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The First Economic Revolution[1]

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THE purpose of this article is to provide a new explanation for the development of agriculture in human prehistory. It builds upon the work of anthropologists and archaeologists by incorporating their explanation into a more general economic model derived from recent theoretical work in the study of property rights.

Man's shift from being a hunter and gatherer to a producer of food has been regarded by common consent as one of the two major breakthroughs in his ascent from savagery to modern civilization. Prior to this first economic revolution, man lived in communal groups or bands, taking from nature what could be killed or gathered. The limits of man's livelihood were fixed by a resource base upon which he could not yet improve. He could live only within its biological constraints. With the development of settled agriculture and the conscious production of foodstuffs, man first acquired the basic ability to increase his resource base, an increase which has continued from that time onward. This transition, which involved the shift from hunting/gathering to settled agriculture, has been termed the Neolithic Revolution by V. Gordon Childe,[2] and has correctly been compared in importance to the Industrial Revolution. Both eras witnessed marked increases in man's control over nature, an ability which enabled him to support a larger population, to secure higher living standards, and to create in the process complex civilizations.

The Industrial Revolution has been the major preoccupation of economic historians, almost to the exclusion of prior events. The Neolithic Revolution, on the other hand, has been almost entirely the province of archaeologists and anthropologists. Yet in terms of man's material advance in history, it should

[1] We should like to acknowledge our indebtedness to the many anthropologists, historians, and economic historians who have made valuable suggestions at seminars where we have presented earlier drafts of this essay. Without in any way implicating them in our conclusions, we were particularly helped by Robert Higgs, M. D. Morris, C. G. Thomas, James Watson, and K. Yamamura.

[2] V. Gordon Childe, *What Happened in History* (1942).

occupy at least equal prominence with the Industrial Revolution. The sparse nature of the evidence partially explains the historian's neglect. Another reason lies in the preoccupation, until recently, of economic theory with market phenomena. There simply was no applicable theory that could be used to explain the Neolithic Revolution. This situation has changed with the recent development of theory to deal with common property resources and the evolution of property rights.

The absence of such theory has, in the past, caused scholars to view the transition from hunting/gathering to settled agriculture as being the crucial development occurring during the first economic revolution. However, this approach missed the fact that it was not the type of economic activity so much as the kind of property rights that were established that accounts for the significant increase in the rate of human progress after this revolution. In particular, the transition from an economy where common property prevailed to one in which exclusive communal property prevailed radically altered man's incentive to acquire and apply new knowledge to his economic activities.

Implicit in the reasoning of many archaeologists and anthropologists is the view that the invention of cultivation and that of domestication were discrete events. Yet analyses of the invention process,[1] as well as the existing evidence, suggest that it was an incremental process in which the borderlines between gathering, cultivation, and domestication were not well defined and the transitions were not always the result of conscious decisions. Rather, trial and error and chance would result in successive small changes in the directions of domestication. The bands that successfully took these steps enhanced their chances for survival. The key to our explanation is that the development of exclusive property rights over the resource base provided a change in incentives sufficient to encourage the development of cultivation and domestication.

In this article we first present a simple comparative static model stating the conditions that would lead to a transfer of labour from hunting to agriculture. This will involve indicating the existing relevant evidence about man's prehistoric past. We shall then present our own model, which explicitly considers the influence of property rights and population growth upon man's behaviour. In the last section we employ this model as the basis for an explanatory sketch of the first economic revolution.

