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Migration, Human Capital, and Poverty in a Dual-Economy Model of a Developing Country

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Migration, Human Capital, and Poverty in a Dual-Economy Model of a Developing Country

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Abstract

The coexistence of urban and rural poverty and migration to cities is studied in a dual economy model where the acquisition of skills is costly and involves migration to urban areas. In this model, both the distribution of innate abilities and the distribution of wealth matter for the migration decision, and costs of backmigration may produce an urban poverty trap if unemployment lowers household wealth below the cost of skills acquisition.

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"[A]ll developing economic life depends on city economies..." Jane Jacobs (1984), p. 132.

"The rural child seldom gets even half the town child's chance of an education...[I]t compels many bright children to urbanise if they seek adequate secondary or even primary education, and this is often the first step towards permanent settlement in the city..." Michael Lipton (1976), p. 261.

I. Introduction

In most if not all developing countries, studying poverty requires understanding its prevalence in both rural and urban areas, as well as the interaction of the various dimensions of deprivation—among which income, security, education, and health (World Bank, 2000). Both rural and urban poverty are pervasive in developing countries. Rural poverty, which is estimated to constitute some 60–75 percent of the total, is typically associated with subsistence agriculture paying low returns using traditional low-skilled inputs (see for instance, Khan 2001; IFAD, 2001). Urban poverty is more likely to be a result of under- or un-employment, since those employed in the urban formal sector are paid relatively high wages, and urban unemployment is itself exacerbated by migration away from rural poverty.

The coexistence of rural migration and urban unemployment was modeled three decades ago by Harris and Todaro (1970), and this framework has served as a workhorse developing-country model since then. In that article, the authors identify a distortion that keeps urban wages too high (either due to formal minimum wages or efficiency wage considerations), and the expectation of that high wage encourages migration up until the probability of unemployment offsets the wage differential between urban and rural areas. Harris and Todaro go on to discuss possible policy measures to reduce poverty and improve welfare, and in particular single out the desirability of an employment subsidy to increase urban employment as well as restrictions on migration.

There have been a number of articles that have fleshed out the Harris-Todaro model and have shown how the policy recommendations depend on specific features assumed by the authors. Corden and Findlay (1975) show for the benchmark case where manufacturing is more capital intensive than agriculture that capital accumulation and productivity growth *increase* urban unemployment, while labor force growth *reduces* it. They also show that an agricultural wage subsidy financed by lump-sum taxes must improve welfare, while a manufacturing wage subsidy when there is intersectoral capital mobility (Harris-Todaro assume sector-specific capital) could lower aggregate output and welfare. Neary (1981) shows that for the model with intersectoral capital mobility to be stable, the urban manufacturing sector must be more *capital abundant* (comparing the ratio of existing capital to employed *and unemployed* labor) than the agricultural sector. Yabuuchi (1993) examines the effect of international capital mobility, while Gang (1987), Clarete and Whalley (1988), and Beladi and Marjit (1993) consider the possible role of tariffs in that model. Krichel and Levine (1999) include urban agglomeration effects, some urban real wage flexibility, and a government budget constraint in a version of the model which they simulate to assess various policy changes.

Bencivenga and Smith (1997) present a model in the spirit of Harris and Todaro but where a non-market-clearing wage is the result of adverse selection problems, the employer not observing the type (skill level) of the agent. This model with urban capital accumulation produces multiple steady-state equilibria if population growth is in an intermediate range, and can result in both oscillations and development trap phenomena associated with rural-urban migration.

A neglected issue in explaining urban migration is the acquisition of skills (human capital). In practice, obtaining an education and learning the techniques that are useful for employment in the modern sector of the economy often require moving away from rural areas. In many developing countries policies are biased against the rural poor; urban areas benefit disproportionately from public investment in infrastructure (for education, health care, water, and sanitation) and provision of safety nets. As a result, access by the rural population to health services, adequate sanitation, and safe drinking water is dramatically worse than in urban areas in many countries of Africa, Asia, and Latin America, while illiteracy rates are typically 50 percent (or more) higher in rural than urban areas (IFAD, 2001). As the Rural Poverty Report 2001 documents, the poor lack human capital that would facilitate obtaining high paying jobs. The objective of acquiring that human capital is therefore a factor which helps to explain migration to the city. In this paper, we focus on rural/urban differences in the possibilities for skill acquisition.

There is a potentially important role for the initial distribution of wealth in deciding who has access to investment in human capital. Though primary and secondary education may be provided by the state, there is an opportunity cost for the family because children may otherwise be able to generate income for the household, and basic expenses often must be incurred even if education per se is free. These expenses and the opportunity cost of education make its acquisition impossible for the very poor, and the cost of skill acquisition may explain the persistence of poverty across generations.

Loury (1981) shows that when abilities are identically and independently distributed and parents cannot borrow to make human capital investment in their offspring, there may be welfare-improving redistributive policies that increase the access to human capital. Galor and Zeira (1993) show that inequality can be perpetuated (and associated with low average incomes) in a model where there is an indivisibility that requires a certain minimum investment in order to acquire human capital and there are capital market imperfections (see also Bénabou, 1996, who points out more generally that non-convexity can produce this result). In the Galor-Zeira model, individuals can borrow, but collateral constraints prevent all those who want to from doing so. As a result, only those wealthy enough can acquire the human capital and earn the higher, skilled wage. This in turn permits them to pass on higher bequests to their children, who then also have the opportunity to acquire human capital. The need to acquire costly skills may thus be a factor in the perpetuation of poverty.[2]

In this paper, we first review some of the stylized facts concerning urban migration and city growth, rural and urban poverty, and differential opportunities in the two areas. The paper then goes on to develop a formal model that adds the important features of acquisition of human capital and wealth bequests to the rural/urban economy model of Harris and Todaro in order to examine income inequality and migration decisions together. Earlier articles have also suggested the usefulness of modeling income inequality in terms of the dual economy model, in particular Thorbecke (1997), Bourguignon and Morrisson (1998), and García-Peñalosa (2000). However, those papers do not model the cost of acquiring skills, and its effect on perpetuating income inequality. In what follows, we show that the interaction of migration decisions and constraints on human capital investment can produce complex dynamics and several equilibria for per capita income levels. In particular, migration may be associated with skill acquisition, but a spell of unemployment may lead to falling into a poverty trap where wealth is no longer adequate to permit educating the children and giving them access to higher-skilled jobs. Thus, persistent urban poverty may result, as well as rural poverty among those not migrating to the cities.

Implications and extensions to the model are explored in a concluding section.

II. Stylized Facts About Urban and Rural Poverty and Migration

The explosive growth of cities in developing countries has long preoccupied demographers and economists. Table 1 illustrates this phenomenon by detailing the growth of those cities that currently have a population of 10 million or more. Some cities, such as Lagos, have experienced incredibly rapid growth, with that city expanding from 230,000 in 1950 to its current size in excess of 13.4 million, an average annual growth rate of 7.5 percent—far above the growth of the population of Nigeria itself, which averaged 2.8 percent per annum over that period. While less rapid, many other developing countries experienced similar growth, creating megacities with serious problems of overcrowding, poor sanitation, transportation, and housing, as well as the creation of large numbers of urban unemployed and urban poor. Between 1975 and 1990, rural-urban migration accounted for at least half of urban growth in many African, Asian, and Latin American countries (Gugler, 1997, p. 43).

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[2] Lloyd-Ellis and Bernhardt (2000) develop a model in which agents differ in their entrepreneurial skills, and where becoming an entrepreneur requires making a minimum investment. They relate the evolution of wealth distributions to stages of development.

The causes for the vast migration to urban areas have been the subject of much debate.[3] Table 2 shows that industrial countries typically have much higher levels of urbanization than developing countries. Even though they experienced earlier phases of rapid urbanization at the time of the industrial revolution, urbanization has further increased since 1950. Therefore, the experience of developing countries could be viewed as a similar response to the higher wages and employment opportunities available in cities as a result of industrialization. This position was taken by "modernization theorists," who assumed that the urbanization process would parallel that in developed countries; however, social scientists concluded in the 1970s that the process of city growth differed from that in the developed world. In particular, rather than being a generator of growth, it was associated with inequality and economic and social stagnation (Smith, 1996, p. 5). A different view to that of modernization theory was advanced, namely that of "urban bias," whereby policymakers tend to favor urban areas over rural by disproportionately allocating resources to the cities in ways that are inequitable and inefficient, creating large numbers of rent-seekers, including government employees (Lipton, 1976). This view led to the concept of "over urbanization," in which migration outstrips the growth in production in cities. A recent World Bank study concludes: "Cities in Africa are not serving as engines of growth and structural transformation. Instead, they are part of the cause and a major symptom of the economic and social crises that have enveloped the continent." (World Bank, 1999, p. 130).

Despite problems plaguing cities, data on the services available to urban and rural residents confirm a wide disparity between the two regions in most countries. Access to sanitation and health care continues to be significantly better in urban than rural areas (Table 3), while differences in illiteracy rates suggest very unequal access to education (Table 4). However, evidence shows that a significant fraction of urban residents work neither in the modern productive sector nor in government bureaucracies. Data suggest that "informal sector" employment is large in most urban areas (Table 5), though the concept presents difficult measurement problems. The informal sector may in fact be capturing the need for those who are unemployed to fall back on some way of providing for a minimum level of subsistence. Whether as a result of urban unemployment or low-paying urban informal-sector jobs, urban poverty is pervasive in developing countries, though it is typically well below rural poverty (Table 9).

