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Growth and Process in a Lineage-Based Social Technology

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ABSTRACT. This paper presents a computer simulation of the demographic growth process of a hypothetical African patrilineage where agriculture is "female dominated" and cattle are used as bridewealth. The model makes use of a Dahl and Hjort (1976) herd growth scenario and examines the growth of human population in relation to the growth of the herd.

Given the set of parameters that specify the level of bridewealth, fertility, age of marriage and the relative size of the initial herd, it is shown that there exists a specific percentage of cattle that must be used each year for bridewealth if the growth process is to have the properties of a "steady-state" that maintains stability in the number of wives and cattle per man for all future generations. Furthermore, the percentage of cattle that should be used each year is sensitive to the parameters of the model, so that the management of bridewealth is intrinsically complicated. Finally, it is found that the introduction of a "prestige" market for agriculture alters this system fundamentally in its formal aspects and in its implications for human behavior.

KEY WORDS: African bridewealth, demographic growth, world systems

1. INTRODUCTION

A complex modern economy is not made fully understandable or manageable on the basis of facts that are readily observable; there are simply too many facts, too many interrelationships, too many interdependent actors; and the relationships among the parts appear to be affected by a logic that is independent of the will of individual actors. Economists have developed rather elaborate models of the processes of the modern economy. They have done so in an attempt to illuminate the significance of certain observable facts, deduce the existence of unobservable facts and, in a manner that often seems to ignore the obvious, unravel the sets of relationships that generate the system.

Traditional African economies, on the other hand, are perceived to have relatively simple processes of production, coordinated through face-to-face relationships, that can be readily understood on the basis of direct observation. For anthropologists the focus of interest has been on the set

of complex kinship networks within which these economies are embedded. It can be shown that African economic processes, even at the lineage level, manifest a number of complex systematic characteristics that are not fully understandable from direct observation. In this sense, lineage-based systems, like market systems, may possess a logic that is not immediately implied by the observed behavior of system participants.

In this paper we present the results of a series of computer simulations of a lineage economy in order to explore the interaction of a number of significant factors in these systems. This investigation was prompted by the observation that the agricultural, cattle-raising, "Bantu-speaking" groups that migrated down and across the African continent, beginning perhaps during the second half of the last millenium B.C. (Fage 1978: 20), were able to absorb and/or dominate many of the peoples that they encountered in their path. The fact that they did so is not fully explained by their advanced technologies of production — their possession of iron tools, animal husbandry and cultivation (Sahlins 1972). Although nutritional limitations on demographic growth cannot be dismissed, it can be demonstrated that the possession of an effective technology of production is only one of the necessary conditions for superior demographic growth in a traditionally organized African lineage.

These lineage-based societies vary widely in terms of the specific rules governing production, reproduction, ritual and other processes. Some of them are matrilineal, rather than patrilineal, while a number appear to have systems of dual descent. Hence, there is no clearly defined African form of social organization and the differences among these many societies are often more interesting than their similarities. On the other hand, since our model employs only a few of the many structural characteristics of these systems, it is hoped that the implications of our study apply rather broadly among the ethnographic variations of African patrilineal systems.

We shall assume that the system is patrilineal, that wives can be taken from outside of the group whenever an internal shortage arises, that wives are the major source of the workpower in agricultural production and that agricultural land is readily available, thereby assuring the economic feasibility of polygyny (White and Burton 1988). Cattle are the major factor in bridewealth, so that the number of women that can be made available to the lineage depends in part on the effective management of the herd and on the management of relationships with other (wife-providing) lineages and societies. Given these assumptions, those groups within a given geographical terrain that are relatively more effective in the management of the herd and of the wife exchange process will tend to dominate demographically their neighbors.

The assumption that wives are available from outside of the group by free exchange with cattle is contradicted by the frequency of warfare as a factor in the acquisition of wives and of resources to use in exchange for

wives (White and Burton 1988). Indeed, if the processes of demographic growth that we describe here were common to many groups in a given geographic area, then the competition among wife-taking groups would prepare the context for warfare. The realism of our assumption depends in part on the meaning of "group" in this discussion. If the relevant group is a lineage, then the plausibility of its growth relative to other lineages within the same society may be feasible. However, if the society as a whole becomes a net wife-taker, then some other society or societies must accommodate them to the detriment of their own growth and independence.

Although the availability of wives is presumed in these models, the demographic growth process will be constrained by another consideration. We shall assume that the percentage of cattle that can be expended for bridewealth in each year must be such that it assures for every future generation the same number of wives and cattle per man.

This "steady-state" assumption is less intrusive than it may initially appear. First of all, if we know the technical capacity of the group to manage cattle, there can be said to be a technically determined upper limit to the cattle/man ratio, and, hence, a *lower limit* on the percentage of cattle that can be used annually for bridewealth. Secondly, there is *an upper limit* on the use of bridewealth, such that the expenditure of cattle at any higher level is demographically damaging to the group, threatening to remove it from the field of ethnographic observation. It turns out that the space between these two limits is fairly small, so that our focus on the specific steady-state value that lies between those limits is of importance, primarily, in simplifying the exposition.

We begin with an agricultural group whose herd of cattle grows through normal processes of fertility, as described by the Dahl and Hjort (1976) baseline herd. Dahl and Hjort do not consider the implications of bride-wealth for the growth of the herd because they are concerned primarily with pastoral societies in semi-arid regions for which cattle have been the primary food source and where during the last century problems of drought and disease have made herd maintenance a central issue. However, we are concerned with the characteristics of non-pastoral groups that live in non-arid regions for whom cattle provide only a supplementary (albeit important) source of nutrition. The Dahl and Hjort scenarios are adopted, in spite of their questionable applicability, because they are presented as explicit simulations which we could replicate exactly (to four decimal points). In this way we avoid introducing anything into the model relative to the growth and composition of the herd.

Determining the rate at which cattle should be used in bridewealth is clearly an issue of significance and controversy within lineage groups. It is often noted that juniors are in conflict with seniors over the timing of their first marriages and that the taking of second and third wives by seniors raises issues of equity within, as well as between, age groups. However,

this conflict should not be viewed myopically, seeing only a face-to-face issue among self-interested individuals. The long-term growth and viability of a lineage or of a set of lineages (a "society") may depend on the appropriate resolution of these controversies.

It is not our intention to suggest that the seniors of any group were able and willing to adopt a steady-state strategy. Indeed, there may have been a proclivity toward socially inadvisable decisions within many groups. However by examining bridewealth within a technical steady-state process we can reveal the complexity with which the variables are interwoven and the sensitivity of effective decisions to alternative states of the world.

11. BASIC ASSUMPTIONS

Dahl and Hjort present a number of cattle-herd growth processes that depend on alternative calving rates, mortality rates and calving periods (the ages during which cattle will be fertile), given a "baseline" herd of a specified age composition. They considered eight basic scenarios. The "normal" case, which we have chosen as our standard scenario, "shows what could normally be expected if the data from the survey of nomadic literature and the assumptions based on these are correct. In this example a calving period of four to ten years has been chosen in accordance with the data from Williamson and Payne on the decline of cattle fertility. The calving rate of 70 percent corresponds to the upper end of the interval given by Meyn, and to the information from Ruthenberg on the Bahima." (p. 64)

The time paths generated by the normal case and the other cases are displayed in Figure 1 (reproduced directly from Dahl and Hjort, p. 65). There is no special reason to assume that the Dahl and Hjort "normal case" applies to non-nomadic peoples, or to any specific group of African agriculturalists. However, the normal case seems not unreasonable to apply, since it generates a relatively modest rate of herd growth, 3.4 percent per year. Of the eight cases considered by Dahl and Hjort there were two with negative growth rates and one with a 2.1 percent rate. All others had rates of growth above that of the normal case. The results discussed in this report require only that cattle have a natural rate of growth that is higher than the rate at which the human population would grow if wives were obtained only by daughter exchange, which is only 0.82 percent by our assumptions. Consequently, our analysis would not be changed qualitatively if any of the other non-negative cases had been chosen.