I

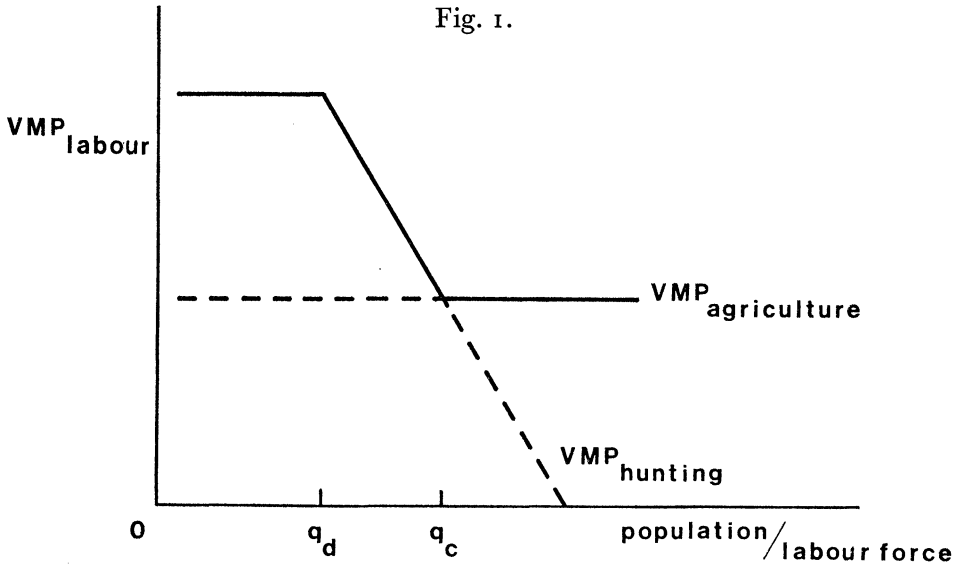
We start by examining, within the context of a comparative static economic model, the conditions that would account for the first economic revolution. The purpose of this model is to derive the conditions under which the scarce labour resource of the band[2] would shift from its traditional occupation in hunting/gathering to agriculture. The major resource of the band, it is assumed, is the labour of its members. It has the choice of how it will employ its labour to produce the goods and services desired by the group. The band will attempt to

[1] See in particular the work of Nathan Rosenberg. A useful summary is contained in his 'Problems in the Economist's Conceptualization of Technological Innovation', *History of Political Economy*, VII (1975), 456–81.

[2] The term "band" is adopted from Colin Renfrew, *The Emergence of Civilization* (1972), p. 363. See his discussion of the anthropologist's distinction between band, tribe, and state: pp. 363–5.

allocate its resources in the manner that will maximize the value of the scarce labour resource and, therefore, the economic welfare of the group. In the absence of a market to determine the relative prices of the two kinds of output (hunting/gathering or agriculture) the band's preferences will establish these relative valuations. We assume that they remain unchanged for purposes of our analysis. Hence, the marginal product of labour or the opportunity schedule in each activity becomes the crucial variable in the band's determination of how it will allocate its labour between the two sectors.[1]

Fig. 1.



Let us initially assume that the work-force is fixed. The opportunity for labour in the hunting[2] sector is the value of the marginal product schedule for labour in hunting. We also assume that the stock of resources is biologically determined,[3] and therefore subject to diminishing returns as hunting effort is increased. Thus, the value of the marginal product schedule in hunting when graphed will after a period of constant returns (oq_d in Fig. 1) eventually slope downward. The relevant downward-sloping portion of the demand for labour in the hunting

[1] Throughout this section we are assuming that man actually possessed sufficient knowledge of plants and/or animals to have engaged in cultivation and/or herding prior to the actual transition. We shall derive what these conditions were. In the final section we shall relax this assumption in order to demonstrate that the results will be the same once exclusive property rights are created. What this article asserts is that the invention of agriculture is not the most important issue. Rather, it is the incentive change resulting from exclusive property rights that will inevitably create agriculture.

[2] Hereafter "hunting" should be understood to mean hunting/gathering.

[3] A more precise assumption is a model that specified a biological growth law for animals.—See Vernon Smith, 'The Economics of the Primitive Hunter Culture, Pleistocene Extinction and the Rise of Agriculture', *Journal of Political Economy*, LXXXIII (1975), 727–56. Smith's model is consistent with our analysis. The distinction is that Smith provides a formal and elegant comparative static model. Ours is an essay in economic history which attempts to describe the time-path of the transition from hunting/gathering to agricultural society and identify the institutional changes that were required to make the transition. More specifically, our article attempts to explain the characteristics of development that archaeologists have discovered.

sector is q_d . q_c in Fig. 1. The agricultural sector, reflecting the abundance of land at this time suited to this purpose, exhibits constant returns to scale for additional units of labour. Thus, the relevant portion of the demand for labour in agriculture is the horizontal section beyond q_c. The total effective demand for the band's labour can be viewed as the solid line in Fig. 1. This schedule, when combined with the quantity of labour available, determines the marginal value product of labour and how the available land determines the marginal value product of labour and how the available labour will be allocated between the two sectors.