An influential article by Harris and Todaro (1970) attempted to reconcile the existence of urban unemployment (and poverty) with high migration from rural areas. In their model, a distortion keeps the urban wage for those fortunate enough to get a job in the modern sector (whether in private business or public bureaucracies) higher than the market clearing wage. This could be consistent with a variety of explanations. Despite this distortion that keeps the urban wage above agricultural wages, there is an equilibrium where migration eventually stops,

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[3] Urbanization per se needs to be distinguished from the creation of megacities. Ades and Glaeser (1995) show that the latter are likely to be associated with dictatorships and political instability, and to be negatively correlated with the extent of international trade.

because there is a limit to the number of jobs, and migrants rationally take into account the possibility of unemployment. Migration stops when the point is reached where the expected (unemployment corrected) urban wage equals the rural wage.

The Harris-Todaro model helps to explain the coexistence of high urban wages for some, migration to the cities, and large-scale unemployment. As such it has helped to understand the developing country urbanization phenomenon, though it has not explained it, since the key feature of the model is the labor market distortion, which is simply assumed. Their model is however consistent with other theories, such as urban bias, that provide explanations for that distortion.

A feature that is ignored by the Harris-Todaro model is that migration occurs not merely to go to a high wage job, but also to acquire the skills that give access to the better jobs by both parents and their children. It is instructive to look at a particular case, Nigeria, where a wealth of information exists on the causes of urban migration. A survey of the reasons why migrants came to Lagos in the early 1970s indicates that "to go to school" and "to learn a trade" were the reasons supplied by 23.5 percent of respondents, while "to look for wok" explained 43.9 percent (Fapohunda, 1976). Adegbola (1976) links post-colonial urban migration to the social and economic programs of the government: "For migration patterns, the most important social program relates to expansion of educational facilities... Although educational selectivity is not well documented, all available evidence points to a positive correlation between the level of completed education and the propensity to migrate to cities." While some of the migrants go directly into employment, others may take advantage of the greater opportunity for formal education as well as on-the-job-training offered by cities. Essang and Mabawonku (1974) report that the reason that many migrants did not send money home was that they incurred educational expenditures.

It is clear that no single explanation of urban growth in developing countries is valid everywhere. In discussing urbanization in Nigeria, for instance, Smith (1996) argues that a complete analysis requires considering both external and internal forces: the role of a city in the world economy, as well as internal features of the economy with respect to urban bias, relative sectoral productivity levels, the colonial past, and the geographical factors. In this paper, we focus on one feature, the superior educational opportunity offered by cities, and see how it interacts with the traditional wage incentive highlighted by Harris-Todaro in affecting rural-urban migration.[4]

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[4] Of course, agriculture also involves human capital formation and learning of new techniques, as stressed by the work of Theodore Schultze (e.g. Schultze, 1964).

III. A Model of Migration and Skill Acquisition

It is assumed that the economy produces three goods—a rural agricultural good, an urban manufacture, and the output of the urban informal sector—whose prices are fixed (the terms of trade are exogenously given by the rest of the world) so they can be aggregated into a single good.[5] The rural good is produced using land (in fixed supply) and unskilled labor, L^a, while the urban manufacturing sector uses capital and skilled labor L^s. Urban firms can borrow or lend at the world interest rate r, which is fixed. The urban unskilled workers or unemployed skilled workers produce without capital, using a constant returns technology paying a constant (low) marginal return w^n.

As in Harris and Todaro, the urban wage for skilled workers is fixed at a level w^s which is above the marginal product of labor, and as a result urban unemployment prevails. The above-market-clearing wage could be due either to minimum wage legislation or to efficiency wage considerations (these are described in Stiglitz, 1974). As in Harris-Todaro, migration decisions are made on the basis of expected income, corrected for the probability of unemployment. However, we add the feature that the expected higher urban wage requires investment in skill acquisition, so that only those above a certain wealth level have the incentive to move. Thus, the urban wage needs to exceed the rural wage not only to reflect the probability of unemployment (and the resulting lower wage earned in the informal urban sector) but also the cost of investment in human capital. Only the relatively better off can afford that investment and thus have an incentive to migrate.

The total population of size N is assumed to be constant. Each person lives for 2 periods, having 1 child in the second period of her life. When born, each agent i of generation t inherits a bequest x_t^i left by her parent, an agent of generation $t-1$. (As we will see below, we can associate the index i both with the parent and the child; it identifies a particular dynasty). In the first period of her life, each agent makes a decision about migration, i.e. whether or not she will move to the other location or stay where her parent lives. In the second period, she supplies labor and is either employed or unemployed; only urban labor faces the (random) possibility of unemployment, and only those living in the city can invest in human capital.

If an agent born at t decides to stay or migrate to the rural area in the first period of her life, then she is endowed with one unit of labor in the second period of her life, and earns a rural wage w_{t+1}^a. Given the existence of a fixed factor, land, and a competitive rural labor market, the rural wage equals the marginal product of labor, which declines with the size of the rural labor force.
Specifically, writing the production function for agricultural goods as

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[5] A more disaggregated framework, termed a '"dual-dual" model (Thorbecke, 1997), would also differentiate rural agricultural production between a modern sector and an informal, traditional sector.

$$Q_t = A(L_t^a)^\alpha \tag{1}$$

where $\alpha < 1$, then

$$w_{t+1}^a = \alpha A(L_{t+1}^a)^{\alpha-1} \tag{2}$$

If the agent decides to migrate to the urban area, or she is born in the urban area and decides to stay there, then she also makes a decision on whether to invest in human capital, which requires a fixed, indivisible investment. If the urban agent decides not to invest in human capital, or is skilled but unemployed at time period $t+1$, she earns the unskilled labor wage w_{t+1}^n. If she has invested in human capital and she obtains employment, she earns a skilled labor wage $w_{t+1}^s > w_{t+1}^n$. Since these two wage rates are fixed, henceforth we dispense with time subscripts.

Unlike the Galor and Zeira model where the investment in human capital is equal to h>0 for all agents, here we allow for the possibility of different innate abilities, which are modeled as involving different costs h_t^i for acquiring human capital (see also Galor and Tsiddon, 1997a). In the model of this paper, these different abilities are assumed to apply to all generations of a dynasty, so $h_t^i = h^i, \forall t$, but other more realistic and analytically difficult assumptions are possible.[6]

[6] It would be of interest to consider where the ability level of individuals is not identical to that of their parents, so that there is some element of randomness. For instance,

$$h_t^i = H^i + \varepsilon_t^i \tag{3}$$

where H^i is the constant average skill level for dynasty i, and ε_t^i is some mean zero random variable, which may however exhibit persistence over time. Another possibility is that the skill level of the population as a whole matters for the investment needed to acquire human capital: there are human capital externalities. For instance, if N_t^s is the number of skilled workers, then

$$h_t^i = H(H^i, N_t^s) \text{ with } H_2 < 0 \tag{4}$$

But these externsions quickly make the model difficult if not impossible to solve analytically, making use of simulation techniques necessary.

Agents consume in the second period of their life. They also derive utility from leaving bequests to their children. Individuals' utility maximization is similar to that described in Galor and Zeira (1993). Agent *i*'s lifetime utility is given by:

$$u_t^i = \beta \log C_{t+1}^i + (1-\beta)\log b_{t+1}^i \tag{5}$$

where C_{t+1}^i is the second-period consumption of the composite consumption good and b_{t+1}^i is the bequest left to the offspring born at $t+1$. The Cobb-Douglas utility function insures that constant shares of lifetime, realized income are allocated to consumption and bequests. The bequest of the parent b_{t+1}^i becomes the endowment x_{t+1}^j of the next generation, providing a link between agents *i* and *j*. For notational convenience, since we do not need to keep track of consumption of the older generation, we can use the index *i* to refer to both the child and parent. This allows us to write $x_{t+1}^i = b_{t+1}^i$.

Agents can invest in human capital only if their inherited bequest is $x_t^i \geq h^i$ (and they live in the urban area). Those who inherit an amount $x_t^i < h^i$ cannot borrow and are thus constrained to work as unskilled workers. We could easily specify a model with some financial development that allowed collateralized borrowing, as in Galor and Zeira. However, the main qualitative feature of the model, that some agents are credit rationed if they have not received a high enough bequest from their parent (i.e., they cannot use human capital as collateral), would remain, so we choose the simpler specification. Agents who save earn the world rate of interest, *r*.

Agents maximize utility subject to their specified lifetime income, that is, income available in the second period from both saving and second-period employment. Agents make decisions in the first period on migration and on whether to invest in human capital, based on the differences in expected utilities. Given the form of the utility function, utility rankings will be identical to those for expected second-period income.

Thus, a rural agent will decide to migrate to the city if her wealth is high enough to invest in human capital,

$$x_t^i \geq h^i \text{ and} \tag{6}$$

$$-h^i(1+r) + (1-u_{t+1}^e)w^s + u_{t+1}^e w^n > w_{t+1}^{a,e} \tag{7}$$

Since the skilled and unskilled urban wage rates are known, agents need only form expectations on the urban unemployment rate and the agricultural wage, both of which depend on the migration decisions of others. In particular, given the split between the rural and urban labor force, the unemployment rate for urban skilled labor, u_t, is given by:

$$u_t \equiv \frac{N - L_t^n - L_t^a - L^s}{N - L_t^n - L_t^a} \text{ provided } N - L_t^n - L_t^a \geq L^s \qquad (8)$$

where L_t^n is the number of urban *unskilled* workers (see below), L_t^s the number of urban *skilled* workers, and L_t^a the agricultural (rural) labor force. L_t^s is determined by the marginal productivity condition of urban workers, given the exogenous urban wage and the exogenous world interest rate. Since these are constant, so is L_t^s and the time subscript can be dropped.