Now, suppose that the herd is under the control of a patrilineage within which there are age specific survival rates for persons, such that one-half of all persons survive to age 21 and no one survives beyond age 60:

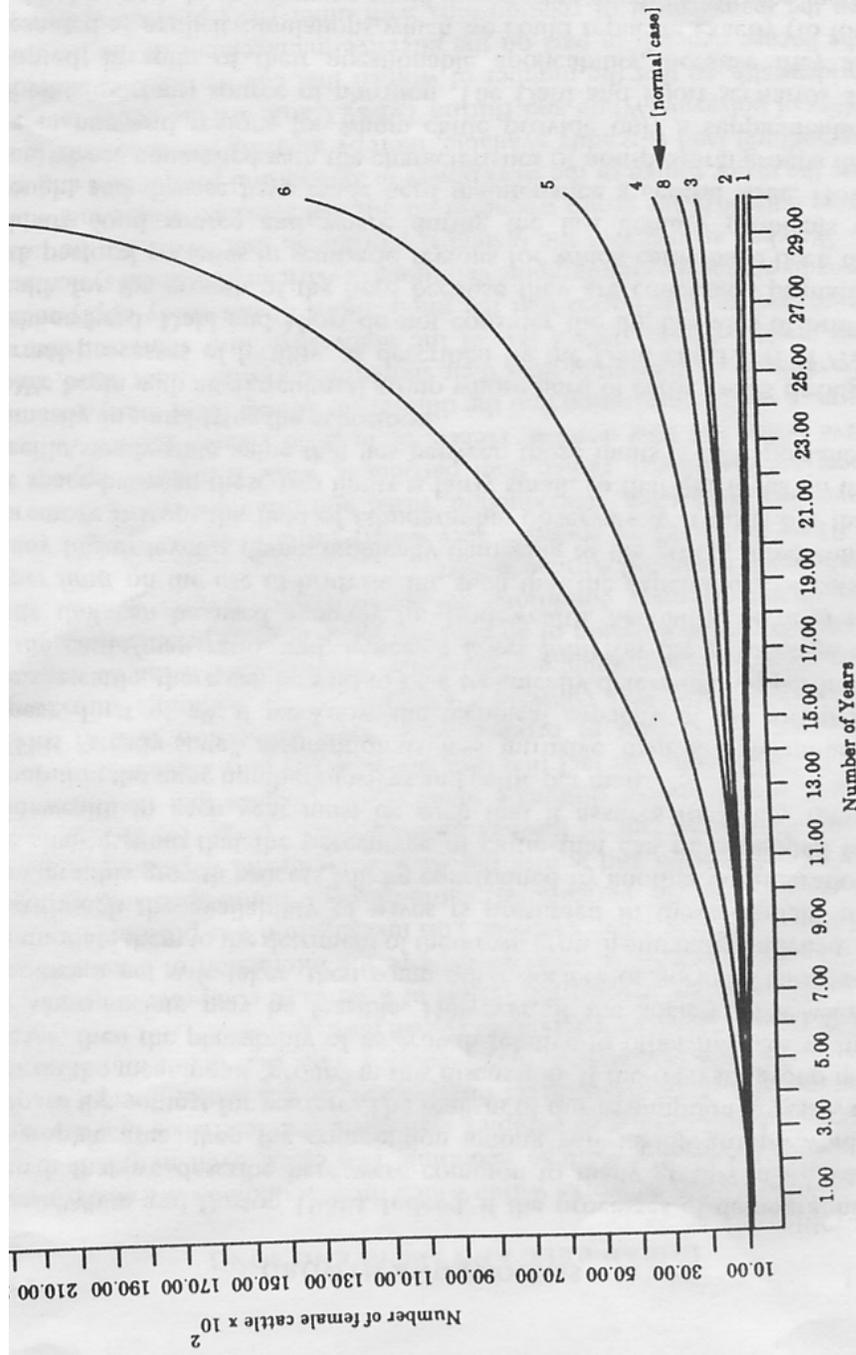


Fig. 1 The annual changes in the total female herds of cattle. Examples 1--8. (Source: Dahl and Hjort, Figure 2.21)

(age, *annual* survival rate) —
 [(0-1, 0.8), (1- 6, 0.95), (7-11, 0.98), (12-36, 0.99), (37-
 41, 0.98), (42-46, 0.95), (47-51, 0.9), (52-56, 0.8), (57-
 59,0.5), (60,0.0)].

These survival rates are rather crudely determined to represent a pre-European contact configuration. More recent data seem to indicate much higher rates of infant mortality in some parts of Africa (Reinhard, Annengaud, and Dupaquier 1968). However, current conditions are hardly indicative of the distant past. The higher population densities and greater pressure on resources of recent periods have dramatically affected fertility and survival rates in many parts of the world, including Africa.

Given these survival rates and some additional assumptions, one can simulate the demographic growth process of a lineage-group in the same way that Dahl and Hjort simulate the growth process for cattle. In generating the full model we must specify the fertility rate of wives, the age at which women marry, and the cattle required in bridewealth:

(a) Bridewealth cattle are exactly four years old (in every case) and in the standard case bridewealth requires 20 cattle. In comparison cases, bridewealth requires 15 or 30 cattle. According to Schneider (1964), twenty cattle are in the "high" range for bridewealth in Africa. However, it is in the middle range of the twenty-five patrilineal societies in his sample.

(b) The age of brides is 18 in the standard case with comparisons at 15 and 20. The marriage age of men is 25 in every case, since their marriage age is shown to be inconsequential for demographic growth. In the model all men and women marry on schedule.

(c) Women have children after marriage until the age of 40 with a total fertility rate of 6 in the standard case, with comparison cases of 4 and 8. Fertility is assumed to be uniform over the fertility period for the aggregate of women.

A "total fertility ratio" of 6 was chosen on the basis of current data on Kenya (World Bank, 1985) and data from a study of fertility in a Nigerian village (Onwuazor 1977) where in each case the estimated fertility rates were between 6 and 8. There is no suggestion here that these data are representative of contemporary Africa or that they bear any special relevance to pre-contact fertility rates.

(d) In all cases the total population begins at 500 females and 500 males, where 260.56 of the females are age 18 and over and 194.79 of males are 25 and over, so that the system begins with 1.34 wives per man, simply as an artifact of differential marriage age.

(e) The herd consists of 1,000 female cattle with ages distributed in

accordance with the Dahl and Hjort baseline herd. Male cattle are presumed to be consumed as food, except for a necessary number of bulls.

III. MODELLING THE DYNAMIC PROCESS

A society with these characteristics can be modelled on the basis of a fairly simple computer program; and we have examined its growth characteristics over a period of 250 years, or ten generations. The purpose of the model is to determine the *sensitivity of* the wife-acquisition and demographic growth processes to variations in the fertility of wives, the age at which women marry, the number of cattle required per marriage, and the initial size of the herd. This is achieved by determining the percentage, "alpha," of the four-year-old cattle that should be used each year for bridewealth under alternative assumptions about the independent variables.

Studying the sensitivity of a system of social and material relations is not a substitute for the study of actual historical processes. Rather, it implies an examination of the factors that constitute the underlying *social technology* of the group. By using the term social technology we suggest a sophisticated machinery wherein the rules governing social relations constitute significant components. It is assumed, further, that human agents make critical decisions in relation to this social technology in order to realize socially defined goals. The characteristics of a social technology introduce incentives and constraints relative to particular courses of action and, hence, may affect the historical record. However, the actual record is affected by innumerable external factors, accidents and coincidences, that make it difficult, if not impossible, to relate events to systematic factors within the social technology. For this reason it is inappropriate to expect history to "validate" the model. On the contrary the simulation model is useful largely because the course of actual affairs does not permit the systematic examination of important parameters within the social technology.

We have defined alpha as the percentage of four-year-old cattle that should be expended each year in bridewealth and whose adoption would produce identical wives/man and cattle/man ratios for every future generation. In order to gain insight into the manner in which alpha affects the system, consider the case where the lineage adopts an alpha that is larger than this steady-state value. In this case an excessive number of four-year-old cattle are withdrawn from the herd, and the rate of growth of the herd will fail to be commensurate with the growth rate of population, leading to a declining cattle/man ratio, a declining wives/man ratio and, for large alpha, an absolute decline in the size of the herd.