Let us now examine the conditions under which man would devote his efforts exclusively to hunting. This would occur if the value of the marginal product of labour in hunting after fully employing all the available labour is still above the value of the marginal product of the first unit of labour employed in agriculture. This would occur if the size of the labour-force was, in Fig. 1, q_c or less.

Assuming that for a time the size of the work-force remains below q_c, then there are only two parametric shifts that can result in the reallocation of labour from hunting to agriculture. One would be a shift to the left of the value of the marginal product of labour in hunting/gathering, reflecting a general decline in productivity in this sector. If such a shift took place, then the band would reallocate to agriculture that portion of the work-force previously devoted to hunting/gathering whose output was now below what it would be if employed in agriculture. This result also implies a decline in the band's standard of living.

A second parameter shift that would reallocate labour from hunting to agriculture would be if the value of the marginal product schedule for labour in agriculture shifted up, reflecting an increase in the productivity of labour in this sector. A shift of this nature would have some of the same results as described above: the productivity of a portion of the work-force previously employed in hunting would now be higher if reallocated to agriculture, and so a transfer of labour would occur. The standard of living of the band in this event, however, would rise. If either or both of these parameter shifts were pronounced enough, the effect would be to transfer all of the labour out of hunting into agriculture. If we allow the labour-force to grow holding the opportunity schedules for labour constant in each sector, then a transfer of labour to agriculture would eventually result. If the initial work-force was less than q_d on the graph, then additions to it after reaching that point would result in declining marginal productivity of labour employed in hunting. This would continue until the labour-force reached q_c on Fig. 1. Thereafter, additional increments to the labour-force would be added to the agricultural sector under our assumptions with no further reductions in the marginal productivity of labour. Eventually, if population continued to expand with each addition being allocated to agriculture, that sector would come to dominate economic life.

In sum, there are three changes that could account for the transition from hunting to agriculture. Individually or acting in concert, a decline in the productivity of labour in hunting, a rise in the productivity of labour in agriculture, or a sustained expansion of the size of the labour-force, could have resulted in the transition of man from being exclusively a hunter to increasingly a farmer.[1]

[1] The existing explanations for the Neolithic Revolution can be interpreted within this framework. The explanation of V. Gordon Childe in *Man Makes Himself* (New York, 1951) suggests climatic change

Any explanation for the transformation must be consistent with the following known pieces of evidence about man's prehistoric past:

1. The development of settled agriculture occurred approximately 10,000 years ago. Since man is distinguishable from other animals more than one million years ago, an acceptable explanation must account for the fact that this development came late in man's history, occurring within the last few minutes in the whole day of man's existence on earth.[1]
2. This development appears to have occurred independently in different areas at different times, certainly including the "fertile crescent", Meso-America, and possibly others.[2]
3. The spread of agriculture took thousands of years. The rate of spread across Europe, for example, appears to have averaged only about 1 kilometre per year.[3]
4. The extinction of a variety of larger animal species occurs in the later Pleistocene period. Some 200 species have been listed as disappearing.[4]
5. The population of man increased, and man migrated into new regions, the most dramatic example of which was his movement into the New World and to Australia.[5]

In the next section we shall develop an explanation which is consistent with this evidence. In the process we shall postulate a behavioural assumption, examine the nature of existing property rights in prehistory, and specify the demographic characteristics of the model. By combining these elements we can then trace out how a growing population within the existing property-rights context could account for the transition from hunting to agriculture.