Realized second-period income (identical to lifetime income) Z_{t+1}^i will differ from expected income, but given the Cobb-Douglas utility function agents will allocate constant fractions, β and 1- β, of their realized income to their consumption C_{t+1}^i and bequest, b_{t+1}^i, respectively. Agents' realized income depends on whether they live in the rural or urban area, whether they are employed or not. Those who are unemployed in the manufacturing sector are chosen at random (this is an assumption made by Harris and Todaro, and retained in much of the subsequent literature). The realized lifetime income of an agent who spends the second period of her life in the rural area is given by:

$$Z_{t+1}^i = x_t^i(1+r) + w_{t+1}^a \qquad (9)$$

The realized income of an urban agent who invested in human capital in the previous period is given by:

$$Z_{t+1}^i = (x_t^i - h^i)(1+r) + (1-\delta_{t+1}^i)w^s + \delta_{t+1}^i w^n \qquad (10)$$

where $\delta_{t+1}^i = 1$ if i is unemployed at $t+1$, otherwise 0.

Finally, we need to consider the possibility of backmigration from the city to the country. If the parent is unemployed at t, then human capital acquisition necessary to get the child a skilled urban job at $t + 1$ may not be possible, because $x_t^i < h^i$. It is assumed that $w^n < w_{t+1}^a$ in the relevant range for rural employment, so that in this case there would be an incentive to move back to the country. However, we also allow for the existence of moving, psychological, or other costs c that may inhibit backmigration, so that only if

$$w^n + c < w_{t+1}^{a,e} \qquad (11)$$

do urban residents at t who cannot afford to invest in skills move back to the country. Depending on whether c is zero or prohibitively high, this specification is general enough to nest the possibilities of no unskilled urban workers (no one stays in the city if they cannot acquire skills) and of no backmigration (so there is persistent urban poverty across generations of the unskilled).

The realized income of an agent who spent her life in the urban area, but did not invest in human capital, is given by:

$$Z_{t+1}^{i} = x_t^i(1+r) + w^n \quad (12)$$

Given the realized lifetime income, agent *i's* consumption and bequests are given by:

$$C_{t+1}^{i} = \beta Z_{t+1}^{i} \quad (13)$$

$$b_{t+1}^{i} = (1-\beta)Z_{t+1}^{i} \quad (14)$$

IV. Short-Run Equilibrium, Dynamics, and Steady State

A. Migration And Unemployment Equilibrium

The short-run equilibrium equalizes the wage incentives to migrate with the costs of skill acquisition. As in the standard Harris-Todaro model, the probability of unemployment affects the expected urban wage. Indeed, if the sizes of the agricultural and urban labor forces are determined simultaneously with the migration decision (but not who is unemployed), then in a rational expectations equilibrium everyone forms the same expectations for the unemployment rate and the agricultural wage, which are equal to their realized values. Thus, there is no aggregate uncertainty (for given wealth levels), but the selection of those actually unemployed is random, so there is individual uncertainty.

The short-run equilibrium that determines aggregate unemployment and the agricultural wage can be drawn as in Figure 1 (see also Corden and Findlay, 1975), for a given number of urban unskilled workers and a given distribution of wealth. For the marginal worker with $x_t^i > h^i$, who is indifferent between urban and rural areas, the following condition applies:

$$-h^i(1+r) + (1-u_{t+1}^e)w^s + u_{t+1}^e w^n = w_{t+1}^{a,e} = \alpha A(L_{t+1}^a)^{\alpha-1} \quad (15)$$

Figure 1 is drawn for several values of h^i, showing that if the value for the marginal worker is higher, then agricultural employment is also higher, and urban migration and unemployment are lower.

B. Wealth Dynamics

We now study wealth accumulation, taking as given for the moment the agricultural wage and aggregate unemployment equal to $\overline{w}^a$ and $\overline{u}$, respectively. Since bequests become initial endowments, we can write the evolution of the x_t^i as follows:

$$x_{t+1}^i = (1-\beta)\left[(x_t^i - h^i)(1+r) + (1-\delta_{t+1}^i)w^s + \delta_{t+1}^i + w^n\right] \qquad (16)$$

if i invests in human capital at t,

$$x_{t+1}^i = (1-\beta)\left[x_t^i(1+r) + \overline{w}^a\right] \qquad (17)$$

if i remains in the rural area, and

$$x_{t+1}^i = (1-\beta)\left[x_t^i(1+r) + w^n\right] \qquad (18)$$

if i remains in the city but does not invest in human capital.

Wealth dynamics can be analyzed using a phase diagram that takes account of the individual's ability level, migration choice, and the possibility of unemployment. We need to consider several cases that differ with regard to whether the steady-state wealth level of the urban unskilled is higher or lower than the cost of acquiring human capital, and whether backmigration to the country is costly or not. Figure 2 presents the case where ability is in an intermediate range (h^i is above the steady-state wealth of the urban unskilled, i.e., those in the informal sector, but below that in agriculture).[7] The line whose y-intercept is equal to $(1-\beta)\overline{w}^a$ describes wealth accumulation for individuals working at the agricultural wage while the line with intercept $(1-\beta)\left[-h^i(1+r)+w^s\right]$ represents the wealth accumulation for a skilled urban

[7] If ability is very low, h^i is so high that investment in skills is never undertaken because the agricultural wage is greater than the expected return from human capital, $w^a > -h^i(1+r) + w^s$. In this case, only the agricultural dynamics apply.

worker who remains employed, and that with $(1-\beta)w^n$, wealth accumulation for the urban unskilled. There is also a separate curve for those who invested in skills, but did not get a job, so that their net income is lower than either skilled employed workers or those who earn the same informal sector wage but did not incur the cost of education. The slopes of the four curves are the same, since the coefficients of x_t^i in equations (16)-(18) above are all equal to $(1-\beta)(1+r)$, which is assumed (as in Galor and Zeira) to be less than unity.

Only if the initial endowment $x_t^i \geq h^i$ will *i* be able to afford the investment in human capital and migrate to the city. If a worker stays in the rural area, her wealth converges to $\overline{x}^a$ (plotted in Figure 2), where

$$\overline{x}^a = (1-\beta)\overline{w}^a / [1-(1-\beta)(1+r)] \quad (19)$$

(we ignore the interaction of wealth accumulation with the agricultural wage for the moment, and take the latter as given). In the low ability case (not illustrated) where $h^i > \overline{x}^a$, individual *i* would never migrate to the city (provided the dynasty's initial wealth was below the steady-state level).

For those with sufficient wealth to invest in skill acquisition and migrate to the city, the upper line describes wealth accumulation if they remain employed. Wealth converges to an ability-specific level

$$\overline{x}^{s,i} = (1-\beta)[-h^i(1+r)+w^s]/[1-(1-\beta)(1+r)] \quad (20)$$

It must be the case that $-h^i(1+r)+w^s > w_t^a$ for all those who migrate to the city; otherwise there would be no migration.

However, unemployment cannot be ignored. It is assumed that the probability of unemployment $\overline{u}$ is given (and equal for all skilled urban workers). Suppose that a rural-based dynasty starts with wealth x_0 and in the next period earns enough so that her wealth exceeds h^i (see the Figure), and she migrates to the city and invests in skills. Then if employed, her wealth is given by the top line, if unemployed, it is given by the bottom line: these alternatives are shown as i or ii on the Figure. For the next generation of the dynasty of the unemployed urban worker, there are in turn two possibilities (as drawn):

iii. If the wealth falls below h^i, and $w^a < w^n + c$, *i* remains in the city and works in the informal sector. This possibility corresponds to a poverty trap for urban unskilled workers; since $x^n < h^i$, no subsequent member of the dynasty can accumulate sufficient wealth to acquire skills.

iv. If wealth falls below h^i, and $w^a \geq w^n + c$, i returns to the country and earns the agricultural wage.

It is also possible that wealth remains above the threshold h^i, in which case i invests in skills and remains in the urban area (this is not drawn).

The case of higher ability workers $(h^i < \overline{x}^n)$ is illustrated in Figure 3 (the same four possibilities as in Figure 2 are labeled i-iv). Here, the steady-state wealth for those earning the unskilled wage is higher than the cost to individual i of investing in human capital, so that even the combination of urban unemployment and high costs to backmigration does not prevent these dynasties from reacquiring skills. Thus, no poverty trap exists for high ability individuals.

C. General Equilibrium

Wealth accumulation feeds back onto aggregate unemployment and the agricultural wage and these in turn affect individual's migration and wealth accumulation decisions. As in Banerjee and Newman (1993), the system cannot be described by a stationary Markov process, because the wealth distribution affects the probability of transitions between states. Given its complexity, this process cannot be completely characterized analytically, which is why we resort to simulations, described in the next section. However, several observations on the nature of possible equilibria can be made.

First, with heterogeneity of abilities there will be a self-selection by higher ability individuals who invest in skills and migrate to the city, and by lower ability workers who stay in the country and work in agriculture. Where ability levels differ continuously over the relevant range, this additional dimension of heterogeneity permits equalization of the long-run average urban and rural wages *for some marginal agent i:*

$$\overline{w}^a = -h^i(1+r) + (1-\overline{u})w^s + \overline{u}w^n \qquad (\textit{provided } \overline{x}^i > h^i) \tag{21}$$

In this case, there is a set of possible long run urban income levels, some of them below the wealth implied by the agricultural wage , and some above, depending on whether the ability level was high (low h^i) or low (high h^i). Only the higher ability workers would migrate to the city and invest in human capital; however, it would not necessarily be the case that all urban workers were richer than rural workers.