For example, given the standard parameters, an alpha of 25 percent is much too large. At the end of the period the total population would grow from 1,000 to 10,383, a compound rate of 0.94 percent per year, and the herd would be reduced to only 348 head, corresponding to a cattle/man ratio of only 0.19, compared with the initial ratio of more than five cattle per man. This small and declining herd may be nutritionally inadmissible. And to the extent that a growing herd is culturally and ideologically important to the group, this scenario is destabilizing.

On the other hand, an alpha value that is too small leads to an excessive growth in the herd relative to population, even though the rate of population growth may be admirably high. For example an alpha of 10.0 percent is too small. In ten generations the population would grow rapidly to 23 864, a 1.27 percent compound rate. The number of wives per man would be relatively high as well, 1.78, indicating that a sacrifice by early generations in taking few wives and allowing the herd to grow leads to the possibility of a higher wives/man ratio for future generations. However, the scenario is infeasible, because the number of cattle grows from 1,000 to 134,779, or from 5.13 cattle per man to 37 cattle per man. The latter figure corresponds to 5.6 cattle *per capita* and, according to Schneider (1979), a cattle-to-people ratio of six or more entirely precludes agricultural activity. Hence, the scenario associated with this small value of alpha is ultimately inconsistent with the maintenance of the agricultural society with which we began this discussion. Of course such an alpha could be adopted temporarily in order to build up the herd following some calamity, but no more than that.

Between 10 percent and 25 percent lies the “steady-state” value of alpha -- the value that maintains a stable universe for every generation. Given the standard parameters, this value is 15.52 percent. Were this value to be chosen, the population would grow to 14,935, a rate of 1.08 percent, over the 250 year period. There would be 1.51 wives per man and 6.57 cattle per man. This steady-state would be reached gradually from the baseline conditions in only 66 years. See Figure 2. It provides a 15 percent increase in the wives/man ratio, relative to the ratio that is achievable from daughter exchanges alone.

IV. CHANGING THE PARAMETERS

The sophistication of the bridewealth management process can be appreciated when one considers the effect of changes in the standard parameters on other characteristics of the system. We shall consider changing the initial (baseline) size of the herd, the number of cattle required in bride-wealth, the fertility rate of wives, and the ages at which men and women first marry.

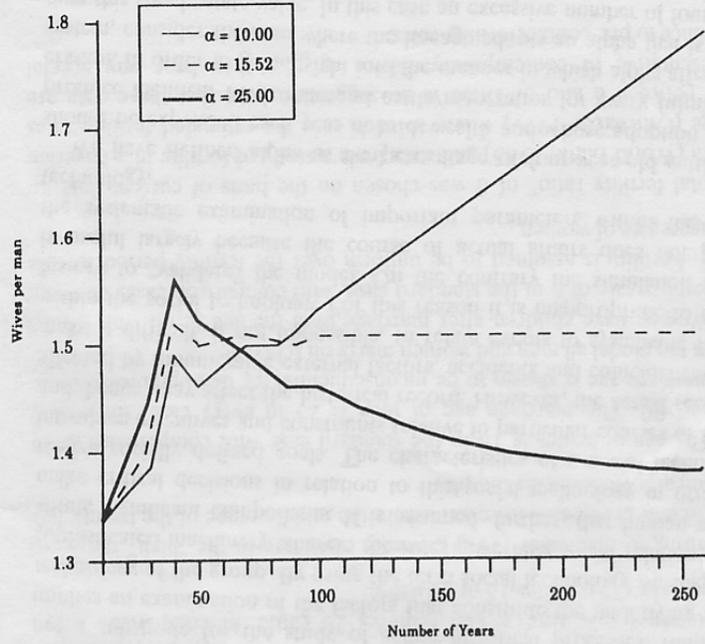


Fig. 2a. Wives/man as a function of alpha.

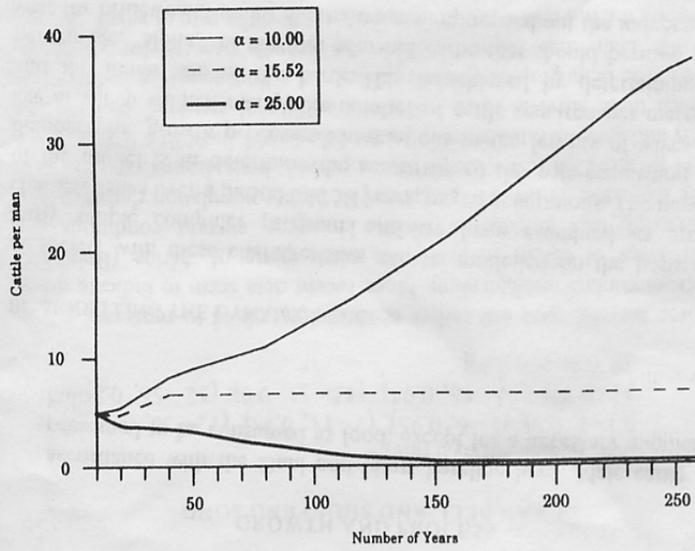


Fig. 2b. Cattle/man as a function of alpha.

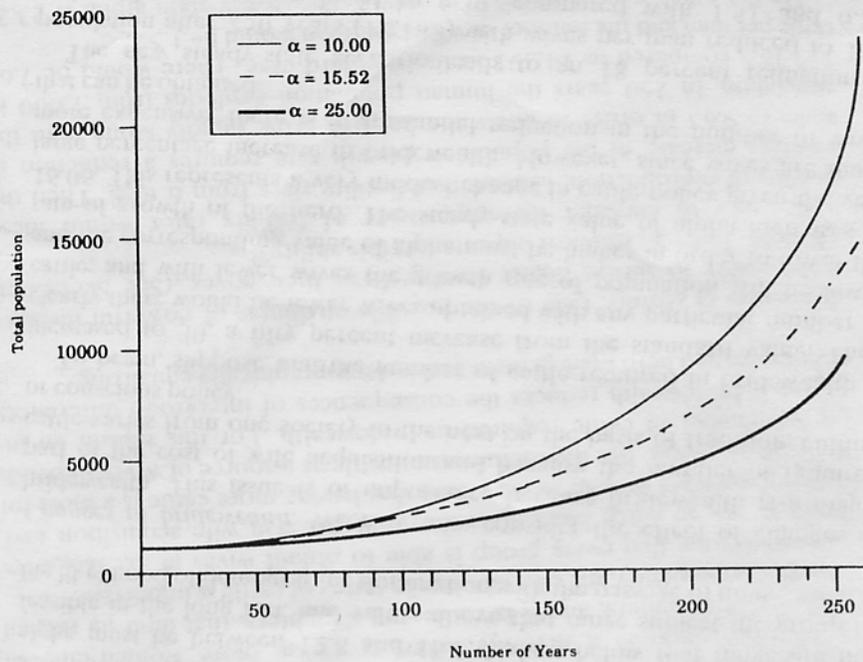


Fig. 2c. Demographic growth as a function of alpha.

Changing the size of the baseline herd. It is common for dynamic models to possess somewhat arbitrary, but inconsequential, assumptions regarding the initial state of the system. For example the age compositions of the baseline herd and of the human population are inconsequential, because the assumed fertility and survival rates generate in due time profiles of ages that are independent of the initial conditions. And, similarly, if the human and cattle populations both increase by any common multiple, the steady-state values of alpha and the critical ratios remain unchanged. These are very desirable characteristics of the model. However, if the size of the herd were reduced to 500 with the human population unchanged (at 1,000), the steady-state value of alpha would rise to 16.35 percent. One must use a larger percentage of a smaller herd! The reason for this result is that with a smaller herd the human population will grow more slowly and, hence, the steady-state rate of herd growth must be lower and consequently alpha must be larger. When alpha is 16.35, the herd will grow from 500 to 6,109 after 250 years compared with 8,440 when alpha is 15.52. Hence, were the society to use the smaller value of alpha for the initially smaller herd, the resulting scenario would not generate culturally unsustainable ratios. Instead, the

system would grow steadily *without reaching a steady-state* for more 1000 years, and only then would the system converge into cattle/man and x wives/man ratios that approximate the standard case.

