts are perfectly, exogenously enforceable – all children would be educated to the optimal level conditional on their natural ability. By contrast, in a spatially varied economy characterized by weak or missing rural financial markets, only sufficiently wealthy children attain their optimal level of education. Rural children dependent on informal finance for education are constrained to relatively low returns to human capital and are thus less likely to migrate. While wealth constraints might affect attainment of optimal levels, exceptionally high ability children may be able to increase their expected returns to human capital by migrating to urban centers. The consequence of such a situation would be rural poverty traps alongside urban economic mobility through education.

In this paper, we outline a theoretical model that provides one explanation for apparent underinvestment in education in rural areas. Practically, without a complete picture of the preferences, choices and constraints faced by households deciding how much to invest in education, it is difficult to ascertain that relatively low rates of educational attainment are in fact sub-optimal. This is especially the case in rural subsistence economies with imperfect labor markets where the expected returns to education may not be sufficiently high – or the risk inherent to educational investment (e.g. of ex post unemployment among graduates) too great – and households may therefore rationally opt to have children work on family land tending crops, rearing livestock, etc. However, with the option to migrate to areas where returns to skilled labor

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students who are qualified. Thus, there is not universal subsidized higher education.

are high, education has increasingly come to be regarded as a crucial human capital investment even in the most remote of communities.

For example, in our recent surveys of six communities in the sparsely populated, largely traditional semi-arid to arid lands of northern Kenya, an overwhelming majority of respondents strongly agreed with the statement: "The benefits of education are greater than the costs people have paid for education." Moreover, of 16 different options, education was ranked only after human health, water, and livestock health in terms of development priorities for generating improved livelihoods among these pastoralists in an area where formal sector employment is exceedingly rare. Nevertheless, notwithstanding the apparent importance attached to education, in 2000 57% of those aged 15-24 had not completed a single year of schooling. Despite this, contributions by other households in the form of informal loans, was insignificant. While the existing data do not allow us to determine the empirical relationship between household contributions, or informal transfers in general, and the rate of migration, this paper provides a theoretical model that shows how informal financing can unravel due to migration options, leaving most poor children under-educated in infrastructure-deficient regions.

The rest of the paper is structured as follows: Section 2 builds the general structure of a simple two-period, dual economy model that parsimoniously captures the essence of the problem. In section 3, we explore the implications of the model for patterns of educational investment and migration. Section 4 examines the inefficiencies resulting from credit conditions that deviate from the first best world and Section 5 discusses the policy implications of our findings and concludes.

2. The Model

Consider a two period dual economy setting. In period one, the adult household head makes educational investment decisions in the children in the community (no one invests in children outside their own community). Then, in period two, the (now grown) children make residential/work decisions conditional on the human capital they accumulated in period one. The economy consists of two locations: A rural area with weak productive infrastructure that represents a more traditional mode of production and an urban area which represents settings enjoying better communications, power, transport and public services that underpin modern industrial and service economies. As such, returns to education are higher in the urban area. We treat the differences in productive infrastructure across locations as exogenous and assume that human capital productivity is increasing in infrastructure. This spatial variation in the returns to education generates incentives to migrate[2] and geographic variation in private education investment, especially in the absence of perfect credit contract enforcement.

Assume there are $j = 1,..., N$ households in the rural village, each with one adult decision maker and one child. Each adult decision maker is endowed with wealth w_i and each child with a random assignment of some innate ability α_j, where $\alpha \in [0,1]$. Given knowledge of the distribution of abilities across all children in the village, in period one the adults choose (non-cooperatively) how to split their wealth between educating their own children, investing in the education of other children in the village at a given net interest rate *r*, or holding it in the form of a composite, alternative asset that pays no interest or dividends and suffers no depreciation.[3] At the outset of period two, each now-adult child makes a decision as to where to live and work.

As we are mainly concerned with demonstrating how migration induced by spatial differences in the returns to education leads to rural underinvestment in education by crippling informal finance mechanisms, we make some strong assumptions. Following Banerjee and Newman (1998), we assume that once an individual migrates, they free themselves of their obligations to non-kin in their original, rural community. Our model nonetheless allows for urban-to-rural remittances to family, which Stark (1991) and others have shown to be commonplace. This assumed kin-nonkin distinction derives from an observed, qualitative difference between taking advantage of distance and relative anonymity to default on informal loans provided by non-kin community members and the breaking of ties or responsibility to family. In a comprehensive survey of the relevant literature, Remple and Lobdell (1978) find that a substantial majority of urban remittances go to the household of the migrant with village elders being the only

[2] We focus on the rural economy and use the urban area only as a magnet for migrant laborers from the village. In our framework, it would never be rational for an urban dweller to migrate to the rural area, given the decreased return on their human capital that will result.
[3] This composite alternative asset obviously serves just as a benchmark against which educational investments are measured.

non-kin that receive a significant share of remittances. We incorporate this distinction into our model by allowing households to derive material or non-material (i.e., altruistic) benefits from their child's income regardless of whether the child migrates.

An emigrant might also have purely selfish motivations that would assure that they pay back their loans. For example, should an emigrant ever want to move back to his rural home, invest in assets there, or even secure his inheritance, ties to the community may continue to be valuable (Lucas and Stark, 1985). This might become important when, despite higher expected incomes, urban areas have high rates of unemployment. Individuals might then migrate in the hope of securing a sufficiently lucrative occupation but with the knowledge that because competition is tight, they might fail and choose to return home. While our model does not explicitly allow for this option, one can imagine that in the aggregate, such a phenomenon would merely affect the relative returns to human capital between the rural and urban sector, making the urban sector relatively less productive. Our model specifies a parameter that allows us to capture this effect. It is important to note, however, that of the given reasons for remittances driven by migrant self-interest only returning to reside in the rural area would positively affect non-kin. Migrants interested in securing some inheritance or looking to find trustworthy individuals to coordinate and take care of their investment purchases while remaining in the city need only remit to their close family in order to satisfy their needs. Our model accommodates intra-family remittances.

One way non-family community members can assure returns to their investment is by tracking down emigrants in urban areas and demanding repayment or reciprocity, such as using their home as a base for developing their own ties in the urban area. While emigrants might default on their loan commitment, it is more difficult for them to completely escape traditional norms that call for hospitality and the provision of food and shelter to natal community members who request it. In this way, emigrants can act as 'beachheads' for the rural community, establishing a foundation that facilitates greater rural-urban interaction. By utilizing emigrants for this purpose, community lenders can recoup some of their otherwise lost investment.

But while lenders can tap into the benefits emigrants provide to recover part of their loans, the 'beachhead' effect alone does not alter a potential lender's loan decision *ex ante* because community norms generally require the emigrant to oblige *any* natal community member who requires assistance in the city, not just those who have extended him credit in the past. So long as emigrants cannot exclude any community members from assistance, then each potential lender in the rural community has an incentive to free ride on the 'beachhead' opportunity sponsored by some other lender due to the non-exclusivity of the service being offered. In the interests of simplicity, we therefore assume away beachhead effects in our model, as they do not affect the qualitative results.

We move on to formalize the model. We follow the standard solution technique of backward recursion, solving the child's period two migration decision first, then solving the adults' first period educational investment decision conditional on the child's subsequent best response.

2.1 The Child's Problem

Let E_{ji} denote the educational attainment of child *j* resulting from an investment by household *i*. Then let $h_j = (\sum_{i=1}^{N} E_{ji})\alpha_j$ be the level of human capital of child *j*, where $\sum_{i=1}^{N} E_{ji}$ represents the total level of education attained by child *j* by summing up the contribution of all households in the community to his education. Thus we allow for a child to have any portion of his education financed by other households. The labor productivity of a child with human capital h_j is then given by the strictly concave function $\rho(h_j)$. An individual whose productivity is $\rho(h)$ in the village has an increased productivity level $\lambda\rho(h)$ in the city, where $\lambda > 1$ and reflects the relative urban/rural infrastructure ratio X_u / X_r where X_u represents the level of urban infrastructure and X_r represents the level of rural infrastructure.