Second, the wealth of all the rural population would converge to the same steady-state wealth level for agricultural workers $\overline{x}^a$, which is independent of ability level h^i. Wealth would differ across urban workers, in contrast, to an extent that would depend principally on how unequal were abilities, how high was unemployment (assuming that $w^s - w^n$ is large), and whether there was an urban poverty trap (*c* large) or not.

Third, heterogeneity of skills is key to making the equilibrium determinate with some of the population living in the city and some in the country. If all abilities were the same, so $h^i = h$, and *c*=0, all individuals would either converge to long run wealth level $\bar{x}^u$ consistent with the weighted average of skilled and unskilled urban wage, or to the wealth level $\bar{x}^a$ consistent with the equilibrium agricultural wage, $\bar{w}^a$. Equilibrium unemployment and the agricultural labor force are given by the following equilibrium conditions, as in the Harris-Todaro model (note that with *c*=0 the number of urban unskilled workers is zero):

$$\bar{u} = \frac{N - L^a - L^s}{N - L^a} \qquad (22)$$

$$\bar{w}^a = \alpha A(L^a)^{\alpha - 1} \qquad (23)$$

However, without any heterogeneity this equilibrium will be a knife-edge with either everyone living in the city or the country, depending respectively on whether

$$\bar{w}^a \quad < \quad -h(1+r) + (1-\bar{u})w^s + \bar{u}w^n \qquad (provided\ also\ \bar{x}^u > h)\ or \qquad (24)$$

$$\bar{w}^a \quad > \quad -h(1+r) + (1-\bar{u})w^s + \bar{u}w^n \qquad (25)$$

Fourth, the case of *c* large amplifies the possibility of hysteresis because those unemployed would run the risk of not being able to escape from the poverty trap, if their wealth were too low. Depending on the distributions of wealth and ability, it could happen that all who migrated to the city (those with higher ability) eventually became unemployed, and hence urban poor, while the lower ability individuals stayed in rural areas—giving a bipolar distribution of wealth.

Finally, there is an externality in migration to the city because migration increases the unemployment rate and hence the probability that others will fall back into rural or urban poverty. As a result, there may be Pareto-improving policies that discourage migration, e.g. by subsidizing rural wages. However, a more unequal initial wealth distribution could also lead to higher average income for a time by limiting the number of those with $x_t^i > h^i$, and thus able to migrate and invest in skills. By decreasing the rate of unemployment, it would permit more rapid wealth accumulation, at least initially, and might permit (at least for high ability individuals) an escape from the poverty trap that they might have fallen into if their wealth had been lower.

V. SIMULATIONS

In this section, we present simulation results for parameterized versions of the theoretical model discussed above. We consider in particular how the distributions of abilities and of initial wealth affect the outcomes. We allow for the endogeneity of the agricultural wage, migration and skill acquisition, and the wealth accumulation dynamics. Parameter values chosen were the following: $w^s = 10, w^n = 2, \alpha = \beta = 0.7, N = 1000, L^s = 300$. The parameter A of the production function is chosen such that the demand for agricultural labor equals 700 when $w^a = 2.5$. The other parameters are described below.

We first consider the case where c=0 (no costs of backmigration) and where the agricultural wage is relatively high, initial wealth levels are low relative to steady-state, and initial mean wealth is lower than the mean cost of acquiring skills. In particular, initial wealth and ability are drawn from uniform distributions with ranges 0.5 to to 1.5 and 1 to 3, respectively:

$$x_0^i \sim U[0.5, 1.5] \qquad (26)$$

$$h^i \sim U[1, 3] \qquad (27)$$

The population is initially completely rural, and by construction there is no correlation between ability levels and initial wealth. Figures 4-5 plot the key variables for 100 periods (generations). Initially, there is some migration to the city, until the unemployment rate rises to about 54 percent and discourages further migration. Wealth accumulation proceeds in both the agricultural and urban areas, making the cost of acquiring skills less and less of a constraint. After 100 periods, wealth distribution has stabilized in a way that reflects the distribution of abilities: the more able migrate to the city and acquire skills, while those who remain rural workers do so because they face a higher average cost of acquiring skills (Figure 4). Despite occasional spells of unemployment, urban workers converge to steady-state levels of wealth that depend on their abilities, while all rural workers converge to the same x^a (Figure 5). The correlation between ability and wealth at this point has stabilized to 0.9, and the Gini coefficient for wealth, at 19.0, is only slightly greater than the Gini for abilities, which equals 17.0. In this parameterization, the initial distribution of wealth has no importance for the steady-state distribution, since all dynasties are able eventually to acquire sufficient wealth to acquire skills, if their ability makes it worthwhile. A higher dispersion of abilities may however make it permanently unprofitable for some to migrate, and thus increases the inequality of wealth and decreases the average wealth level of the economy.

The opposite relationship between dispersion of abilities and average income may also prevail, however, and this may produce a positive correlation between steady-state *wealth inequality* and *average income (or wealth).* In particular, simulations were performed for parameterizations with the initial mean level of wealth farther below the mean cost of acquiring skills. Here, $\bar{x} = 5, \bar{h} = 8,$ and the range of the distribution of abilities was varied to examine the effect of this aspect of inequality. Figure 6 plots the average value of wealth, wealth inequality (as measured by the gini coefficient), and the unemployment rate for periods 11–100, against the dispersion of abilities. In particular,

$$h^i \sim U[8-\sigma_2/2, 8+\sigma_2/2] \quad (28)$$

$$x_0^i \sim U[2.5, 7.5] \quad (29)$$

so σ_2 measures the dispersion of abilities. It can be seen that increased dispersion of abilities increases the economy's per capita income in this case. Increased dispersion causes a greater self-selection as concerns urban migration and skill acquisition: those most able can acquire skills at a lower cost, and this allows them to accumulate more wealth. In contrast, those with lower ability earn the agricultural wage anyway, so do not suffer from the greater dispersion. This produces both greater inequality in wealth and a higher average level of wealth.[8]

We go on to consider $c = 1.5 > w^a - w^n$, so that there is the possibility of an urban poverty trap. This case is illustrated in Figures 7–8, for the same distributions of initial wealth and abilities in Figures 4–5, namely,

$$x_0^i \sim U[0.5, 1.5] \quad (30)$$

$$h^i \sim U[1, 3] \quad (31)$$

In this simulation, by t=100, 10 percent of the population are urban poor (Figure 8); after migration to the city they became unemployed, and their wealth was insufficient to allow children to acquire skills. In Figure 8, the distribution of wealth at t=100 is bi-modal, in contrast with Figure 5, because there is a peak at $\bar{x}^n = 6.09$, corresponding to steady-state wealth of the urban poor (the larger peak corresponds to the wealth of agricultural workers, while wealth levels of the urban skilled are both higher and more dispersed). Here the Gini coefficient of wealth equals 20.3. Though the Gini for abilities is the same as before (17.0), there is further sorting between the urban poor and the urban skilled. The former, because they face higher costs of skill acquisition (higher h^i), cannot escape from urban poverty with x=6.09, while those with greater ability are able to.

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[8] As before, the initial wealth distribution has negligible effects on the ultimate distribution, because even agricultural workers become wealthy enough to acquire urban skills if they desire to do so. They remain rural workers in equilibrium because for them the expected return for investment is below the agricultural wage.

VI. EXTENSIONS AND CONCLUSION

How are the insights from the Harris-Todaro and Galor-Zeira models affected by the interaction of migration and skill acquisition? Clearly, wealth inequality and migration affect each other in complex ways. First, if migration is in part the response to a desire to acquire skills associated with urban education and production, and skills acquisition is costly, then wealth distribution will matter for migration. There will be self-selection by the wealthier and more able to migrate to the cities, and by the less able and/or less wealthy to remain in the countryside. If large scale migration has undesirable effects, a possible remedy would be to develop the rural education system, providing formal-sector employment opportunities there, and reducing the cost of urban-rural backmigration. Though this has long been suggested as a development strategy, as noted above developing countries in fact have often adopted an urban bias.

Second, the relationship between wealth inequality and growth (or per capita income) is not as straightforward as in Galor and Zeira (1993). Because there is an additional cause of inequality, namely difference in skill levels, and the more skilled have greater access to the higher wage activity (the urban formal sector), greater inequality may in some cases be associated with higher average income, even if also accompanied by higher unemployment. This possibility is recognized in the literature, but in the polar case of no persistence across dynasties of differences of abilities (Loury, 1981) this produces no long run consequences for income distribution; in contrast, here these differences are assumed to be permanent.