This result partially contradicts our earlier statement that the initial size of the herd affects the steady-state value of alpha. We see that if enough time is allowed to pass, there is a convergence to the ratios of the standard case when the standard alpha is adopted. Moreover, one may argue that 15.52 is better for the 500 cattle case than the steady-state value (16.35) since it has a superior demographic growth path and does not encounter an excessive cattle/man ratio. However, steady-state values of alpha are not necessarily the "best" values. Our simulated steady-state scenarios are not evaluated in terms of the preferences of the system's participants; those preferences are unknown. Nevertheless, we reject scenarios in which the stability of critical social characteristics is not reached for 1,000 years, because we are interested in characterizing systems in which stable social valuations and unchanging cultural practice are feasible.

Critical lower bounds on alpha. Having alpha greater than the steady-state value is problematic, because it leads to gradual reductions in all resources over time and, hence, can be said to imply an unfair depletion of the herd by the current generation to the disadvantage of later generations. Furthermore, groups that adopt such practices are demographically less viable than others and are likely to be absorbed. Indeed, processes of absorption and demographic domination may have been common features of traditional African societies prior to European contact.

On the other hand, we have seen that a group may adopt an alpha below the steady-state value and reap long-term benefits, provided that alpha is not so low that it gives rise eventually to too many cattle. So, what is the lowest value of alpha that is consistent with the group's capacity for herd management?

We have assumed a female-dominated agriculture, so that some men can "support" more than one wife. In particular we shall assume that six-tenths of the work-time of a man (6/10th of an "adult-equivalent") is required to supplement the efforts of each wife in domestic production; and we assume that one adult-equivalent can manage 40 cattle. Obviously, these numbers are somewhat arbitrary. Wives may be more or less self-sufficient than this assumption implies; and the difficulties of herd management will vary with the local ecology. However, even if two boys (one adult equivalent) can herd 100 cattle, a herd of that size seems unlikely in a society where the cattle/man ratio is only 6.57. In some societies households may assemble their cattle into herding groups for more efficient management (Rigby 1969); but even if such a device is employed, a herd of 40 seems reasonable.

Additionally, we must specify the number of adult-equivalents attributable

to males of various ages, and given the population of males by age, determine the total number of adult-equivalents available to the group as a whole. Adult-equivalents as a function of age are specified as follows:

(age, adult-equivalent for *each* year)
 [(5-10, 0.1), (11-15, 0.4), (16-20, 0.8), (21-45, 1.0), (46-50, 0.9), (51-54, 0.8), (55-57, 0.5), (58-60, 0.1)].

With these assumed work capabilities and the assumed work requirements associated with wives and cattle, the feasibility of any specific growth scenario can be ascertained. Although a lower value of alpha generates more workpower, it also leads to higher wives/man and cattle/man ratios, so that a higher percentage of available adult equivalents is required. In the standard case the lowest feasible value of alpha (one that exhausts workpower) is 12.8.

It follows that the bridewealth policy that corresponds to our standard assumptions is restricted to values of alpha within a very small range; alpha must be between 12.8 and 15.2. Values below that range are not feasible in the long run, and values above that range subject the group to the likelihood of demographic domination with the passage of time.

Changes in bridewealth. We may now consider the effect of changes in bridewealth. This issue is of importance because bridewealth is a major part of the cost of wife acquisition and because the number of required cattle varies from one society to the next on the basis of tradition, culture or conscious policy.

To begin, suppose that the number of cattle required in bridewealth is increased to 30, a fifty percent increase from the standard value. Then clearly there would be fewer wives obtained with any particular number of cattle; and with fewer wives the growth rate of population will be lower and the corresponding value of alpha must be higher in order to lower the rate of growth of the herd. The steady-state value of alpha increases to 16.06. This represents a very modest change in cattle policy given the very large percentage increase in bridewealth. However, since wives are much more expensive, there is a substantial reduction in the number of wives that can be obtained.

The new steady-state scenario leads to an 18 percent reduction in population after 250 years (12,182) with wives per man reduced to 1.46 and cattle per man reduced to 6.39, compared with 1.51 and 657, respectively, in the standard case. Hence, the principal consequence of an increase in bridewealth is not upon the critical ratios, but on the rate of population growth.

On the other hand, if the required bridewealth cattle were reduced to 15, a larger number of wives could be obtained from a given number of cattle and the steady-state value of alpha would fall to 15.03 in order to

allow the herd to grow faster. After 250 years the total population would be 18,027. This is almost 21 percent above the standard case. Moreover, the number of 'wives and cattle per man increase to 1.54 and 6.7, respectively.

These results tell us that the level of bridewealth has little impact on the of alpha or for the relations of social reproduction, since the change in the wives per man ratio is less than 3 percent in response to quite large percentage changes in required bridewealth. The more serious consequence is for demographic growth. Consequently, the number of cattle required in bridewealth may be a matter of importance to the group as a whole but once this requirement has been well established, it needn't become an issue that affects the politics of junior-senior interaction.

On the other hand the level of bridewealth could be important for the relationships among intermarrying groups. If each group takes only as many wives from others as it gives to others, then each group would grow at a rate determined by the availability of daughters, independently to the level of bridewealth. However, in the cases considered here, the group under observation is a *net wife taker*, receiving more women than it produces as daughters; and it is cattle, not daughters, that limit its rate of growth. Consequently, the cost of wives in terms of cattle is important.

If we assume that every group is able to obtain wives in exchange for daughters on an equal basis, then they will differ in wife acquisition and, hence, population growth to the extent that having more cattle is a basis for having more wives. But the usefulness of cattle as a source of wives depends on the number of cattle required in bridewealth. For this reason an increase in bridewealth reduces the consequences of inter-group differences in herd size and herd management and is demographically equalizing.

Differences in fertility. One of the possible attributes of powerful lineages is the ability to secure higher fertility from their wives. (See Schneider, 1979, pp. 114—5.) But how important is this ability?

In order to consider the importance of fertility rates within these systems of reproduction, assume that fertility rises from 6 to 8. Then the resulting increase in the population growth rate requires a reduction in alpha to 9.63 in order to allow the herd to grow rapidly along with the population. In 250 years the human population explodes from 1,000 to 135,382, compared to 14,395 in the standard case. There would be 7.67 cattle per man and the number of wives per man would be 1.52.

On the other hand, if fertility is only 4, the steady-state alpha is 23.20 and the system suffers demographic decline. After 250 years the total population would be 710 and continuing to decline. The herd would be declining along with population, because alpha must be less than 22.5 if one is to avoid negative growth for the herd. The cattle per man ratio would be 5.11 and the wives/man ratio would be 1.49.

We see that the system is extremely sensitive to the fertility rate, so that even if stronger lineages are able to extract only modestly different fertility rates from their wives, the demographic strength of the lineage will be greatly augmented. Moreover, given the survival rates that have been assumed for persons, a fertility rate of 4 implies the undesirability of a policy that stabilizes the wives/man and cattle/man ratios. When fertility is low the condition for lineage survival is to adopt an alpha below the steady-state value, allowing the herd to grow faster than population and, hence, to eventually make possible an increase in the number of wives/man as a compensation for the reduced fertility per wife.

Effect of marriage age of women. The high wives/man ratios that have characterized these models have been produced largely by the differential age of marriage for men and women. The wives/man ratio would be 1.38 on the basis of simple daughter exchange, given the assumption that women marry at 18 and men at 25. Were the woman's age of marriage raised to 20 the daughter exchange ratio of wives/man would fall by 10 percent to 1.24; and were it lowered to 15 that ratio would jump by 8 percent to 1.49. However, the impact of changing the age of marriage for women is much greater than these numbers indicate. Even if we assume that the total fertility of women is unchanged by marriage age, the steady-state scenarios differ markedly from the standard case.

By delaying marriage of all women to age 20, holding total fertility at 6, we reduce the rate of demographic growth by 30 percent. After 250 years the total population would be only 6,619 (compared with 14,935 in the standard case) and the wives/man ratio would be reduced to 1.38. The lower rate of population growth encourages a lower rate of growth of the herd, so that alpha must be raised to 17.65.

On the other hand a lowering of marriage age to 15 generates an explosive 46 percent increase in the growth rate of population. After 250 years there would be a total population of 51,165. There would be an impressive 1.72 wives/man ratio and because of the low steady-state value of alpha (12.25), the cattle/man ratio would rise to 7.24. Hence, changes in the marriage age of women have dramatic consequences for the behavior of these systems, consequences that are second only to those that result from changes in fertility.