In the event that their parent's wealth is insufficient to cover their optimal level of education, children may have to seek educational loans in period one from other households. In the absence of credit markets with perfect, exogenous contract enforcement, children can renege on these loans in period two. For the sake of simplicity in the model, we assume that the child tries to renege on any loans received from other households if and only if he migrates to the city. This can provoke retribution, however, which we model as full punishment from the village which serves to hold his productive capacity to 0.[4] We denote as $1-\pi$ the probability of catching a reneging child. Educated children will rationally migrate and renege on their educational loan contracts when there is significant spatial variation in the returns to education λ, the costs of migration *c* are low and enforcement of loan contracts is weak (i.e, π is high).

Suppose a child with human capital h_j stays in the village. His net earnings will then be $\rho(h_j)$ - $(1+r)P_E\sum_{i\neq j}^{N}E_{ji}$ where r is the net interest rate and P_E is the cost of a unit of education.[5] Should the child decide to migrate, his expected gross earnings will be $\pi\lambda\rho(h_i)$ and he incurs a migration cost, *c*. The migration cost *c* incorporates both the financial costs of relocation as well as the social costs that result from a loss of social relationships that may be intrinsic as well as instrumentally important. The child's second period choice is thus quite simple:

$$\text{Max}\ (\ \rho(h_j)-(1+r)P_E\sum_{i\neq j}^{N}E_{ji}\ ,\ \pi\lambda\rho(h_i)\ \text{- c}) \qquad (1)$$

Adults make educational investments in children fully knowing this calculus of migration in which children will subsequently engage.

2.2 Adult's Problem.

All the adults in the village can observe each child's innate ability by the time they need to make educational investments.[6] In deciding how to allocate resources between educating their child and investing in the education of other children, an adult considers

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[4] Note that such a specification can still cater to a situation in which a migrant cannot fully renege on his loan commitment simply by leaving the rural area. This can be conceived as a reduction in π which would in effect capture the fact that the individual will still have pressure to support the community in some way resulting in a reduced amount of his earnings that are of personal benefit. In such a case, migration would be merely damage limiting as migrants can be tracked down by relatives, or other loan providers thereby forcing migrants to in some way contribute to community demands.

[5] A child does not have to explicitly repay education financed by his parents. This allows for an adult's decisions on their children's education to involve additional considerations beyond merely material investment returns.

[6] In the northern Kenya setting we have in mind, primary education is free, so educational investments begin at secondary level, making this a tenable assumption. Primary education is often free or subsidized in most countries.

the returns to each investment option, taking into consideration the possibility that children leave the area and subsequently renege on their loan contracts.

Let $E_j \equiv [E_{1j},...E_{Nj}]$ be the vector of educational units provided to each child $i = [1,...,N]$ by household j, and $E^j \equiv [E_{j1},...E_{jN}]$ be the vector of all educational units received by child *j* from each household $i = [1,...,N]$. Note that the first subscript indexes the child and the second the household. The adult household head's first period decision problem can be then be characterized by

$$\underset{E_j}{Max}\ w_j - \sum_{i=1}^{N} E_{ij} P_E + \delta(1+r)P_E \sum_{i \neq j}^{N} E_{ij} + \delta\beta Y_j \qquad \delta, \beta \in (0,1) \quad (2)$$

$$\text{s.t.} \qquad Y_j = \text{Max}\ (\ \rho(h_j) - (1+r)P_E \sum_{j \neq i}^{N} E_{ij}\ ,\ \lambda\rho(h_i) - c)$$

$$E_{ij}[\rho(h_i) - (1+r)P_E(E_i - E_{ii}) - \pi\lambda\rho(h_i)\,] \geq 0 \quad \forall i \neq j \qquad (3)$$

where δ is a discount factor reflecting current valuation of lagged repayments and of the child's future income. Note that a household's expenditure on the education of its own child indirectly affects its well being via the function $\delta\beta Y$; The household's utility increases in its child's future productivity. The function $\delta\beta Y$ flexibly accounts for parental investments in their children's education due to any combination of material and nonmaterial (e.g., altruistic, status) purposes. Consequently, investment in the education of one's own child is more broadly characterized as driven by some non-negative (altruistic or materialistic) relationship between the child's future productivity and the household's utility. $\beta < 1$ assures that parents do not receive more pleasure than their children from a certain amount of child's income, and varying β changes the valuation households have for their children's future earnings.

The patterns of optimal investment that result are intuitive. Households will continue to invest in their own child as long as the increase in their well being resulting from a marginal gain in their child's productivity exceeds the opportunity cost of investing in another child from the community. An adult will only invest in a child from another household within the community if that child will repay his loan. This creates an incentive compatibility constraint (ICC), reflected in equation (3), such that all children receiving educational loans will be educated only to the point that they have an incentive to migrate to the city and subsequently default on the loan. As we will show, the incentive compatible level of education depends fundamentally on the spatial variation in returns to education, λ, the cost of migration, c, and the enforcement of loan contracts, as reflected in the probability that one can successfully renege on contracts by moving, π. The ICC for the optimization problem reflects the fact that if household j does not provide any funding for the education of child $i \neq j$, then it is indifferent to child j's decision to migrate. Wealthy households may want their own children to migrate after they are educated, but if they have invested in others' children's education, they will not want those children to leave.

3 Analysis

We now analyze the factors that affect the educational outcomes of the children and the education expenditure and investment decisions taken by the adults. Specifically, we investigate how various educational financing schemes affect the optimal education levels in a dual economy setting and how rural educational investments vary in response to changes in the model's parameters.

To establish a basis for comparison, we first analyze the case in which children only receive educational funding from their own parents and characterize the conditions for migration and the optimal levels of education in each sector. We then allow children to receive informal loans from other households. We show that the presence of an informal credit market weakly increases the educational attainment of all children. Finally, we consider the case of a first-best world, where children can borrow on their future productivity from a formal credit market to finance their education. We make comparisons to show how informal credit markets can break down in the presence of migratory pressures and lead to underinvestment in education.

3.1 Household Funded Education

In this first scenario, children's education can only be funded by their household.

3.1.1 The Child's Decision

We begin by studying the child's problem. Suppose that a child j receives all of his education from his own household j. Then, from (1) we know that he will migrate if his total level of human capital h_j implies

$$\lambda\rho(h_j) - \rho(h_j) \geq c \qquad (4)$$

Let $\bar{h}$ denote the level of h_j that solves equation (4) with equality. We call this the threshold level of human capital necessary to migrate. Any child with a human capital level greater than the threshold would rationally migrate to the urban sector. Furthermore, since $h = E\alpha$, the threshold level of education needed to induce migration $\bar{E}(\alpha) = \bar{h}$, is decreasing in natural ability.

$$\partial(\bar{E}(\alpha)/\partial(a) < 0 \qquad (5)$$

Condition (5) tells us that, for a given level of c and λ, as one's level of innate ability increases, the threshold level of education decreases. Thus, everything else equal, high potential individuals are more likely to attain the threshold level and migrate. This is consistent with the brain drain literature that attempts to explain why highly skilled individuals are more likely to migrate to areas with higher expected returns than their less skilled counterparts.

It is also true that

$$\partial(\bar{h})/\partial(\lambda) < 0 \qquad (6)$$

and

$$\partial(\bar{h})/\partial(c) > 0 \qquad (7)$$

Condition (6) says that as the urban/rural infrastructure ratio increases, the human capital threshold level decreases and more people are likely to migrate. Indeed, both within and across nations, we witness migration patterns that are overwhelmingly toward higher productivity regions. Since, as we show, this leads to an unraveling of informal credit for education in remote areas, spatial infrastructure differences can lead to educational poverty traps, as demonstrated by Loury (1981). Condition (7) simply indicates that as the cost to migration increases, so does the human capital level required to migrate. This wedge creates some modest, but bounded, spatial differences in incentives to invest in education.