How are these results sensitive to the particularly stark assumptions made in the model of this paper? First, the assumption that the minimum wage in the urban formal sector is fixed at a level above the market clearing level is ad hoc. However, the assumptions of fixed skilled and unskilled urban wages are not necessary to give the above results. Second the assumption of perfect capital mobility neglects an important part of the developmental process, namely the accumulation of capital through domestic saving.[9] As Aghion and Bolton (1997) show, this introduces a nonlinearity in individual wealth accumulation that may produce multiple invariant distributions. As in that paper, general analytical results are likely to be difficult, and hence this generalization of our model is best explored by simulation. Third, production technology is rudimentary for sake of simplicity but similar results would be obtained with an endogenous growth model. A more convincing long run description of the development process would allow not just the level but also the growth rate of productivity to be higher in urban production, leading to possible links between inequality and growth rather than just between inequality and average income.[10] Such a model could also incorporate an externality in production involved in urban employment, which might partly offset the externality involved in urban migration

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[9] Galor and Moav (2000) argue that physical capital accumulation is a dominant factor in the initial stages of development, human capital in later stages

[10] See for instance Galor and Tsiddon (1997b) and Aghion and others (1999).

discussed above, that higher migration increases the probability of unemployment for other urban workers. But the complex interaction between migration and inequality would remain in a model with a distortion that led to above-market-clearing urban wages. Fourth, the distribution of abilities is assumed to be permanent and unchanging across dynasties, leading to permanent effects on wealth distribution. A more satisfactory treatment would allow for both permanent and transitory shocks to abilities. Nevertheless, differences in abilities would still cause self-selection in migration, and would prevent simple associations between inequality and the level or rate of growth of income and wealth. Finally, a model of financial intermediation[11] would make it possible to understand better the nature of the financial distortion and possible measures to limit its contribution to persistent inequality. However, the qualitative aspects discussed above would remain.

Such extensions would however help make the model more useful in quantitative analysis of developing country poverty issues, and it is therefore intended to proceed with simulation of more elaborate, agent-based models incorporating those features.[12]

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[11] See among others, Banerjee and Newman (1993) and Bencivenga and Smith (1991).

[12] For surveys of agent-based modeling techniques and applications, see Arifovic, Bullard, and Duffy (1997), Axtell (2000) , and Tesfatsion (2000).

Table 1: Developing Countries: Population and Growth Rates of Urban Agglomerations with More Than 10 Million Inhabitants, 1950–2000

Urban Agglomeration	Population (in millions)			Annual growth rate (in percent)	
	1950	1975	2000	1950–1975	1975–2000
Mexico City	3.1	11.2	18.1	5.3	1.9
Bombay	3.0	6.9	18.1	3.5	3.9
Sào Paulo	2.8	10.0	17.8	5.3	2.3
Shanghai	10.4	11.4	12.9	0.4	0.5
Lagos	0.4	3.3	13.4	9.3	5.8
Calcutta	4.5	7.9	12.9	2.3	2.0
Buenos Aires	5.3	9.1	12.6	2.2	1.3
Dhaka	0.4	2.2	12.3	6.7	7.1
Karachi	1.0	4.0	11.8	5.5	4.4
Delhi	1.4	4.4	11.7	4.7	4.0
Beijing	6.7	8.5	10.8	0.9	1.0
Jakarta	1.8	4.8	11.0	4.0	3.4
Manila	1.6	5.0	10.9	4.7	3.2
Rio de Janeiro	3.5	7.9	10.6	3.3	1.2
Cairo	3.5	6.1	10.6	2.2	2.2

Sources: (1) World Urbanization Prospects; 1999 revision, UNDP;
(2) Distribution of cities by Population Size in Developing Countries, Institute of Developing Economies, Tokyo, Japan, 1989.

Table 2. Distribution of Population of Major Areas, 1975–2030

Major Area	(Percentage Urban) 1975	2000	2030
North America	74	77	84
Latin America and the Caribbean	61	75	83
Europe	67	75	83
Oceania	72	70	74
Africa	25	38	55
Asia	25	37	53

Source: World Urbanization Prospects; 1999 revision, UNDP.

Table 3. Selected Developing Countries: Comparison of Urban and Rural Access to Health and Sanitation (in percent of population)

	Adequate Sanitation		Safe Drinking Water		Health Services	
	Urban	Rural	Urban	Rural	Urban	Rural
Africa						
Ghana	62	44	88	52	92	45
Nigeria	50	32	80	39	85	62
Uganda	75	55	60	36	99	42
Asia						
China	74	7	...	...	100	89
Indonesia	77	49	87	57	...	...
Pakistan	93	39	85	56	99	35
Philippines	89	63	91	81	77	74
Latin America						
Bolivia	74	37	88	43	77	52
Ecuador	95	49	81	10	70	20
Paraguay	65	14	70	6	90	38

Source: IFAD (2001), Table 2.5.

Table 4. Selected Developing Countries: Urban and Rural Illiteracy Rates[1/]

	Urban	Rural
Asia		
Bangladesh	37.7	69.6
China	12.0	26.2
Philippines	2.7	10.3
Thailand	3.3	7.5
Latin America		
Bolivia	8.9	36.1
Brazil	10.7	31.1
Guatemala	16.8	47.8
Near East and North Africa		
Algeria	42.9	71.2
Morocco	41.1	79.3
Tunisia	31.9	60.0

1/ Latest available year.
Source: IFAD (2001), Table 2.6.

Table 5. Selected Developing Countries: Urban Informal Sector Employment, 1997 or latest year (in percent of urban employment)

Africa	
Cote d'Ivoire	52.7
Ghana	78.5
Kenya	58.1
South Africa	17.4
Tanzania	67.0
Asia	
India	44.2
Indonesia	20.6
Pakistan	67.1
Philippines	17.0
Latin America	
Argentina	45.7
Brazil	48.2
Mexico	54.0

Source: ILO, *Key Indicators of the Labour Market*, 1999 (Geneva: International Labour Office). Data are ILO definition where available.

Table 6. Selected Developing Countries:
Rural – Urban Differences in Poverty (Country Specific Poverty Lines)
(in percent of population)

	Rural	Urban	Rural – Urban Ratio
Africa			
Burkina Faso	51.1	10.4	4.9
Ghana	33.9	26.5	1.3
Kenya	46.7	28.9	1.6
Nigeria	36.4	30.4	1.2
Senegal	40.4	16.4	2.5
Uganda	48.2	16.3	3.0
Asia			
Bangladesh	39.8	14.3	2.8
China	17.4	4.1	4.2
India	34.2	27.9	1.2
Indonesia	22.0	17.8	1.2
Philippines	51.2	22.5	2.3
Latin America			
Bolivia	81.7	33.8	2.4
Brazil	41.5	13.2	3.1
Colombia	31.2	8.0	3.9
Ecuador	47.0	25.0	1.8
Peru	64.7	40.4	1.6
Venezuela	73.1	45.8	1.6

1/ Latest available year.
Source: IFAD (2001), Annex Table 2.1

Figure 1: Equilibrium Wage and Unemployment Rate in Harris–Todaro Model with Different Ability Levels

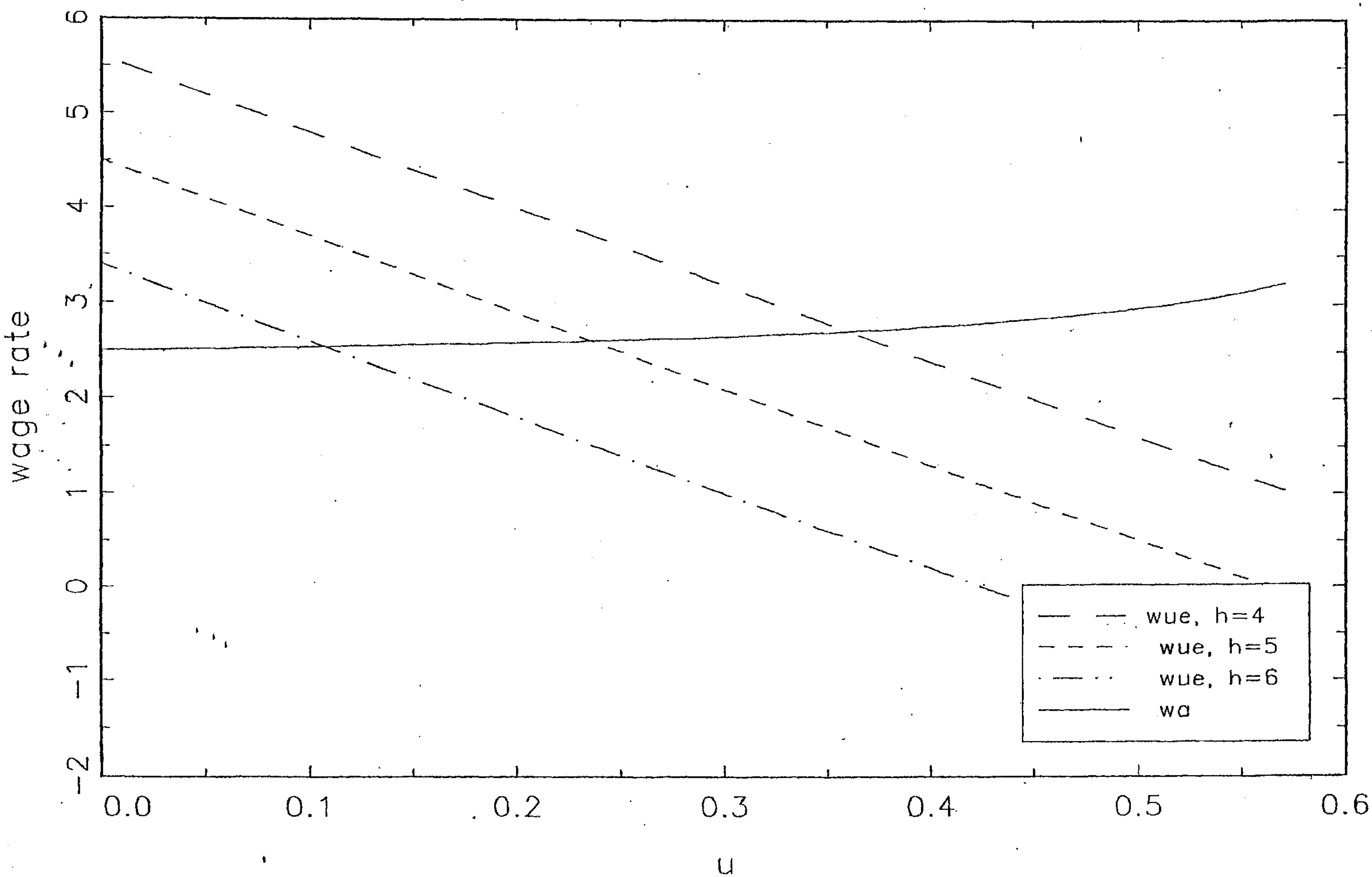


Figure 2: Wealth Accumulation and Migration (Intermediate Ability)