The marriage age of men. We know that marriage age is important to men because it is only when they marry that they are given control over cattle and the possibility of developing the set of social relationships that constitute power within the lineage. However, in terms of the limited number of factors considered in this paper, it appears that their marriage age is of no consequence whatsoever. The allocation of wives among men of different ages has no impact on the value of alpha and no consequence

on any system variable, except for the fact that the cattle and wives per man ratios must be changed to reflect the different definitions of man. Consequently, seniors can determine the allocation to suit themselves without violating their responsibility to their ancestors for assuring continued lineage growth.

However, the finding that marriage age of men is inconsequential depends on the assumption that fertility is not affected by age of husband. If older men produce fewer children or if fertility declines as the number of wives increases, then the senior-junior allocation of wives becomes a sensitive demographic variable. Groups in which men marry younger would then experience higher rates of demographic growth. And if growth is augmented sufficiently, the number of wives per man will increase over time, potentially nullifying the initial reduction in the number of wives held by older men.

V. INTRODUCING A MARKET FOR AGRICULTURE

Within economic theory dynamics is related to the time path of a set of *variables* in the context of a specific process or structure. We know that dynamics, so defined, is not about the real world because variables are properties of models, not of the real world. Furthermore, the models that are typically featured in the discussion of dynamics are models of intertemporal behavior where the general structure of the process is unchanged; the focus is not on structural change, but on change within a given structure.

Anthropologists are likely to use the term dynamics in reference to processes of social or cultural change where one's focus is on changes in structure, in addition to changes within structures. Nevertheless, the latter concept of dynamics applies to Fortes' study (1945) of Tale clanship and lineage processes. On the other hand, the dynamics of social change require the identification of mechanisms within the structure that induce it to change. For Marxian theory, class struggle is such a mechanism; it is an *endogenous force*, an essential element within each structure, that leads to the replacement of one structure by another.

The previous sections of this paper were concerned with demographic growth within an unchanged analytical structure, while this section explores the consequences of structural change. However, since the structure changes under consideration arise from *exogenous* forces, they are not associated with the dynamics of structure; rather, they relate only to a *comparative dynamics* of structure. In particular, we consider the comparative dynamics of the African lineage model relative to the introduction in varying degrees of a "prestige" market for agricultural goods such that some fraction of a group's agricultural output can be directly ex

changed for cattle and, hence, for wives. Such a possibility is revolutionary because it means that the work of men (and women) can complement the growth of the herd as a source of demographic growth.

In African societies that feature "female-dominated" agriculture, agricultural goods are often exchanged among women for other "products of women," but not for cattle, iron bars, slaves or other goods within the prestige market (Bohannon 1955). However, as male labor becomes more important to agriculture, the exchange of foodstuffs for cattle is more likely to be culturally admissible. We shall assume that women continue in the production of domestic food requirements and that prestige agricultural output is the product only of men. The amount that can be produced depends on the amount of work-time remaining after every wife has received 6/10ths of an adult-equivalent from her husband (or sons) and after one adult-equivalent has been allocated per forty cattle. The workpower remaining after these allocations will be called "excess adult-equivalence" (EAE).

The model is complete once we express a relationship between the current EAE and the number of bridewealth-eligible (four-year-old) cattle that can be obtained in exchange. For example, if we assume that one adult-equivalent is worth two cows, then ten person-years of agricultural work would be required to obtain a wife in the standard case. Such an assumption seems reasonable; however, the market for the agricultural good is potentially much less rewarding than that. Hence, a new parameter, X , is introduced that indicates the relationship between available EAE and the amount of cattle that can be obtained in exchange for agricultural goods. In particular, X times the EAE of a given year equals the amount of cattle that can be obtained through exchange for the *next* year. The purchased cattle are added to the herd as a supplement to the normal process of herd growth.

The effect of market processes will be considered by introducing positive values of X into the standard case. To begin, suppose that X equals 0.05 (meaning that a work-year is worth only 0.05 of a cow), then it follows that 400 person-years of agriculture equals one wife. Such a miserable reward for cash cropping can hardly be expected to have a major impact on a traditional system of lineage production and reproduction. But it does. Even this fractional introduction of a prestige product of male labor alters the system dramatically.

First of all the steady-state value of α ceases to be unique. If X is 0.05 α rises *sharply* to 18.1, and any value of α greater than this is also a steady-state value! Nevertheless, we may still identify 18.1 as a uniquely desirable steady-state value, because any larger value is inferior on all dimensions (demographic growth, wives/man and cattle/man), this steady-state value will be called *alpha-min* because it is the lower bound of the set of such values. A picture of *alpha-min* can be seen in Figure 3. It

shows that alpha-min rises from 15.52, when X is zero, to 19.8, when X is 0.1 and then falls steadily to 4.0 when X is 1.0.

In addition to having important formal consequences for the model, small values of X have major behavioral implications. When X is 0.05, the population grows to 17,523, relative to 14,935 in the standard case; a 7 percent increase over 250 years. And given how little they seem to change in response to changes in other variables, the critical ratios also change significantly: wives/man and cattle/man rise to 1.539 and 6.922, compared to 1.505 and 6.570, respectively.

At first glance the large impact of such limited access to cash cropping is counter-intuitive. However, the traditional system provides considerable leisure to adult males; and as the system grows in population the available EAE become quite substantial. Hence, even a small fraction of EAE constitutes a large contribution to the system.

An X of 0.2 is still quite small; it implies that 100 man-years of agriculture equals one wife. At this point alpha-min is about 19.0, but the demographic and other consequences of cash cropping have already become dramatic. Population now grows to 27,504 in 250 years, 84 percent above the standard case; and the critical ratios rise to 1.650 and 11.137.

The drama of this story does not end with alpha-min but continues with a heretofore unmentioned relative: the value of alpha that maximizes the rate of demographic growth, to be called *alpha-max*. One of the lessons drawn from the standard case was that by postponing current utilization of cattle, one can gain a herd of such size that even abstemious use of cattle in bridewealth will provide many wives and rapid population growth. In the standard case (where X equals zero) alpha-max was nearly zero (0.2), so that in spite of its positive demographic implications it was ignored because it was not the steady-state value and because any alpha below 12.8 would generate an unmanageably large herd. However, if X is progressively larger, alpha-max rises slowly upward from values below 12.8; and as X approaches 0.355, alpha-max, rising quite rapidly, suddenly enters the region of feasibility and becomes equal to alpha-min at alpha equals 14. Then, as X increases beyond 0.355, alpha-max rises above alpha-min and becomes *the alpha of choice* (being both feasible and steady-state). Finally, once X has reached 0.415, alpha-max reaches 100 percent. See Figure 3.

Consequently, even when access to the prestige market for agriculture is still very limited (and 48 work-years in agriculture are required for a wife), the fertility of cattle ceases to be the most effective basis for the acquisition of wives and ceases to be the factor of relevance in maximizing demographic growth. By the time one person-year of effort is exchangeable for 42/100s of one cow, one no longer maintains a herd of any size. Rather, whenever cattle are received in exchange for agricultural goods, all

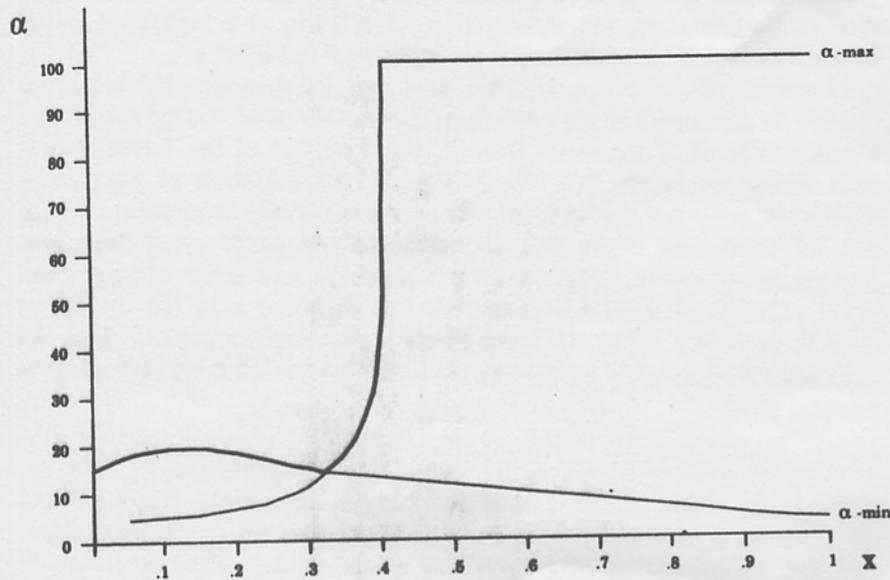


Fig. 3. α -min and α -max as functions of X .

of the cattle are used to obtain wives. This is done in order to eliminate cattle as a drain on the workpower that would otherwise be devoted to agriculture.