3.1.2 Household Head's Decision

We now analyze the adult or household head's problem. We first characterize the conditions under which an adult will spend all of her wealth on the education of her own child. This will be the case when her wealth endowment is insufficient to cover the costs of the educational level that equates the marginal utility of expenditure on own child to the opportunity cost of investment, $\delta(1+r)P_E$.

Recalling that, for the moment, we only permit the parent to pay for her child's education, suppose child *j* migrates. Then, it must be the case that

$$P_E \overline{E}_j \leq w_j \leq P_E E_{jj} \text{ for } E_{jj} \geq \overline{E}_j \qquad (8)$$

$$\text{and } -P_E + \delta\beta\lambda\rho'(\alpha_j E_{jj})\alpha_j \geq \delta(1+r)P_E \qquad (9)$$

That is, that the adult household head must at least have the level of wealth needed to educate her child such that, given his innate ability, his human capital is above the threshold level and, that for some level of education E_{jj} above the threshold, the marginal benefit accruing to the household is larger than the opportunity cost. Let $\overline{w}_j = P_E \overline{E}_j$ denote the level of wealth a household requires to be able to provide its child with the threshold level of education. In addition, let $\hat{E}_j$ be such that (9) holds with equality. $\hat{E}_j$ represents the optimal level of education that a household *j* faced with an opportunity cost of $\delta(1+r)P_E$ would provide to its child conditional on the child migrating. It follows that

Proposition 1 *An adult j whose wealth satisfies* $\overline{w}_j < w_j \leq P_E \hat{E}_j$ *will exhaust all of her wealth on her child. The child will receive* $E^*_{jj} = w_j / P_E$ *units of education and migrate. If on the other hand* $w_j > P_E \hat{E}_j > \overline{w}_j$ *then child j will receive* $\hat{E}_j$ *units of education and his household will be a net investing household supplying* $w_j - P_E \hat{E}_j$*.*

Proposition 1 specified the educational outcomes only for children who migrate. We now look at the case of a child who will not migrate. We know that where $w_j \leq \overline{w}_j$ the child *j* will not migrate. In such a situation, the adult head will continue to spend on her child so long as E_{jj} satisfies

$$-P_E + \delta\beta\rho'(\alpha_j E_{jj})\alpha_j \geq \delta(1+r)P_E \quad \text{where} \quad E_{jj} < \overline{E}_j \qquad (10)$$

This condition assures that at the level of education that exhausts the household's wealth, the marginal benefit to the household from an increase in the child's education in the rural area is greater than the opportunity cost of investing in the children of other households. Let $\widetilde{E}_j$ solve (10) with equality. $\widetilde{E}_j$ represents the optimal level of education that a household *j* faced with an opportunity cost of $\delta(1+r)P_E$ would provide to its child given that the child will not attain the level of education needed to migrate (that is $w_j \leq \overline{w}_j$). We therefore have that:

Proposition 2 *An adult j whose wealth satisfies* $w_j \leq \overline{w}_j$ *and* $w_j \leq P_E\widetilde{E}_j$ *will exhaust all of her wealth on her child. The child will receive* $E^*_{jj} = w_j / P_E$ *units of education and stay in the rural area. If on the other hand* $P_E\widetilde{E}_j \leq w_j < \overline{w}_j$*, then child j will receive* $\widetilde{E}_j$ *units of education and his household will be a net investing household supplying* $w_j - P_E\widetilde{E}_j$.

It is now a simple task to classify the set of all children who will migrate in an environment where a child could only look to his household to finance his education. Given the set of all community-specific parameters λ and *c*, whether a child migrates or not depends entirely on his innate ability and the level of his household's wealth. Intra-community variation in migration and education patterns thus arise due to cross-sectional variation in initial endowments. Recognize that due to the strict concavity of $\rho(.)$ the LHS of equation (10) is decreasing in E. Then, since from equation (5) we know that the threshold level of education, $\overline{E}$, is decreasing in α , then it must be that at low levels of innate ability α , $\overline{E}$ gets larger than the optimal level of household provided education in the urban area $\hat{E}$. Let α^M be such that for all children *j* that satisfy $\alpha_j \leq \alpha^M$, $\hat{E}_j \leq \overline{E}_j$ or similarly, that $\overline{E}(a^M) = \hat{E}_j$. Therefore, all children *j* with $\alpha_j \leq \alpha^M$ will never migrate despite the wealth of their household. This follows since beyond the level needed to make migration worthwhile for the child, the marginal utility of expenditure on own child's education to the household is less than the opportunity cost of not investing in another child. It follows that:

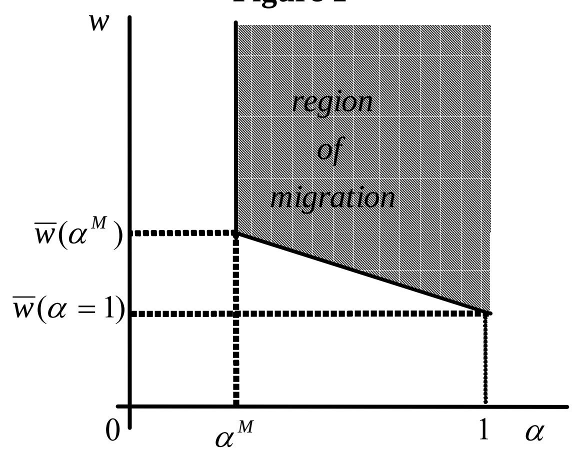
Proposition 3 *All children j such that* $\alpha_j > \alpha^M$ *and* $w_j > \overline{w}_j$ *will migrate.*

Equation (5) shows that children with higher innate abilities need less education to make the threshold level of human capital $\overline{h}$. This implies that the more innately intelligent a child is, the lower will be the minimum wealth his household requires to provide him with his threshold level of education. That is

$$\partial(\overline{w})/\partial(\alpha) < 0 \qquad (11)$$

Figure 1 graphs the combination of innate abilities and wealth levels that jointly determine a child's locational choice in the second period, conditional on λ and c.

Figure 1



To facilitate analysis, denote as $M(\alpha, w) = \{0,1\}$ a function that operates on a particular combination of α and w and returns a zero if a child with such a combination would not migrate, and a one otherwise. Clearly, $\forall \alpha \geq \alpha^M$ and $w \geq \overline{w}$, $M(\alpha, w) = 1$. The function

$$G = \sum_{i=1}^{N} M(\alpha_i, w_i)/N \qquad (12)$$

denotes the fraction of the children that will migrate. We now ask how changes in the parameters affect G.