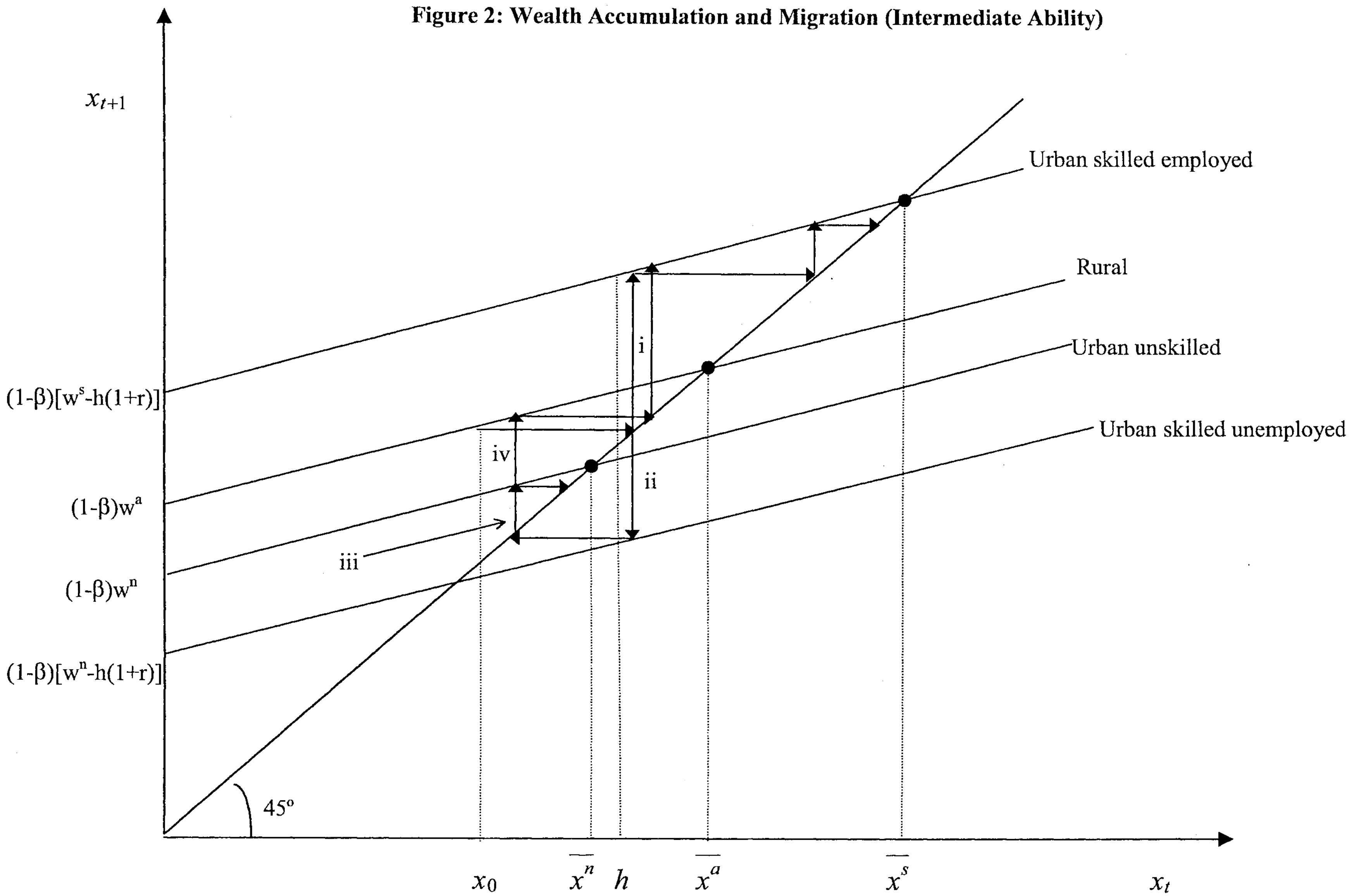


Figure 3: Wealth Accumulation and Migration (High Ability)

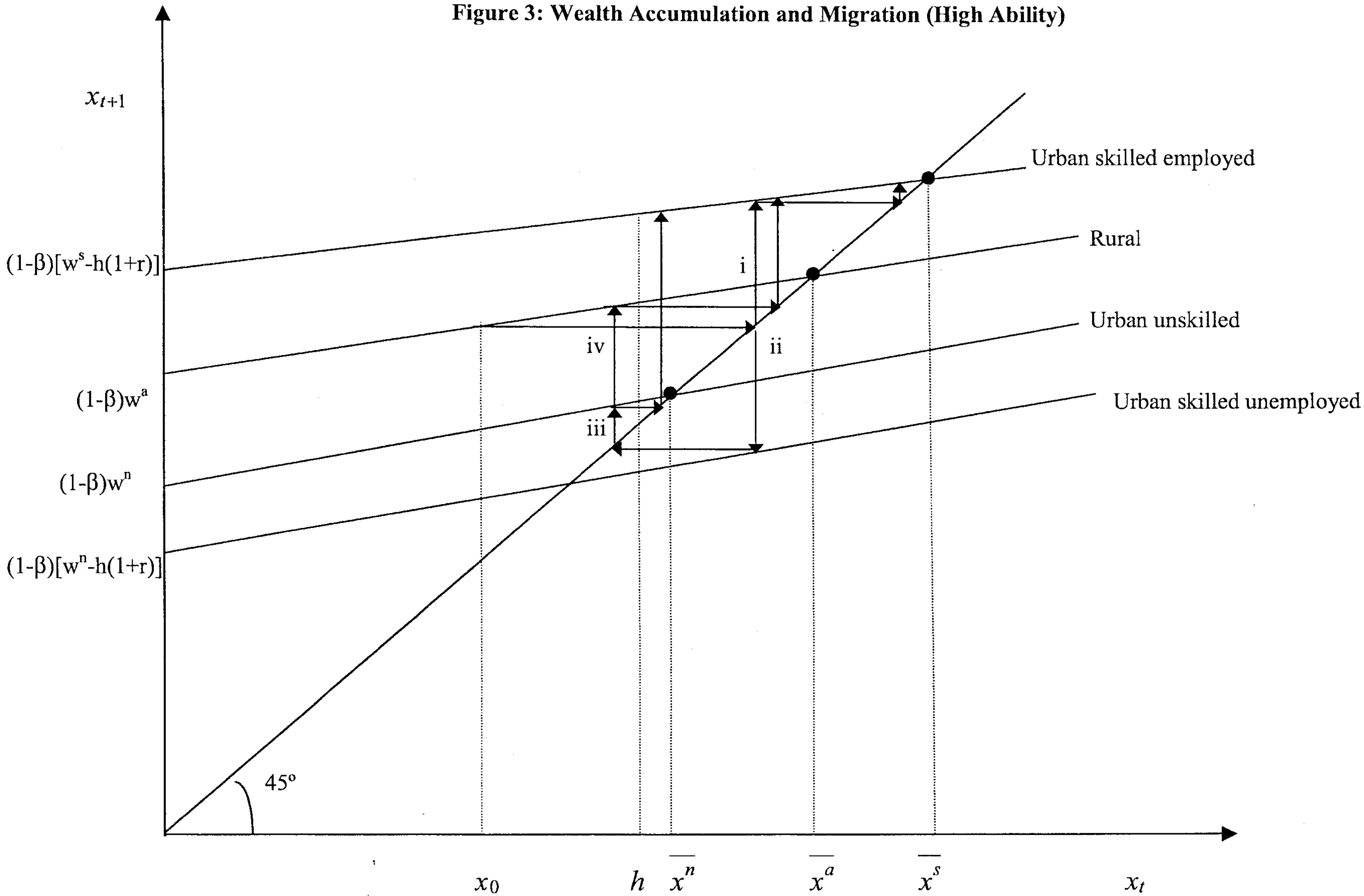


Figure 4. Agricultural Labor Force Share and Urban Unemployment Rate (c=0)