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which, by reducing or eliminating the prey, reduced the productivity of employing labour in hunting, causing man to shift to agriculture. A competing theory by Robert J. Braidwood, *Prehistoric Men* (Chicago, 1963), implicitly postulates an upward shift of the opportunity for labour in agriculture due to increases in knowledge about plants and animals acquired over time. In certain areas, called nuclear zones, the plants and animals were better suited to domestication than in others, so the shift to agriculture occurred first in these areas. A third explanation, originally stated by Lewis R. Binford in 'Post Pleistocene Adaptations', in L. R. Binford, ed. *New Perspectives in Archaeology* (Chicago, 1968), and elaborated by Kent Flannery, 'The Origins and Ecological Effects of Early Domestication in Iran and the Near East', in P. S. Ecko and G. W. Dimbley, eds. *The Domestication of Plants and Animals* (Chicago, 1969), suggests that population growth and migration brought about the shift. A fourth explanation by Carl O. Sauer in 'Agricultural Origins and Dispersals', *American Geographical Society*, reprinted in S. Struever, ed. *Prehistoric Agriculture* (Garden City, N.Y. 1971), pp. 407–14, suggests that men invented agriculture in regions where the abundance of resources gave them the leisure to be creative. In this case, agriculture was discovered while still in the constant returns to scale section of the hunting opportunity schedule and agriculture proved to be more productive. Each of these explanations is either inconsistent with one or more of the pieces of evidence presented in the next section or with the incremental process by which innovation occurs as described above in section 1. Their most serious deficiency, however, is that they do not explain the timing of this transformation. A satisfactory theory must explain the acceleration of knowledge and economic growth in the last 10,000 years in comparison with the previous million years. Viewing settled agriculture as a once-for-all invention fails this crucial test. A change in the rate of return to acquiring knowledge is essential to a satisfactory theory.

[1] Exact dating obviously depends on surviving evidence but the general timing is not an issue.

[2] Exactly how many independent discoveries is unknown. North China, Peru, and the Indus Valley are other likely independent developments.

[3] L. L. Cavalli-Sforze, 'The Genetics of Human Population', *Scientific American*, CCXXXI, 3 (1974).

[4] Paul Martin and N. E. Wright, eds. *Pleistocene Extinctions* (New Haven, 1967).

[5] Kingsley Davis, 'The Migrations of Human Populations', *Sci. Amer.* CCXXXI, 3 (1974).

II

Our model assumes that when prehistoric man was presented with the choice between two alternatives, he would tend to choose the one that made him better off. We do not suggest that this assumption accurately described the behaviour of any one individual or band of prehistoric men. In a world of uncertainty it is impossible to know *a priori* which choice is the "correct" one.[1] Instead, as many bands faced a similar decision, a few of the groping responses to a new situation would turn out to be the "correct" ones in terms of a band's struggle for survival; that is, these decisions made the band materially better off, hence increased its chances for survival *vis-à-vis* other bands. The bands that select the "correct" alternative, whether consciously or by chance, will be favoured by a process of natural selection. Other groups initially selecting other actions and as a result doing less well will over time either change over to the techniques of their more successful rivals or perish.[2]

Prehistoric man, as postulated by the simple comparative static equilibrium model presented above, had two basic alternative employments for his secure labour. Those bands which chose the alternative that maximized the value of production would over time be favoured over those that did not. The simple comparative equilibrium model with which we began this article is therefore acceptable as far as it goes. That model, however, is incomplete for our purposes in that it does not explicitly consider the nature of the existing property rights within which prehistoric man existed; nor does it include any demographic hypothesis. Since the existing structure of property rights channels man's economic behaviour, the individual will find it in his interest to behave differently under one set of rights than another. Prehistoric man employed his labour in conjunction with natural resources to produce his living. The natural resources, whether the animals to be hunted or vegetation to be gathered, were initially held as common property. This type of property right implies free access by all to the resource. Economists are familiar with the proposition that unconstrained access to a resource base will lead to its inefficient utilization. This inefficiency as the demand for the resource increases eventually leads to the depletion of the resource. The depletion can take the form, in the case of a reproducible resource, of a reduction in the biological stock below the level required for sustained yield harvesting.

This instance is an example of incentive failure caused by cultural or institutional (property rights) inadequacies. The individual or band has an incentive to ignore certain costs which results in the resource being over-utilized and perhaps even its continued existence endangered.

Let us examine the situation where several bands compete for the same commonly held migratory animals. The animals are valuable to the bands only after they are captured. The band then has the incentive to exploit the resource to the point where the value of the last animal killed or the last measure of grain gathered is equal to the private costs of killing or gathering it. The collection will continue

[1] A. Alchian, 'Uncertainty, Evolution and Economic Theory', *Jnl. Pol. Econ.* LIX (1950).