3.1.3 Determinants of migration rate

Suppose the urban sector underwent a period of heavy investment in its infrastructure, resulting in a relative increase in urban labor productivity. Consequently, the threshold level of $\overline{h}$ drops and therefore, for any given α , so does $\overline{E}$ and $\overline{w}$. Moreover, note that the LHS of equation (9) is both increasing in λ and decreasing in h (or $E\alpha$). This has a mutually reinforcing effect on α^M . An increase in λ , increases the marginal benefit accruing from each level of human capital thus resulting in higher $\hat{E}$ for all levels of α . Since $\overline{E}(\alpha^M) = \hat{E}$, a decrease in $\overline{h}$ and an increase in $\hat{E}$ implies a decrease in α^M . To summarize, we have that

$$\partial(\overline{w})/\partial(\lambda) < 0 \qquad (13) \qquad \text{and} \qquad \partial(\alpha^M)/\partial(\lambda) < 0 \qquad (14)$$

Furthermore, note that as the threshold wealth $\overline{w}$ decreases, and/or the threshold level of innate ability α^M falls, it is likely that more households now have wealth greater than $\overline{w}$ and more children have innate ability greater than α^M . That is, that the probability that $M(\alpha_j, w_j) = 1$ for any given *j* is weakly increasing as $\overline{w}$ and/or α^M decreases. This, along with equations (13) and (14) imply the following:

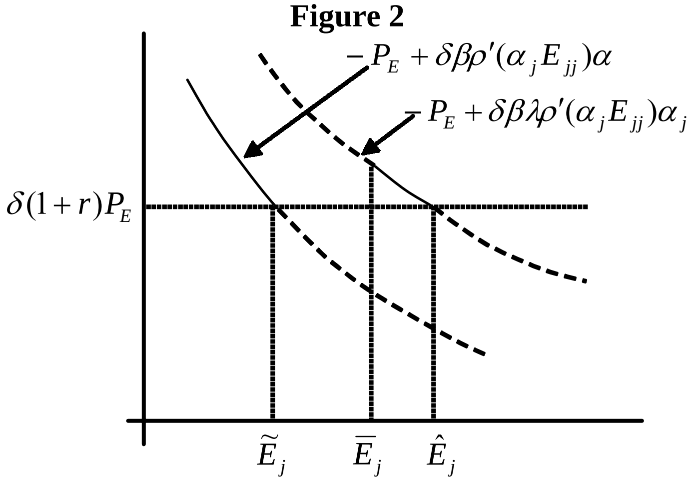
Proposition 4 *As the urban infrastructure increases relative to the rural* λ *, the rate of migration G weakly increases. That is,* $\partial(G)/\partial(\lambda) \geq 0$.

An increase in the cost of migration c will also affect the rate of migration. From equation (7) we know that an increase in *c* will increase the threshold level of human capital $\overline{h}$. This results in an increase of $\overline{E}$ and thus $\overline{w}$ for each α . In addition, since *c* does not appear on the LHS of equation (9), (and thus does not affect $\hat{E}$), then $\overline{E}(\alpha^M) = \hat{E}$ implies that α^M increases. A similar argument to the above confirms that an increase in $\overline{w}$ and/or α^M weakly decreases the probability that $M(\alpha_j, w_j) = 0$ for any *j*. This leads to a fairly intuitive result.

Proposition 5 *As the cost to migration c increases, the rate of migration G weakly decreases. That is,* $\partial(G)/\partial(c) \leq 0$.

While we have shown how the rate of migration is affected by various parameters, we are primarily interested in how the educational attainment of each child is affected by the spatially varying returns to human capital. We now analyze the differences between $\tilde{E}$ and $\hat{E}$, and show how they impact the educational attainment of each child. From the strict concavity of $\rho(.)$ it is clear that the LHS of both (9) and (10) are decreasing in E. This is a consequence of the decreasing marginal productivity of education in both the rural and urban sectors. However, due to increased productivity in the urban area, marginal productivity of education is higher at each education level than in the rural area[7]. Therefore it will always be the case that $\tilde{E} < \hat{E}$. Figure 2 plots the marginal productivity of education against opportunity cost for a given α.

Figure 2



The solid portions of the curves depict possible equilibrium educational attainment while the dashed portions are non-equilibrium values. Note that after $\bar{E}$, the child migrates and receives the added benefits that come with increased urban productivity. In the depicted scenario $\delta(1+r)P_E$ and α are such that $\tilde{E} < \bar{E} < \hat{E}$[8]. In this case, should the child live in a household where $w > \bar{w}$, he will migrate. If not however, the maximum education a child can hope to attain is $\tilde{E}$. The implication is that living in a household with insufficient wealth can result in a huge and discontinuous reduction in the optimal education that a child receives. The extent of this disparity

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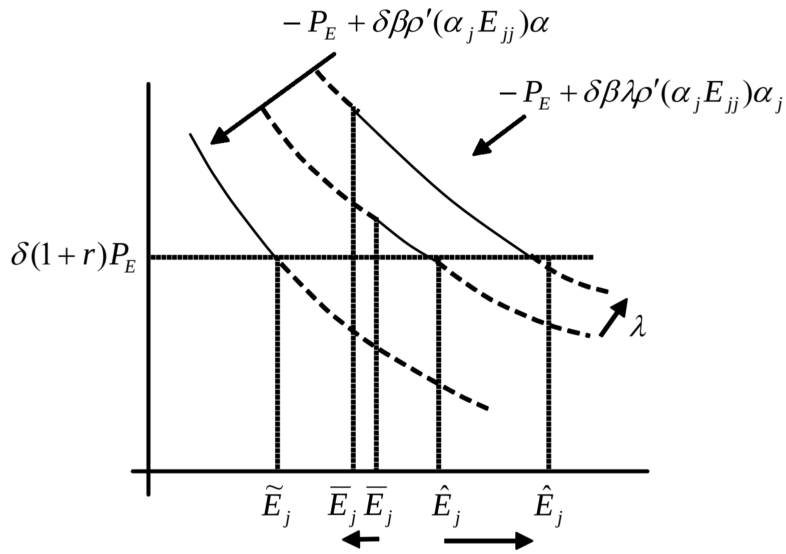
[7] More formally, $\delta\beta\lambda\rho'(\alpha_j E_{jj})\alpha_j > \delta\beta\rho'(\alpha_j E_{jj})\alpha_j \ \forall \text{E} > 0$ where $\lambda > 1$

clearly depends on the gap between $\widetilde{E}$ and $\hat{E}$, and their distance from $\overline{E}$.

As we have previously shown, an increase in λ here will have the dual effect of decreasing $\overline{E}$ for any given α and increasing the optimal level of household financed education in the urban area, $\hat{E}$. Figure 3 diagrams this case.

Figure 3



Because $\widetilde{E}$ remains unchanged ($\widetilde{E}$ is independent of λ) but $\hat{E}$ increases, the rural-urban education gap widens. Though more people may migrate (due to decreased $\overline{E}$), those who are unable to migrate fall further back relative to their better endowed neighbors. To summarize:

Proposition 6 *As* λ ¸ *increases, the differences between rural and urban optimal household sponsored education (for any given level of* α *) increases.*
That is, $\partial(\hat{E} - \widetilde{E})/\partial(\lambda) > 0$.

This coincides with the well known phenomenon that as urban centers in developing nations develop at a faster pace than their rural counterparts, the socio-economic disparity between urban elites and rural elites grows. Proposition 6 describes this social polarization in terms of increasing optimal levels of education in urban areas. Nevertheless, it is important to keep in mind that only the optimal level of education in

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[8] Note that α^M is such that for all $\alpha \le \alpha^M$, $\widetilde{E} < \hat{E} < \overline{E}$. Put differently, this case does not apply to

the urban area increases. This does not mean that all, or even most of the urban dwellers achieve this level of education. Indeed equations (13) and (14), along with Proposition 4 argue that increased relative productivity in the urban area increases the rate of migration by loosening the lower boundaries on the ability and wealth constraints. This means that the urban area begins to attract more skill-poor individuals as well as individuals coming from low wealth households. It is therefore safe to conjecture that such a dynamic not only increases the urban-rural polarization but also results in increasing urban inequalities as well although we leave that topic for future extensions of the model.

Thus far we have restricted our attention to the case in which a child's education is financed solely by its own household. While this is interesting in its own right, we are most interested in understanding the relationship between spatial variation in the returns to human capital and the in financing of educational investments. We now move on to analyze a household's decision to invest in other children.