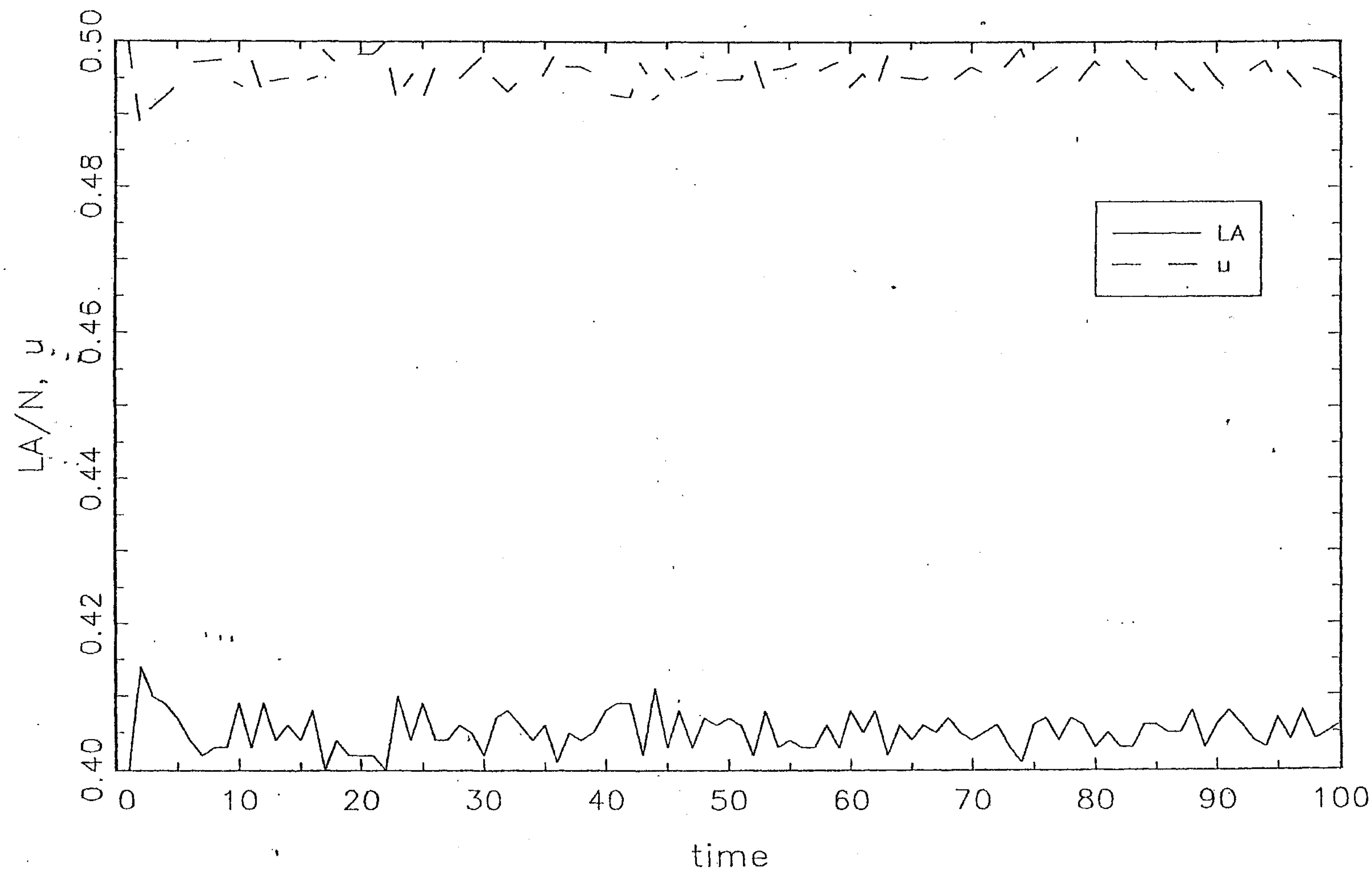


Figure 5. Average Urban and Rural Wealth and Skills (c=0)