[2] The scarcity of resources guarantees competition which in turn ensures that observable behaviour consistent with the wealth maximization hypothesis will emerge via the selection process, if not as a result of conscious design.

until all of the income the scarce resource would have earned under private property rights is dissipated.[1] This occurs because no band has any incentive to take into consideration the reduction in the size of the stock taking place, which raises the cost of hunting to rival bands. Nor does any one band have any incentive to conserve the resource, since the animals left to reproduce probably would be taken by its rivals. Even if this were not the case, the next year's harvest would have to be shared by all, the conservationist gaining only a portion. The stock of animals itself thus could be placed in danger of extinction, because little incentive is provided to conserve the resource. The crucial element causing this inefficiency is the lack of any barrier to the exploitation of the commonly owned resource base. Individuals or bands enter the hunt when they perceive their private returns to be greater than the benefits of doing the next best thing. The result is too many hunters. After some level of exploitation, the size of the stock itself would begin to decline, thus raising costs (reducing productivity) to all hunters. This causes the opportunity for labour in hunting schedule (VMPH) to shift back. This fact will not dissuade new hunters from joining the hunt as long as their productivity in hunting remains above what it would be in their next best alternative, agriculture.

It has been shown that if some of the potential entrants are excluded from utilizing the resources not all of the income would be dissipated.[2] Thus, primitive agriculture, which must have been organized as exclusive communal property, had the advantage over hunting in terms of the efficiency of the property rights. It is inconceivable that, from the very beginning, the first farmers did not exclude outsiders from sharing the fruits of their labours. Furthermore, the band was probably a small enough group to monitor easily the activities of its members to ensure that collective behaviour did not over-utilize the scarce protected land resource held in common by the group. Thus, the band in principle at least could have exploited its opportunities in agriculture by constraining its members with rules, taboos, and prohibitions, almost as effectively as if private property rights had been established.[3] We shall see that this difference between common property rights in hunting and exclusive communal rights in agriculture is crucial to an explanation of the first economic revolution. The hunting sector must be considered within the framework of a common property resource[4] and the agricultural sector as exclusive communal property regulated so as to border upon private property in its influence upon man's behaviour.

The difference in the nature of the two types of property rights governing hunting and agriculture respectively has important implications for the effect technological chance would have upon the band's welfare in the long run. There

[1] The classic article developing the common property resource model is by Howard Scott Gordon, 'The Economic Theory of a Common Property Resource: The Fishery', *Jnl. Pol. Econ.* LXII (1954). See also Smith, loc. cit. and Steven N. S. Cheung, 'The Structure of a Contract and Theory of a Non-Exclusive Resource', *Journal of Law and Economics*, XIII (1970), 49–70.

[2] Cheung, loc. cit.

[3] Economists' solutions to the common property dilemma are a user charge, a change to private property, or enforcing rules of behaviour. See Smith, loc. cit. 741.

[4] While there is no evidence that property rights existed over megafauna in Palaeolithic times, there have been widespread attempts to establish such rights amongst hunters in subsequent eras.—Smith, loc. cit. The costs of measuring and enforcing such rights have their contemporary counterpart in the case of whaling.

is no doubt that prehistoric man was inventive. The progress that was made in the development of tools is ample testimony to this fact. Also, there can be little doubt that the main stimulus to technological change in particular and productivity change in general during this era was learning by doing, by experimentation. As man concentrated his efforts on one task, he became more proficient at doing it and discovered ways to do it better.

The long-run influence of these changes upon the economic well-being of prehistoric man would be very different if these improvements were applied to activities where common property rights prevailed than they would be in activities where exclusive communal rights ruled. The short-run effects are similar. Technological change which improved man's productivity in hunting would make hunting initially more rewarding relative to the alternative of agriculture (the opportunity for labour schedule in hunting, the VMP curve in Fig. 1, would shift out). The same would be true of a technological change in agriculture which shifted the VMP_A curve upwards, hence making agriculture a relatively more rewarding pursuit. The long-run effects, however, are quite different. The increased rewards to pursuing agriculture would remain while those in hunting would be dissipated by the effects upon the resource base of increased effort in that area. The opportunity for labour schedule in hunting would initially shift out, attracting more resources into hunting and hastening the depletion of the stock of animals held as common property, eventually causing the schedule to shift to the left of its original position. The different types of property rights in hunting/gathering as against agriculture ensure that technological change in either sector would eventually cause a shift of labour out of hunting into agriculture.[1]

III

Another crucial element in our analysis is a hypothesis about man's prehistoric demographic performance. It is clear that the number of people upon this earth has increased through time but not either continuously or at a constant rate. The secular trend is upward but the trend has been uneven and at times even interrupted. A complete explanation for the fluctuations in the human population is beyond the task of this article. However, detailing some of the elements that such an explanation would contain are necessary for our purposes.