Since the policy of adopting alpha-max leads to a reduction (or elimination) of the herd for the sake of maximizing demographic growth, it will be rejected by any group that places a high social valuation on the possession of cattle. In this event the availability of cash cropping can be the basis for quite a different policy: If alpha-min is below the boundary of feasibility (12.8), then 12.8 becomes a steady-state value and its adoption would have the attractive property of maximizing the rate of growth of the herd (relative to any feasible value of alpha). For this reason one could argue that an alpha of 12.8 is more consistent with African inclinations toward cattle accumulation (see Ferguson 1985).

On the other hand one is not limited to choosing between a policy of maximizing the number of cattle or maximizing the number of people, since any alpha between 12.8 and alpha-max is a potentially desirable steady state value, to be selected in order to obtain a preferred balance between wives and cattle.

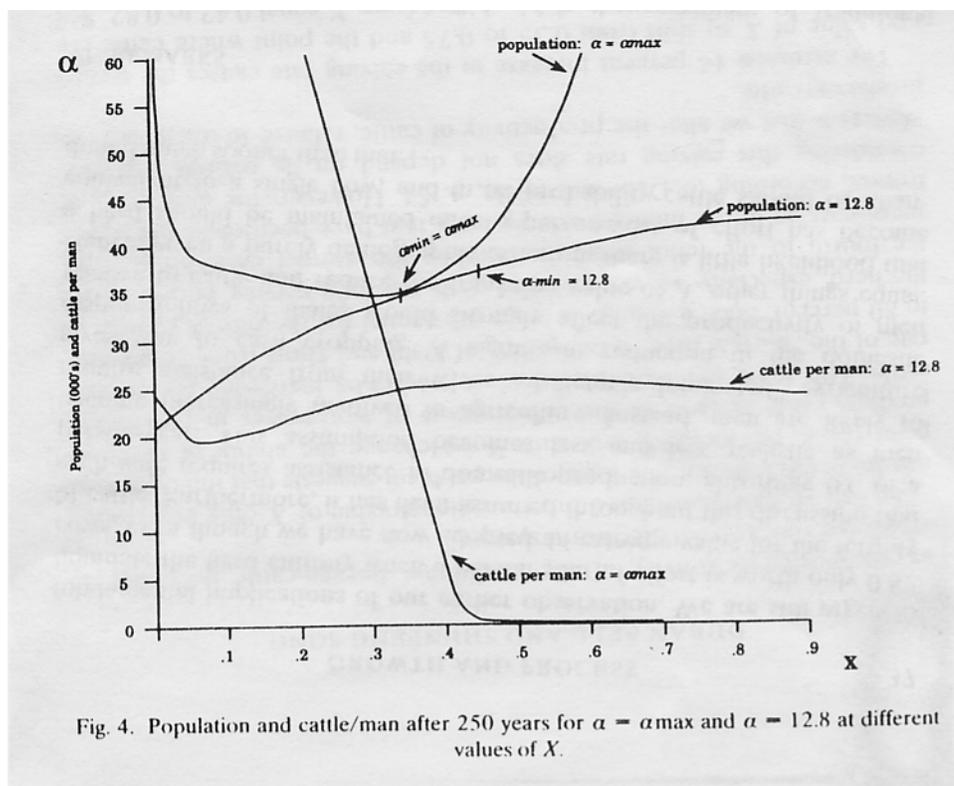
An alpha of 12.8 has merits beyond the maximization of herd growth. Given the adoption of 12.8, the rate of growth of population and the number of wives and cattle per man tend to be fairly insensitive to changes in X . In other words, 12.8 has the property of stabilizing the group's

resources and demographic growth relative to impacts from the world system. Furthermore, this stabilization takes place at a high level on all dimensions, relative to t

he pre-impact situation. See Figure 4. However, as attractive as 12.8 may be, its demographic weakness relative to alpha-max is very substantial; and this relative weakness grows exponentially as X increases. Hence, the "survival of the fittest" theme with which we began this paper requires the adoption of alpha-max.

Moreover, since our model considers only comparative dynamics, we need not be concerned about the *abandonment* of cattle as X increases. Instead we compare those societies with cattle and those without, each being considered in steady-state. We can see that with the arrival of market processes those who are already pure agriculturalists enjoy an enormous demographic advantage, even when the market for agriculture is not very good.

Varying the point of transition. As the market for agriculture expands, the demographically dominating strategy changes from alpha-min to alpha-max. However, the low level (of X) at which this transition takes place and the abruptness of that transition are shocking. They demonstrate



an unexpected sensitivity of the traditional lineage-cattle economy to exogenous shocks from the "world system."

So far we have considered this transitional value of X only in terms of one set of parameters. The logic of the problem suggests that the transition point (at X equals 0.35) will shift if we change the ability of cattle to produce cattle relative to the effectiveness of workpower in purchasing cattle. This logic can be explored most readily by increasing the calving rate of the "normal case" assumptions of Dahl and Hjort from 70 percent to 80 percent. Such a change is quite substantial for the rate of growth of the herd, especially when combined with the long calving period (from the fourth to the tenth year) assumed in the normal case. 80 percent represents an upper limit on calving rates that have been observed in the tropics, according to Dahl and Hjort, p. 54. However, the usefulness of considering this calving rate does not depend on its realism. All that matters is that we alter the productivity of cattle, relative to manpower, in producing cattle.

The assumed 14 percent increase in the calving rate causes the transition value of X to shift from 0.35 to 0.75 and the point where cattle are no longer demographically useful is shifted from X equal 0.42 to 0.82. See Figure 5.

The shift shown in α -max is impressive, but fails to change the

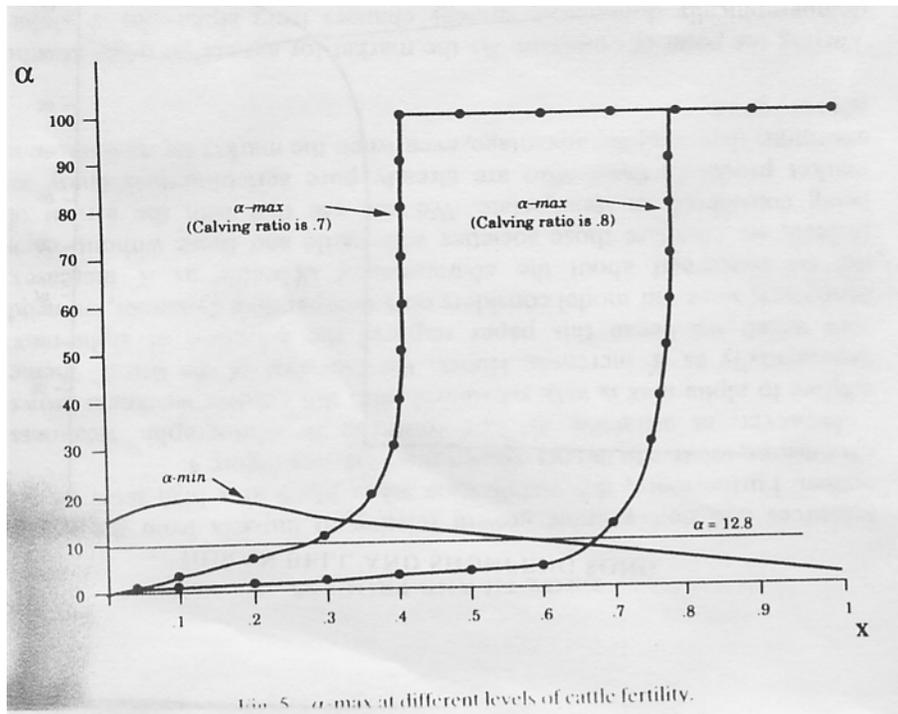


FIG. 5. α -max at different levels of cattle fertility.