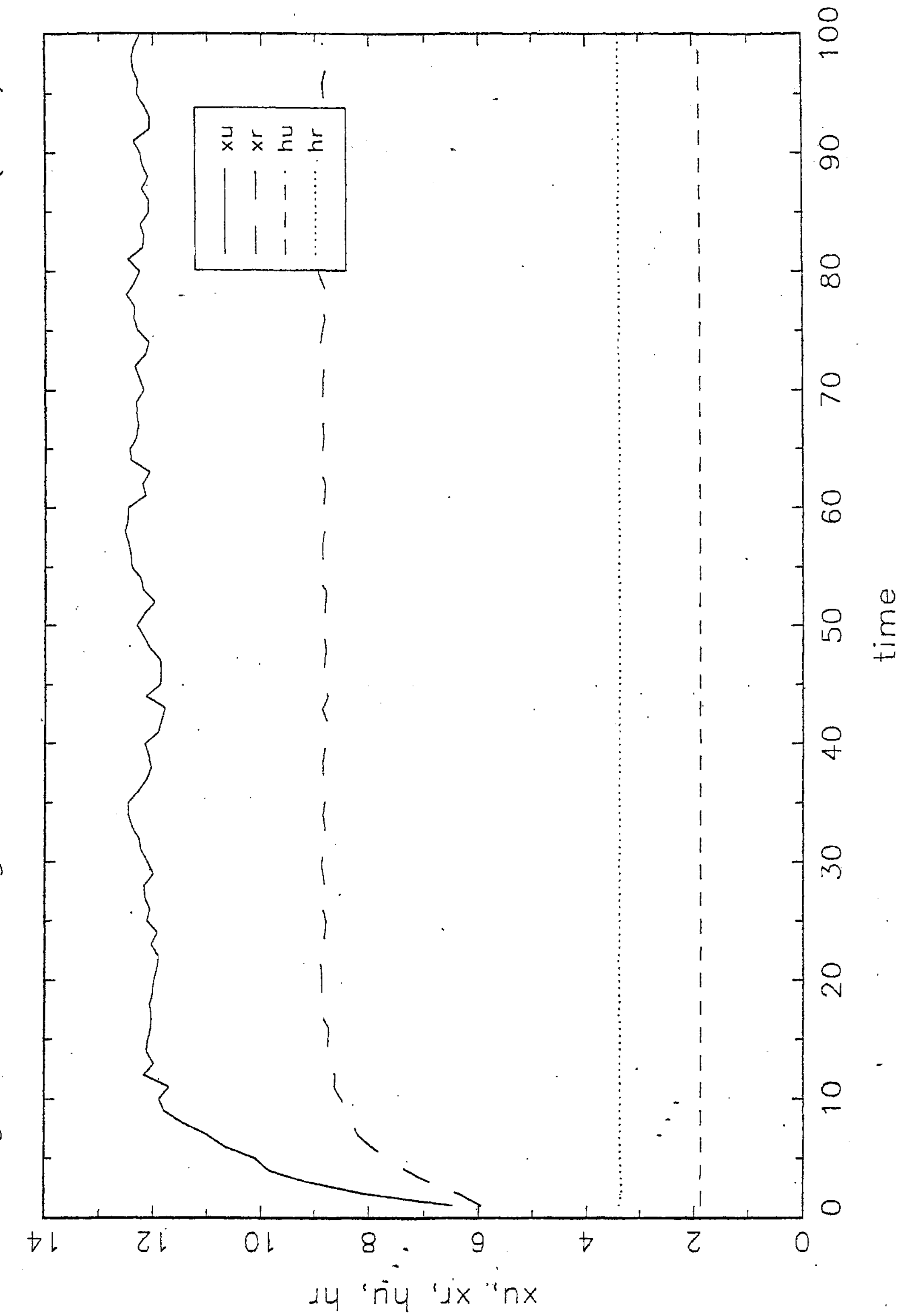


Figure 6. Distribution of Wealth (c=0), t=100

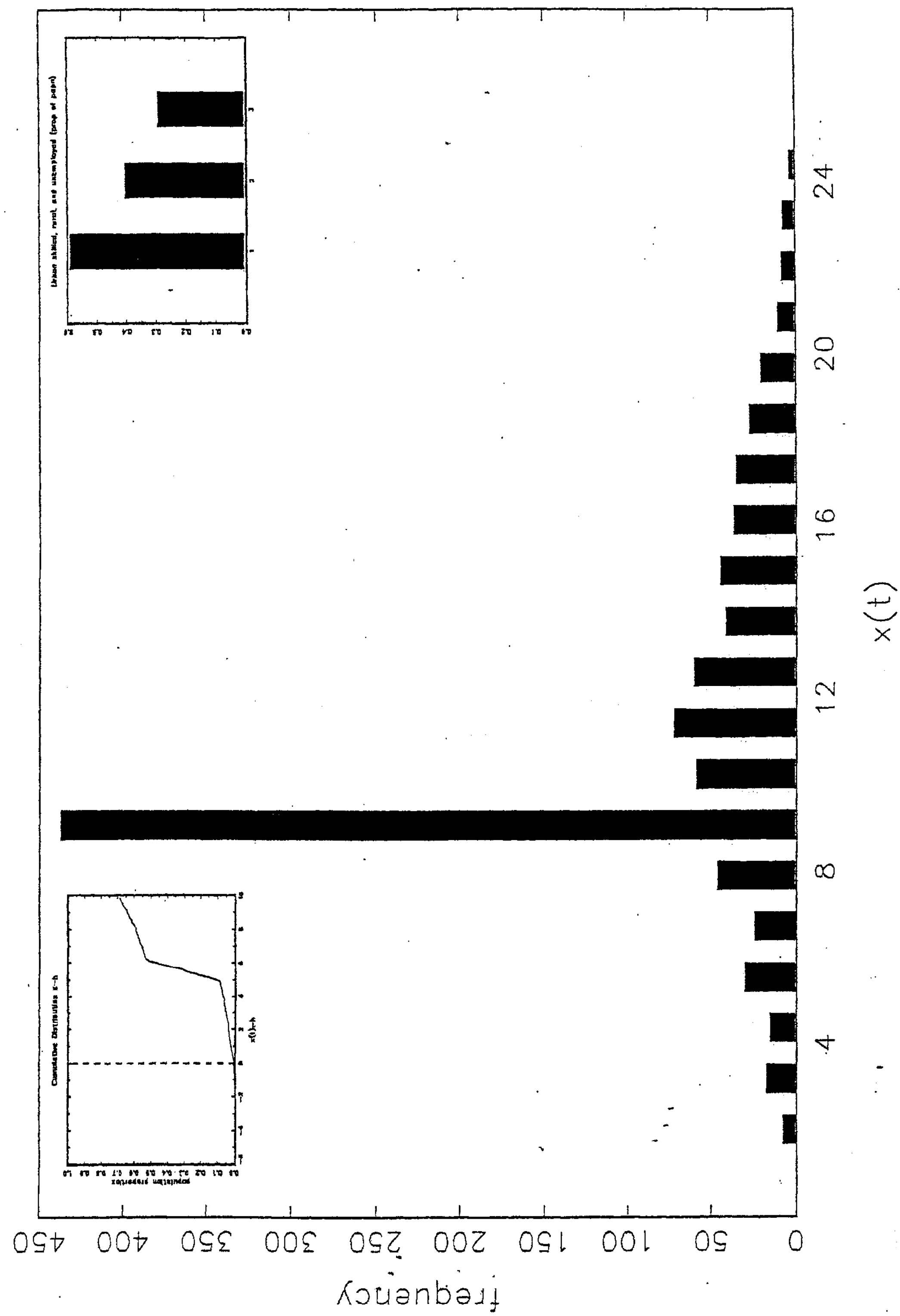


Figure 7. Average Wealth, Inequality, and Unemployment Plotted Against Sigma2 (hbar=8;xbar0=5)

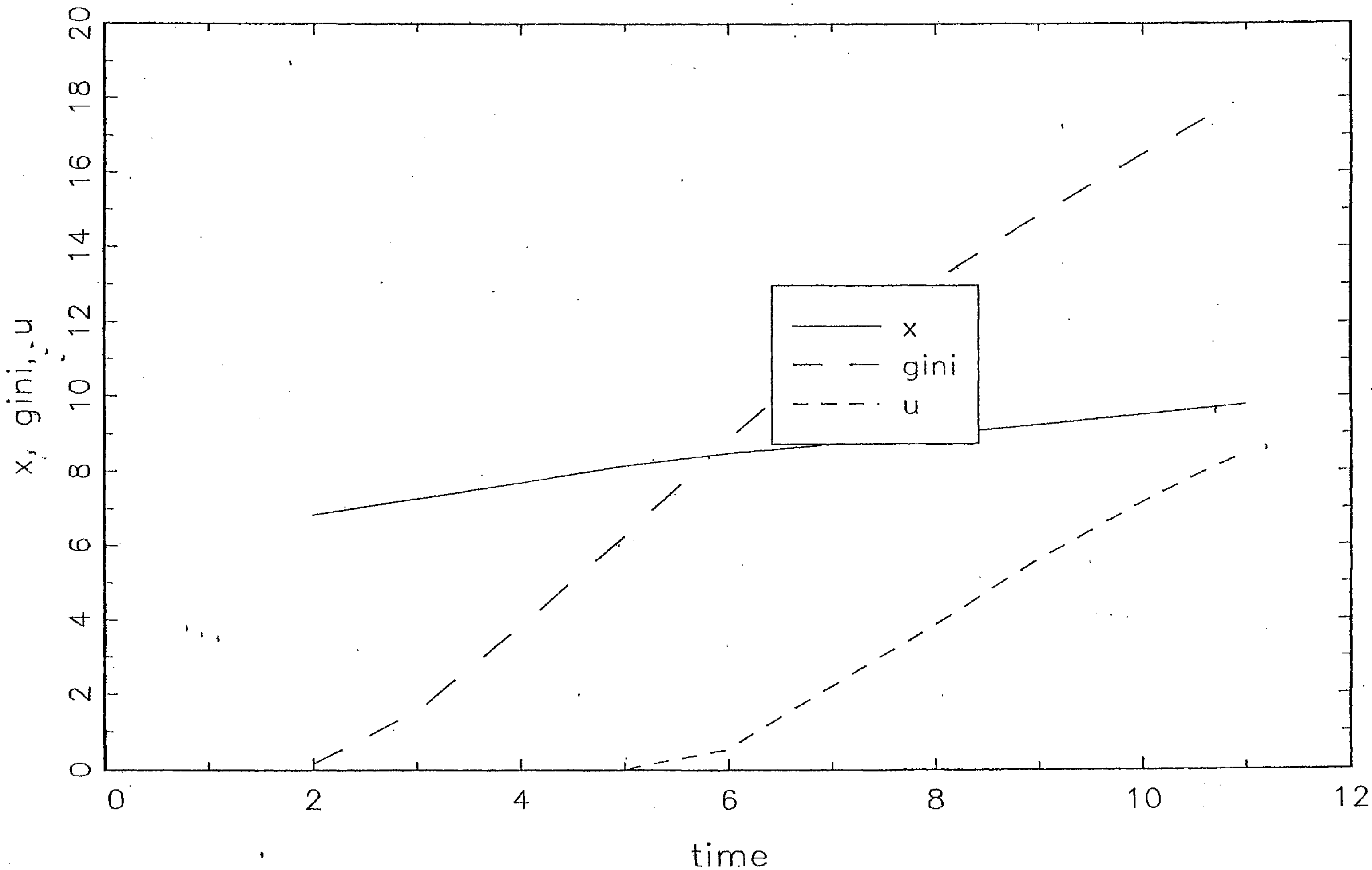
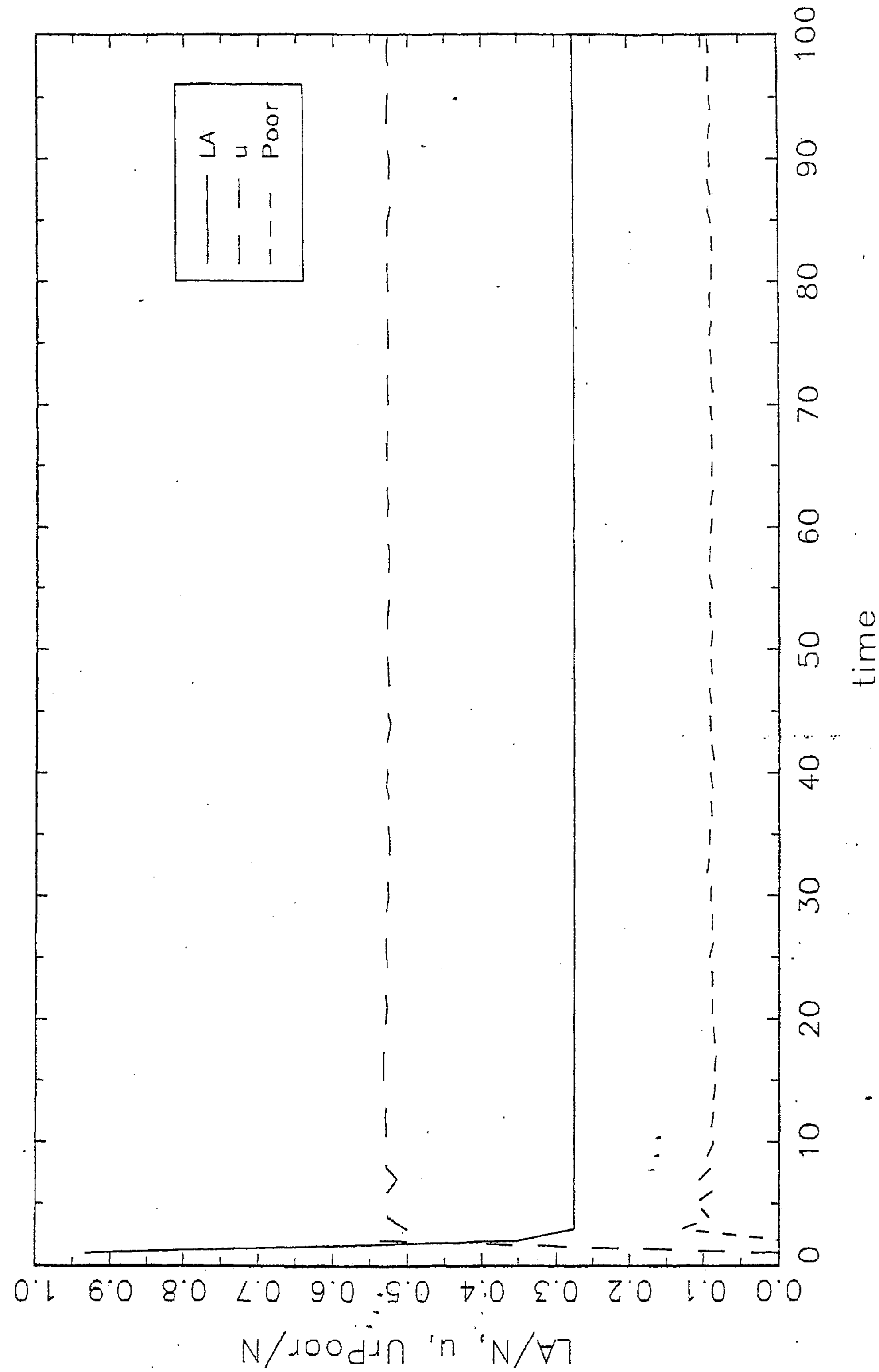


Figure 8. Agricultural Labor Force Share,
Urban Unemployment Rate and Urban Poor (c>wa−wn)



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