3.2 Informal Credit Market

We now characterize the conditions under which a household will supply educational loans for investment purposes and a child will demand such loans. We assume that the return on investment is independent of the child so long as the child remains in the village. The investor is assured of $(1+r)$ from non-migrants. The child is similarly indifferent as to who in the community provides the loans. These assumptions allow us to focus on a representative household whose adult can supply investment loans to a community fund and whose child can apply for educational loans from the same fund. To this end, let $E^{-j} = \sum_{i \neq j} E_{ji}$ denote the sum total of educational loans that child *j* receives from the community. Recall from the ICC that for a community household to invest in a child *j* it must be the case that for $E^{-j} > 0$

$$\pi\lambda\rho(\alpha_j(E_{jj} + E^{-j})) - \rho(\alpha_j(E_{jj} + E^{-j})) \leq c - (1+r)P_E E^{-j} \quad (15)$$

This condition provides assurances to the lending household(s) that the recipient child will not migrate and thus renege on his loan. The contract is designed so that at the

children of marginal ability, only to children of higher ability.

incentive compatible levels of educational investment, the expected net gain from migration is less than the net gain resulting from the opportunity to default on loan. Let $\ddot{E}^{-j}$ solve (15) with equality. $\ddot{E}^{-j}$ then represents the maximum amount of education child *j* will be eligible to receive from the community and $E_{jj} + \ddot{E}^{-j}$ denotes child *j*'s incentive compatible threshold level of education. Allowing for educational loans shifts the migration threshold since migration effectively generates windfall earnings in the form of loan non-repayments. The incentive compatible threshold level shifts, relative to the household financed threshold in response to the size of loan taken (and thus the magnitude of gains from reneging) as well as the probability of getting caught. The lower the risk and the larger the loan, the lower will be the threshold as lenders adjust for the increased attractiveness of migration.

What determines $\ddot{E}^{-j}$ and how do shifts in the model's parameters affect it? Graphing condition (15) in Figure 4 against E^{-j} gives a general indication of the main relationships. Recall that the RHS of (15) captures the net cost of migration. When $E^{-j} = 0$, the net cost is simply the parameter *c*. However as E^{-j} increases, the net cost decreases at the rate $(1+r)P_E$ (as migrating now provides the added benefit of freeing the individual from his debt burden). Thus the net cost curve intersects the vertical axis at *c* and slopes downward thereafter. The LHS of (15) crosses the vertical axis below *c*.[9]

Since both functions are strictly concave, and thus their difference is also strictly concave, then for any given E_{jj}, $(\pi\lambda - 1)\rho(\alpha_j(E_{jj} + E^{-j})$ is increasing in E^{-j}. $\ddot{E}^{-j}$ is the value where the productivity gains equal the net costs.

Figure 4

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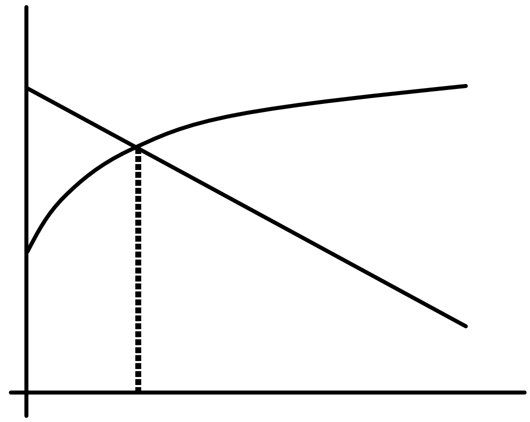
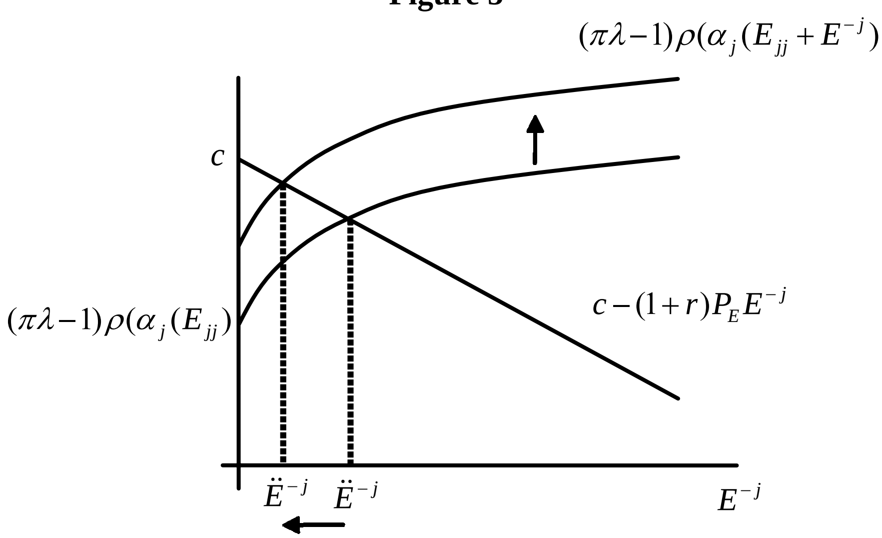
[9] We know that $E^{-j} > 0$ implies that $E_{jj} < \overline{E}_j$. Thus, since $\overline{E}_j$ is such that $((\lambda - 1)\rho(\alpha_j \overline{E}_j) = c$, then for $E^{-j} = 0$ and $\pi \in (0,1)$, it follows that $(\lambda\pi - 1)\rho(\alpha_j(\overline{E}_j + E^{-j}) < c$.



3.2.1 The Supply of Community Funded Education

$\ddot{E}^{-j}$ is of critical interest to the hypothesis we advance in this paper. $\ddot{E}^{-j}$ represents the units of community funded education, that if available, a student could tap into to borrow against the future increase in his productivity resulting from higher education. We now analyze the comparative statistics of $\ddot{E}^{-j}$ to show how spatial differentials in labor productivity due to the richer infrastructural environment in urban areas discourage informal lending for education.

Figure 5



Recall that π denotes the probability that a reneging child escapes attempts by the community to punish him for breaking the agreement to honor his loans. For large π, migrants find it relatively easy to avoid punishment. A rural household with surplus investable resources will rationally seek to protect itself from potentially bad investments.

As Figure 5 shows, because an increase in π shifts up the expected gain of migrating, it lowers $\ddot{E}^{-j}$, reducing the supply of informal educational loans $P_E \ddot{E}^{-j}$.

A similar graphical representation explains the decrease in $\ddot{E}^{-j}$ resulting from an increase in λ. Again, this is merely the rational response of adults protecting their investments in the face of an increased incentive to migrate. On the other hand, a community with tightly entrenched social customs and strong network systems that results in an increased cost of moving is likely to relax the constraint of loan provision arising from the fear of losing investments to migration. We summarize these three results in the following proposition:

Proposition 7 *For a child j tapping into community educational loans, as the expected benefit of migration increases (captured by either an increase in π and/or λ¸ or a decrease in c), the maximum amount of loans the community is willing to provide, $\ddot{E}^{-j}$, decreases. That is, $\partial(\ddot{E}^{-j})/\partial(\lambda) < 0$, $\partial(\ddot{E}^{-j})/\partial(\pi) < 0$, $\partial(\ddot{E}^{-j})/\partial(c) > 0$.*

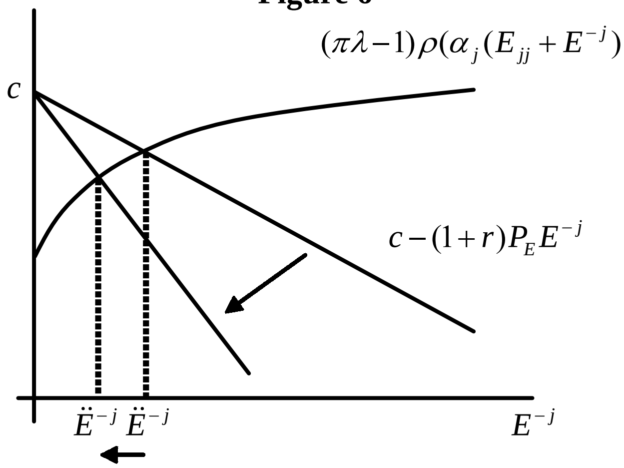
The return on educational investment is given by $(1+r)$. One would expect that increases in investment return arising from an increase in the going interest rate would increase $P_E \ddot{E}^{-j}$, the amount of loans the community is willing to give for each α. However, in this case an increase in the return to investment signifies a larger debt burden per level of education for the child and thus also increases his incentive to migrate and renege. The result of this is as follows:

Proposition 8 *Increases in the interest rate r result in a decrease of $\ddot{E}^{-j}$, the maximum level of education the community is willing to invest in any child j. That is, $\partial(\ddot{E}^{-j})/\partial(1+r) < 0$.*

Figure 6 shows this result. An increase in r represents a steeper slope on the net cost to migration curve which then intersects the expected net gain to migration curve at a lower

$\ddot{E}^{-j}$.[10]

Figure 6



3.2.2 The Demand for Community Funded Education

As a result of the fixed rate of repayment $(1+r)$ that an investor receives per unit of education financed if the child remains in the rural area, the investor may be willing to invest in a child beyond the level that optimizes the child's productivity. The child's parent, however, will reject all loan offers that will not benefit the child since the parent's welfare is an increasing function of the child's income net of any loan repayments. Recall that $\widetilde{E}_j$ was child *j*'s optimal level of education if he stayed in the rural area and only received education from his household. Now, however, we seek to find the child's demand for community provided educational loans. Given an optimal level of education provided by his own household, E^*_{jj}, child *j* will accept any level of community funded educational units E^{-j} that satisfies

$$\rho'(\alpha_j(E^*_{jj} + E^{-j}))\alpha_j \geq (1+r)P_E \qquad (16)$$

Let $\vec{E}^{-j}$ solve (16) with equality. $\vec{E}^{-j}$ then denotes child *j*'s optimal demand for community funded education. If $\ddot{E}^{-j} \geq \vec{E}^{-j}$, then child *j's* total educational attainment will be $E^*_{jj} + \vec{E}^{-j}$ and will not be constrained by the contractual demands of the informal

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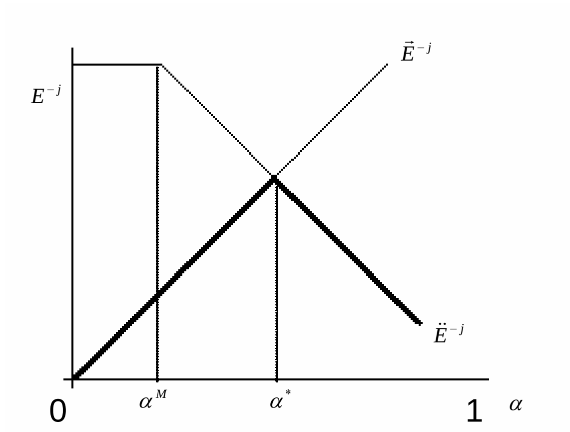
[10] As $P_E E^{-j}$ represents the maximum amount of loans the community is willing to invest in any child *j*, then as the price of education increases, the units of extra-familial education child *j* can tap into decreases proportionately.

credit market structure. If on the other hand $\ddot{E}^{-j} < \vec{E}^{-j}$, then the child will receive a total education attainment of $E^{*}_{jj} + \ddot{E}^{-j}$.

Figure 7



Whether a child's level of community funded education is constrained by the amount of education the community is willing to finance or by the level of education they demand depends on the child's endowment of ability and his household's wealth. Recall that community educational loans are available only for those children who will remain in the rural area, i.e., those children *j* for whom $w_j \leq w_j^M$. We know that all children with $\alpha \leq \alpha^M$ will never migrate despite household wealth. These children will always receive the amount of loans they demand because community investors need not incorporate incentive compatible measures in their loan contract. Although even with $\alpha_j = 1$, a child *j* will always have access to a positive supply of community loans,[11] for children with $\alpha > \alpha^M$, the community supplies educational loans as a decreasing function of ability. All else equal, more able children have lower threshold levels of educational attainment and investors respond to this by offering only that level of educational loan that keeps the child from migrating and subsequently defaulting. The supply curve for informal educational loans is therefore perfectly elastic up to a kink point at α^M, where it begins

[11] This result follows from the definition of $\overline{E}_j$ and $\ddot{E}_j$. $\overline{E}_j$ is such that $(\lambda - 1)\rho(\alpha_j \overline{E}_j) = c$ and $\ddot{E}^{-j}$ solves $(\lambda\pi - 1)\rho(\alpha_j(\overline{E}_j + \ddot{E}^{-j})) = c - (1+r)P_E \ddot{E}^{-j}$. Let $\alpha_j = 1$ and $\pi \in (0,1)$. Suppose $\ddot{E}^{-j} = 0$,

sloping down in a child's latent ability. Meanwhile, a child's demand for education, and thus for educational loans if his household has insufficient wealth to pay for his schooling, is monotonically increasing in α. Figure 7 depicts the demand and supply of community education as a function of α.

The bold sections of the demand and supply schedules represent the actual community funding E^{-j} that child *j* will receive. All those children with $\alpha \leq \alpha^*$ will receive their optimal level of education while children with $\alpha > \alpha^*$ will be constrained by the amount of loan the community is willing to finance. This outcome implies that in a world of imperfectly enforceable credit contracts, children are implicitly punished for being born intelligent. High innate ability increases the benefits to migration, inducing rational investors to reduce their loan supply as a defense against prospective default. This perverse result yields an important, testable hypothesis: are educational loans increasing in innate ability, as would be the case under perfect credit markets (as the next subsection demonstrates) or under altruistic lending (wherein lenders give in response to child demand), or are they decreasing in a child's innate ability, as predicted by this model? Testing this hypothesis, however, is beyond the scope of this paper.

Although credit contract enforcement difficulties may limit educational loan markets in rural villages, with perverse consequences for high-ability children from low-wealth households, almost all children who do not migrate receive some community-funded education.[12] As such, the presence of an informal credit market weakly improves the educational attainment of rural children.

It must be noted that we built our model of the informal credit market without considering the actual availability of community resources to meet their willingness to invest in the education of each child *j*, ($\ddot{E}^{-j}$). We modeled a perfectly endowed community financier who is always capable of meeting the demand ($\vec{E}^{-j}$) subject only to the incentive compatibility constraint. Whether this condition is met depends on the distribution and aggregate level of wealth across households and the distribution of

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this implies that $(\lambda - 1)\rho(\overline{E}_j) = c$, and $(\lambda\pi - 1)\rho(\overline{E}_j +) = c$. This is a contradiction and thus $\ddot{E}^{-j} > 0$.

abilities across children in the community. A community poorly endowed with wealth but richly endowed with intelligence is likely to have many loan worthy children demanding loans but come up short due to the low level of investible surplus in the community.

A more realistic model would take the available community funds for loans as the actual supply. This would require building in actual distributions of α and w across households into the model. In addition, only by the inclusion of distributions in our analysis can we precisely establish the degree to which an informal credit market deviates from the optimal. Nevertheless, any form of informal financing can easily be shown to weakly dominate the household only provision of education under any distribution of α and w.

The benefits of informal financing are also sharply limited by financial market imperfections. We now demonstrate this by briefly describing the first-best counterfactual in order to formalize the inefficiencies that result from an imperfect credit market and to show how spatial differences in infrastructure affect those inefficiencies.