fundamental implications of our earlier observation. We are still liquidate the herd entirely when a person-year of effort is worth only 0.82 cows even though we have now adopted an extreme value for the fertility of cattle. Furthermore, it has been assumed throughout this discussion that each wife requires assistance in domestic production, absorbing 0.6 of a person-year. This assumption becomes less and less realistic as men become increasingly involved in agriculture. Instead, men are likely to require assistance from their wives as "female-dominated" agriculture gives way to cash cropping. A significant reduction in the domestic responsibilities of males would strongly affect the productivity of men relative to cattle and reduce the transition value of X , other things equal. Hence, given a purely demographic criterion, there is little likelihood that a herd should be maintained once a person-year of effort has become equivalent to a single cow, and in all

VI REMARKS

We have been interested in discovering the sensitivity of traditional African social processes to "management" decisions that are implicit in the cultural norms that govern the use of cattle for bridewealth. Our examination of these systems as complex dynamic processes contrasts with those discussions that would deny sophistication and rational optimization to the culturally embedded processes that have guided them. In addition we have been interested in the purely technical sensitivity of these systems to impacts from the world system, over and above the problems of coercion and violence.

From this investigation has emerged a number of surprises. We had expected that the critical ratios (the number of wives and cattle per man) would be more sensitive to changes in the principal parameters of the model. For example, the number of cattle required in bridewealth did not have a large impact on the critical ratios, nor on the number of cattle used for bridewealth in a given year. These effects proved to be small relative to the fairly significant consequences for demographic growth, and hence for the long-term viability of the group. We were particularly surprised by the effect on demographic growth of changes in the age of marriage for women. It is known that delay of marriage reduces total fertility substantially in the modern period (World Bank 1985). However, we have assumed that the total fertility of women is unaffected by the age of marriage; only the shifting generations effect remains.

The greatest and most significant surprise is the extent to which the lineage model is technically sensitive to the introduction of a prestige market for agriculture. Not only are cattle inferior to agriculture at rather poor terms

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of trade for the latter, but the technical transition takes place with uncommon abruptness for those groups that remain demographically dominant.

ACKNOWLEDGEMENT

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APPENDIX

General Explanation

In deriving a value of alpha, we begin with a baseline herd as described by Dahl and Hjort. We must then specify baseline distributions for the human population. This is done by assuming that at some initial period there are fifteen females (or males) aged zero, and allow this group to evolve in accordance with the assumed survival probabilities. This procedure generates a population of roughly 500 females or males.

Given baselines for cattle and people, and the fertility rates for women and cattle, one can computer-generate the population growth rates of each. However, we introduce alpha - a reduction in the number of four year-old cows for use as bridewealth - with the result that the growth rate of the herd is reduced and the growth rate of the human population is increased (due to the increase in the number of wives). The problem, then is to find the value of alpha that equates the rate of growth of the herd with the rate of growth of the male population (the lineage). At that point the number of cattle and wives per man will stabilize.

This problem was solved under alternative assumptions about the birth rates of women, the number of cattle required in bridewealth, the age of marriage of women and the initial size of the herd. The final consideration is the use of "adult-equivalence" in manpower that remains after men have provided essential time to wives and cattle. It is assumed that all such excess adult equivalence is devoted to agriculture and that agricultural output is converted to cattle by a ratio specified by the variable X.

Mathematical Model and Computer Program

Given the baselines of cattle, women and men, the computer simulations are carried out with a standard case and a number of variations that depend on a change in the value of one of the variables.

The baseline of cattle is given by Dahl and Hjort as:

$$C(i, 0), \quad i = 0, 1, 2, \dots, 13.$$

We shall specify the baselines of women and of men are assumed to be equal at each age and are given as:

$$W(0, 0) = 15 \quad \text{and}$$

$$W(i, 0) = (1 - dd_{i-1}) W(i-1, 0), \quad i = 1, 2, \dots, 60,$$

$$M(i, 0) = W(i, 0), \quad i = 0, 1, 2, \dots, 60.$$

Assume that the fertility rate of cattle from age 4 to age 10 is 70 percent. Denote B the women's fertility rate in their lives, K the bride price, and Alpha the proportion of cattle at age 4 used to buy wives, d_i ($i = 1, \dots, 13$) is the death rate of cattle at each age, and dd_i ($i = 1, \dots, 60$) is the human death rate at each age.

Then, we have the population distribution of cattle at time t :

$$(1) \quad C(0, t) = \sum_{j=4}^{10} C(j, t-1),$$

$$(2) \quad C(i, t) = (1 - d_{i-1}) C(i-1, t-1), \\ i = 1, \dots, 13 \quad \text{but} \quad i = 4,$$

$$(3) \quad C(4, t) = (1 - \text{Alpha})(1 - d_3) C(3, t-1),$$

and

$$(4) \quad PC(t) = \sum_{i=0}^{13} C(i, t) \text{ is the total number of cattle at time } t.$$

The population of human females is computed by:

$$(5) \quad W(0, t) = \sum_{j=18}^{40} (B/50) W(j, t-1),$$

$$(6) \quad W(i, t) = (1 - dd_{i-1}) W(i-1, t-1), \\ i = 1, \dots, 60 \quad \text{but} \quad i = 18,$$

$$(7) \quad W(18, t) = (1 - dd_{17}) W(17, t-1) + \\ (\text{Alpha}/K) (1 - d_3) C(3, t-1),$$

$$(8) \quad PW(t) = \sum_{i=0}^{60} W(i, t), \text{ is the total population of females and}$$

$$(9) \quad PPW(t) = \sum_{i=18}^{60} W(i, t) \text{ is the total number of wives at time } t.$$

The population of human males is computed by:

$$(10) \quad M(0, t) = W(0, t),$$

$$(11) \quad M(i, t) = (1 - dd_{i-1})M(i-1, t-1),$$

$$(12) \quad PM(t) = \sum_{i=0}^{60} M(i, t) \text{ is the total population of males, and}$$

$$(13) \quad PPM(t) = \sum_{i=25}^{60} M(i, t) \text{ is the total number of husbands at time } t.$$

The number of cattle per man, and the number of wives per man at each time period are determined by,

$$(14) \quad PCM(t) = PC(t)/PPM(t),$$

$$(15) \quad WM(t) = PPW(t)/PPM(t).$$

The total population at time t is

$$(16) \quad PP(t) = PM(t) + PW(t).$$

When we consider the total adult equivalence (TAE) in this model, we have at time t :

$$(17) \quad TAE(t) = \sum_{i=0}^{60} a_i M(i, t),$$

where a_i is the rate of adult equivalence at each age.

$EAE(t)$ is the excess adult equivalence at time t (the total adult equivalence remaining after the requirements of domestic production and cattle herding have been met).

$$(18) \quad EAE(t) = TAE(t) - 0.6PPW(t) - PC(t)/40.$$

Information about the EAE is introduced into Equations (3) and (7) (with other equations unchanged):

$$(3') \quad C(4, t) = (1 - \text{Alpha})[(1 - d_3)C(3, t-1) + EAE(t-1)X],$$

$$(7') \quad W(18, t) = (1 - dd_{17})W(17, t-1) + (\text{Alpha}/K)[(1 - d_3) \times C(3, t-1) + EAE(t-1)X],$$

where X is the exchange rate between one adult equivalence and cattle.

By trial and error the programmer now attempts to find a critical value of Alpha such that the values of $WM(t)$ and $PCM(t)$ are stable over time.