The simple arithmetic of population change over the first million years suggests a very slow rate of growth. But it does appear that population did grow. Thus, despite probable setbacks during climatic changes, fertility tended to exceed mortality.[2] So long as the standard of life was above a certain level, there was a tendency for man to increase in numbers. The trend would have been upward despite the effects of factors that periodically would tend to increase mortality. This line of argument runs directly counter to the observations of anthropologists who have discovered that contemporary Stone Age tribes tend to have stable populations. In addition, the level of population maintained by

[1] Another way of viewing this process is that technological change in hunting would reduce the private costs of hunting, increasing the rate of exploitation of the common property resource, hence hastening the over-exploitation of the resource.

[2] Ansley Coale, 'The Human Population', *Sci. Amer.* CCXXXI, 3 (1974).

such tribes seems well below that which would damage the resource base. This modern observation has suggested to anthropologists and archaeologists that the view of population dynamics developed above is inappropriate and should be rejected in favour of an assumption that prehistoric man tended towards a homeostatic population.

There are several difficulties in making this extension between modern Stone Age tribes and their historical antecedents. Let us examine the conditions under which a homeostatic population could be established and maintained. First, limiting, fixed resource must be present to create diminishing returns to additions to the population. Second, exclusive communal property rights to the resource must exist to eliminate competition between rival groups. And, third, some form of communal regulation of access to the resource must exist to regulate the economic behaviour of members of the group.

The first must exist or additions to populations would impose no cost upon the group, hence no reason for the group to attempt to limit population. The second and third are necessary if the common property result is to be avoided. Suppose for the moment that one band was engaged in exploiting a common resource and had succeeded in limiting its population to the level that did not threaten the resource. Then another band appeared which desired to share the resource. The ability of the first band to exclude the second is surely a function of the size of its population. The larger the population, the better its chances of successfully excluding others. Thus the bands that do not attempt to limit their population will tend to dominate those that do when they come into contact with one another. A homeostatic population can exist only among isolated bands. Indeed, that is where they are found today—in areas remote from the rivalries of other peoples.[1]

In the world of prehistoric man those bands that attempted to adjust their population to the size of the local resource base would eventually lose out to those bands that encouraged large and increasing populations, even if it meant migration and the subdivision of the band. Thus, the human population of the prehistoric era had built into its behaviour, whenever the standard of living permitted, a collective tendency for population to grow.

IV

Now let us look at this model in the context of the evidence developed by the archaeologist and anthropologist. Man lived in small bands that had to be ready to move whenever the local food supply dwindled. Small children and old people were a burden. Man lived in whatever natural shelters he could find as the band moved after the animals they hunted. There is little evidence of permanent villages, although a few half-buried huts have been found. As population grew over the million or so years of man's history as a hunter, bands divided and subdivided and migrated in search of food. At first man hunted the larger animals. A number of kill sites with great quantities of bones have been found, indicating that the hunting tactic of driving large animals over a cliff was employed. It is possible that man's increasingly efficient ability to hunt the great cold-weather animals—the mammoth and the woolly rhinoceros as they retreated northward

[1] Modern-day survivals are discussed in Binford, loc. cit.

—contributed to their extinction in the period between 25,000 and 12,000 years ago.[1] About 30,000 years ago, population expansion pushed man across the Bering Strait from Asia into America. Thereafter, he moved throughout that land mass. Coincident with the appearance of man was the disappearance of several species of large animals.