3.3 The First-Best World

A first-best world implies a complete, competitive credit market in the rural sector with perfect contract enforcement. In such a world, children would have to repay loans irrespective of their second period locational choice. Therefore, a child j will migrate only if

$$\rho(\alpha_j(E_{jj}^* + E^{-j})) - (1+r)P_E E^{-j} < \lambda\rho(\alpha_j(E_{jj}^* + E^{-j})) - (1+r)P_E E^{-j} + c \quad (17)$$

Since the child has to repay the same amount in both sectors, the fact that one receives loans does not change the threshold level and child *j* will migrate if $E_{jj}^* + E^{-j} > \overline{E}_j$. Thus migration thresholds are endogenous to lending patterns only in imperfect financial markets due to contract enforcement problems. Whether the child actually migrates depends on whether there exists E^{-j} such that

$$E_{jj}^* + E^{-j} > \overline{E}_j \quad \text{and} \quad \lambda\rho'(\alpha_j(E_{jj}^* + E^{-j}))\alpha_j \geq (1+r)P_E \qquad (18)$$

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[12] The low-density exception are children of households whose wealth and resulting investment choices bring the child nearly to the migration threshold, but a single unit of community-financed education would

Condition (18) merely assures that child *j*'s sum total education is greater than the threshold for migration and that the amount E^{-j} of his education that was formally financed provides net benefits to him at the margin. Let $\breve{E}^{-j}$ equate (18). $\breve{E}^{-j}$ is the unconstrained optimal level of education for child *j*. Note that this is the level of education that obtains for urban children even in the case of imperfect financial markets.[13] In a first best world, all rural children *j* for whom $E_{jj}^{*} + \breve{E}^{-j} > \overline{E}_{j}$ will migrate and borrow the amount needed to fund $\breve{E}^{-j}$ units of education. If $E_{jj}^{*} + \breve{E}^{-j} \leq \overline{E}_{j}$, then child *j* would never migrate and thus reverts to making his loan purchasing decision conditional on staying in the rural area. This corresponds to him borrowing the amount E^{-j} that equates (16) and thus, the first best optimal level of rural education is exactly equal to the optimal demand for community funded education $\vec{E}^{-j}$. In the next section we study the inefficiencies arising from the informal credit market in this dual economy setting.

4. Sources of Inefficiency

The informal provision of educational loans is clearly an improvement over an environment that limits children's educational attainment to the wealth constraint of their own household. More specifically, informal financing benefits only those children whose household wealth satisfies $w_j \leq \overline{w}_j$ and, that given E_{jj}^{*} (the amount adult *j* spends on her child), the child demands a positive amount of community loans for education ($\vec{E}^{-j} > 0$), and the community is willing to supply a positive amount of community loans ($\ddot{E}^{-j} > 0$).

Note from Figure 5, that for all $E_{jj}^{*} \leq \overline{E}_{j}$ (which covers the set of all those children that could benefit from informal finance), $\ddot{E}^{-j} > 0$. To determine when $\vec{E}^{-j} > 0$, note that by rearranging equation we get

$$E_{jj}^{*} + \vec{E}^{-j} = \rho'^{-1}\left(\frac{(1+r)P_E}{\alpha_j}\right)\frac{1}{\alpha_j} \qquad (19)$$

provide education sufficient to make it worth the child's while to migrate.

[13] This assumes that λ is sufficiently large so as to make urban-to-rural migration purely for the sake of loan default unattractive to the child.

Then, since for each *j*, the RHS of (19) is a constant, this implies a one to one tradeoff between E_{jj}^{*} and $\vec{E}^{-j}$. We proceed to show the conditions under which $\vec{E}^{-j} > 0$. From equations (10) and (16) we have that

$$-P_E + \delta\beta\lambda\rho'(\alpha_j \tilde{E}_j)\alpha_j = \delta(1+r)P_E \qquad (20)$$

$$\text{and } \rho'(\alpha_j(E_{jj}^{*} + \vec{E}^{-j}))\alpha_j = (1+r)P_E \qquad (21)$$

Dividing the left hand equation by δ, we equate the two to get

$$-\frac{P_E}{\delta} + \beta\rho'(\alpha_j \tilde{E}_j)\alpha_j = \rho'(\alpha_j(E_{jj}^{*} + \vec{E}^{-j}))\alpha_j \qquad (22)$$

since $\beta < 1$ and $P_E, \delta > 0$, this implies that

$$\rho'(\alpha_j \tilde{E}_j)\alpha_j > \rho'(\alpha_j(E_{jj}^{*} + \vec{E}^{-j}))\alpha_j \qquad (23)$$

and by the strict concavity of $\rho(.)$, it follows that

$$\tilde{E}_j < E_{jj}^{*} + \vec{E}^{-j} \qquad (24)$$

It follows that for any child *j* for whom α_j>0 and who does not migrate, $\vec{E}^{-j} > 0$ and they demand a positive level of community funded education.[14] This is true because while a child absorbs the full return from increased productivity resulting from more education, the ensuing indirect increase in the household's utility is discounted by β. Furthermore, the household head must factor in the opportunity cost of foregone investment.

Since we know that the actual amount of education that a non-migrating child will receive from community funds is $\min\{\vec{E}^{-j}, \ddot{E}^{-j}\}$ and that for all *j* such that $M(\alpha_{j,} w_j) = 0$, $\vec{E}^{-j} > 0$, and $\ddot{E}^{-j} > 0$ it follows that:

Proposition 9 *Provision of an informal credit market that taps into the investment potential of education by providing loans improves the educational outcomes of all children in the rural area vis-à-vis the case of only household funded education. The*

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[14] One can prove this as follows. Suppose not. Then $\vec{E}^{-j} = 0$. Equation (24) then implies that $\tilde{E}_j < E_{jj}^{*}$. This is a contradiction since from Proposition 5, we have that the optimal level of household funded rural education is $\tilde{E}_j$ and thus it must be that $E_{jj}^{*} \le \tilde{E}_j$. It follows that $\vec{E}_j > 0$.

total increase in aggregate rural education is given by $\sum_{j=1}^{N} \min\{\vec{E}^{-j}, \ddot{E}^{-j}\}$.

While we have shown that informal credit is better than no credit, clearly the incentive compatibility constraint on the provision of such credit loans results in inefficiencies. We investigate these inefficiencies by comparison with the first best outcome. Consider first all those children who will not migrate even in a first best world. These are all children *j* s.t. $E^{*}_{jj} + \breve{E}^{-j} \leq \overline{E}_{j}$. We know already that all such children will then attain their first-best optimal level of education in the rural sector, $E^{*}_{jj} + \vec{E}^{-j}$. It follows that all such children *j* who also satisfy $\vec{E}^{-j} \leq \ddot{E}^{-j}$ receive their first-best level of credit financed education even under a regime of informal credit markets. All those children *j* for whom $\vec{E}^{-j} > \ddot{E}^{-j}$ however, are effectively trapped in a sub-optimal state by the constraints of informal financing. To summarize we have that:

Proposition 10 *All children who remain in the rural area in a first-best world and who satisfy* $\min\{\vec{E}^{-j}, \ddot{E}^{-j}\} = \ddot{E}^{-j}$ *would be better off by the introduction of formal credit markets. The total increase in aggregate rural education resulting from formalizing credit markets is given by* $\sum_{j=1}^{N} (\vec{E}^{-j} - \ddot{E}^{-j})$ *for all j such that* $\min\{\vec{E}^{-j}, \ddot{E}^{-j}\} = \ddot{E}^{-j}$.

Improving loan contract enforcement in the rural area also improves the educational outcomes of children who subsequently migrate. From equations (9) and (18) we have that

$$-P_E + \delta\beta\lambda\rho'(\alpha_j \hat{E}_j)\alpha_j = \delta(1+r)P_E \qquad (25)$$

and $$\lambda\rho'(\alpha_j (E^{*}_{jj} + \breve{E}^{-j}))\alpha_j = (1+r)P_E \qquad (26)$$

Conducting the same exercise that led to equation (24), it follows that

$$\hat{E}_j < E^{*}_{jj} + \breve{E}^{-j} \qquad (27)$$

And by a similar argument to the proof in footnote 14, we find that:

Proposition 11 *Any child j that migrates will demand a positive level of education loans from the credit market and will attain a level of education greater than his optimal level of household financed education* $\hat{E}_j$. *That is, for all j such that* $E^*_{jj} + \breve{E}^{-j} > \overline{E}_j$, $\breve{E}^{-j} > 0$ *and* $E^*_{jj} + \breve{E}^{-j} > \hat{E}_j$.