The Computer Program (Fortran)

The following program is for the standard case, in which $x = 0$, $B = 6$, and $K = 20$.

```

INTEGER T
REAL PP (0:1000), C4(0:1000), D(0:12),
  T1(0:1000), T2(0:1000), T3(0:1000)
REAL T4(0:1000), T5(0:1000), T6(0:1000),
  TAE(0:1000), DD(0:59), CC(0:13)
REAL C(0:13, 0:1000), PC(0:1000),
  W(0:60, 0:1000), PW(0:1000),
  PPW(0:1000)
REAL M(0:60, 0:1000), PM(0:1000),
  PPM(0:1000)
REAL PCM(0:1000), WM(0:1000),
  EAE(0:1000)

```

Specification of death rate of cattle among ages:

```

DATA D/0.2, 3*0.07, 3*0.05, 2*0.1, 0.2,
0.33, 0.49, 0.9/

```

Specification of death rate of men and women among ages:

```

DATA DD/0.2, 5*0.05, 5*0.02, 25*0.01,
5*0.02, 5*0.05, 5*0.1, 4*0.2, 3*0.5, 2*0.9/

```

Specification of baseline of cattle:

```

DATA CC/136, 108, 101, 94, 89, 85, 80,
76, 69, 62, 49, 33, 17, 1/X=0

```

Assigning a value of Alpha

```

44          TYPE 44
            FORMAT('TYPE Alpha:')
            ACCEPT 55, Alpha
55          FORMAT(F10.6)
DD 1       I = 0, 13
1          C(I, 0) + CC(I)

```

Generation of baseline for women: $W(i, 0)$ is calculated from $W(i, 0) = (1 - d(i - 1))W(i - 1, 0)$. Let $W(0, 0) = 15$ so that the sum of $W(i, 0)$ over all $W(i, 0) = (1 - d(i - 1))W(i - 1, 0)$. Let $W(0, 0) = 15$ so that the sum of $W(i, 0)$ over all ages is close to 500, and thus the total population is close to 1000.

```

W(0, 0) = 15
DO 5 I = 1, 5

```

```

5      W(I, 0) = 0.95*W(I - 1, 0)
      DO 10 I = 6, 10
10     W(I, 0) = 0.98*W(I - 1, 0)
      DO 15 I = 11, 35
15     W(I, 0) = 0.99*W(I - 1, 0)
      DO 20 I = 36, 40
20     W(I, 0) = 0.98*W(I - 1, 0)
      DO 25 I = 41, 45
25     W(I, 0) = 0.95*W(I - 1, 0)
      DO 30 I = 46, 50
30     W(I, 0) = 0.9*W(I - 1, 0)
      DO 35 I = 51, 54
35     W(I, 0) = 0.8*W(I - 1, 0)
      DO 40 I = 55, 57
40     W(I, 0) = 0.5*W(I - 1, 0)
      DO 45 I = 58, 60
45     W(I, 0) = 0.1*W(I - 1, 0)
      DO 47 I = 0, 60

```

The baseline of men is assumed to be the same as the baseline of women.

```

47     M(I, 0) = W(I, 0)

```

Ending of baseline generation.

```

      C4(0) = 89
      EAE(0) = 40

```

Simulation at different time points:

```

      DO 500 T = 1, 250
      C(0, T) = 0
      DO 50 J = 4, 10
50     C(0, T) = C(0, T) + 0.35*C(J, T - 1)
      DO 100 I = 1, 13
      C(I, T) = (1 - D(I - 1))*C(I - 1, T - 1)
      IF (I.EQ.4) THEN
      C4(T) = (1 - D(I - 1))*C(I - 1, T - 1) +
          X*EAE(T - 1)
      C(I, T) = (1 - Alpha)*C4(T)
      END IF
100    CONTINUE
      W(0, T) =
      DO 150 J = 18, 40
150    W(0, T) = W(0, T) + 6.0/0.50.*W(J, T - 1)
      M(0, T) = W(0, T)
      DO 200 I = 1, 60

```

```

W(I, T) = (1 - DD(I - 1))*W(I - 1, T - 1)
M(I, T) = (1 - DD(I - 1))*M(I - 1, T - 1)
IF (I.EQ.18) THEN
W(I, T) = (1 - DD(I - 1))*W(I - 1, T - 1) +
Alpha/20.0*C4(T)
END IF
200 CONTINUE
W(0, T) = 0
DO 150 J = 18, 40
150 W(0, T) = W(0, T) + 6.0/50.0*W(J, T - 1)
M(0, T) = W(0, T)
DO 200 I = 1, 60
W(I, T) = (1 - DD(I - 1))*W(I - 1, T - 1)
M(I, T) = (1 - DD(I - 1))*M(I - 1, T - 1)
IF (I.EQ.18) THEN
W(I, T) = (1 - DD(I - 1))*W(I - 1, T - 1) +
Alpha/20.0*C4(T)
END IF
200 CONTINUE
PW(T) = 0
PM(T) = 0
DO 210 I = 0, 60
PW(T) = PW(T) + W(I, T)
PM(T) = PM(T) + M(I < T)
210 CONTINUE
PC(T) = 0
DO 220 I = 0, 13
220 PC(T) = PC(T) + C(I, T)
PPW(T) = 0
DO 230 I = 18, 60
230 PPW(T) = PPW(T) + W(I, T)
PPM(T) = 0
DO 240 I = 25, 60
240 PPM(T) = PPM(T) + M(I, T)

```

Total population:

$$PP(T) = PW(T) + PM(T)$$

Number of cattle per man, and number of wives per man:

$$PCM(T) = PC(T)/PPM(T)$$

$$WM(T) = PPW(T)/PPM(T)$$

Calculation of total adult equivalence: (with specification of adult equivalence rate for each age)

```

T1(T) = 0
DO 300 I = 5, 10
300 T1(T) = T1(T) + 0.1*M(I, T)
T2(T) = 0
DO 310 I = 11, 15
310 T2(T) = T2(T) + 0.4*M(I, T)
T3(T) = 0
DO 320 I = 16, 20
320 T3(T) = T3(T) + 0.8*M(I, T)
T4(T) = 0
DO 330 I = 21, 45
330 T4(T) = T4(T) + M(I, T)
T5(T) = 0
DO 340 I = 46, 50
340 T5(T) = T5(T) + 0.8*M(I, T)
T6(T) = 0
DO 350 I = 51, 60
350 T6(T) = T6(T) + 0.5*M(I, T)
TAE(T) = T1(T) + T2(T) + T3(T) +
T4(T) + T5(T) + T6(T)

```

Excess of adult equivalence:

```

EAE(T) = TAE(T) - 0.6*PPW(T) -
PC(T)/40.
TYPE 499, T, PP(T), PPM(T), PC(T),
WM(T), PCM(T)
499 FORMAT(14, 3F13.0, 2F10.4)
500 CONTINUE
STOP
END

```

REFERENCES

- Bohannon, Paul 1955 Some Principles of Exchange and Investment Among the Tiv. *American Anthropologist* 57: 60-70.
- Dahl, Gudrun and Anders Hjort, 1976 *Having Herds: Pastoral Herd Growth and Household Economy*. Department of Social Anthropology, University of Stockholm.
- Fage, J. D. 1978 *A History of Africa*. London: Hutchinson of London.
- Ferguson, James G. 1985 *The Bovine Mystique: Power, Property and Livestock in Rural Lesotho*. *Man* 20: 647-674.
- Fortes, Meyer 1945 *The Dynamics of Kinship Among the Tallensi*. Oxford: Oxford University Press.
- Onwuazor, Sammy N. 1977 *Continuity and Change: Abortion and Family Size in a Nigerian Village*. In Epstein and Jackson, eds., *The Feasibility of Fertility Planning*. Oxford: Pergamon Press.

- Reinhard, Marcel, Andre Armengaud, and Jacques Dupaquier 1968 *Histoire generale de la population mondiale*. Paris: Editions Montchrestien.
- Rigby, Peter 1969 *Cattle and Kinship Among the Gogo*. Ithaca: Cornell University Press.
- Sahlins, Marshall 1972 *Stone Age Economics*, New York: Aldine de Gruyter Press.
- Schneider, Harold K. 1964 A Model of African Indigenous Economy and Society. *Comparative Studies in Society and History* 7(1): 37–55.
- Schneider, Harold K. 1979 *Livestock and Equality in East Africa*. Bloomington and London: Indiana University Press.
- White, Douglas R. and Michael L. Burton 1988 *Causes of Polygyny: Ecology, Economy, Kinship, and Warfare*. *American Anthropologist* 90: 4.
- World Bank 1985 *Population Change and Economic Development*. Oxford: Oxford University Press.