Let us put this very general description into our economic framework. Initially, this was a world in which the supply of animals and plants upon which man could feed appeared endless. As the population of man expanded and threatened the supply of foodstuffs in a given area, bands would subdivide and move to new areas thus gradually spinning off new groups. This process is described by anthropologists as an open donor system. In terms of our model this was a world of constant returns to an increasing labour force, so that growth in population resulted in a proportionate increase in output. This world of constant returns persisted as long as there was empty land of equal productivity for a growing population to exploit. So long as this condition existed, there was no incentive to attempt to delineate exclusive ownership over plants or animals. We should expect, however, that groups that found themselves inside the population frontier would initially try to develop stable relationships between the population of the band and the resource base since they were bounded by other bands and as yet had no way to expand the resource base. Such population groups would attempt to reach precisely the kind of homeostatic relationships that the anthropologists have described, as existing among contemporary primitive societies. These bands would limit fertility by taboos, infanticide, and various other means in an attempt to keep the relationship between the population and the resource base constant. Moreover, we should expect that these bands attempted to develop a set of customs and rules to regulate hunting/gathering and in a way that would maintain stability. This attempt is due to fail for the reasons discussed above: a homeostatic population can exist only among isolated bands.

Once population had expanded to the point where the resource base was fully utilized, then any further increase in population led to a decline in the marginal produce of labour in hunting/gathering. Nevertheless, given the characteristics of competing tribes and a common property resource, population would continue to grow. We can illustrate the consequences in Fig. 1 above. Population expansion to q_d could occur without a diminution in the stock of the resource base but further increases produced diminishing returns. Big animals increasingly became scarcer and gradually man was forced to search for new sources of food among the lower orders of animals. We do know that beginning about 20,000 B.C. man began successively to adapt himself to different kinds of animals and plants to eat.[2] This era can itself only have been a transitional phase because as population pressure continued to grow and compete for these common property resources even they would become increasingly scarce and relatively more "costly" in labour time to gather.[3]

[1] For an economic analysis of this phenomenon, see Smith, loc. cit. [2] Flannery, loc. cit.

[3] Ester Boserup's *The Conditions of Agricultural Growth* (Chicago, 1973) is a provocative study which also makes population expansion the exogenous variable and contains a great deal of material to reinforce our interpretation. Unfortunately, her study provides no theoretical bridge to connect population pressure to organizational changes which lead to growth and as a result has been frequently dismissed. See George

The solution to the common property dilemma in which prehistoric man found himself was the development of exclusive communal property rights. While animals and plants remained abundant relative to the demands of the human population, there was no incentive to incur the costs of establishing property rights over them. It is only during this transitional phase of increasing scarcity that it became worthwhile for man to incur the costs necessary to develop and enforce property rights that could limit the rate at which the resources were exploited.

The evolution of property rights has historically consisted of first excluding outsiders from harvesting the resource and then devising rules that limited the intensity of exploitation of the resource by insiders. As Flannery points out, "We know of no human group on earth so primitive that they are ignorant of the connection between plants and the seeds from which they grow."[1] In terms of the previous diagram, when population reached q_c additional labour could now be more productively used in cultivation and herding. Prior to reaching this point, as the marginal return to hunting diminished, more effort would be spent in gathering. At some point, it is a logical step for the band to attempt to find an area that was naturally fertile, and then settle and repel new arrivals. Bands living inside the frontier thus became increasingly sedentary. As the population of the bands grew, the natural resources of the area were exploited more intensively.

It is interesting that the viewpoint of Flannery described in the above quotation has led some anthropologists and archaeologists to suspect that the first domestication of plants and animals did not occur where they were naturally in abundance as we suggested. Instead, they reason, domestication would first have occurred where the natural harvests were less rich because if man could obtain sufficient wild wheat by gathering, he would not have bothered to cultivate. Harlan and Zohary comment, "Why should anyone cultivate a cereal where natural stands are dense as a cultivated field? . . . farming itself may have originated in areas adjacent to rather than in the regions of greatest abundance of wild cereals."[2] This argument ignores the fundamental dilemma of growing population pressure and the common property resource problem. It is more likely that man found rich areas where there was an abundance of wild grain that could be harvested with a sickle and then began to defend these areas against intruders. Thus, we would speculate that Jean Perrot's view that the semi-sedentary Natufian culture in Palestine was based on intensive wild cereal cultivation is a more likely step towards the development of domestication than the alternative of growing the seeds on marginal land.[3]

Our reading of the evidence suggests that it is more likely that agriculture was an already existing alternative to hunting/gathering. The independent develop-

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Cowgill, 'On Causes and Consequences of Ancient and Modern Population Change', *American Anthropologist*, LXXVII (1975), 505–25. Our model provides just such a theoretical bridge.