There is another way in which perfect credit markets improve on household financing and informal credit provision. Note that in discussing the benefits that come with formal financing, we attain our results conditional on a child's ex-post locational decision without studying whether the change in market structure affects the spatial distribution of children across the two locations in the second period. For the case of informal credit markets we did not have to worry about such an eventuality because informal credit can only benefit those who would not migrate (all *j* such that $M(\alpha_j, w_j) = 0$) and then conditions loan provision to assure that they still have no incentive to migrate. It is likely, however, that there exists a set of children who can migrate (and thus achieve their full potential) only if they had access to a formal credit market. We proceed to characterize the set of all such children.

From a rearranging of equation (18) we get

$$E^*_{jj} + \breve{E}^{-j} = \rho'^{-1}\left(\frac{(1+r)P_E}{\alpha_j \lambda}\right)\frac{1}{\alpha_j} \qquad (28)$$

Then, since for each *j* the RHS of (28) is a constant, this implies a one to one tradeoff between E^*_{jj} and $\breve{E}^{-j}$. Whereas, child *j* (should he migrate) will always attain a total level of education equal to $E^*_{jj} + \breve{E}^{-j}$ in the first-best world, how much he actually borrows to finance his education will depend on the amount E^*_{jj} that his household contributes to his education. However, though this will affect the gross income that a child will receive, it will not affect the level of education he will attain. Indeed, should a child *j* come from a household of zero wealth, he will simply borrow enough to finance $\rho'^{-1}\left(\frac{(1+r)P_E}{\alpha_j \lambda}\right)\frac{1}{\alpha_j}$ units of education. It follows that the only condition child *j* has to satisfy to migrate is that $E^*_{jj} + \breve{E}^{-j} > \overline{E}_j$. This depends solely on his innate ability α_j. Recognize that this implies that household wealth is no longer a factor in a child's decision to migrate and all children with $\alpha > \alpha^M$ now migrate irrespective of w. In addition, introduction of perfect credit markets also lowers the threshold level of innate ability needed to migrate. To see this, recall that α^M is such that $\overline{E}(\alpha^M) = \hat{E}_j$. From equation (27) it follows that

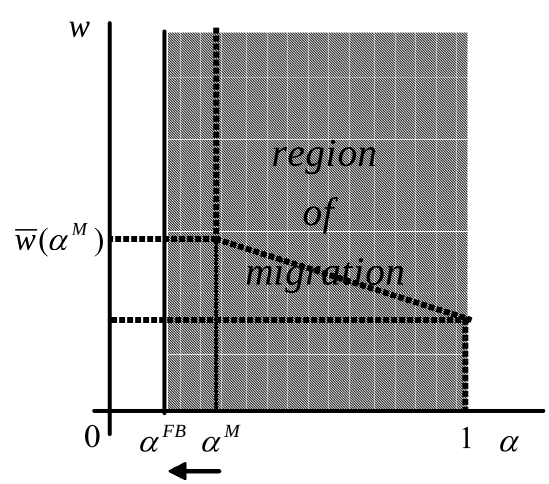
$$\overline{E}(\alpha^M) < E^*_{jj} + \breve{E}^{-j} \qquad (28)$$

Denote the level of α that equates (23) as α^{FB}. Since $\overline{E}(\alpha)$ is strictly decreasing in α, it follows that $\alpha^{FB} < \alpha^M$. To summarize:

Proposition 12 *The provision of a formal market for credit increases the rate of migration by making the migration decision independent of household wealth and lowering the threshold level of innate ability needed to migrate.*

Figure 8 shows the increase in migration resulting from the introduction of formal financing.

Figure 8



The preceding results confirm that perfect credit markets provide Pareto optimal education financing. They increase the optimal level of education and of available educational credit for all but the lowest ability children who would remain in the rural village regardless. Perfectly enforceable credit contracts also yield an optimal spatial distribution of individuals. Absent first-best credit markets, informal credit provides a means for certain rural children to overcome the constraints of household financing and receive a better education. But informal credit fails to meet the needs of higher ability children from low wealth households, creating important inefficiencies and inequities.

5. Discussion and Policy Implications

The central results of our model highlight three key points. First, we demonstrate the consequences of spatial inequality in productive infrastructure for rural education investment in an environment of imperfect credit markets. Spatially varied returns to education tighten the incentive compatibility constraints inherent to informal credit markets and thereby limit the usefulness of informal educational loans. Second, our model underscores the crucial importance of the presence of credit contract enforcement mechanisms for the optimal investment in and attainment of education. Provision of formal education loans affords children the opportunity to meet their full potential and break free of sub-optimal education traps caused by low household wealth endowments, the incentive compatibility constraints of informal financing, and a household's rational attention to the various other needs that compete for resources.

If increasing educational attainment in less-favored rural communities, perhaps especially among high ability children, is an objective for policymakers, then our analysis suggests two possible means by which public investment might "crowd in" private educational investment. First, governments and donors might improve rural infrastructure in ways that encourage private business investment that stimulates skilled employment and thereby raises the expected returns to human capital. This might include programs of rural electrification, road improvement and maintenance, and provision of police protection. Improving rural infrastructure reduces incentives to migrate out of rural villages, making informal loan contract enforcement easier and thereby increasing the provision of private, informal finance. Second, governments and donors can invest in credit contract enforcement, either through credit reporting bureaus, improved juridical enforcement of contracts and other formal mechanisms, or through informal mechanisms based on social norms and generalized morality that induce people to honor agreements irrespective of their location (Platteau 2000).

Third, and perhaps the most worrying implication of our model, is that increasing spatial inequality in productive infrastructure is accompanied by a weakened ability of community social norms to ensure contract compliance. Without any significant improvements in formal contract enforcement mechanisms, a stylization that seems to fit many rural areas of the low-income world today we would expect to see increased incentives for rural-to-urban migration, but with the relatively wealthy increasingly disproportionately able to capitalize on these opportunities as informal finance for education becomes increasingly difficult to obtain in rural villages. More poor children, especially those of high innate ability, thus become consigned to a sort of low-education poverty trap of the sort first posited by Loury (1981).

To be sure, informal credit provision is a welcome source of financing, even in the presence of spatial inequality in returns to human capital. By providing at least some supplement to parent financing of children's education, informal educational loans add to the stock of available financing for all children. But in poor communities where there are few or no households able to invest in any child's education, the supply of informal loans may be insufficient to satisfy even the limited loan volume that is incentive compatible. Aggregate loan supply, not just child-specific loan supply, can constrain educational investments in areas of extreme and widespread poverty. External interventions are plainly necessary in such areas if children are to acquire education with which they can take advantage of their innate abilities.

It would be instructive to expand on this model to allow for dynamics in order to explore the potential divergence of rural and urban livelihoods and the prospective intergenerational reproduction of poverty. Indeed, as poorer and less skilled individuals tend to remain in the rural area, we would expect that spatial mobility combined with imperfect credit markets would yield over time a rural population with a distribution of innate abilities and wealth that results in a decreased rate of migration and a low steady-state level of rural educational attainment. The simple two-period model we have developed nonetheless provides a novel and credible answer to the puzzle of underinvestment of education in rural areas based on the twin empirical regularities of spatially varied returns to human capital and imperfect loan contract enforcement in rural credit markets.

6. **References**

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