[1] Kent Flannery, 'Archaeological Systems Theory and Early Mesoamerica', in B. J. Meggers, ed. *Anthropological Archaeology in the Americas* (Anthropological Society of Washington, Washington, D.C. 1968), p. 68.

[2] Jack R. Harlan and Daniel Zohary, 'Distribution of Wild Wheats and Barley', *Science*, CLIII (1966), 1074–80.

[3] Jean Perrot, 'Le Gisement Natufied de Mallaha (Eynan), Israel', *L'Anthropologie*, LXX (1966), 437–84.

ments of agriculture in different parts of the world and the slow rate of its spread north-west across Europe seems to be more consistent with this assumption. But it is important to note that even if new knowledge was necessary to engage in cultivation and herding it does not damage the basic argument of this article that exclusive property rights will raise the incentive to acquire new knowledge. The explanation sketch in this section can be read either as a story of the shift to an already known alternative or as one in which bands developed property rights over rich stands of wild grain and then had the incentive to acquire the knowledge necessary for cultivation and domestication. Probably the first step was the establishment of exclusive territory such as has been observed among primitive bands and tribes in modern times. Demsetz, citing the anthropologist Eleanor Leacock, describes the creation by the Montagnais Indians of exclusive hunting territory for beaver in response to the growing demand by the Hudson Bay Company.[1] An exclusive territory could be established at relatively low cost for plants and non-migratory animals, but only at much higher cost for migratory animals. Once exclusivity was established, weeding, primitive irrigation, and seed selection would gradually develop in a trial-and-error process of learning by doing. The productivity of cultivation was thereby increased and shifted upward the marginal value product of labour employed in agriculture.

The difference between cultivation and domestication is a subtle one. The latter implies a genetic alteration in the plant or animal to improve its value to man.[2] Two famous examples of prehistory were the evolution of emmer and einkorn wheat from the shattering to non-shattering form and the modification of wild sheep to a quieter more tractable animal. Both instances of domestication may have come about as accidental results of the selection process. But under exclusive property rights the rewards from domestication would encourage the trial-and-error process of seed and animal selection.

There is no implication in our explanation that the transformation from hunting/gathering to agriculture occurred rapidly. The evidence accumulated by archaeologists suggests that it required a substantial period of time. The transition occurred as a result of persistent population pressure which produced changes in the relative scarcities of the resources exploited by prehistoric man. In response to these developments, individual bands began to attempt to exclude outsiders from access to the resource base. In the process such bands became sedentary. The establishment of exclusive communal property raised the bands' return to attempts to increase the productivity of the resource base. Many groups probably failed to make this transition, but some by luck or chance managed to make the transformation and it is from these beginnings that we see the development of civilization and economic growth that has occurred in the 10,000 years since.

The first economic revolution was not a revolution because it shifted man's

[1] H. Demsetz, 'Towards a Theory of Property Rights', *American Economic Review*, LVII (1967). See, however, the caveat by John McManus which indicates that a group survival criteria overcame the individual internal allocation.—John McManus, 'An Economic Analysis of Indian Behaviour in the North American Fur Trade', *Journal of Economic History*, XXXII (1972), 36–53. Smith, loc. cit. describes a number of anthropological studies of primitive property rights.

[2] For a discussion of cultivation and domestication, see Erich Isaac, *Geography of Domestication* (Englewood Cliffs, N.J. 1970).

major economic activity from hunting and gathering to settled agriculture. It was a revolution because the transition created an incentive change for mankind of fundamental proportions. The incentive change stems from the different property rights under the two systems. When common property rights over resources exist, there is little incentive for the acquisition of superior technology and learning. In contrast, exclusive property rights which reward the owners provide a direct incentive to improve efficiency and productivity, or, in more fundamental terms, to acquire more knowledge and new techniques. It is this change in incentive that explains the rapid progress made by mankind in the last 10,000 years in contrast to his slow development during the long era as a primitive hunter/gatherer.

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